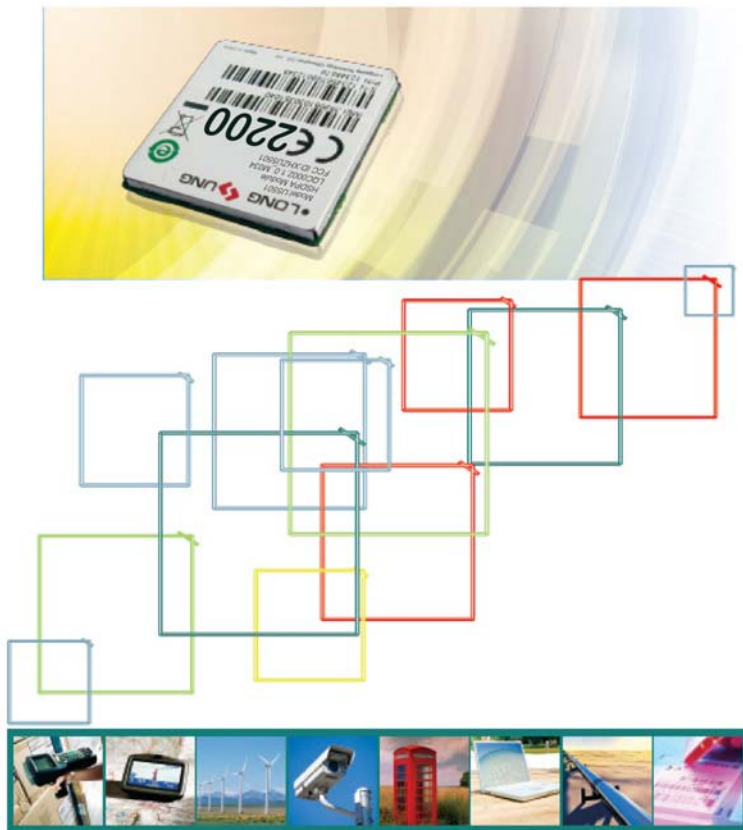# U5501_Hardware_User_Guide _V2.3

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CAUTION: U5501 HSDPA module is an ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 1 K Volts readily accumulate on the human body and test equipment and can discharge without detection. Permanent damage may occur on devices subjected to high-energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.
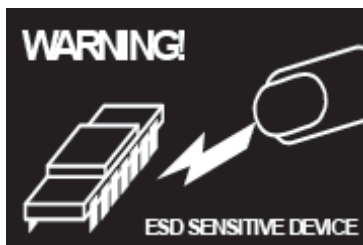
Warning:

The U5501 module is designed to comply with the FCC statements.FCC ID is XHZU5501.The Host system using U5501 should indicated "Contains FCC ID: XHZU5501".

This device complies with part 15B of the FCC rules. Operation is subject to the following two conditions:

(1) this device may not cause harmful interference

(2) this device must accept any interference, including interference that may cause undesired operation.

Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authorityto operate the equipment.

This equipment complies with FCC/IC radiation exposure limits set forth for an Uncontrolled environment.This equipment should be installed and operated with minimum distance 20cm between the radiator and your body as well as kept minimum 20cm from radio antenna depending on the portable or Mobile status of this module usage.

The manual of the host system,which use U5501 must include RF exposure warning statement to advice user should keep minimum 20cm from the radio antenna of U5501 module depending on Mobile status.

The U5501 module can not be installed with other radio .such as co-located or operating in conjunction with any other antenna or transmitter.

Antenna Type: Connector

Antenna Gain: GSM850:1.2dBi;GSM1900:1.2dBi.

Contents

Tables

Figures

1. Overview

U5501 is a wireless module which is designed for the global market. It is a consumptive product; it can be designed in many kinds of applications which can work on HSDPA/UMTS/EDGE/GPRS/GSM network.

On HSDPA network in the world, U5501 enables connection to the Internet at DL data speed up to 3.6Mbps. In areas where HSDPA service is not available, U5501 still enables reliable and secure data connections over UMTS at speed up to 384 Kbps or EDGE at speed up to 237Kbps or GPRS at speed up to 85.6Kbps.

U5501 provides Audio, SMS, Phonebook functions as well as high speed access. It can be designed in many kinds of applications. Such as Video monitor, Tablet, Electric-book, MID, Vehicle equipment, etc.

1.1. Purpose of the document

The document described the basic functions, supported services, the key features, main interfaces and reference design, the mechanics and the electronic characteristics of the module U5501. It will guide the user to design U5501 in their applications.

1.2. Summary

The following lists the contents of this document.
- ✧ Chapter 1: Described the overview, purpose, correlative documents, document's history and abbreviations.
- ✧ Chapter 2: Described the basic functions, key features and hardware interfaces of the module.
- ✧ Chapter 3: Described in detail the module's interfaces and reference design.
- ✧ Chapter 4: Described the mechanical specifications of the module.
- ✧ Chapter 5: Described in detail the power consumptions of the module.
- ✧ Chapter 6: Described in detail electrical specifications of the module.

1.3. Correlative documents

- ✧ U5501_SPEC
- ✧ U5501_ATC

◇ U5501_EVB_User_Guide
◇ U5501_Reference_Circuit
◇ U5501_Application_Guide

1.4. Document's history

Table 1：Document's update history

Version	Author	Release Time	Description
V2.3	Huaming Zhang	2012-7-24	V2.3 create

1.5. Abbreviations

Table2：Abbreviation and description

Abbreviations	Description
AMR	Adaptive Multi-rate
BER	Bit Error Rate
BTS	Base Transceiver Station
PCI	Peripheral Component Interconnect
CS	Circuit Switched (CS) domain
CSD	Circuit Switched Data
DCE	Data communication equipment
DTE	Data terminal equipment
DTR	Data Terminal Ready
EDGE	Enhanced Data rates for GSM Evolution
EFR	Enhanced Full Rate
EGSM	Enhanced GSM
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
FR	Frame Relay
GMSK	Gaussian Minimum Shift Keying
GPIO	General Purpose Input Output
GPRS	General Packet Radio Service
GSM	Global Standard for Mobile Communications
HR	Half Rate
HSDPA	High Speed Downlink Packet Access

HSUPA	High Speed Uplink Packet Access
HSPA	HSPA High-Speed Packet Access
IEC	International Electro-technical Commission
IMEI	International Mobile Equipment Identity
I/O	Input/Output
ISO	International Standards Organization
ITU	International Telecommunications Union
bps	bits per second
LED	Light Emitting Diode
M2M	Machine to machine
MO	Mobile Originated
MT	Mobile Terminated
NTC	Negative Temperature Coefficient
PC	Personal Computer
PCB	Printed Circuit Board
PCS	Personal Cellular System
PCI	Peripheral Component Interconnect
PCM	Pulse Code Modulation
PCS	Personal Communication System
PDU	Packet Data Unit
PPP	Point-to-point protocol
PS	Packet Switched
QPSK	Quadrate Phase Shift Keying
SIM	Subscriber Identity Module
TCP/IP	Transmission Control Protocol/ Internet Protocol
UART	Universal asynchronous receiver-transmitter
USIM	Universal Subscriber Identity Module
UMTS	Universal Mobile Telecommunications System
USB	Universal Serial Bus
WCDMA	Wideband Code Division Multiple Access

2. Introduction

U5501 is a wireless module which is designed for the global market. It is a consumptive product; it can be designed in many kinds of applications which can work on HSDPA/UMTS/EDGE/GPRS/GSM network.

U5501 support the Bands as the following:
Dual-Band UMTS（WCDMA/FDD）：900/2100 MHz；
Quad-Band GSM ：850/900/DCS1800/PCS1900 MHz。

On HSDPA network in the world, U5501 enables connect to the Internet at DL data speed up to 3.6Mbps. In areas where HSDPA service is not available, U5501 still enables reliable and secure data connections over UMTS at speed up to 384 Kbps or EDGE at speed up to 237Kbps or GPRS at speed up to 85.6Kbps.

U5501 provides Audio, SMS, Phonebook functions as well as high speed access. It can be designed in many kinds of applications. Such as Video monitor, Tablet, Electric-book, MID, Vehicle equipment, etc.

U5501 integrates the RF and Baseband onto one small PCB. It can fulfill all the functions of RF signal receiving and transmitting, Baseband signal processing and audio signal processing so that the customers can realize all kinds of their own wireless products with very few peripheral components.

Designed on a single-side PCB, U5501 has a tiny dimension of 30.0mm×30.0mm×2.5mm, with a LGA PAD interface, which provides all hardware interfaces between the module and customers' boards. The main hardware interfaces of U5501 consist of power supply interfaces, USB interface, UART interfaces, USIM/SIM interface, Audio interfaces, PCM interface, ADC interface, VRTC interface and GPIO.

U5501 is integrated with the TCP/IP protocol, it not only supports standard AT (Complied with Hayes 3GPP TS 27.007 and 27.005), but also support Longsung extended AT commands, which are very suited for developing all kinds of the customized applications.

U5501 provide main interfaces for applications, the interfaces as the following:
1) Power interface
2) USB interface

3) UART interface
4) USIM/SIM interface
5) Analog audio interface
6) PCM interface
7) GPIO
8) RESET interface
9) Power on off interface
10) Work status indicator
11) RTC interface
12) Voltage ourput
13) Antenna interface

2.1. Key features

Table3：Key features of U5501

Feature		Description
Power supply		3.3V～4.2V（Typical 3.8V）
Frequency Bands		UMTS: Dual-Band, 900/2100MHz
		EDGE/GPRS/GSM: Quad-Band, 850/900/1800/1900MHz
Data	HSDPA	DL:3.6Mbps
	UMTS	UMTS PS: 384 kbps(DL), 384 kbps(UL)
		UMTS CS: 64 kbps(DL), 64 kbps(UL)
	EDGE	EDGE: Class12, 236.8kbps(DL), 118kbps(UL)
		Mobile station class B
		Coding schemes: MCS1-9
	GPRS	GPRS: Class12，85.6kbps(DL)，42.8kbps(UL)
		Mobile station class B
		Coding schemes: CS1-4
		Support Full PBCCH
	CSD	GSM CSD：9.6kbps
Voice		Triple-rate codec for HR、FR、EFR
		Support AMR
		Support DTMF
		Caller identification, Call forwarding, Call holding, Call waiting and Three party service
SMS		Point to point MO、MT
		SMS cell broadcast
		Support Text and PDU mode
Temperature		Normal operation: -20℃～+65℃
		Restricted Operation: -30℃～+75℃
		Storage temperature: -40℃～+85℃
ESD		VBAT, GND: Air discharge ±8KV，Contact discharge ±4KV
		RF interface: Air discharge ±8KV，Contact discharge ±4KV
		Else ports: Air discharge ±4KV, Contact discharge±2KV
Max power RF transition		Class 4 (2 W) for GSM850/GSM900
		Class 1 (1 W) for GSM1800/GSM1900
		Class E2 (0.5 W) for EDGE900
		Class E2 (0.4 W) for EDGE1800
		Class 3 (0.25 W) for UMTS
Current consumption		Power off mode：50μA
		Sleep mode：<4mA
		Idle mode：<40mA

	Voice mode：<300mA
	Data mode：<600mA
Application interface	LGA PAD
LGA PAD	Power interface
	1 USB2.0 High-Speed interface
	1 UART interface
	1 USIM/SIM interface（Compatible 3V&1.8V）
	2 analog audio compatible
	1 PCM interface
	1 RESET interface
	2 NETLIGHT ourput interface
	2 voltage output(2.6V & 1.8V)
	1 power on off interface
	1 VRTC
	12 GPIOs（2 of them voltage are 1.8V, the others are 2.6V）
	2 sleep and wakeup GPIOs
	Antenna interface
Dimensions	30.0mm×30.0mm×2. 5mm
Weight	<8g
Fixed structure	Solder with LGA PAD
AT command	Standard AT commands (Hayes 3GPP TS 27.007 and 27.005)
	Support LongSung Extend AT commands
Approvals	RoHS

2.2. Operating modes

Table4：Overview operating modes

Mode	Function	
Sleep mode	Set WAKEUP_IN to low, the U5501 will enter to sleep mode, the module will reduce the current consumption to minimal level.	
GSM mode	GSM IDLE	Software is active. Module has registered to the GSM network, and the module is ready to send and receive.
	GSM TALK	Connection is going on between two subscribers. In this case, the power consumption depends on network settings.
GPRS mode	GPRS IDLE	Module is ready for GPRS data transfer, but no data is currently sent or received. Power consumption depends on network settings and GPRS configuration (e.g. multi-slot settings).
	GPRS DATA	GPRS data transfer in progress. Power consumption depends on network settings (e.g. power control level), uplink/downlink data rates and GPRS configuration (e.g. used multi-slot settings).
EDGE mode	EDGE IDLE	Module is ready for EDGE data transfer, but no data is currently sent or received. Power consumption depends on network settings and EDGE configuration (e.g. multi-slot settings).
	EDGE DATA	EDGE data transfer in progress. Power consumption depends on network settings (e.g. power control level), uplink/downlink data rates and EDGE configuration (e.g. used multi-slot settings).
WCDMA mode	WCDMA IDLE	Software is active. Module has registered to the WCDMA network, and the module is ready to send and receive.
	WCDMA TALK	Module is serving in audio. The power consumption depends on WCDMA network settings.
	WCDMA DATA	WCDMA data transfer in progress. Power consumption depends on network settings (e.g. power control level), uplink/downlink data rates and WCDMA configuration.
Minimum Function mode	VBAT remains applied. Use AT+CFUN=0 to let module go into Minimum Function mode	
Power Down	Module will go to power off mode when:	

	1. Send AT^SMSO
	2. VBAT to low
	3. Press the POWER_ON_OFF to power off module.

2.3. Hardware functional block diagram
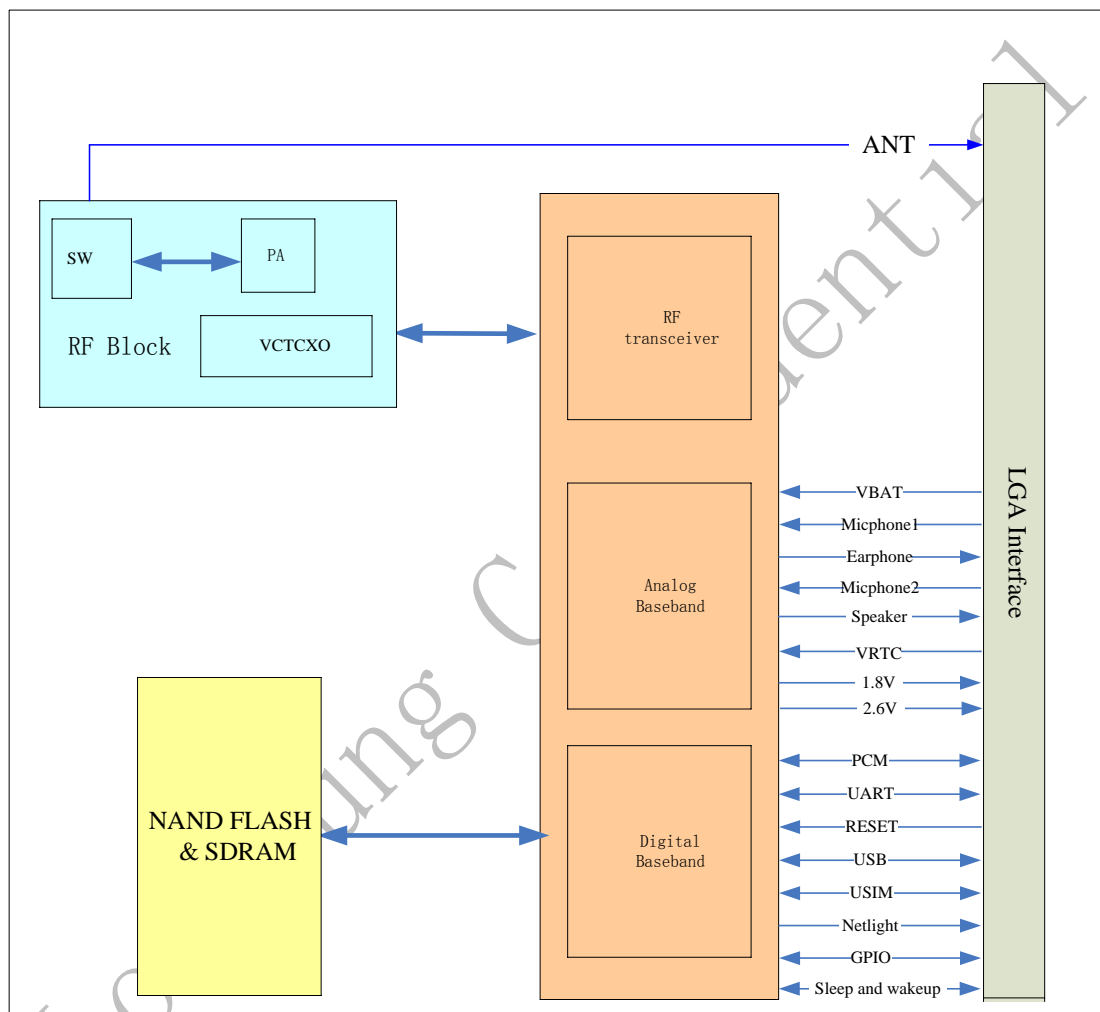
Figure1：U5501 Hardware functional block diagram

☆ RF include:
1) WCDMA Transceiver
2) GSM Transceiver
3) SW
4) VCTCXO

☆ Baseband include:
1) PMU
2) Audio process unit
3) Digital Baseband chip

4)   NAND FLASH and SDRAM

3. Application interfaces description

3.1. 116-pin LGA PAD
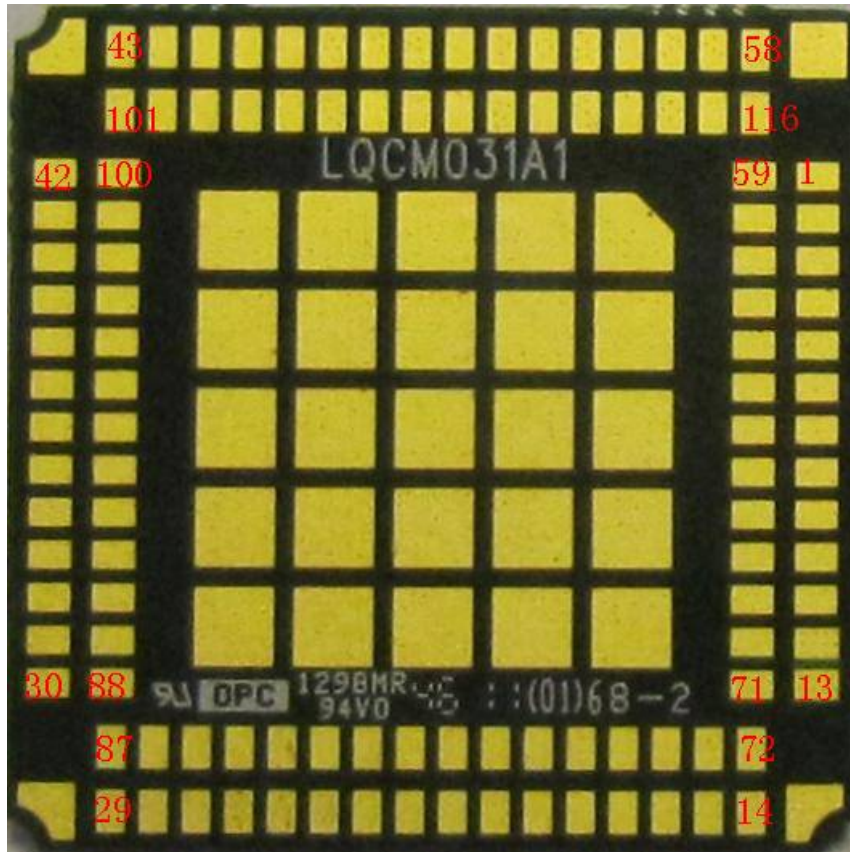
Figure2：U5501 116-pin LGA PAD pins sign

Table5：U5501116-pin LGA PAD pin definition

PIN NO.	PIN Name	I/O	Describe
1	NC	-	-
2	NC	-	-
3	NC	-	-
4	NC	-	-
5	PCM_SYNC	I/O	PCM interface sync(2.6V)
6	PCM_DIN	I	PCM I/F data in(2.6V)
7	PCM_DOUT	O	PCM I/F data out(2.6V)
8	PCM_CLK	I/O	PCM interface clock(2.6V)
9	NC	-	-
10	NC	-	-
11	WAKEUP_IN	I	External system wakeup module(2.6V)
12	VBAT	I	Power supply input(3.3V~4.2V, typical 3.8V/1A
13	VBAT	I	Power supply input(3.3V~4.2V, typical 3.8V/1A
14	NC	-	-
15	GPIO_2.6V	I/O	2.6V
16	NC	-	-
17	NC	-	-
18	NC	-	-
19	NC	-	-
20	NC	-	-
21	NC	-	-
22	NC	-	-
23	NC	-	-
24	NC	-	-
25	NC	-	-
26	NC	-	-
27	NC	-	-
28	GPIO_1.8V	I/O	1.8V
29	GPIO_1.8V	I/O	1.8V
30	NC	-	-
31	VCC_EXT_2.6V	O	2.6V power output(20Ma)
32	VCC_EXT_1.8V	O	1.8V power output(20mA)
33	NC	-	-
34	SIM_VCC	O	Power supply for SIM card(1.8V/2.85V)
35	VRTC	I	VRTC input(1.5V~3.25V, typical 3.0V)
36	NC	-	-
37	NC	-	-
38	MIC2_P	I	Positive pole of the input of audio interface 2
39	MIC2_N	I	Negative pole of the input of audio interface 2

PIN NO.	PIN Name	I/O	Describe
40	MIC1_P	I	Positive pole of the input of audio interface 2
41	MIC1_N	I	Negative pole of the input of audio interface 2
42	NC	-	-
43	GPIO_2.6V	I/O	2.6V
44	GPIO_2.6V	I/O	2.6V
45	GPIO_2.6V	I/O	2.6V
46	GPIO_2.6V	I/O	2.6V
47	NC	-	-
48	GND	-	-
49	GND	-	-
50	GND	-	-
51	GPIO_2.6V	I/O	2.6V
52	GND	-	-
53	GND	-	-
54	GND	-	-
55	GPIO_2.6V	I/O	2.6V
56	GND	-	-
57	GND	-	-
58	GND	-	-
59	GND	-	-
60	NC	-	-
61	NC	-	-
62	NC	-	-
63	NC	-	-
64	NC	-	-
65	NC	-	-
66	NC	-	-
67	NC	-	-
68	NC	-	-
69	NC	-	-
70	SIM_DET	I/O	SIM card insert or remove detect(2.6V)
71	WAKEUP_OUT	O	Module wakeup the external system(2.6V)
72	NC	-	-
73	UART_DSR	O	UART data set ready(2.6V)
74	UART_RTS	O	UART ready for receive(2.6V)
75	UART_DCT	O	UART data carrier detect(2.6V)
76	UART_TX	O	UART transmit data output(2.6V)
77	UART_RING	O	UART ring indicator(2.6V)
78	UART_RX	I	UART receive data input(2.6V)
79	UART_DTR	I	UART data terminal ready(2.6V)

PIN NO.	PIN Name	I/O	Describe
80	UART_CTS	I	UART clear to send(2.6V)
81	POWER_ON_OFF	I	System power on or power off
82	NC	-	-
83	NC	-	-
84	NC	-	-
85	USB_DM	I/O	USB 2.0 high speed D-
86	USB_DP	I/O	USB 2.0 high speed D+
87	NC	-	-
88	SIM_RESET	O	SIM reset
89	SIM_DATA	I/O	SIM data
90	SIM_CLK	O	SIM clock
91	LED_STATUS	O	Status indicator(Drive current: 10mA)
92	NC	-	-
93	NC	-	-
94	NC	-	-
95	NC	-	-
96	EAR_OUT_N	O	Negative pole of the output of earphone
97	EAR_OUT_P	O	Positive pole of the output of earphone
98	SPKR_OUT_P	O	Positive pole of the output of speaker
99	SPKR_OUT_N	O	Negative pole of the output of speaker
100	RESET_N	I	Reset module(1.8V)
101	LED_MODE	O	Mode indicator(Drive current: 10mA)
102	NC	-	-
103	NC	-	-
104	NC	-	-
105	GPIO_2.6V	I/O	2.6V
106	GND	-	-
107	MAIN_ANT	-	RF main antenna interface
108	GND	-	-
109	GPIO_2.6V	I/O	2.6V
110	GND	-	-
111	NC	-	-
112	GND	-	-
113	GPIO_2.6V	I/O	2.6V
114	GND	-	-
115	NC	-	-
116	GND	-	-

3.2. Power supply

U5501 power on and power off correlative interfaces as the following:
Table6：U5501 Power supply correlative interfaces

PIN Name	I/O	PIN No.	描述
VBAT	I	12,13	Power supply ，3.3V~4.2V，typical 3.8V
VRTC	I	35	1.5~3.25，typical 3.0V
VCC_EXT_1.8V	O	32	Voltage output，1.8V，20mA
VCC_EXT_2.6V	O	31	Voltage output，2.6V，20mA
POWER_ON_OFF	I	81	Power on off control, low active
RESET	I	100	Reset，1.8V，low active
GND		48~50,52~59,106,108, 110,112,114,116	GND

3.2.1. Power Supply and reference design

3.2.1.1. VBAT input

The power supply of U5501 should be a single voltage source with VBAT ranged from 3.3V to 4.2V. As a mobile terminal conformed to the HSDPA/UTMS/GSM criterions, in some case, the ripple in a transmit burst may cause a maximum voltage drop of 450mV while the current consumption will rise to the typical peak of 2A. So the power supply must be able to provide sufficient current.

The capacitor must be a larger one electrolytic capacity (recommend 2200uF/10V) or two smaller dimension tantalum capacities (470uF/6.3V) in parallel (C_A) is recommended. And with a small (0.1 µF to 1µF) ceramic (C_B) in parallel; the capacitors should put as close as possible to the U5501 VBAT pins.
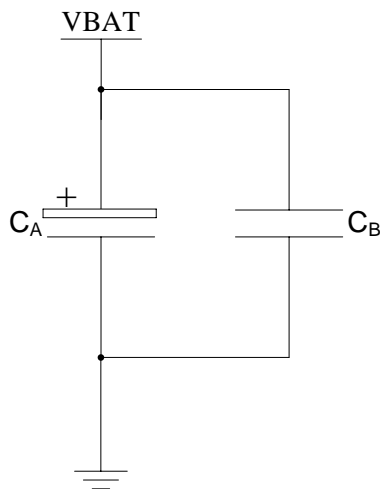
Figure3：U5501 Power supply VBAT input

3.2.1.2. VRTC input

The PIN35 is VRTC interface.

VRTC can be used for connecting backup rechargeable battery. When VBAT power supply is not available, the battery supplies the power to RTC core of U5501. When VBAT is available, U5501 can recharge the battery via VRTC pin. If the RTC is useless for you, you can set PIN51 as NC.

Reference design as the following:
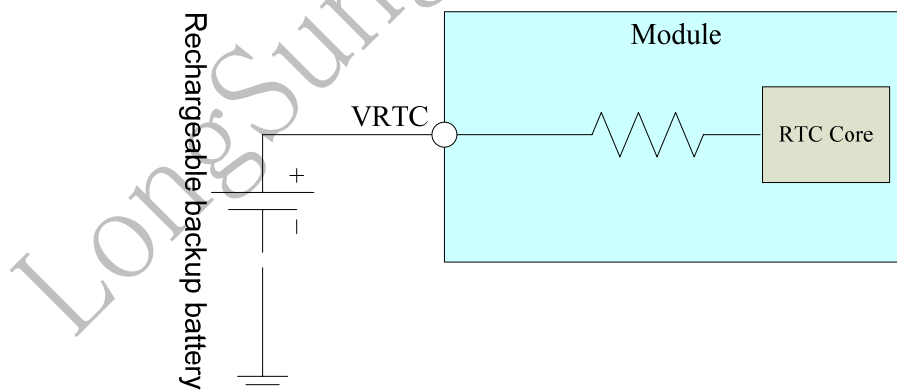
Figure4：VRTC connect to rechargeable battery

If use non-rechargeable battery, the reference design as the following:
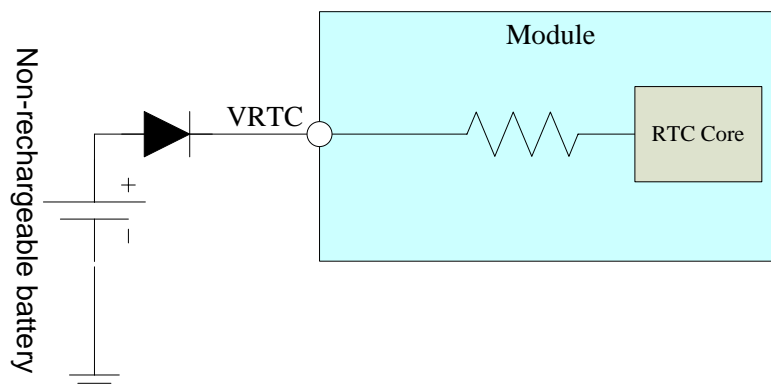
Figure5：VRTC connect to non-rechargeable battery

If use a large capacitance capacity, the reference design as the following:
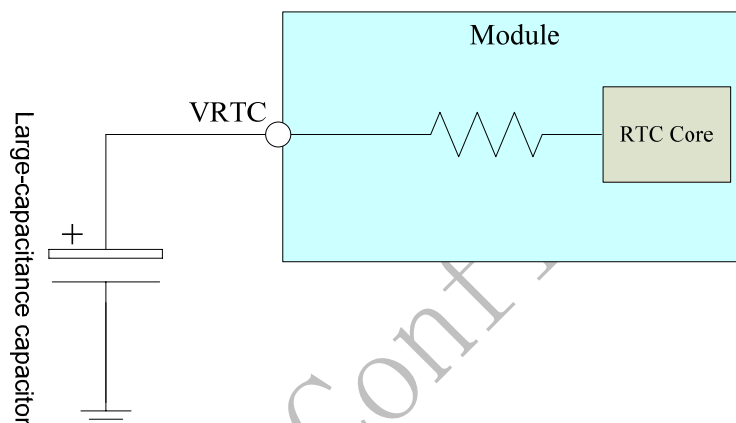
Figure6：VRTC connect to large capacitance capacity

3.2.1.3. VOUT voltage output

During U5501 working, 2.6V voltage will output through PIN31 and 1.8V voltage will output through PIN32, which named VCC_EXT_2.6V and VCC_EXT_1.8V. The current is rated for 20mA. They can be used as a power supply of the external device, such as LCD. And you can read the level of VCC_EXT_2.6V to judge whether the module is working.

3.2.1.4. POWER_ON_OFF input

The POWER_ON_OFF (PIN81) is used to control U5501 power on and power off.

✧ When module is power off, pull down POWER_ON_OFF for at least 0.5s, the module is powered on;
✧ When module is power on, pull down POWER_ON_OFF for at least 2.5s again, the module is powered off.

The reference circuit is shown as follow，the AP_PWR_CTRL is the control signal from the application side.

POWER_ON_OFF

81

Module

AP_PWR_CTRL

◄Ton►
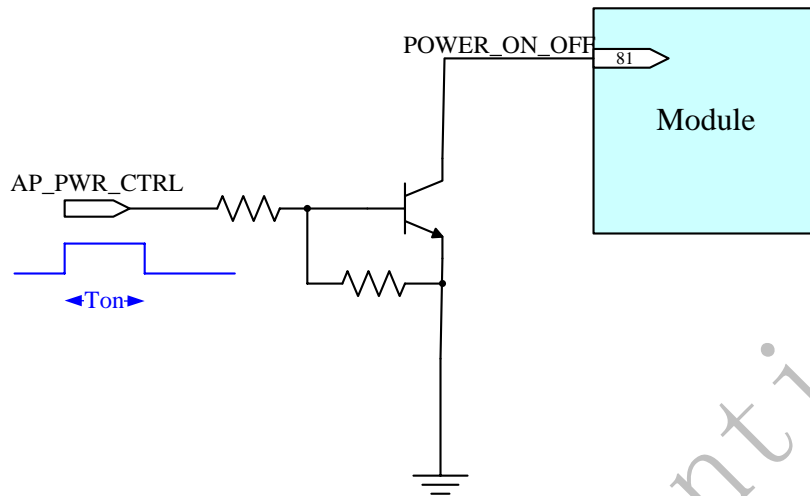
Figure7：POWER_ON_OFF reference circuit

3.2.1.5. RESET_N input

The RESET (PIN100) can control U5501 module to reset. The RESET is active by low level.

✧ A low level pulse with 100mS will be used when set module reset.

The part of RESET reference design as the Figure11. AP_RESET is the control signal from the application.

RESET_N

100

Module

AP_RESET

Tst
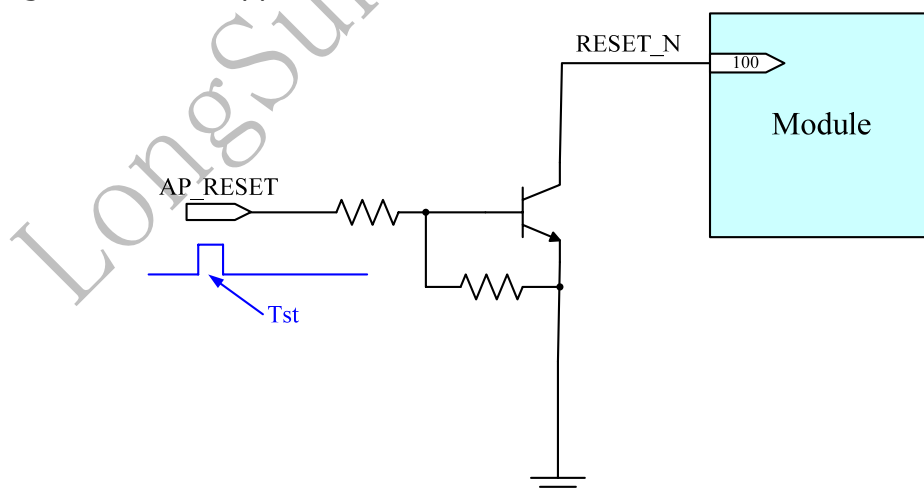
Figure8：RESET control module reset

3.2.2. Power on/off time sequence

3.2.2.1. Power on time sequence

Insure that the power supply of U5501 VBAT is active (3.3V~4.2V, typical 3.8V).The POWER_ON_OFF must be controlled.
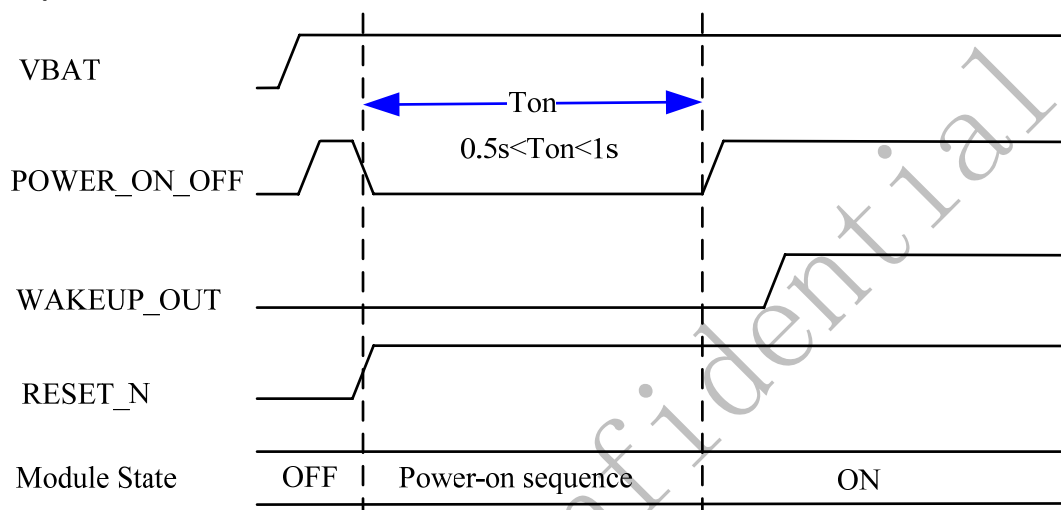
Figure9：power on time sequence

3.2.2.2. Normal power off time seqence

U5501 support press POWER_ON_OFF and send AT command to power on.

✧ When module is power on, pull down POWER_ON_OFF for at least 2.5s, the module is powered off;
✧ When module is power on, send AT^SMSO, the module is powered off.

Power off time sequence is as follow:
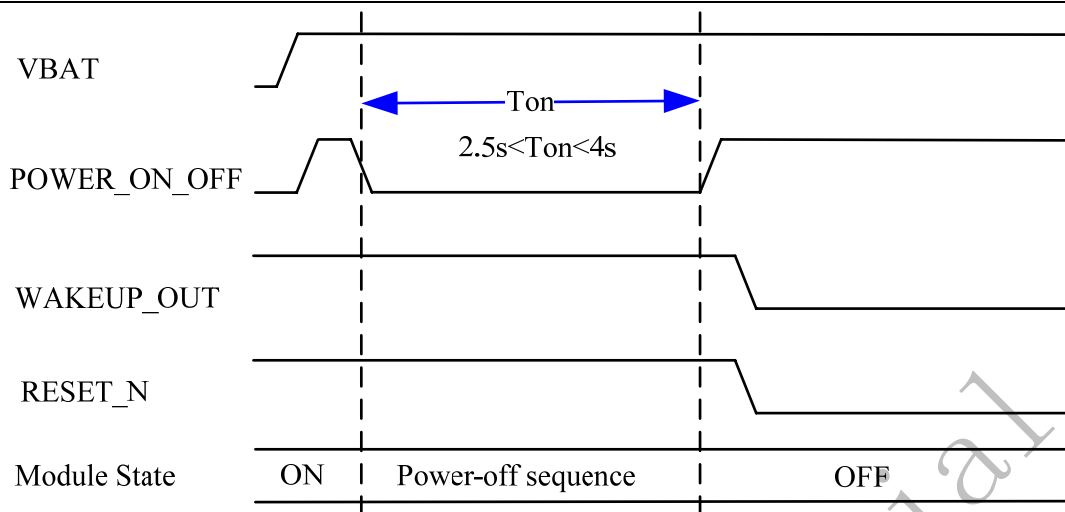
Figure10：U5501 power off time sequence

3.2.2.3. Low power to power off

When the power supply of U5501 VBAT is below 3.3V (include VBAT is off), the module will be power off.

Note: In this case, the module don`t logout from the BS.

3.2.3. Reset time sequence

Control RESET_N (RESET) to set U5501 reset. The RESET_N is active by low level. The RESET_N signal must be a Tst (100mS) low pulse. Send AT+RESET can reset the U5501 too.
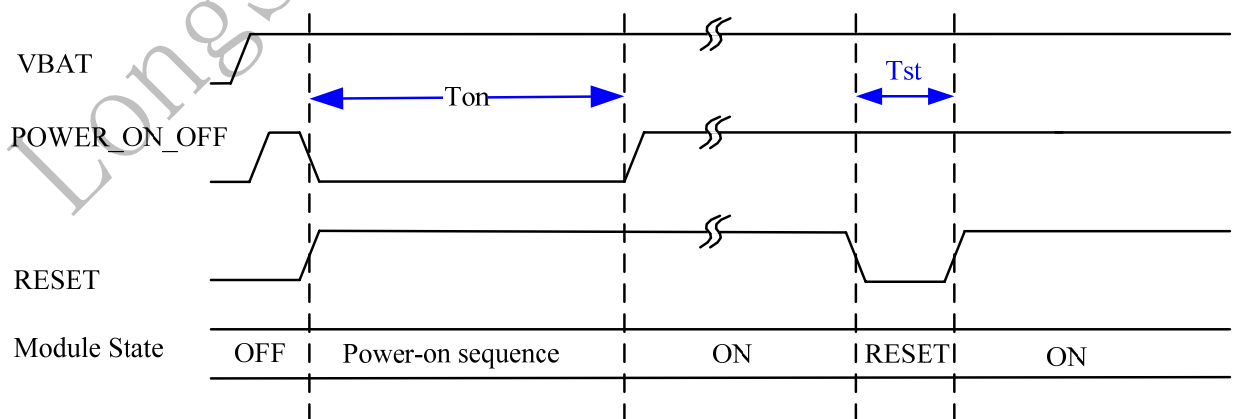
Figure11：U5501 RESET time sequence

3.3. USB interface

3.3.1. USB interface description

U5501 module supports a USB2.0 High-Speed interface. U5501 default PID is 0X9603. When the USB drivers of U5501 are installed, the OS will detect 3 virtual serial ports: Modem port, Diagnostic port and AT port.

Table7：U5501 USB interface

PIN Name	I/O	PIN No.	描述
USB_DM	I/O	85	USB data-
USB_DP	I/O	86	USB data+
GND		48~50,52~59,106,108, 110,112,114,116	GND

3.3.2. USB reference circuit

The USB part reference design circuit is as follow
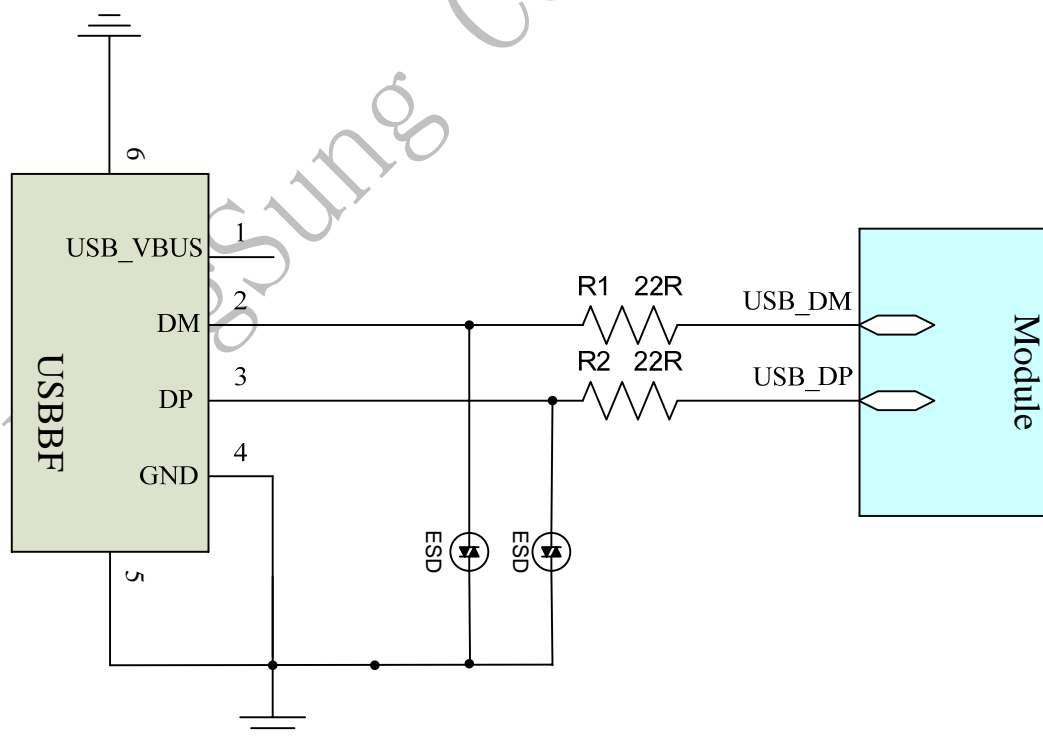
Figure12：U5501 USB reference circuit

1) To get the reliable USB power supply, it is recommended to use a 10uF (C1) filter capacitor and a 33pF (C2) filter capacitor. DC rated voltage of the capacitors should be above 10V;

2) To reduce the reflection caused by the high frequency alternating signal in the transmission, it is recommended to add a resistor with value below 10Ω to the DM and DP in USB interface to ensure correct transmission for USB data. Just like the resistors R1 and R2;

3) To avoid static electricity in USB interface, it is recommended to use the ESD protection device. Junction capacitance of the ESD component should be less than 5pF;

4) To get the reliable USB data transfer, need protect the USB device. Such as must protect the USB_DP, USB_DM, need 90Ω impedance control, and let them keep away from the interference signal.

3.3.3. USB driver

U5501 module support many kinds of OS, such as: Windows 2000, Windows XP, Windows Vista32/64, Windows 7, Windows CE5.0/6.0, Windows Mobile5.0/6.0. When use these systems, need special drivers for U5501.

For different OS and VID and PID, the drivers are different. If need them, please contact with FAE of LongSung. The default VID and PID is: VID_1C9E & PID_9603.

For Linux OS, such as Radhat, Ubuntu and Android, need the OS itself USB driver usbserial.ko. You need load the driver usbserial.ko and PID, VID to the system.

3.3.3.1. Linux OS load USB driver for U5501

Make sure there is usbserial.ko driver in your Linux system. Linux2.4.X and Linux2.6.X OS have usbserial.ko, but for some Ubuntu editions must recompile the kernel to get the usbserial.ko.

The following is in PC Linux2.6.X OS load driver process. **(Note: Embed Linux OS may have some difference)**

1) Please insert U5501 to the AP with Linux system by USB. And make sure the power supply for U5501 is active and steady and can power on U5501;

2) Preparation of lookup USB devices by Linux usbfs filesystem, mount the USB filesystem, type the command like this:

   #mount -t usbfs none /proc/bus/usb

3) Check the status of AP device, in order to make sure AP is ready, we can type command like this:

   #cat /proc/bus/usb/devices

   Then we will get the result as the following:

   T: Bus=03 Lev=01 Prnt=01 Port=00 Cnt=01 Dev#=9 Spd=12 MxCh= 0

   D: Ver= 1.10 Cls=00(>ifc) Sub=00 Prot=00 MxPS=64 #Cfgs= 1

   P: Vendor=1c9e ProdID=9603 Rev= 0.00

   S: Manufacturer=Qualcomm, Incorporated

   S: Product=Qualcomm CDMA Technologies MSM

   C:* #Ifs= 5 Cfg#= 1 Atr=a0 MxPwr=500mA

   I:* If#= 0 Alt= 0 #EPs= 3 Cls=ff(vend.) Sub=ff Prot=ff Driver=(none)

   E: Ad=81(I) Atr=03(Int.) MxPS=   16 Ivl=128ms

   E: Ad=82(I) Atr=02(Bulk) MxPS=   64 Ivl=0ms

   E: Ad=02(O) Atr=02(Bulk) MxPS=   64 Ivl=0ms

   I:* If#= 1 Alt= 0 #EPs= 2 Cls=ff(vend.) Sub=ff Prot=ff Driver=(none)

E: Ad=84(I) Atr=02(Bulk) MxPS=   64 Ivl=0ms

E: Ad=04(O) Atr=02(Bulk) MxPS=   64 Ivl=0ms

I:* If#= 2 Alt= 0 #EPs= 2 Cls=ff(vend.) Sub=ff Prot=ff Driver=(none)

E: Ad=86(I) Atr=02(Bulk) MxPS=   64 Ivl=0ms

E: Ad=06(O) Atr=02(Bulk) MxPS=   64 Ivl=0ms

If the USB device is ready, we can see the red characters listed above. From it, the vendor ID and product ID is 1c9e and 9603. Like Vendor=1c9e ProdID=9603 Rev= 0.00.

Also, we can see three serial ports displayed by blue characters. They are diagnostic port, AT port and modem port (The ports from the top to the bottom should be like this: DIAG, AT, MODEM).

4)   Install USB drivers in AP, type command like this:

#modprobe usbserial vendor=0x1c9e product=0x9603

5)   Check the status of device driver, type command like this:

#cat /proc/bus/usb/devices

You my get the result as the following:

T: Bus=03 Lev=01 Prnt=01 Port=00 Cnt=01 Dev#=3 Spd=12 MxCh= 0

D: Ver= 1.10 Cls=00(>ifc) Sub=00 Prot=00 MxPS=64 #Cfgs=1

P: Vendor=1c9e ProdID=9603 Rev= 0.00

S: Manufacturer=Qualcomm, Incorporated

S: Product=Qualcomm CDMA Technologies MSM

C:* #Ifs= 5 Cfg#= 1 Atr=a0 MxPwr=500mA

I:* If#= 0 Alt= 0 #EPs= 3 Cls=ff(vend.) Sub=ff Prot=ff Driver=usbserial_generic

E: Ad=81(I) Atr=03(Int.) MxPS=   16 Ivl=128ms

E: Ad=82(I) Atr=02(Bulk) MxPS=   64 Ivl=0ms

E: Ad=02(O) Atr=02(Bulk) MxPS=   64 Ivl=0ms

I:* If#= 1 Alt= 0 #EPs= 2 Cls=ff(vend.) Sub=ff Prot=ff Driver=usbserial_generic

E: Ad=84(I) Atr=02(Bulk) MxPS=   64 Ivl=0ms

E: Ad=04(O) Atr=02(Bulk) MxPS=   64 Ivl=0ms

I:* If#= 2 Alt= 0 #EPs= 2 Cls=ff(vend.) Sub=ff Prot=ff Driver=usbserial_generic

E: Ad=86(I) Atr=02(Bulk) MxPS=   64 Ivl=0ms

E: Ad=06(O) Atr=02(Bulk) MxPS=   64 Ivl=0ms

If the driver is ready, we can see the usbserial_generic on the right side of each port.

6) Check the device point in the /dev filesystem:

#cd /dev

 # ls ttyUSB*

If the AP driver is OK, there should be ttyUSB0~ ttyUSB2.

3.3.3.2. Linux OS AP use AT to control U5501

1) Please insert the USIM/SIM card into the application terminal, make sure the USIM/SIM card with Data service already been permitted. Plug the WCDMA/GSM antenna to RF connector of U5501. Power on the module U5501, load the USB driver, create USB end ports: ttyUSB0~ ttyUSB2.

2) Run minicom application in Linux OS:

#minicom –s

In the menu of minicom select "Serial port setup", set "Serial device " as /dev/ttyUSB1 **(Note: AT(ttyUSB1), Modem(ttyUSB2) can response AT commands, Diag (ttyUSB0) can not response AT commands)**; Then back to the menu of minicom and select "Save setup as df1 ", save the configuration, then select "exit " to exit minicom.

3) Send AT commands by minicom

#minicom

It should prompt as the following:

Welcome to minicom 2.3 OPTIONS: I18n

Compiled on Feb 24 2008, 16:35:15. Port /dev/ttyUSB1

Press CTRL-A Z for help on special keys

Input AT command to open the echo of AT:

ATE

IF the system is running normally, it should prompt as the following:

OK

Input AT command to get the version of firmware:

AT+LCTSW

Will get the following response:

SoftwareVersion: LQA0082.2.3_MG24

InnerVersion: LQA0082_240085_6.0.8W1215_EFS1.5

OK

Input AT command to get the strength and BER:

AT+CSQ

Will get the following response:

+CSQ: 20,74

OK

Input AT command to get the status of registration:

AT+CREG?

Will get the following response:

+CREG: 0,1

OK

Input AT command to get the information operator:

AT+COPS?

Will get the following response:

+COPS: 0,0,"CHN-CUGSM",2

OK

3.3.3.3. Linux OS AP dial PPP connection

1) Repeat loading USB driver and AT communication with U5501. Make sure U5501 get the normal registration, and the strength of RF signal will be stronger than 13 (The first parameter of CSQ).

2) Make sure the Linux OS has pppd application, if it hasn't pppd application, please install kppp, you will get pppd in your OS.

3) Create a new file: /etc/ppp/chat/gprs-connect-chat

    Then add messages as the following:

    TIMEOUT   15

    ABORT   "DELAYED"

    ABORT   "BUSY"

    ABORT   "ERROR"

    ABORT   "NO DIALTONE"

    ABORT   "NO CARRIER"

    TIMEOUT   40

    ''   \rAT

    OK   ATS0=0

    OK   ATE0V1

    OK   AT+CGDCONT=1,"IP","3GNET"

    OK   ATDT*99***1#

    CONNECT   ''

    Note: Different USIM/SIM card which you insert in the application terminal, AT+CGDCONT=1,"IP","3GNET" will be different. Please contact the operator to get the APN and replace the parameter "3GNET".

4) Modify the configuration of pppd: /etc/ppp/options

   If you find the "auth", modify it as "#auth". The result is there aren't ID

   verification.

5) Create a new file: /etc/ppp/peer/gprs

   Add messages as the following: (The end port must be ttyUSB2):

   # Usage: root>pppd call gprs

   /dev/ttyUSB2

   9600

   crtscts

   modem

   #noauth

   debug

   nodetach

   #hide-password

   usepeerdns

   noipdefault

   defaultroute

   user "3gnet"

   0.0.0.0:0.0.0.0

   ipcp-accept-local

   ipcp-accept-remote

   #lcp-echo-failure   12

   #lcp-echo-interval 3

   #noccp

   #novj

   #novjccomp

   #persist

   connect '/usr/sbin/chat -s -v -f /etc/ppp/chat/gprs-connect-chat'

6) Connect to the Internet:

#pppd call gprs

 # ifconfig

If you get the ppp0 net port means that PPP is successful.

eth0 Link encap:Ethernet   HWaddr 00:1D:09:33:A7:E1

inet addr:172.16.180.105   Bcast:172.16.180.255 Mask:255.255.255.0   inet6

addr: fe80::21d:9ff:fe33:a7e1/64 Scope:Link   UP BROADCAST RUNNING

MULTICAST   MTU:1500 Metric:1   RX packets:39793 errors:0 dropped:0

overruns:0 frame:0   TX packets:17971 errors:0 dropped:0 overruns:0 carrier:0

collisions:0 txqueuelen:1000   RX bytes:3445057 (3.2 MiB)   TX bytes:20088925

(19.1 MiB)   Interrupt:169 lo Link encap:Local Loopback   inet addr:127.0.0.1

Mask:255.0.0.0   inet6 addr: ::1/128 Scope:Host   UP LOOPBACK RUNNING

MTU:16436 Metric:1   RX packets:20 errors:0 dropped:0 overruns:0 frame:0   TX

packets:20 errors:0 dropped:0 overruns:0 carrier:0   collisions:0 txqueuelen:0

RX bytes:1160 (1.1 KiB)   TX bytes:1160 (1.1 KiB)

ppp0   Link encap:Point-to-Point Protocol   inet addr:10.182.207.113

P-t-P:10.64.64.64 Mask:255.255.255.255   UP POINTOPOINT RUNNING NOARP

MULTICAST   MTU:1500 Metric:1   RX packets:5 errors:0 dropped:0 overruns:0

frame:0   TX packets:6 errors:0 dropped:0 overruns:0 carrier:0   collisions:0

txqueuelen:3   RX bytes:62 (62.0 b)   TX bytes:101 (101.0 b)

7) Testing the Internet

 # ping 119.75.217.56

It is the IP address of www.baidu.com. If the ping fails, we need add a

route like this:

#route add default gw 10.64.64.64

Note: 10.64.64.64 is the ISP address as the red character above.

 # ping www.baidu.com

If ping www.baidu.com fails, we should add DNS to the /etc/resolv.conf

8) Disconnect the internet

killall pppd

3.4. UART interface

U5501 module provides a UART interface. Which can be used for AT interactive and data transfer.

3.4.1. UART interface description

Table8：U5501 UART 接口

PIN Name	I/O	PIN No.	描述
UART_DSR	O	73	UART data set ready(2.6V)
UART_RTS	O	74	UART ready for receive(2.6V)
UART_DCT	O	75	UART data carrier detect(2.6V)
UART_TX	O	76	UART transmit data output(2.6V)
UART_RING	O	77	UART ring indicator(2.6V)
UART_RX	I	78	UART receive data input(2.6V)
UART_DTR	I	79	UART data terminal ready(2.6V)
UART_CTS	I	80	UART clear to send(2.6V)
GND		48~50,52~59,106,108,110,112,114,116	地

3.4.2. UART interface reference circuit

For an application system, U5501 uses as DCE (Data Communication Equipment) and application terminal uses as DTE (Data terminal equipment). The reference circuit is as follow:
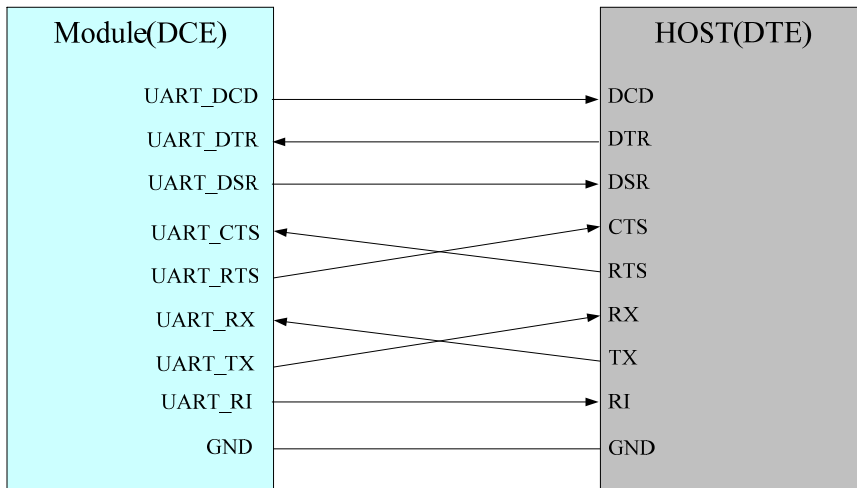
Figure13：U5501 UART connection

3.4.3. UART interface description

1) Full-duplex;
2) 7-bit or 8-bit data;
3) 1-bit or 2-bit stop bit;
4) Odd parity check, even parity check or non-check;
5) Direct memory access(DMA) transmission;
6) Baud rate ranging from 600bps to 230400bps(115200bps by default);
7) Self-adapted baud rate ranging from 1200bps to 115200bps.

3.5. U5501 sleep and wakeup control

In order to describe easily, it is named U5501 as BP and the MCU of application terminal as AP.

Sleep and wakeup interface is described in the table as follow:

Table9：U5501 sleep and wakeup interface

PIN Name	I/O	PIN No.	描述
WAKEUP_IN	I	11	H: DTE wakeup U5501; L: DTE set U5501 to sleep mode.
WAKEUP_OUT	O	71	H: Module is in wakeup mode and module serial/USB is available; L: Module is in sleep mode and serial/USB is not available.
GND		48~50,52~59,106,108,	GND

		110,112,114,116	

3.6. Analog audio interface

U5501 provide 2 channels analog audio interface.

3.6.1. Analog audio interface description

The audio signals are shown in as follow:

Table10：U5501 analog audio interface description

PIN Name	I/O	PIN No.	描述
MIC2_P	I	38	Positive pole of the input of audio interface 2
MIC2_N	I	39	Negative pole of the input of audio interface 2
MIC1_P	I	40	Positive pole of the input of audio interface 2
MIC1_N	I	41	Negative pole of the input of audio interface 2
EAR_OUT_N	O	96	Negative pole of the output of earphone
EAR_OUT_P	O	97	Positive pole of the output of earphone
SPKR_OUT_P	O	98	Positive pole of the output of speaker
SPKR_OUT_N	O	99	Negative pole of the output of speaker

3.6.2. Hands-free channel

The second audio channel can be used for the hands-free without requiring any audio amplifier. The output pins are configured differently, with a rated output of 500mW into an 8 Ω speaker. Considerable current flows between the audio output pins and the speaker, and thus wide PCB traces are recommended 20 mils.

Table11：U5501 second channel audio

PIN Name	PIN No.	Hands-free	Description
SPKR_OUT_P	98	SPK_P	Loudspeaker output differential signal +
SPKR_OUT_N	99	SPK_N	Loudspeaker output differential signal -
MIC2_P	38	MIC_P	Audio input channel 2 differential signal +
MIC2_N	39	MIC_N	Audio input channel 2 differential signal -

3.6.3. Handset channel

The first audio channel can be used for the handset without requiring any audio amplifier. The output power for the differential ear output is typically 350 mW

for a full-scale +3 dBm sine wave into a 32-ohm speaker.

Table12：U5501 first channel audio

PIN Name	PIN No.	Handset	Description
EAR_OUT_N	96	EAR_N	Audio output channel 1 differential signal -
EAR_OUT_P	97	EAR_P	Audio output channel 1 differential signal +
MIC1_P	40	MIC_P	Audio input channel 1 differential signal +
MIC1_N	41	MIC_N	Audio input channel 1 differential signal -

3.6.4. Analog audio reference circuit

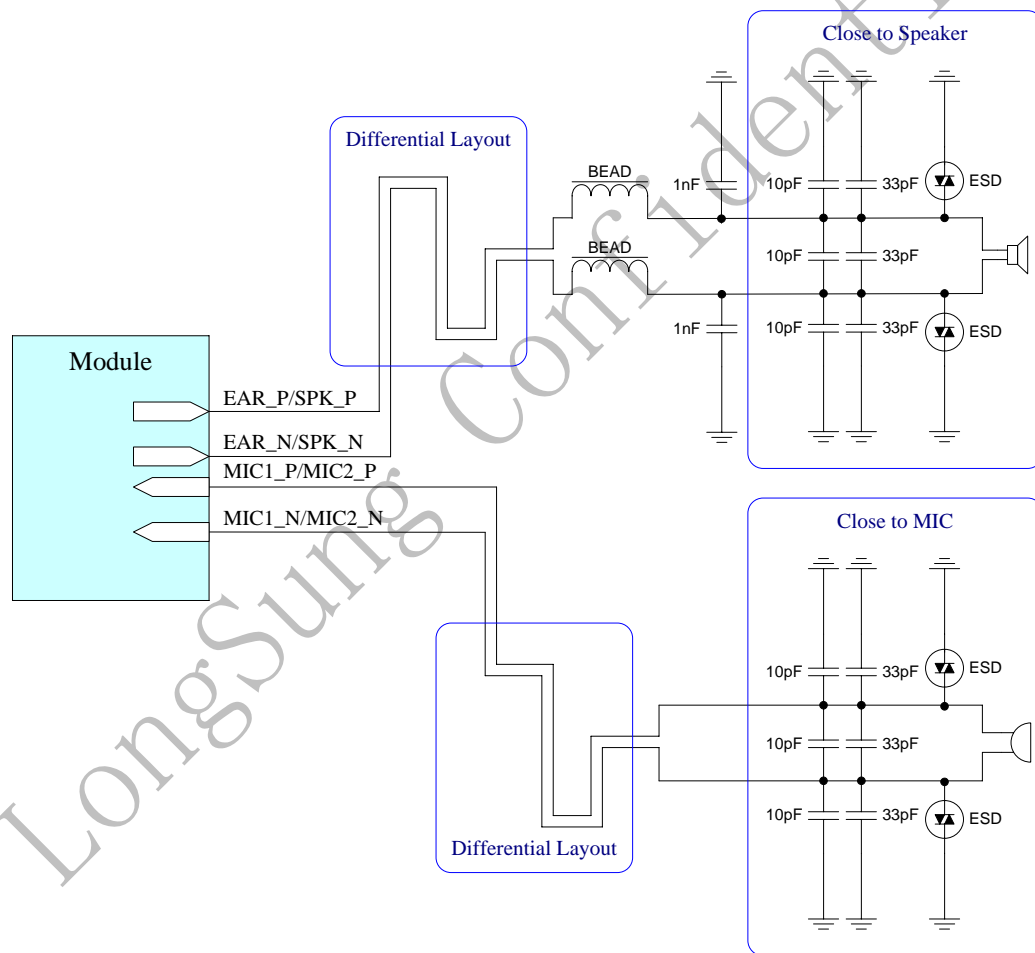The U5501 analog audio reference circuit is shown as follow:

Figure14：U5501 analog audio reference circuit

1) The audio output signals, a pair of differential signals, output to two speakers. The output signals are not real stereo signals which are different

from traditional stereo sound.

2) It is recommended to use the filter capacitor or filter circuit to reduce inter frequency interference and improve audio quality. Just like what is shown in the figure above.

3) To avoid static electricity, it is recommended to use the ESD protection device.

4) It requires connecting audio analog signal ground with the general digital circuit ground, magnetic bead or zero ohm resistance can be used.

5) IF use an audio amplifier for speaker, optional EMI filtering is shown at Fogure14, these components (two ferrite beads and two capacitors) can be added to reduce electromagnetic interference. If used, they should be located near the EAR_P and EAR_N.

6) Considerable current between the audio output pins and the speaker, the width of PCB traces are recommended 20mils.

3.7. PCM interface

U5501 module provides a PCM interface. The PCM include 4 pin digital signals. Use PCM interface can support communication between U5501 and external CODEC.

PCM TX data will be routed from the external codec MIC through the DSP encode path in the U5501 module. PCM RX data will be routed through the DSP decode path to the external codec speaker.

The base band of U5501 can be used in two modes:

1) Auxiliary PCM, the auxiliary PCM that runs at 128 kHz and uses a 62.5 μs sync pulse (half a time frame).
2) Primary PCM, the primary PCM that runs at 2.048 MHz and uses 488 ns sync pulse (one 2.048 MHz clock tick).

Table13：Auxiliary PCM and Primary PCM configuration

Configuration	SYNC	CLK	Clock source	Format
Auxiliary	8KHz	128KHz	Master	8Bits μ-law,

				8Bits A-law, 16Bits Linear (13 bits are valid, the others are blank)
Primary	8KHz	2.048MHz	Master/Slave	

The default configuration of U5501 is Primary PCM, and can use AT command to select Master Mode or Slave Mode.

In Slave mode, the external codec drives the clock and sync signals that are sent to the U5501 module.

U5501 module supports 3 PCM formats: 8Bits μ-law, 8Bits A-law, 16Bits (Linear).

3.7.1. PCM interface description

Table14：U5501 PCM interface

PIN Name	I/O	PIN No.	Description
PCM_SYNC	O	5	PCM Synchronous Signal
PCM_CLK	I	8	PCM CLK
PCM_DIN	I	6	PCM Input
PCM_DOUT	O	7	PCM Output

3.7.2. Auxiliary PCM

The Auxiliary PCM interface enables communication with an external codec to support hands-free applications. The auxiliary codec port operates with standard long-sync time sequence and a 128 kHz clock. The AUX_PCM_SYNC runs at 8 kHz with a 50% duty cycle. Most μ-law and A-law codecs support the 128 kHz AUX_PCM_CLK bit clock.
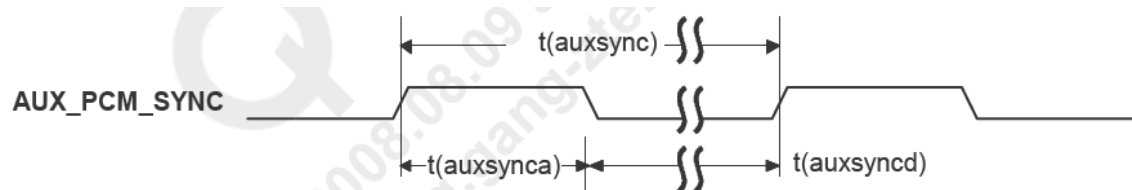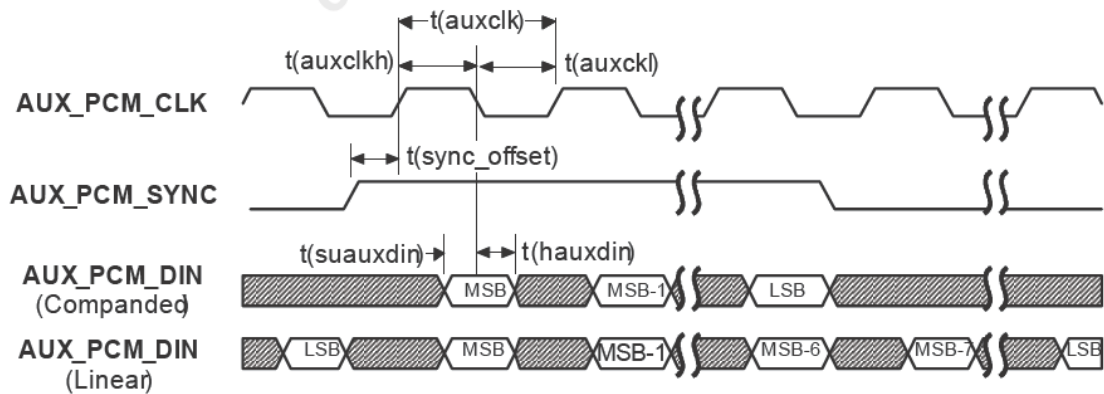

Figure15：AUX_PCM_SYNC time sequence

t(auxclk)

t(auxclkh) | t(auxckl)

AUX_PCM_CLK

t(sync_offset)

AUX_PCM_SYNC

t(suauxdin) | t(hauxdin)

AUX_PCM_DIN (Companded)　MSB　MSB-1　LSB

AUX_PCM_DIN (Linear)　LSB　MSB　MSB-1　MSB-6　MSB-7　LSB

Figure16：AUX_PCM_CODEC to U5501 time sequence

t(auxclk)

t(auxclkh) | t(auxckl)

AUX_PCM_CLK

t(sync_offset)

AUX_PCM_SYNC

t(pauxdout)

AUX_PCM_DOUT (Companded)　MSB　MSB-1　LSB +1　LSB

AUX_PCM_DOUT (Linear)　LSB　MSB　MSB-1　MSB-5　MSB-6　MSB-7　LSB +1　LSB
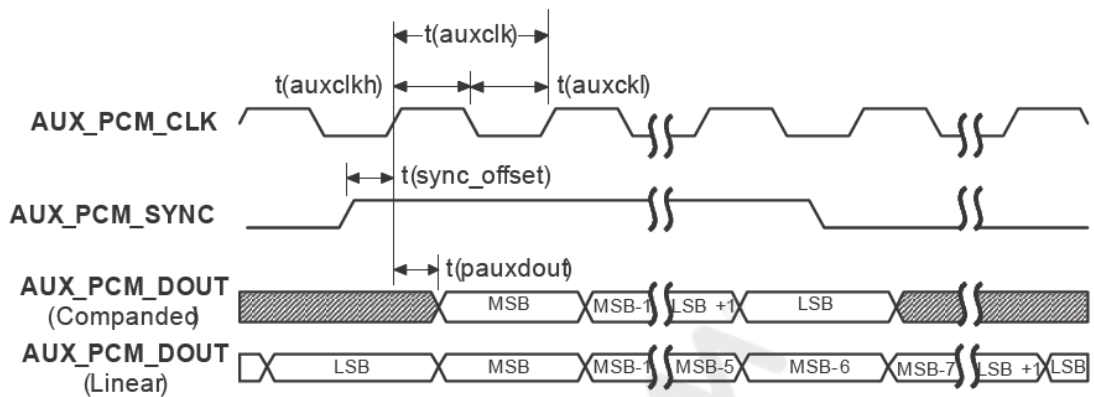
Figure17：U5501 to AUX_PCM_CODEC time sequence

Table15：AUX_CODEC time sequence parameters

Parameter	Description	Min	Typical	Max	Unit	Note
t(auxsync)	AUX_PCM_SYNC cycle time	–	125	–	μs	
t(auxsynca)	AUX_PCM_SYNC asserted time	–	62.5	–	μs	1
t(auxsyncd)	AUX_PCM_SYNC de-asserted time	–	62.5	–	μs	1
t(auxclk)	AUX_PCM_CLK cycle time	–	7.8	–	μs	2
t(auxclkh)	AUX_PCM_CLK high time	–	3.9	–	μs	3
t(auxclkl)	AUX_PCM_CLK low time	–	3.9	–	μs	3
t(sync_offset)	AUX_PCM _SYNC offset time to AUX_PCM_CLK rising	–	1.95	–	μs	4
t(suauxdin)	AUX_PCM_DIN setup time to AUX_PCM_CLK falling	60	–	–	ns	
t(hauxdin)	AUX_PCM_DIN hold time after AUX_PCM_CLK falling	60	–	–	ns	
t(pauxdout)	Propagation delay from AUX_PCM_CLK AUX_PCM_DOUT valid	–	–	60	ns	

Notes:
1. t(auxsync)/2 ± 10 ns.
2. t(auxclk) = 1/(128 kHz).
3. t(auxclk)/2 ± 10 ns.
4. t(auxclk)/4 ± 10 ns.

3.7.3. Primary PCM

U5501 module firmware default configuration is Primary PCM. PRIM_PCM_CLK is 2.048 MHz clock, PRIM_PCM_SYNC is 8 kHz (488nS), and μ-law PCM format.

Figure18：PRIM_PCM_SYNC time sequence
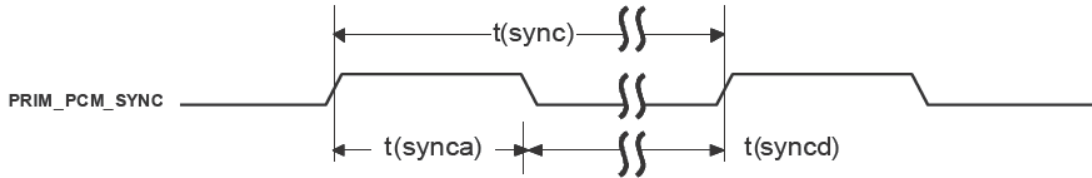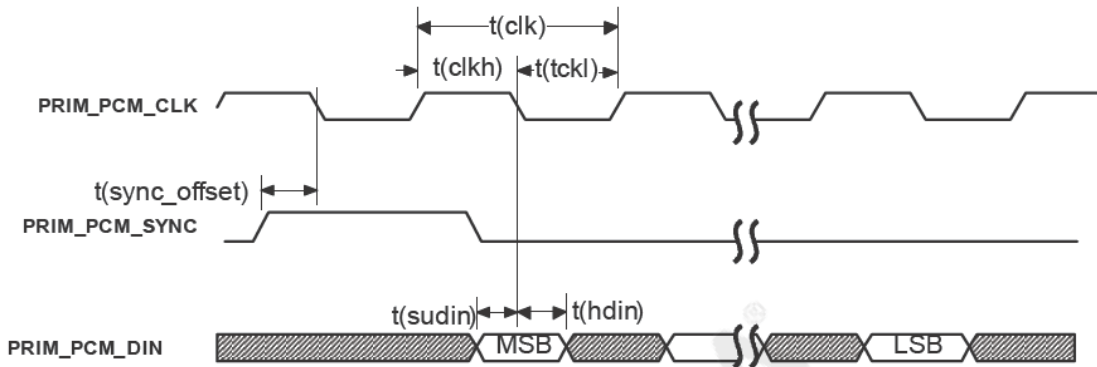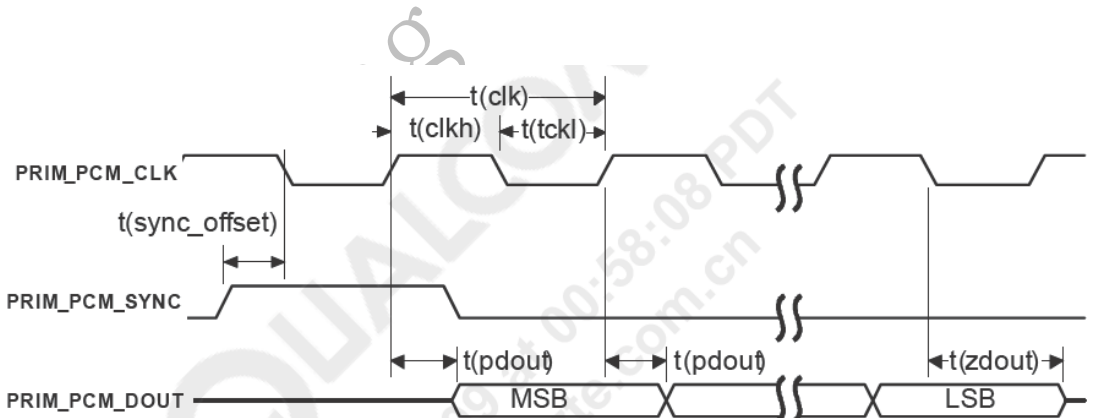
Figure19：PRIM_PCM_CODEC to U5501 time sequence

Figure20：U5501 to PRIM_PCM_CODEC time sequence

Table16：PRIM_CODEC time sequence parameters

Parameter	Description	Min	Typical	Max	Unit	Note
t(sync)	PCM_SYNC cycle time (PCM_SYNC_DIR = 1)	–	125	–	μs	
	PCM_SYNC cycle time (PCM_SYNC_DIR = 0)	–	125	–	μs	
t(synca)	PCM_SYNC asserted time (PCM_SYNC_DIR = 1)	–	488	–	ns	2
	PCM_SYNC asserted time (PCM_SYNC_DIR = 0)	–	–	–	ns	
t(syncd)	PCM_SYNC de-asserted time (PCM_SYNC_DIR = 1)	–	124.5	–	μs	3
	PCM_SYNC de-asserted time (PCM_SYNC_DIR = 0)	–	–	–	μs	
t(clk)	PCM_CLK cycle time (PCM_CLK_DIR = 1)	–	488	–	ns	4
	PCM_CLK cycle time (PCM_CLK_DIR = 0)	–	–	–	ns	
t(clkh)	PCM_CLK high time (PCM_CLK_DIR = 1)	–	244	–	ns	1,5
	PCM_CLK high time (PCM_CLK_DIR = 0)	–	–	–	ns	
t(clkl)	PCM_CLK low time (PCM_CLK_DIR = 1)	–	244	–	ns	1,5
	PCM_CLK low time (PCM_CLK_DIR = 0)	–	–	–	ns	
t(sync_offset)	PCM_SYNC offset time to PCM_CLK falling (PCM_SYNC_DIR = 1, PCM_CLK_DIR = 1)	–	122	–	ns	6
	PCM_SYNC offset time to PCM_CLK falling (PCM_SYNC_DIR = 0, PCM_CLK_DIR = 0)	–	–	–	ns	
t(sudin)	PCM_DIN setup time to PCM_CLK falling	60	–	–	ns	
t(hdin)	PCM_DIN hold time after PCM_CLK falling	60	–	–	ns	
t(pdout)	Delay from PCM_CLK rising to PCM_DOUT valid	–	–	60	ns	
t(zdout)	Delay from PCM_CLK falling to PCM_DOUT High-Z	5	–	60	ns	

Notes:
1. t(clkh) and t(clkl) are independent of PCM_CLK_SENSE.
2. One t(clk) period.
3. PCM_SYNC cycle time minus one t(clk) period.
4. t(clk) = 1/(2.048 MHz).
5. PCM_CLK high or low time = t(clk)/2 ± 10 ns.
6. PCM_SYNC offset time = t(clk)/4.

3.8. USIM/SIM interface

U5501 module supports HSPA/UTMS mode USIM card and GSM/GPRS/EDGE mode SIM card.

3.8.1. USIM/SIM interface description

U5501 module supports 1.8/3.0V USIM/SIM card.

Table17：U5501 USIM/SIM 接口

PIN Name	I/O	PIN No.	Description
SIM_DATA	I/O	89	USIM/SIM DATA
SIM_CLK	O	90	Clock Signal
SIM_RESET	O	88	RESET Signal
SIM_VCC	O	34	USIM/SIM Power

SIM_DET	I	70	USIM/SIM detect
GND		48~50,52~59,106,108, 110,112,114,116	地

3.8.2. USIM/SIM interface reference circuit

For 6-pin USIM/SIM card, we recommend to use the Amphenol C707 10M006 512 2 SIM Holder. For more information, you can visit the Amphenlo company web: http://www.amphenol.com/
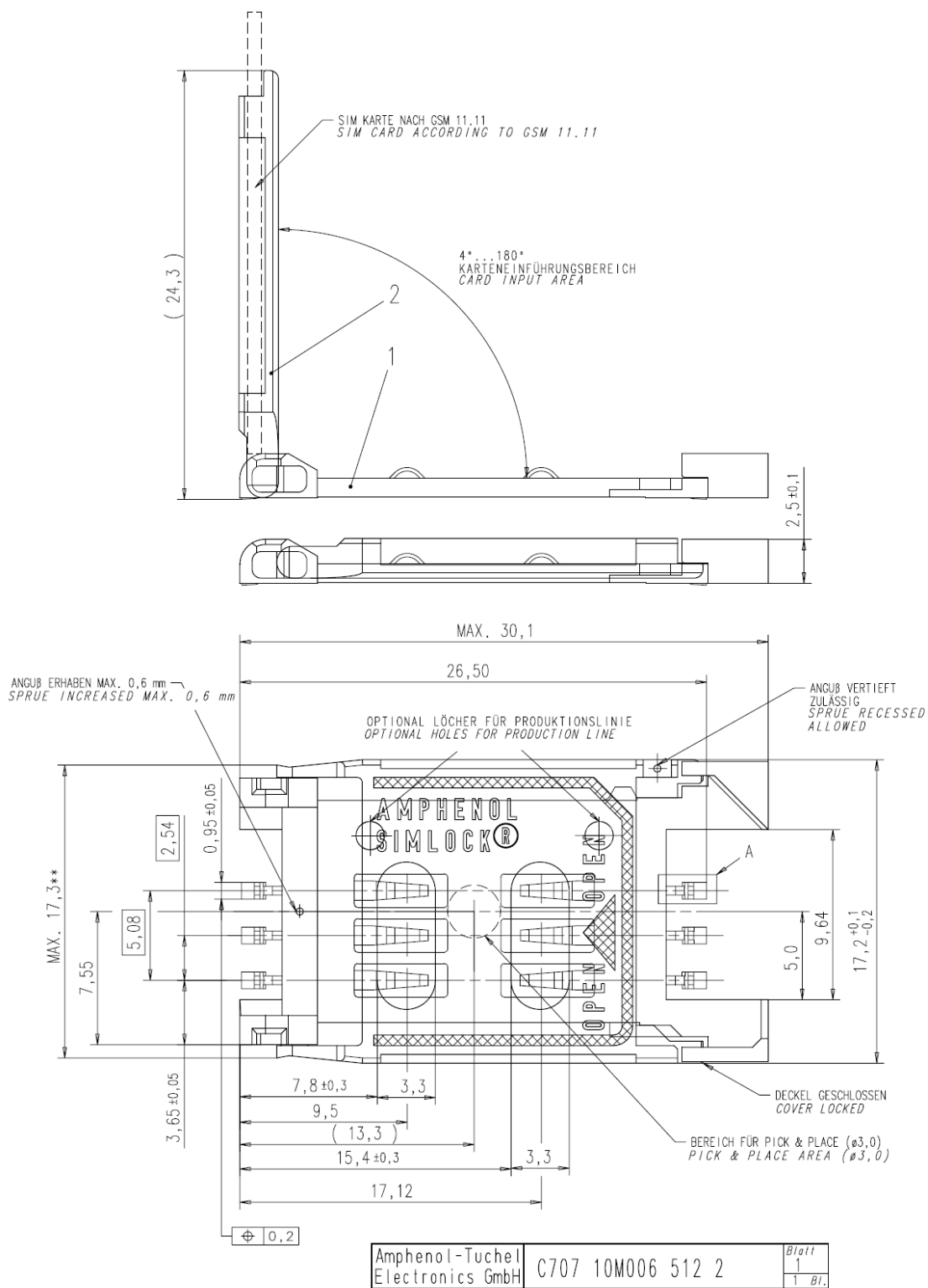
The SPEC of C707 10M006 512 2 SIM Holder is as follow.

Figure21：The SPEC of C707 10M006 512 2 SIM Holder

USIM/SIM interface reference design circuit as follow.
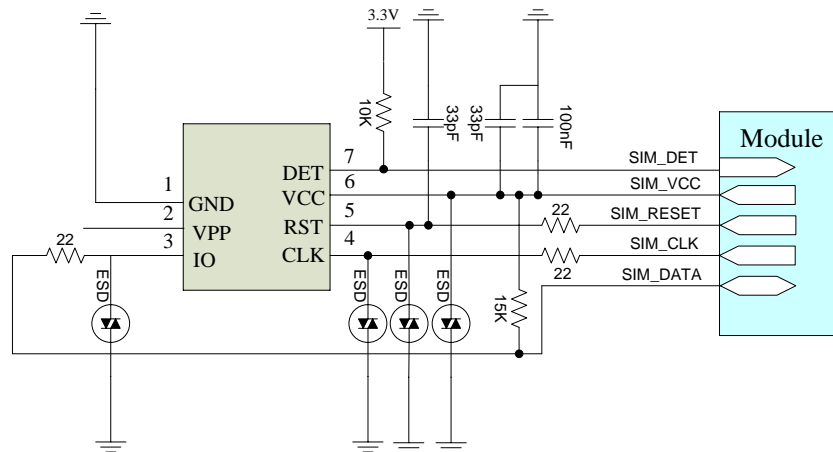
Figure22：U5501 USIM/SIM interface reference circuit

1) The USIM_DATA line of USIM is connected to USIM_VCC by a pull-up resistor with reference value 10KΩ;

2) To avoid the instantaneous voltage overflowing, the resistor with reference value 22Ω can be used for the USIM_DATA, USIM_CLK and USIM_RESET line;

3) To avoid the static electricity in USIM socket, it is recommended to use the ESD protection device for the USIM_DATA, USIM_CLK and USIM_VCC line;

4) To get more flat USIM power supply, it is recommended to use the filter capacitors, and reference value 33pF and 100nF;

5) To eliminate the peak interference and high frequency interference signal on USIM_RESET line, the filter capacities can be placed in USIM_RESET line, the reference value is 33pF;

6) SIM_DET is the USIM/SIM insert or remove detector.

3.9. Status indicator interface

The U5501 provide 2 status indicators, which are PIN91 and PIN101.

3.9.1. Status indicator description

The U5501 status indicator is decribed as follow.

Table18：U5501 status indicator description

PIN Name	I/O	PIN No.	Description
LED_STATUS	O	91	Status indicator
LED_MODE	O	101	Status indicator

Status indicator is described as follow.

Table19：U5501 status indicator description

	Status	LED_STATUS	LED_MODE
1	Registered in 3G network	The indicator blinks once each time(100ms On/2900ms Off)	Light off
2	3G network data transferring	Light on	Light off
3	Download firmware	Light off	The indicator blinks fast (100ms On/100ms Off)
4	Searching network	Light off	The indicator blinks twice each time （ 100ms On/100ms Off/100ms On/2700ms Off）
5	Registered in 2G network	Light off	The indicator blinks once each time (100ms On/2900ms Off)
6	2G network data transferring	Light off	Light on

3.9.2. Status indicator reference circuit

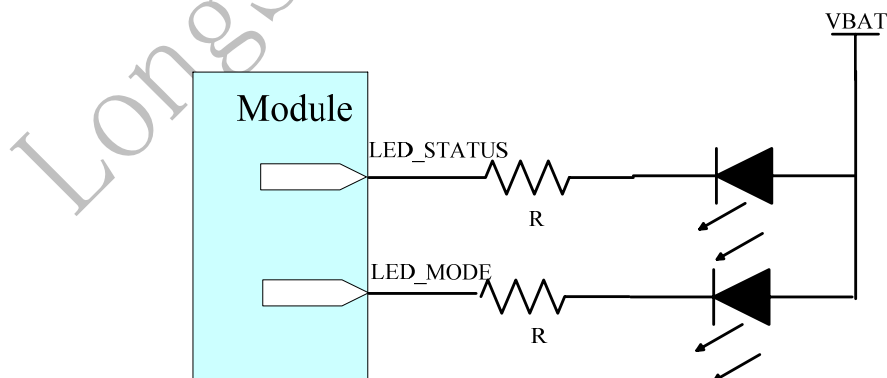The status indicator reference circuit is shown as follow:

Figure23：U5501 status indicator reference circuit

I$_F$ *R+VF = VBAT

V$_F$: LED Forward Voltage

I_F: LED Forward current

3.10. GPIO

U5501 provide several GPIOs.

Table20：U5501 GPIOs

PIN Name	I/O	PIN NO.	Description
GPIO_2.6V	I/O	15	2.6V voltage level
GPIO_1.8V	I/O	28	1.8V voltage level
GPIO_1.8V	I/O	29	1.8V voltage level
GPIO_2.6V	I/O	43	2.6V voltage level
GPIO_2.6V	I/O	44	2.6V voltage level
GPIO_2.6V	I/O	45	2.6V voltage level
GPIO_2.6V	I/O	46	2.6V voltage level
GPIO_2.6V	I/O	51	2.6V voltage level
GPIO_2.6V	I/O	55	2.6V voltage level
GPIO_2.6V	I/O	105	2.6V voltage level
GPIO_2.6V	I/O	109	2.6V voltage level
GPIO_2.6V	I/O	113	2.6V voltage level

3.11. Antenna interface

PIN107 is the antenna pad.

Table21：U5501 antenna interface

PIN Name	I/O	PIN No.	Description
ANT		107	Antenna
GND		48~50,52~59,106,108, 110,112,114,116	GND

There are two types antenna reference design with the U5501, one is the solder antenna, the other is use the antenna connector. We recommend to layout with microstrip line in both of the two types.

3.11.1. Solder antenna

The reference circuit of solder antenna is shown as follow:
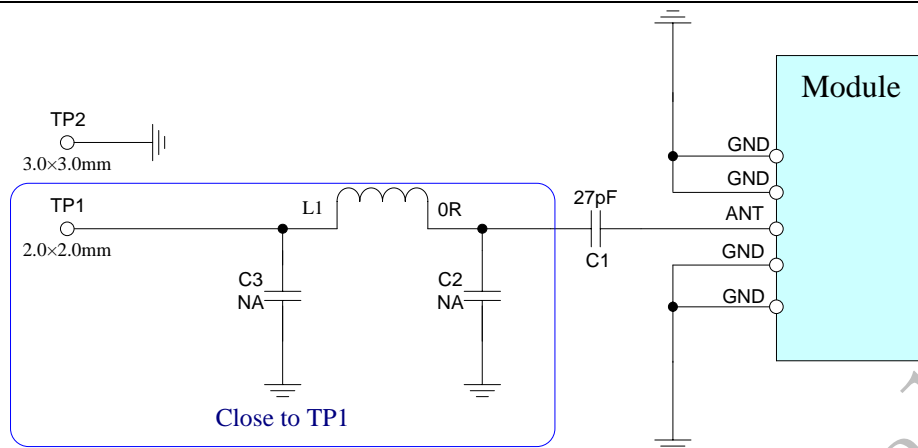
Figure24：U5501 solder antenna reference circuit

The matters need attention about the U5501 solder antenna are as follow:
1) PI type matching filter(L1, C2, C3) must close to the TP1, and separate the GND pad(TP2) from the TP1 0.7mm at least;
2) Control the microstrip line impedance to 50ohm;
3) Keepout: We recommend the trace width 1.2mm in top layer, and separate the other trace from 1.2mm, there need not keepout in bottom layer.

3.11.2. RF connector

The reference circuit of the U5501 use the RF connector is as follow:

Figure25：U5501 RF connector reference circuit

We recommend the antenna connector(J1) type is MM9329-2700RA1 which provided by MURATA.
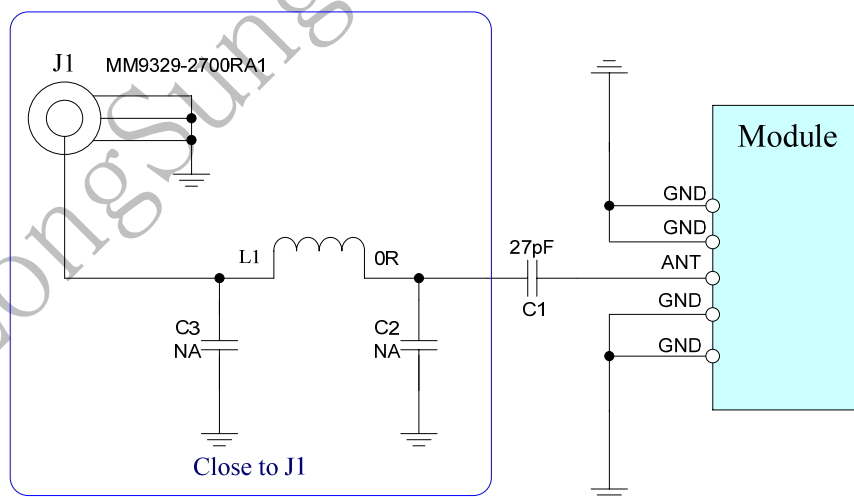
The matters need attention of the U5501 antenna connector are as follow:

1) PI type matching filter(L1, C2, C3) must close to the TP1, and separate the GND pad(TP2) from the TP1 0.7mm at least;
2) Control the microstrip line impedance to 50ohm;
3) Keepout: We recommend the trace width 1.2mm in top layer, and separate the other trace from 1.2mm, there need not keepout in bottom layer.

3.11.2.1. RF cable

When you use RF Connector, please select the RF cable carefully; it is required to use RF cable of which the insertion loss should comply with:

- GSM900/GSM850<1dB
- DCS1800/PCS1900<1.5dB
- WCDMA2100<1.5dB
- WCDMA900<1dB

We recommend use the MXTK88TK200 which provided by MURATA.

3.11.3. U5501 RF output power

The RF output power of U5501 is shown as follow:

Table22：U5501 RF output power

Band	Max	Min
GSM850	33dBm ± 1dB	5dBm ± 5dB
E-GSM900	33dBm ± 1dB	5dBm ± 5dB
DCS1800	29dBm ± 1dB	0dBm ± 5dB
PCS1900	29dBm ± 1dB	0dBm ± 5dB
WCDMA2100	24dBm +1/-3dB	-56dBm ± 9dB
WCDMA900	24dBm +1/-3dB	-56dBm ± 9dB

3.11.4. U5501 RF receiver sensitivity

Table23：U5501 RF receiver sensitivity

Band	Receive sensitivity
GSM850	<-106dBm
E-GSM900	<-106dBm
DCS1800	<-106dBm
PCS1900	<-106dBm
WCDMA2100	<-108dBm

Band	Receive sensitivity
WCDMA900	<-106dBm

3.11.5. U5501 operating frequencies

Table24：U5501 operating frequencies

Band	Receive	Transmit
GSM850	869~894MHz	824~849MHz
E-GSM900	925~960MHz	880~915MHz
DCS1800	1805~1880MHz	1710~1785MHz
PCS1900	1930~1990MHz	1850~1910MHz
WCDMA2100	2110~2170MHz	1920~1980MHz
WCDMA900	880~915MHz	925~960MHz

3.11.6. Antenna parameters requirement

Table25：U5501 antenna parameters requirement

Band	VSWR	Gain		Efficiency	SAR	TRP (dBm)	TIS (dBm)
		Peak	Avg.				
GSM850	<2.5:1	>0dBi	>-4dBi	>40%	<1.6 W/Kg	28	<-102
EGSM900						28	<-102
DCS1800						25	<-102
PCS1900						25	<-102
WCDMA900						18	<-102
WCDMA2100						18	<-104

4. Mechanics

4.1. The view of U5501

Figure26：The view of U5501

4.2. 3D stack

If you need the 3D stack of U5501, please contact us to obtain it.
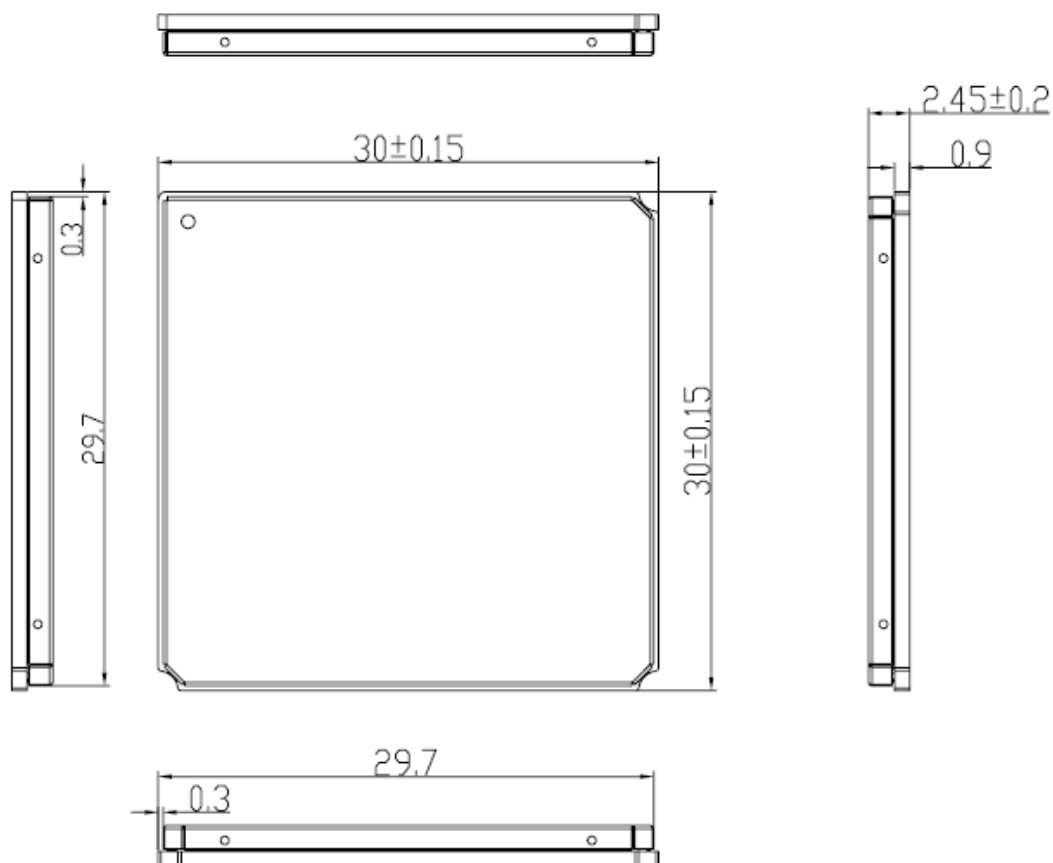
4.3. 2D mechanical dimensions

Figure27: U5501 2D mechanical dimensions

4.4. Application side library of U5501

The library which includes schematic decal and PCB decal. Please contact us to obtain   them.

5. Power consumption

U5501 current consumption (VBAT Power supply: DC3.8V) is shown as follow.
Table26：U5501 max current consumption in some mode

Sleep 模式状态下耗流		
工作频段	配置	平均值(mA）
GSM850	2	3.2
	5	2.1
	9	1.5
GSM900	2	3.1
	5	1.9
	9	1.5
DCS1800	2	3.1
	5	1.8
	9	1.5
PCS1900	2	2.9
	5	2
	9	1.4
W2100	6	3.9
	7	2.4
	9	0.8
W900	6	3.9
	7	2.7
	9	0.8

6. Electrical characteristics

6.1. Absolute maximum power ratings

Absolute maximum power ratings for power supply and the voltage on digital and analog pins of U5501 module are listed as follow. Out of the range, the module should be damaged.

Table27：Absolute maximum power ratings

Parameter	Description	Min	Typ	Max	Unit
VBAT	U5501 power supply	-0.5	3.8	4.2	V
	RMS average current	0		0.9	A
	Voltage drop during transmit burst, I_{VBAT} peak current may up to 2A (Per 4.6ms)			400	mV
GPIO	Digital IO voltage	-0.3	2.6	3.0	V
	Voltage in power off mode	-0.25		0.25	V

6.2. Operating temperatures

U5501 module can normal operate in the environment temperature in -20~+65℃.

If you will use it in the environment which out of the range, we recommend customer has some method to control the temperature around U5501 module.

In the restricted operation temperature, some RF parameter may out of the 3GPP RF standard. The module can work, such as voice, SMS, data.

In the storage temperature, the module may be not able to work, just for storage. The temperature out of the range, the U5501 module should be damaged.

Table28：U5501 module operating temperature

Temperature	Min	Typ	Max	Unit
Normal operation temperature	-20	25	65	℃

Restricted operation temperature	-30 ~ -20		65 ~ 75	℃
Storage temperature	-40		85	℃

6.3. Interface operating status

V_L：logistic low level;
V_H：logistic high level.

Table29：Digital Signal DC Characteristics

Signal	VL		VH		Unit
	Min	Max	Min	Max	
Input	-0.3	0.3*Vpin_min	0.3*Vpin_max	Vpin_max	V
Output	GND	0.2	Vpin_min-0.2	Vpin	V

Note：Vpin_min=2.25V, Vpin_max=3.0V (Vpin is the digital interface high level，Vpin=2.6V)

Table30：U5501 power supply range

Parameter	I/O	Min	Typ	Max	Unit
VBAT	I	3.3	3.8	4.2	V
SIM_VCC	O	1.7/2.75	1.8/2.85	1.9/2.95	V

6.4. Reliability

Table31：Requirements on the environment reliability

Test case	Test requirement
Low temperature Storage test	-40℃±3℃, power off mode storage 24 hours
High temperature Storage test	+85℃±3℃, power off mode storage 24 hours
Temperature change test	In power off mode, between -40℃ and +85℃, stay 0.5h, change time <3min, total 24 times
High temperature high humidity test	Temperature: +85℃±3℃ Humidity: 90~95%RH Power off mode storage 24 hours
Low temperature operating	-20℃±3℃, keep operating for 24 hours
High temperature	+65℃±3℃, keep operating for 24 hours

Test case	Test requirement
operating	
Vibration test	Vibration test requirement: | Frequency	Random Vibration ASD
5~20Hz	0.96m^2/s^3
20~500Hz	0.96m^2/s^3(20Hz), else -3dB/times frequency	
Connector Life Test	Board-to-board connector plug 50 times; RF connector plug 30 times
ESD test	1, When module in voice mode, discharge antenna port, VBAT PAD and GND, ESD must meet the following targets: 1) Contact discharge pass: ±2KV、±4KV test class 2) Air discharge pass: ±2KV、±4KV、±8KV test class 2, When module in voice mode, discharge SIM card hold of EVB, ESD must meet the following targets: 1) Contact discharge pass: ±2KV test class 2) Air discharge pass: ±2KV、±4KV test class

6.5. Electrostatic discharge

U5501 module is a consumptive product. Although the module has some ESD protect function, we recommend in application need more ESD protect means to avoid the static electricity from the application environment, please reference to the interface reference design circuit.

In order to improve the antistatic performance of the system, we recommend customer is advised of the following main board: layout an exposed copper under the module U5501, U5501 shield frame solder feet welded to the customer board. The solder feet, copper, solder feet and GND are connected.

The ESD capacity of U5501 is listed as follow.

Table32: The ESD endure status measured table
(Temperature: 25℃, Humidity: 45%)

Part	Air discharge	Contact discharge
VBAT,GND	±8KV	±4KV
Antenna port	±8KV	±4KV
Other port	±4KV	±2KV