M1506 Hardware Design

Smart Module Series

Version： V1.2

Date： 2016-09-29

Shanghai Mobiletek Communication Ltd.

Notice

Some features of the product and its accessories described herein rely on the software installed, capacities and settings of local network, and therefore may not be activated or may be limited by local network operators or network service providers. Thus, the descriptions herein may not exactly match the product or its accessories which you purchase. Shanghai Mobiletek Communication Ltd reserves the right to change or modify any information or specifications contained in this manual without prior notice and without any liability.

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Version History

Date	Version	Modify records	Author
2016-06-25	V1.1	First release	Jason Liao, lb.xu
2016-09-29	V1.2	Optimized layout format	Jason Liao, lb.xu

Content

1. Overview

M1506 is a 3G communication smart module with SMT package. For the stable performance, the compact appearance, high cost-performance ratio and good extensibility, it can be applied to a variety of compact products. Products are mainly targeted at industry areas requiring 3G smart SOM (System on Module).

1.1 System Block Diagram

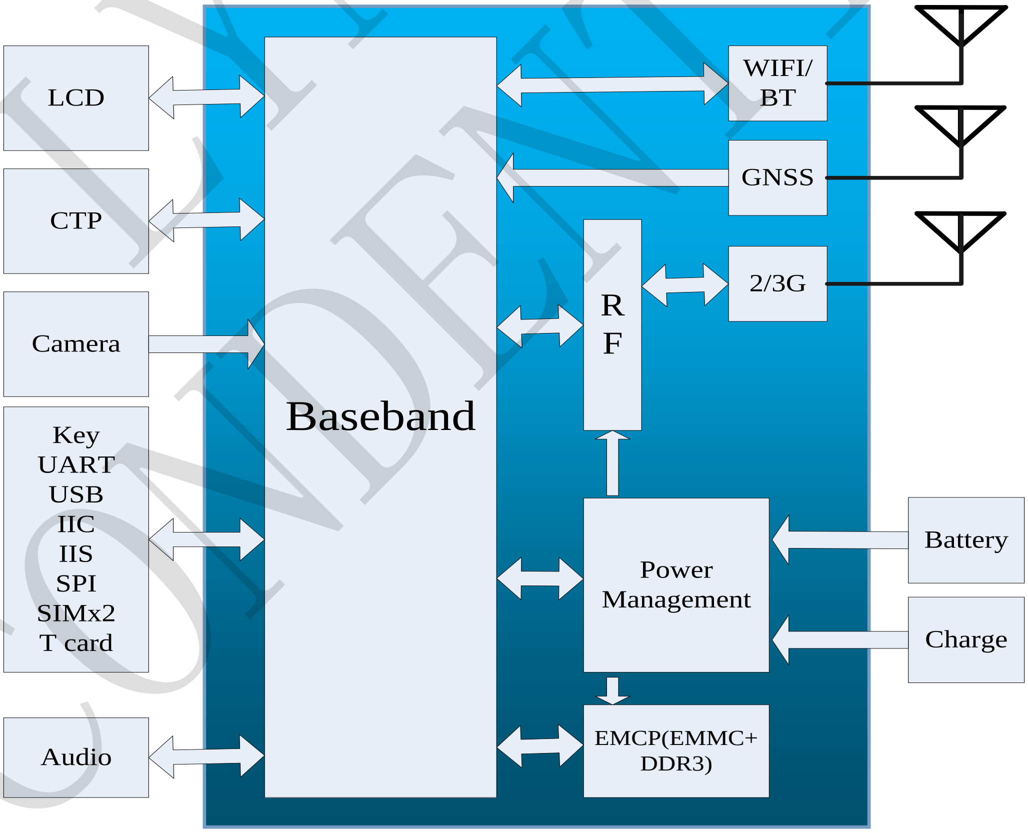


Figure 1-1 M1506 functional diagram

1.2 Features

- Operating System

  Android 6.0 (32bit)

- Processor

  Quad-core ARM@Cortex-A7 MPCore
  1.3GHz/512KB L2 cache

- Memory

  8GB eMMC+1GB LPDDR3（Optional 16GB+2GB）

- Graphics:

  Mali400-MP2 500MHz

  OpenGL ES 1.1/2.0 3D graphic accelerator/ 53.25Mtri/sec and 1000M pixel/sec@500MHz

- Video:

  Decode: H.264 1080P@30fps
  Encode: H.263/MPEG-4 1080P@30fps

- Audio:

  Sampling rates: 8k Hz to 48k Hz
  Sampling formats: 8/16-bit
  Speech codec (FR, HR, EFR, AMR FR, AMR HR)

- Connectivity:

  WIFI: 802.11 b/g/n
  FM: FM Receiver
  Bluetooth: BT3.0/4.0
  GNSS: GPS

- Band:

  WCDMA: Band1/2/5/8
  GSM/GPRS/EDGE: Band2/3/5/8

- Sensor

Support 12 bit tri-axis accelerometer

- User Interface

LCM：HD 1280*720
TP：Capacitive
Audio：3 differential MIC inputs, 2 outputs
Front camera：5MP
Rear camera：8MP

1.3 Specifications

- Supply voltage range：3.5 V to 4.35 V
- Size：52.0 mm * 41.0 mm * 2.85 mm
- 156-pin SMT
- Support FOTA
- Operating Temperature: -30℃ to + 75℃
- 3 antennas（ WIFI/BT、GPS、RF Main antenna）

1.4 Interface

- DPI
- SPI
- GPIO
- EINT
- 3 UART
- 3 IIC
- Key

- IIS
- 2 SIM Card
- LCD（MIPI DSI）
- SDIO 2.0
- 2 Camera(MIPI CSI)
- USB 2.0 HS peripheral (OTG)

1.5 Application Prospect

- Automatic navigation
- Driving recorder
- Remote Monitoring System
- Precise location services
- Smart recognition system
- Mobile scanning equipment
- Mobile HD video conferencing

2. Module Pin Definitions

2.1 Pin Distribution

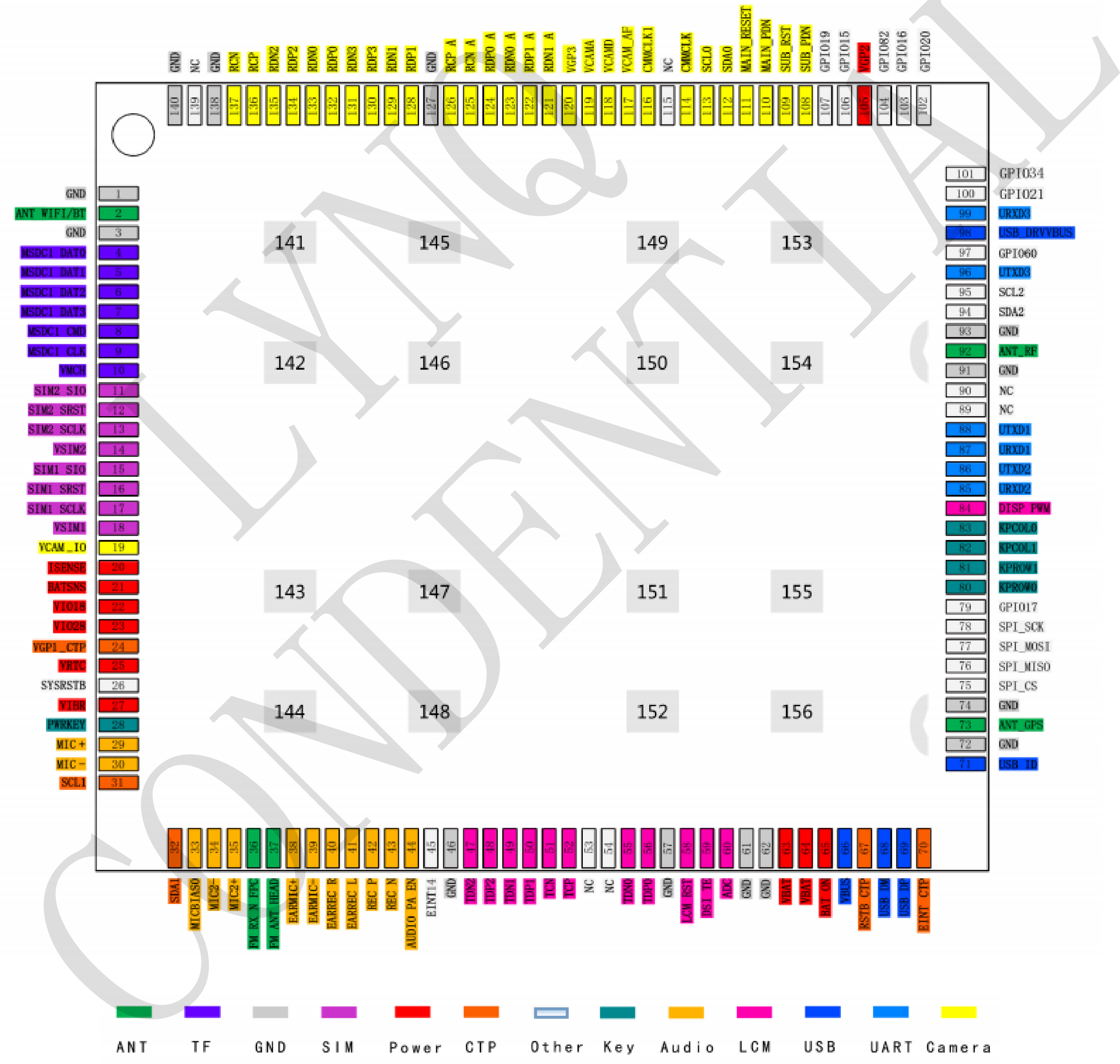


Figure 2-1 M1506 Top View

2.2 Pin Description

M1506 interface specific functions are as follows:

Table 2-1 Pin Description

Pin NO.	Pin name	Type	Function Description	Power domain	State when not used
1	GND	G	Ground		GND
2	ANT_WIFI/BT	/	WIFI/BT Antenna		Open
3	GND	G	Ground		GND
4	MSDC1_DAT0	I/O	SD card data pin	DVDD28_MSDC1	Open
5	MSDC1_DAT1	I/O		DVDD28_MSDC1	Open
6	MSDC1_DAT2	I/O		DVDD28_MSDC1	Open
7	MSDC1_DAT3	I/O		DVDD28_MSDC1	Open
8	MSDC1_CMD	I/O	SD card command pin	DVDD28_MSDC1	Open
9	MSDC1_CLK	I/O	SD card clock output	DVDD28_MSDC1	Open
10	VMCH	P	VMCH output voltage for SD	3.0/3.3V	Open
11	SIM2_SIO	I/O	SIM2 data		Open
12	SIM2_SRST	I/O	SIM2 reset		Open
13	SIM2_SCLK	I/O	SIM2 clock		Open
14	VSIM2	P	SIM2 output voltage	1.8/3.0V	Open
15	SIM1_SIO	I/O	SIM1 data		Open
16	SIM1_SRST	I/O	SIM1 reset		Open
17	SIM1_SCLK	I/O	SIM1 clock		Open
18	VSIM1	P	SIM1 output voltage	1.8/3.0V	Open
19	VCAM_IO	P	Camera IOVDD output voltage	1.8V	Open
20	ISENSE	I	Positive terminal for battery's charging current sensing resistor	2.5～4.5V	Connected to VBAT

21	BATSNS	I	Negative terminal for battery's charging current sensing resistor	2.5～4.5V	Connected to VBAT
22	VIO18	P	1.8V output voltage	1.8V	Open
23	VIO28	P	2.8V output voltage	2.8V	Open
24	VGP1_CTP	P	Output voltage for CTP	1.2/1.3/1.5/1.8/2.0/2.8/3.0V	Open
25	VRTC	P	RTC LDO output. Supply of RTC macro where backup battery can be added	2.8V	Open
26	SYSRSTB	I	System reset signal	VIO18	Open
27	VIBR	P	Output voltage for vibrator	1.2/1.3/1.5/1.8/2.0/2.8/3.0V	Open
28	PWRKEY	I	Powerkey button	0～4.5V	Open
29	MIC1+	AI	Microphone Channel 1	0～3.08V	Open
30	MIC1-	AI		0～3.08V	Open
31	SCL1	I/O	IIC1 clock	VIO18	Open
32	SDA1	I/O	IIC1 data	VIO18	Open
33	MICBIAS0	O	Microphone Bias Voltage	0～3.08V	Open
34	MIC2-	AI	Microphone Channel 2	0～3.08V	Open
35	MIC2+	AI		0～3.08V	Open
36	FM_RX_N_FPC	AI	FM differential RF input, negative terminal		Open
37	FM_ANT_HEAD	AI	FM differential RF input, positive terminal		Open
38	EARMIC+	AI	Earphone channel input	0～3.08V	Open
39	EARMIC-	AI		0～3.08V	Open
40	EARREC_R	AO	Earphone channel output	-1.98～1.98V	Open
41	EARREC_L	AO		-1.98～1.98V	Open
42	REC_P	AO	Receiver output	-1.98～1.98V	Open
43	REC_N	AO		-1.98～1.98V	Open
44	AUDIO_PA_EN	I/O	General Purpose Input Output for	VIO18	Open

			Audio PA enable		
45	EINT14	I/O	External interrupt 14	VIO18	Open
46	GND	G	Ground		GND
47	TDN2	DO	DSI0 lane2 N	VIO18	Open
48	TDP2	DO	DSI0 lane2 P	VIO18	Open
49	TDN1	DO	DSI0 lane1 N	VIO18	Open
50	TDP1	DO	DSI0 lane1 P	VIO18	Open
51	TCN	DO	DSI0 CLK lane N	VIO18	Open
52	TCP	DO	DSI0 CLK lane P	VIO18	Open
53	NC				
54	NC				
55	TDN0	DO	DSI0 lane0 N	VIO18	Open
56	TDP0	DO	DSI0 lane0 P	VIO18	Open
57	GND	G	Ground		GND
58	LCM_RST	I/O	Parallel display interface reset signal	VIO18	Open
59	DSI_TE	I/O	Parallel display interface tearing effect	VIO18	Open
60	ADC	I	AuxADC external input channel	0～1.8V	Open
61	VBAT-	G	Ground of Battery		VBA-
62	VBAT-	G			VBA-
63	VBAT	P	Power Supply	3.5～4.35V	VBAT
64	VBAT	P			VBAT
65	BAT_ON	I	Battery NTC pin for battery and its temperature sensing		Open
66	VBUS	P	USB 5V voltage input	5V	Open
67	RSTB_CTP	I/O	General Purpose Input Output for CTP reset	VIO18	Open
68	USB_DM	DIO	USB port differential data line		Open

69	USB_DP	DIO			Open
70	EINT_CTP	I/O	External interrupt for CTP	VIO18	Open
71	USB_ID	I	USB Identification	VIO18	Open
72	GND	G	Ground		GND
73	ANT_GPS	ANT	Antenna for GPS		Open
74	GND	G	Ground		GND
75	SPI_CS	I/O	SPI chip select	VIO18	Open
76	SPI_MISO	I/O	SPI data in(master in, slave out)	VIO18	Open
77	SPI_MOSI	I/O	SPI data out(master out, slave in)	VIO18	Open
78	SPI_SCK	I/O	SPI Clock	VIO18	Open
79	GPIO17	I/O	General Purpose Input Output 17	VIO18	Open
80	KPROW0	DIO	Keypad row0	VIO18	Open
81	KPROW1	DIO	Keypad row1	VIO18	Open
82	KPCOL1	DIO	Keypad col1	VIO18	Open
83	KPCOL0	DIO	Keypad col0	VIO18	Open
84	DISP_PWM	I/O	Display PWM output	VIO18	Open
85	URXD2	I/O	UART2 RX	VIO18	Open
86	UTXD2	I/O	UART2 TX	VIO18	Open
87	URXD1	I/O	UART1 RX for system debug	VIO18	Open
88	UTXD1	I/O	UART1 TX for system debug	VIO18	Open
89	NC				
90	NC				
91	GND	G	Ground		GND
92	ANT_RF	/	Antenna for Main RF		Open
93	GND	G	Ground		Open
94	SDA2	I/O	IIC2 data	VIO18	Open

95	SCL2	I/O	IIC2 clock	VIO18	Open
96	UTXD3	I/O	UART3 TX	VIO18	Open
97	GPIO6	I/O	General Purpose Input Output 6	VIO18	Open
98	USB_DRVVBUS	I/O	USB OTG Voltage output enable	VIO18	Open
99	URXD3	I/O	UART3 RX	VIO18	Open
100	GPIO21	I/O	General Purpose Input Output 21	VIO18	Open
101	GPIO34	I/O	General Purpose Input Output 34	VIO18	Open
102	GPIO20	I/O	General Purpose Input Output 20	VIO18	Open
103	GPIO16	I/O	General Purpose Input Output 16	VIO18	Open
104	GPIO82	I/O	General Purpose Input Output 82	VIO18	Open
105	VGP2	P	Output voltage VGP2	1.2/1.3/1.5/1.8/ 2.0/2.5/2.8/3.0V	Open
106	GPIO15	I/O	General Purpose Input Output 15	VIO18	Open
107	GPIO19	I/O	General Purpose Input Output 19	VIO18	Open
108	SUB_PDN	I/O	General Purpose Input Output for sub camera powerdown	VIO18	Open
109	SUB_RST	I/O	General Purpose Input Output for sub camera reset	VIO18	Open
110	MAIN_PDN	I/O	General Purpose Input Output for main camera powerdown	VIO18	Open
111	MAIN_RESET	I/O	General Purpose Input Output for main camera reset	VIO18	Open
112	SDA0	I/O	IIC0 data	VIO18	Open
113	SCL0	I/O	IIC0 clock	VIO18	Open
114	CMMCLK	I/O	Master clock to sensor	VIO18	Open
115	NC				
116	CMMCLK1	I/O	Master clock1 to sensor	VIO18	Open
117	VCAM_AF	P	Output Voltage for Camera AF	1.2/1.3/1.5/1.8/ 2.0/2.8/3.0/3.3 V	Open
118	VCAMD	P	Output Voltage for Camera DVDD	1.2/1.3/1.5/1.8V	Open

119	VCAMA	P	Output Voltage for Camera AVDD	1.5/1.8/2.5/2.8V	Open
120	VGP3	P	Output Voltage VGP3	1.2/1.3/1.5/1.8V	Open
121	RDN1_A	DI	CSI1 lane 1 N	VIO18	Open
122	RDP1_A	DI	CSI1 lane 1 P	VIO18	Open
123	RDN0_A	DI	CSI1 lane 0 N	VIO18	Open
124	RDP0_A	DI	CSI1 lane 0 P	VIO18	Open
125	RCN_A	DI	CSI1 CLK lane N	VIO18	Open
126	RCP_A	DI	CSI1 CLK lane P	VIO18	Open
127	GND	G	Ground		GND
128	RDP1	DI	CSI0 lane 1 P	VIO18	Open
129	RDN1	DI	CSI0 lane 1 N	VIO18	Open
130	RDP3	DI	CSI0 lane 3 P	VIO18	Open
131	RDN3	DI	CSI0 lane 3 N	VIO18	Open
132	RDP0	DI	CSI0 lane 0 P	VIO18	Open
133	RDN0	DI	CSI0 lane 0 N	VIO18	Open
134	RDP2	DI	CSI0 lane 2 P	VIO18	Open
135	RDN2	DI	CSI0 lane 2 N	VIO18	Open
136	RCP	DI	CSI0 CLK lane P	VIO18	Open
137	RCN	DI	CSI0 CLK lane N	VIO18	Open
138	GND	G	Ground		GND
139	NC				
140	GND	G	Ground		GND
141	GND	G	Ground		GND
142	GND	G	Ground		GND
143	GND	G	Ground		GND
144	GND	G	Ground		GND

145	GND	G	Ground		GND
146	GND	G	Ground		GND
147	GND	G	Ground		GND
148	GND	G	Ground		GND
149	GND	G	Ground		GND
150	GND	G	Ground		GND
151	GND	G	Ground		GND
152	GND	G	Ground		GND
153	GND	G	Ground		GND
154	GND	G	Ground		GND
155	GND	G	Ground		GND
156	GND	G	Ground		GND

Table 2-2　Pin Type Description

P:POWER	AI:ANALOGY INPUT
G:GROUND	AO:ANALOGY OUTPUT
I:INPUT	DI:DIGITAL INPUT
O:OUTPUT	DO:DIGITAL OUTPUT
ANT:ANTENNA	DIO:DIGITAL INPUT OUTPUT
NC:NOT CONNECT	AIO:ANALOGY INPUT OUTPUT

Notes：For more details, Please refer to the document“M1506_PIN_Application_Spec”.

2.3 Package Information

2.3.1 Dimensions

The M1506 mechanical dimensions are described as following figure (Top view, Side view).

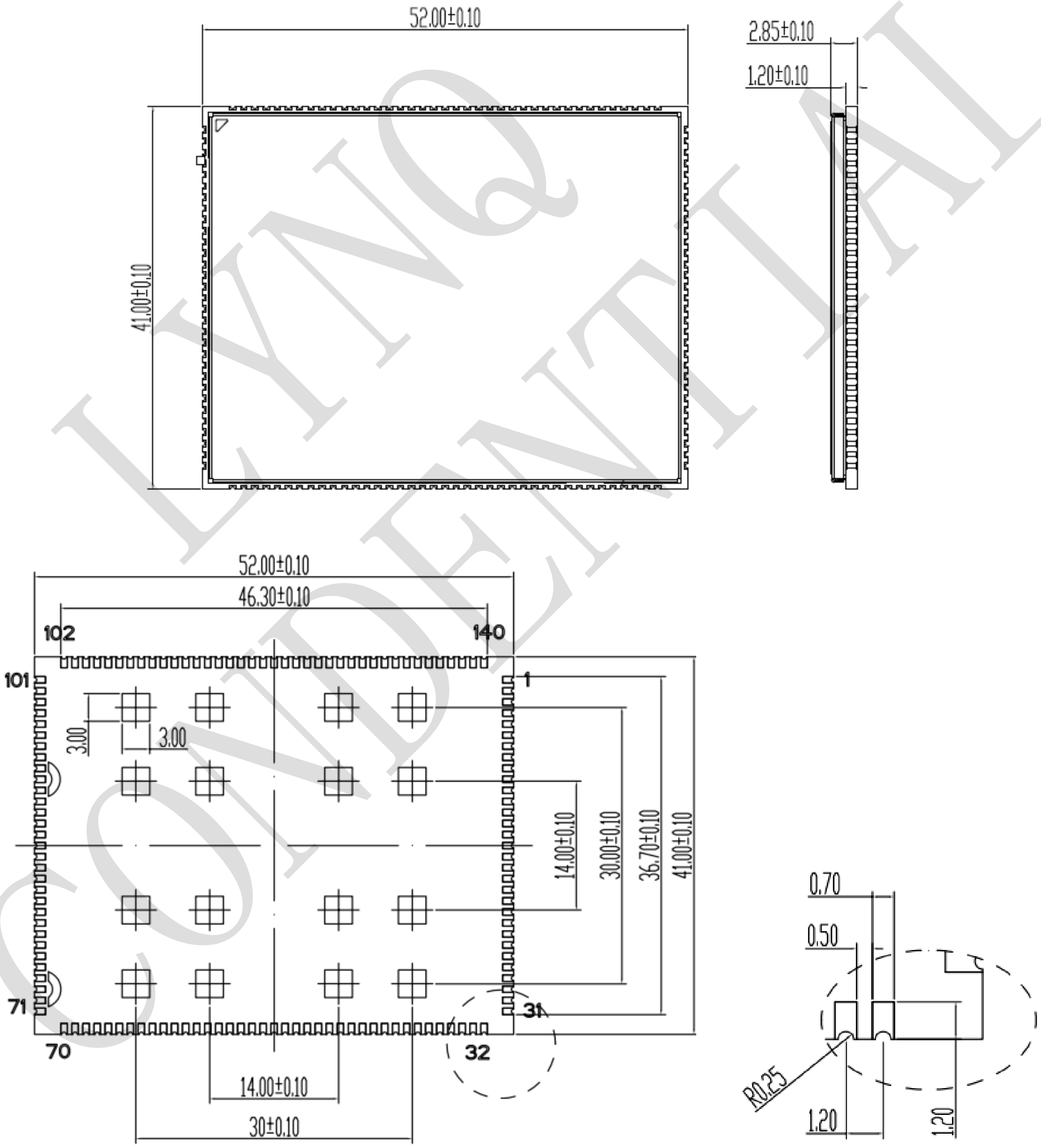


Figure 2-2 Mechanical Dimensions (Unit: mm)

2.3.2 Recommend Pad

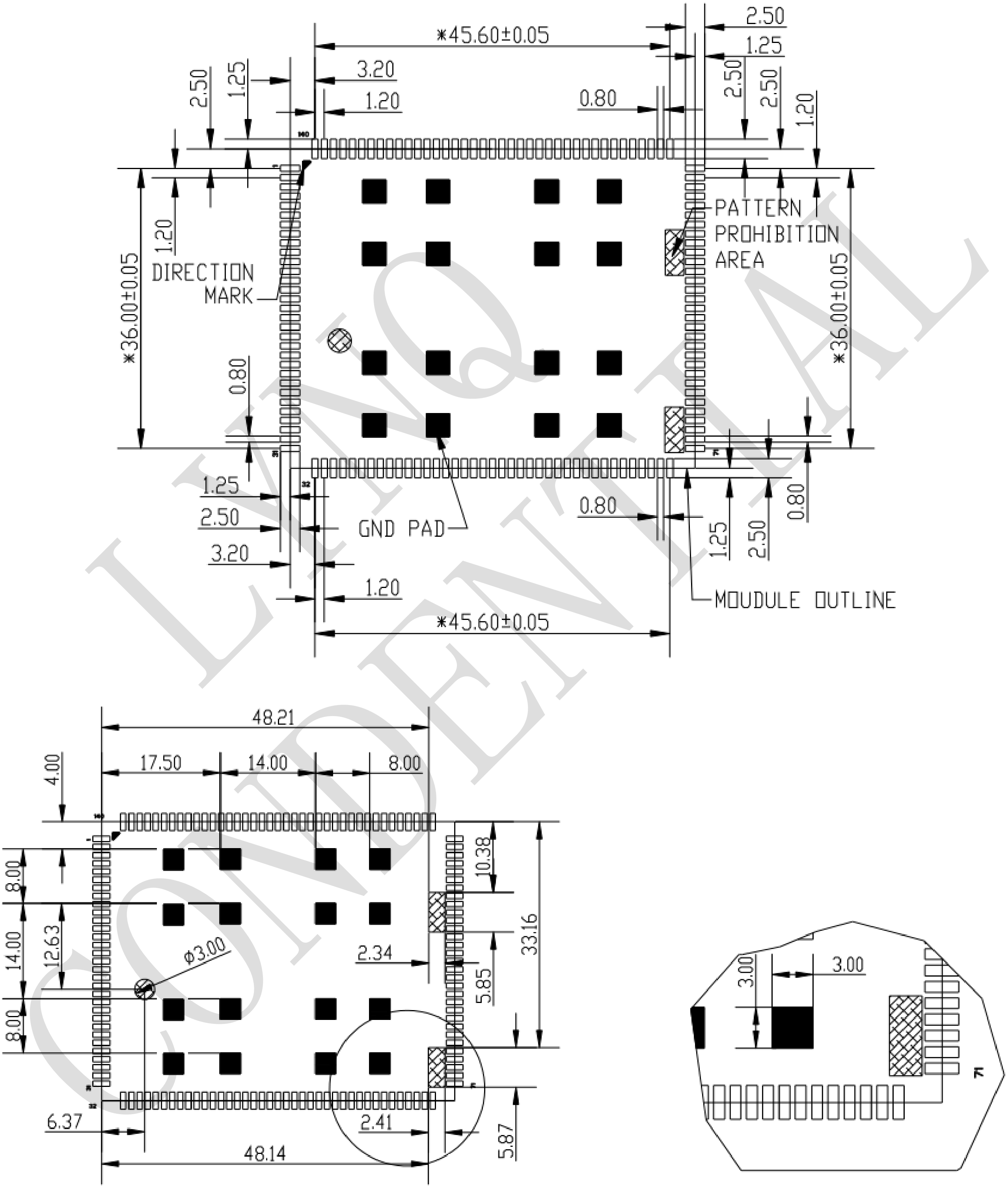


Figure 2-3 Recommend Pad

3. Interface Circuit Reference Design

3.1 Power Section

3.1.1 Power Supply

VBAT is the main power supply of the smart module, and the input voltage range is 3.5V to 4.35V. The recommended voltage is 4.0V. Because the module transmit burst may cause voltage to drop, the highest current peak will reach 2.5A（RF max current will be about 2A, and add the current of other parts of system working）.A large capacitor is recommended to be used near VBAT pins, and the bigger of the capacitor's value is the better. In order to improve the continued flow of large current, it is recommended to use a low-impedance tantalum capacitor 470uF or larger. During layout, the capacitors are close to the VBAT pins.

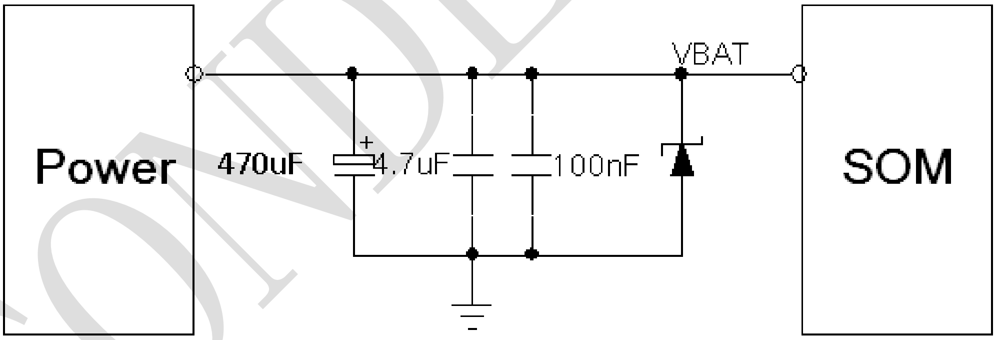


Figure 3-1　Reference circuit of the VBAT input

Notes: According to the environment, please select capacitor as large value as possible; and add 100pF, 33pF capacitors if requiring.

Add Ziner close to our SOM. The ziner should be 5.1V/500mW, Ir<100uA @Vr=4.2V. Ta=25℃。

The Panel of Battery should be close to SOM and the Layout of VBAT should be far away from the RF parts. The width of VBAT should be enough for 3A current. We suggest the width over 3mm and the power plane should be integral with enough GND vias.

VBAT_M and BAT_ON are battery positive and sense pins. CS_P and CS_N are battery power detection signals, and they should be differential traces.

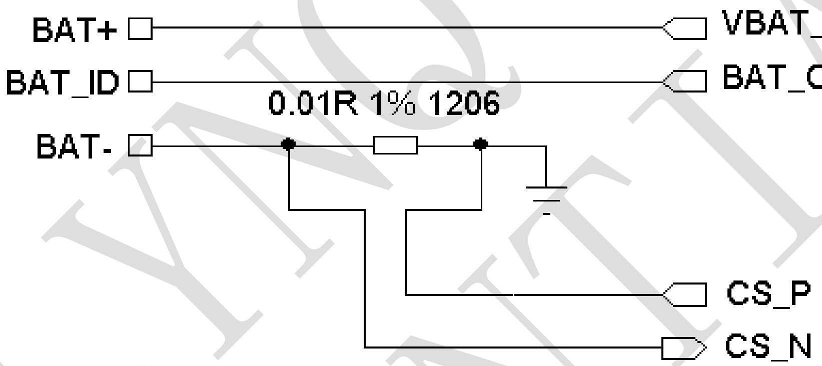
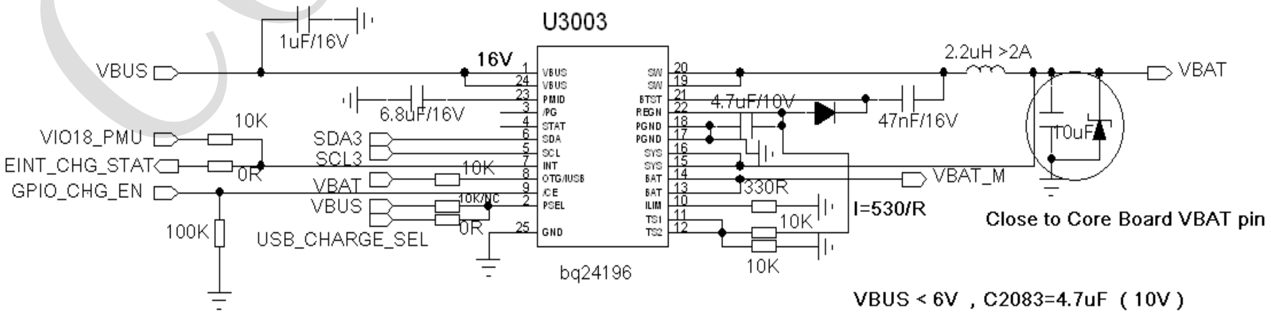


Figure 3-2 battery current detection circuit

3.1.2 Charge

BQ24196 is a USB charging IC, and lithium batteries can be charged. The maximum current for USB OTG can be provided for 500mA. ISENSE and BATSNS are battery current detection signals, with two 0Ω resistors closely connected to VBAT_M and VBAT pin.



Close to Core Board VBAT pin

OTG Pin for OTG current: High--500mA; Low--100mA

VBUS < 6V , C2083=4.7uF (10V)
VBUS > 6V , C2083=1uF (10V)

Figure 3-3 charging circuit

Notes: If customers don’t use electricity quality detection function, BANSNS pin should be pulled up to VBAT. Or else, it will affect the download and power on.

3.1.3 Hardware Power On/Off

Module 28-pin is the Power on/off key. Pulling down the PWRKEY at least 3-5 seconds and then releasing, the module will boot. There is internal pulled-up resistor.

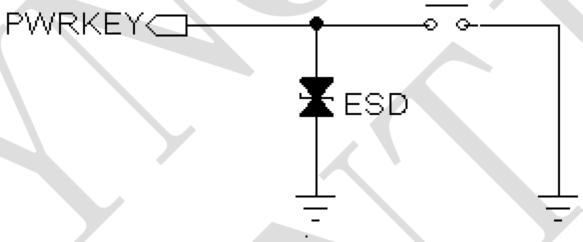


Figure 3-4 Turn on circuit

This net can also be used for hardware reset. When this pin has been pulled down over 11 seconds, the SOM will reset.

3.1.4 Handware Reset

Pin26 is for handware reset. When this pin is pulled down to GND, the SOM will shut down. It is internally pulled-up to 1.8V.

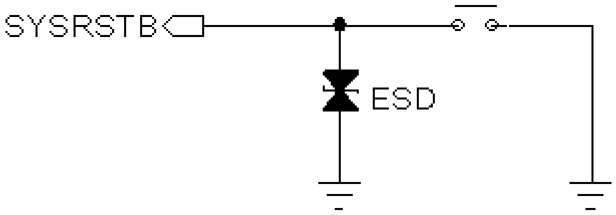


Figure 3-5 Reset key

Notes: SYSRSTB can make the SOM power off, not reset the SOM.
Long press of Power key can reset the SOM.

3.1.5 VRTC

The VRTC supply the power of the internal RTC circuits. The SOM has a 22uF capacitor internally, which can support the time information when the battery missing. However, the capacitor can only support about 10 seconds. If need longer time, a backup battery will be needed.

3.2 Audio Section

The SOM support several audio inputs and outputs, which can meet different audio demands. The audio must take the differential layout and must be protected by GND around it. The audio layout should be not parallel to other layout of power or high speed routes.

3.2.1 Audio input

Audio input includes main MIC, sub MIC and headset MIC.

(1) The SOM has MIC_BIAS signal. The circuits of Silicon MIC and common MIC are shown below. MIC signal needs differential traces.

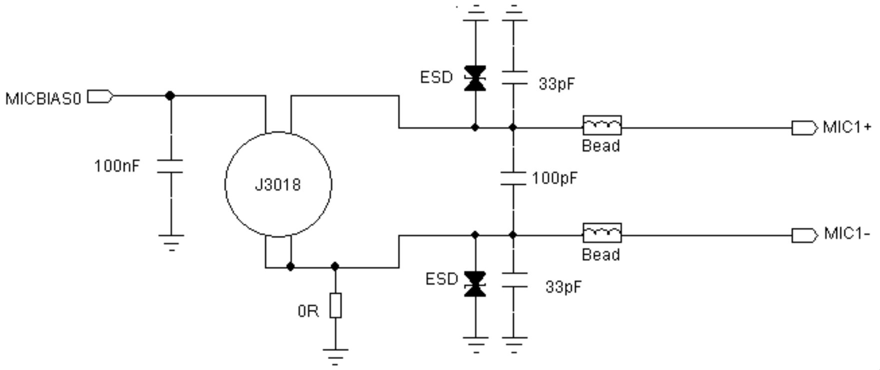


Figure 3-6 Main Silicon Mic circuit

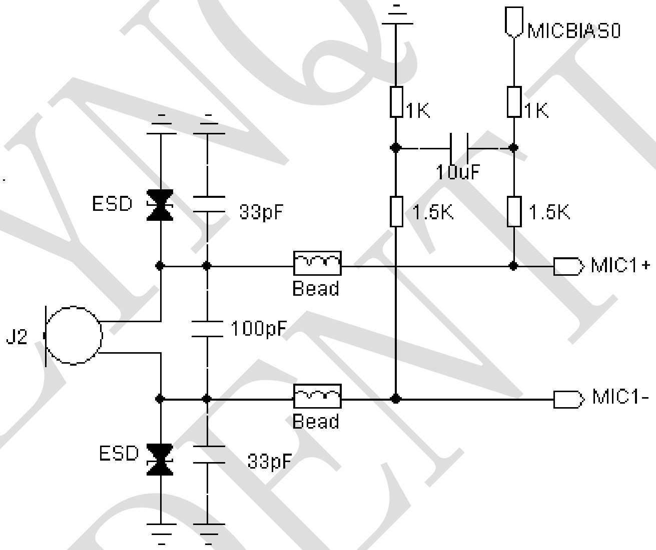


Figure 3-7 Main common MIC circuit

(2) The Sub circuit of the second MIC is same as the Main MIC circuit.

The signals of sub MIC are MIC2+/MIC2-.

Notes: Double MIC has the noise-depression function only in the receiver state. It doesn’t work in handfree, network call, recording state. It is stereo in recording state.

(3) Headphone reference circuit is shown below. Different components should be selected using American standard and European standard headset according to the actual needs. FM_RX_N_FPC and FM_ANT_FPC signals are the radio antenna.

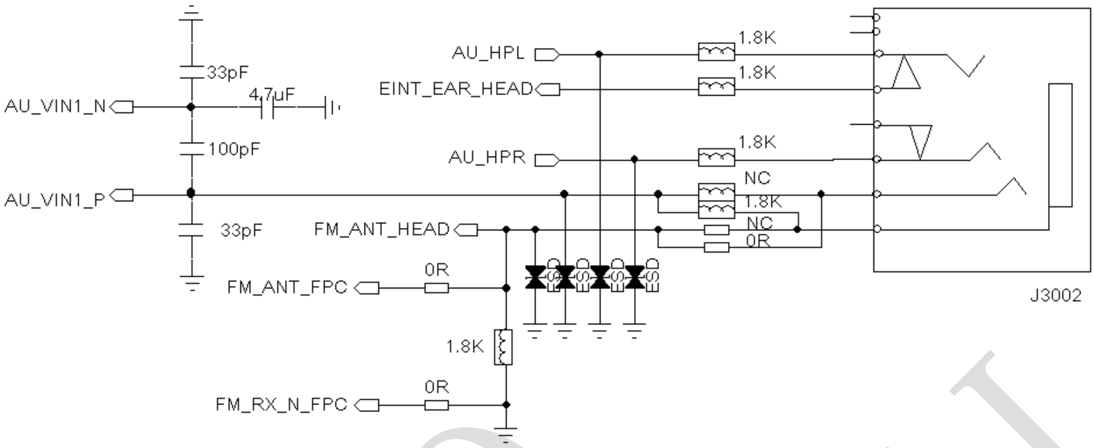


Figure 3-8　Headphone reference circuit

Notes：1.8K Bead can’t be changed to 1.8K resistor.
Bead can help to strong the FM ANT performance.

3.2.2 Audio output

Audio output includes receiver and headset. Speaker circuit uses headset signal as the audio input, and add an external audio PA to come true.

(1) The receiver signals take the differential layout and connect directly to the device;

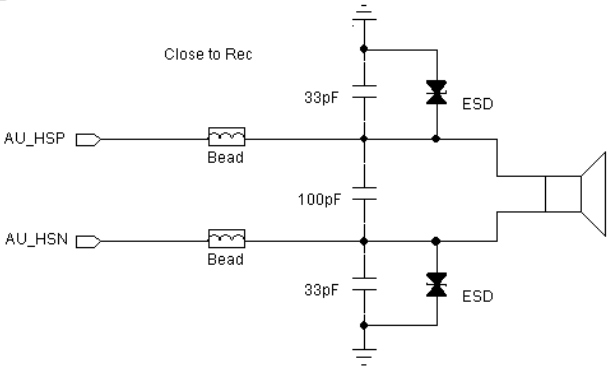


Figure 3-9 Receiver circuit

(2) Speaker circuits use the sixth generation of K class music amplifier AW8736 single-ended input mode, with a gain of 16 and a power of 0.8W, 1W or1.2W. A speaker over 0.7W is recommended.

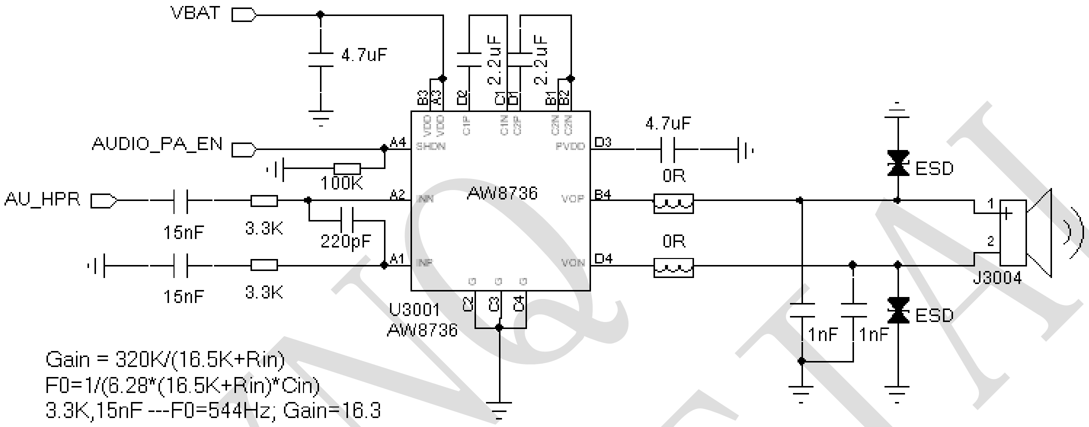


Figure 3-10 Speaker amplify circuit

(3) Headphone reference circuit refers as figure 3-8.

3.3 Interface Section

The SOM has many peripheral interfaces like Antenna, TP, MIPI LCM, MIPI camera, USB, UART, dual SIM cards, TF card, SPI, Motor and keys.

3.3.1 Antenna Interface

(1) Main antenna

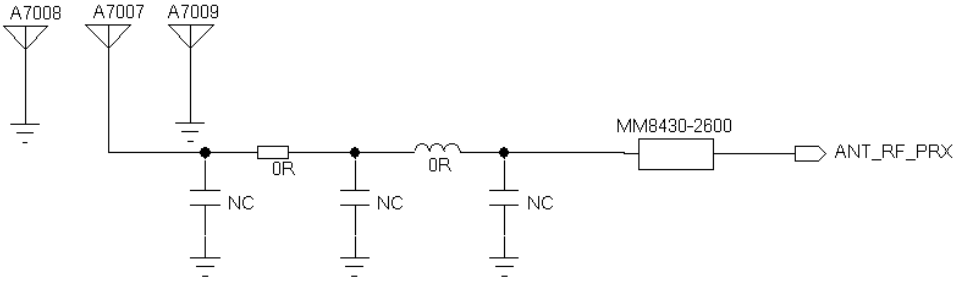


Figure 3-11 Main antenna

(2) WIFI/BT ANT

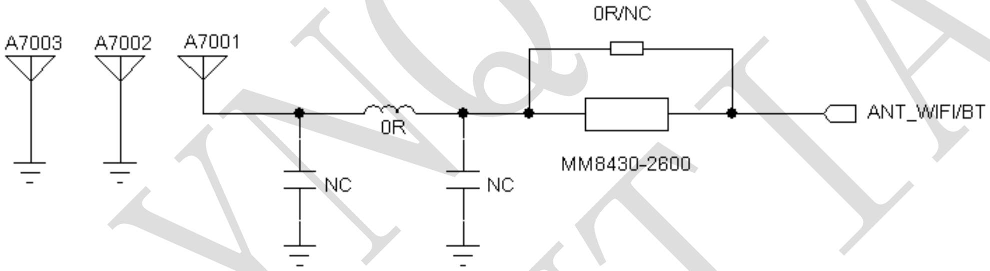


Figure 3-12 WIFI/BT ANT

（3）GNSS ANT

ANT_GPS PI-type matches network connect to a coaxial connector or antenna contact, with the trances required by the 50-ohm impedance

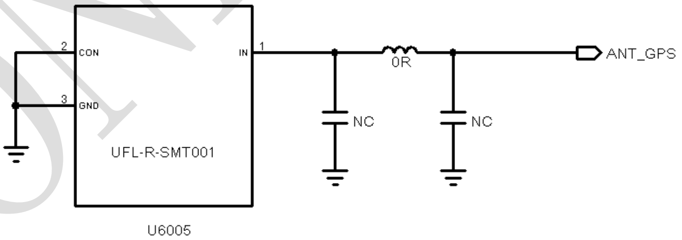


Figure 3-13 GNSS ANT

(4) FM_ANT_FPC is FM antenna pad, which is compatible with the headset.

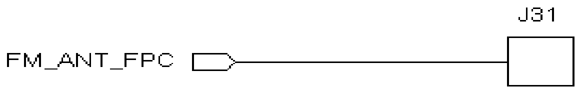


Figure 3-14　FM internal ANT

3.3.2 Display and CTP Interface

The SOM only support MIPI_DSI interface, which be up to HD (1280*720) resolution.

(1) MIPI interface and backlight driver

DISP_PWM0 is the duty cycle signal to adjust the brightness of the screen. and a high level greater than 1.4V can enable the backlight.

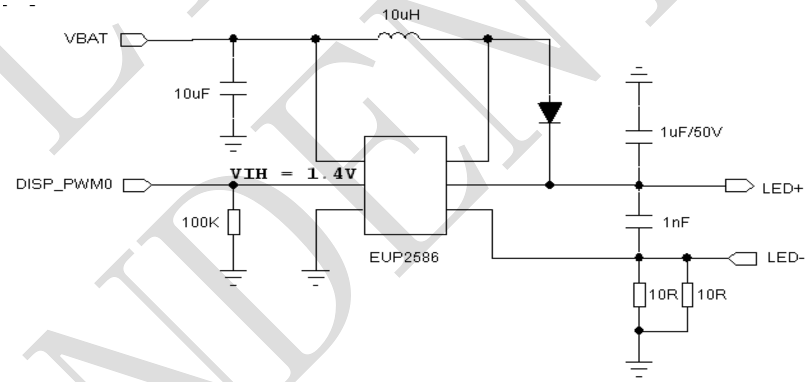


Figure 3-15　MIPI backlight driver circuit

MIPI screen is connected to the connector. The capacitor should be placed close to the power. Avoiding the current leakage, VIO18 and VIO28 are suggested to use external controllable LDO.

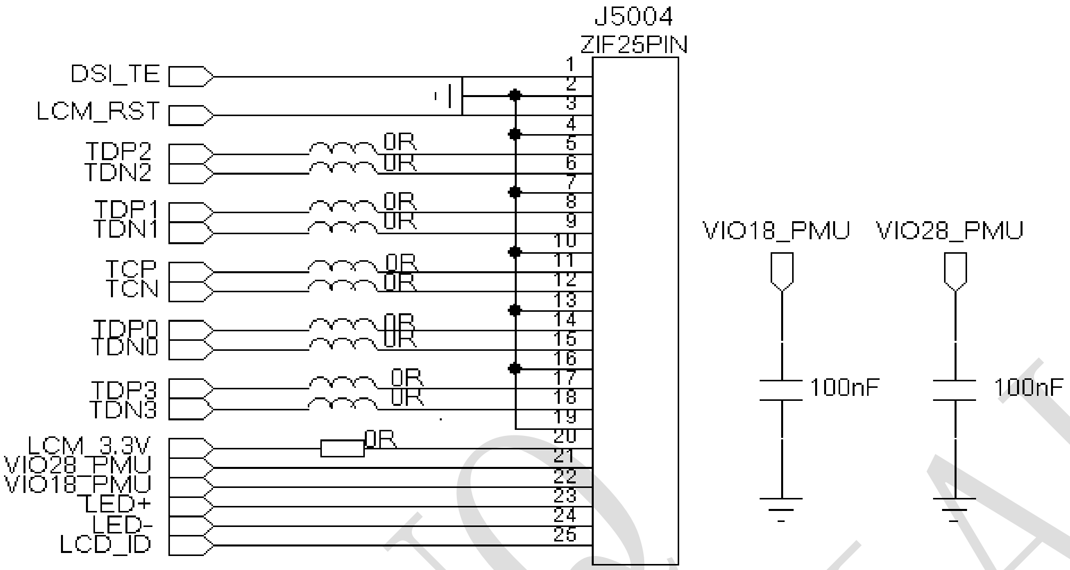


Figure 3-16 MIPI connector

Notes: Module only supports MIPI LCM. It should add MIPI to LVDS or MIPI-RGB IC for the LVDS and RGB interfaces.

Some LVDS pins may be 3.3V so level shift would be needed in this condition.

Based on your system level design, please add common-mode filter for better performance.

(2) TP interface

Each TP signal is suggested to connect a test point for the measurement.

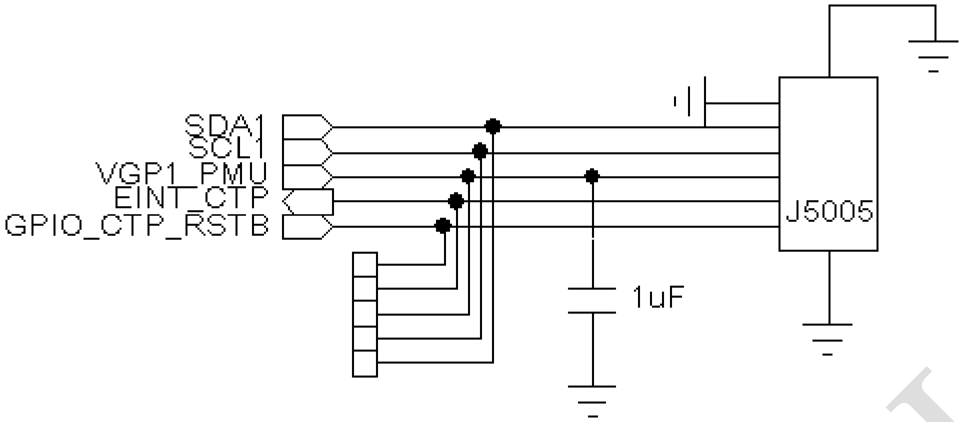


Figure 3-17 TP connector

3.3.3 Camera Interface

Camera supports MIPI interfaces. It can support two cameras with 8M and 5M. Please refer to the AVL of MTK to prepare your peripheral module.

(1) Main camera

It supports 4-Lane camera.

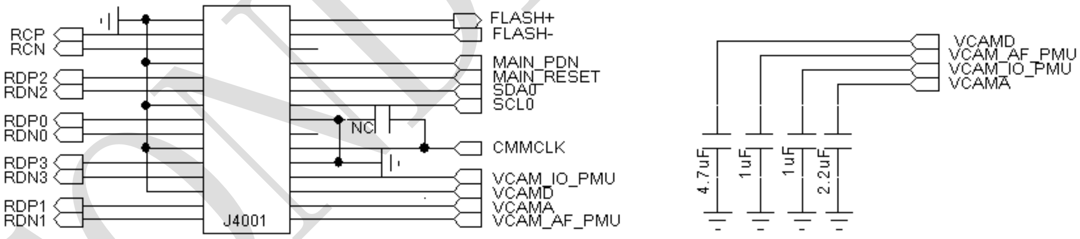


Figure 3-18 Back Camera circuit

(2) Sub camera

Front camera can support 2-Lane module..

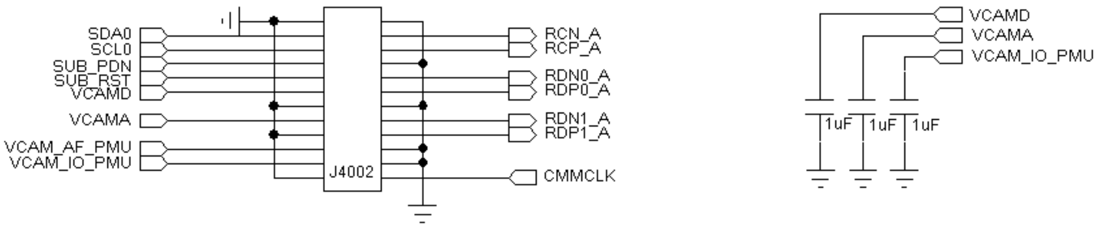


Figure 3-19　Back Camera circuit

(3) Camera power

VCAMA ,VCAMD, VCAM_AF, VCAM_IO please refer to “M1506_PIN_Application_Spec”.For better performance, an external LDO is good select.

Note：M1506 don’t support PIP function (picture in picture).

3.3.4 SIM interface

SOM supports 1.8V/3.0V SIM card, which is dual card and dual standby.

In bad condition, SIM signals need to increase the ESD protection Components close to SIM cards.

When NFC used with SIM-coded, VSIM1_NFC and SIM1_NFC_SWP2 are compatible with this usage.

SIM1_SCLK signal should be protected. SIM2 is the same as SIM1.

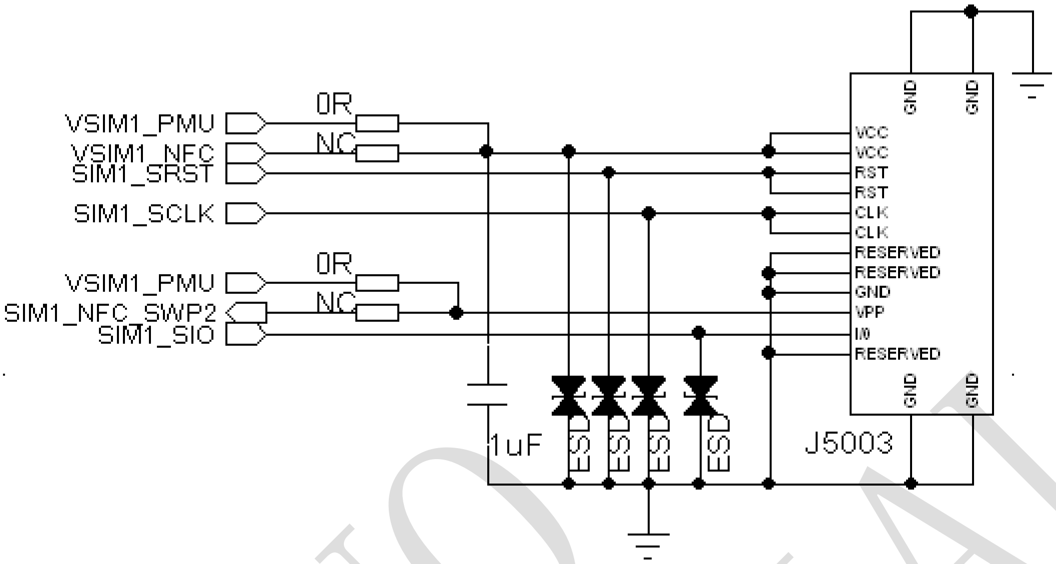


Figure 3-20 SIM card circuit

Notes: The capacity value of ESD components should be under 22pF. However, as NFC function, the value of ESD components alone NFC_SWP should be under 0.5pF.

If need SIM hot plug, please use the exclusive pin136.

SIM_CLK should be protected around by GND.

3.3.5 TF card interface

The SOM support 4-bit SD interfaces and SDIO2.0. Each TF signal should be protected by ESD components close to the connector. MSDC1_CLK signal should be protected by GND.

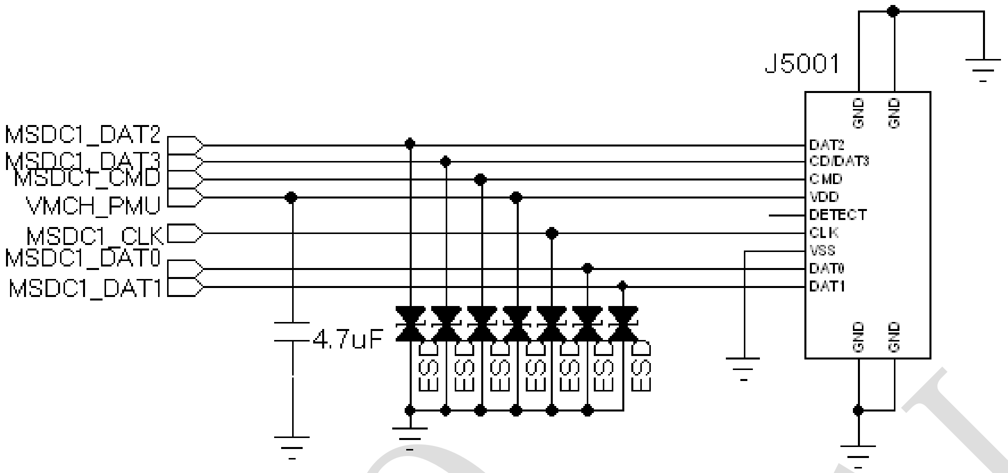


Figure 3-21 TF card circuit

Notes: The capacity value of ESD should be under 10pF. However, as NFC function, the value of ESD should be under 0.5pF.

3.3.6 USB Interface

The SOM can download and transfer the data through USB interface. The circuit is as follows.

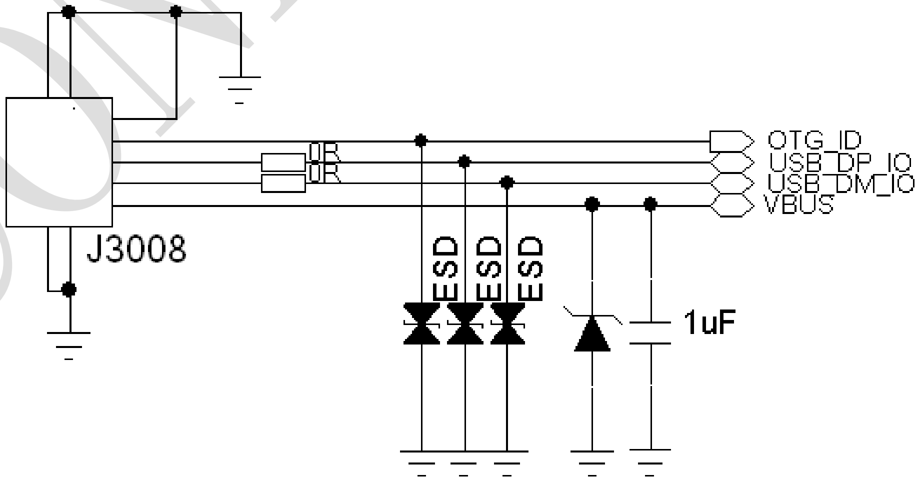


Figure 3-22 USB circuit

Notes：Select suitable voltage of ESD components alone VBUS; Capacitance value of DP/DM ESD should be under 3pF.

USB routes should be differential and controlled with 90ohm resistor. It also should be protected around by GND and not be crossed with other routes.

Under the condition of supporting the USB OTG, a DCDC 5V Voltage output is demanded and the DCDC uses USB_DRVVBUS to enable. The Demo uses the BQ24196 to supply the 5V.

3.3.7 UART Interface

Module provides 3 UART serial ports. Serial port 1 is for the system debugging. Because the module's serial port is 1.8V level, it should pay attention to match the IO level.

Notes: The voltage of Uart is 1.8V so a level shift is needed for the UART using.

Similarly another level conversion connects to the DB9 connector through the 232 level shift IC.

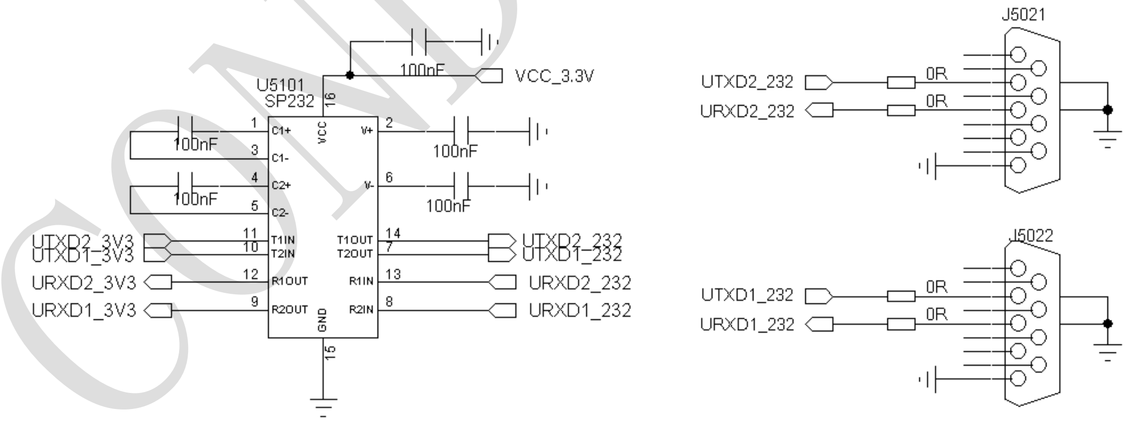


Figure 3-23 UART communication circuit

3.3.8 IIC interface

The Module can support 3 groups of IIC interfaces which are pulled up internally. IIC0 is pulled by VCAM_IO, and others are pulled by VIO18;

Different IIC is suggested to use different function, seeing as follow table. Please note the IC address alone eacg IIC can't be the same.

Table 3-3 IIC Function selection

IIC0	Rear Camera w AF Front Camera w/o AF	Open drain type
IIC1	CTP Charge	Open drain type
IIC2	Mems sensors Flashlight driver	Open drain type

3.3.9 SPI interface

The module supports one SPI interface and is master device in default.

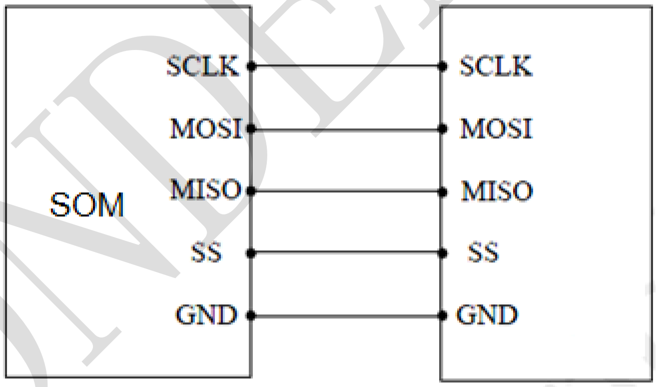


Figure 3-24 SPI connecting

Notes: SPI and IIC interfaces are 1.8V. If level required, please use level shift.

3.3.10 Motor interface

The motor circuit is pretty simply only with a voltage supply.

If the motor is close to ANT, please add 33pF capacity avoiding the motor's effect to the antenna.

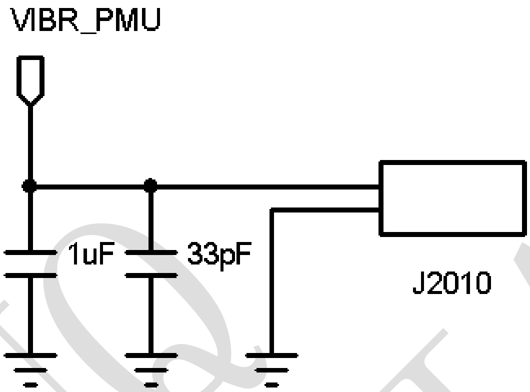


Figure 3-25 Motor circuit

3.3.11 Key interface

The module supports 2*2*2 keys. KCOL0~1 and KROW0~1 can also be extended dual keys. The figure is as follows, and the resistor is 20KR.

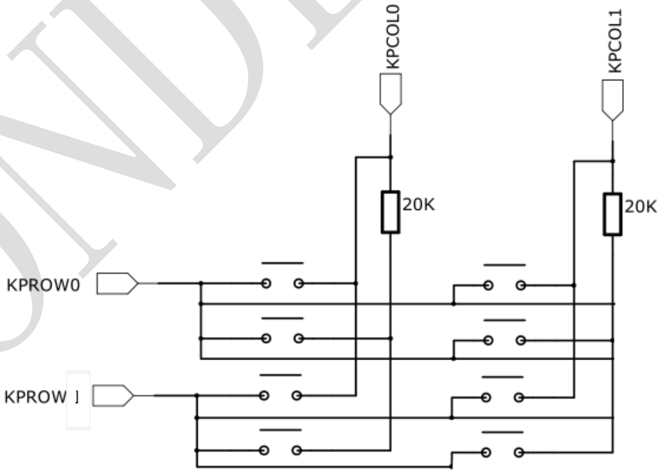


Figure 3-26 Keys

Notes：　Suggest our customers to reserve test point of KCOL0 or use KCOL0 as an external key. When our customers have downloaded other software, KCOL0 connected to GND can help to download new software. However, it is scare to meet that.

3.3.12 ADC interface

The module supports two ADC ways. One detects the battery temperature through pin68 BAT_ON, and another detects the photo resistance and LCM ID through Pin60 ADC;

The Max voltage of ADC is 1.8V with 12-bit accuracy.

Table 3-4　ADC value

Parameter	**Min.**	**Typ.**	**Max.**	**Symbol**
Voltage	0.05		1.8	V

Notes: The Max voltage of ADC is 1.8V with 12-bit.

4. Electrical Characteristics

4.1 Electrical Characteristic

Table 4-1 Electrical Characteristic

Power	Min.	Nom.	Max	Unit
VBAT	3.5	4.0	4.35	V
Peak current	-0.3	-	2.5	A

Notes: The over-low voltage can't power on the module; Over-high voltage may be danger to damage the module.

Using the DCDC supply, please ensure the capacity of DCDC over 2.5A. We don't suggest the LDO as the power supplier.

4.2 Temperature

Table 4-2 Temperature Characteristic

State	Min.	Nom.	Max	Unit
Working	-30	25	75	℃
Storage	-40	25	85	℃

Notes: When the temperature is over the range, the RF performance may be dropped. It also may cause power down or restart problem.

4.3 Power-on Sequence

The power-on/off sequence is shown in the following figure:

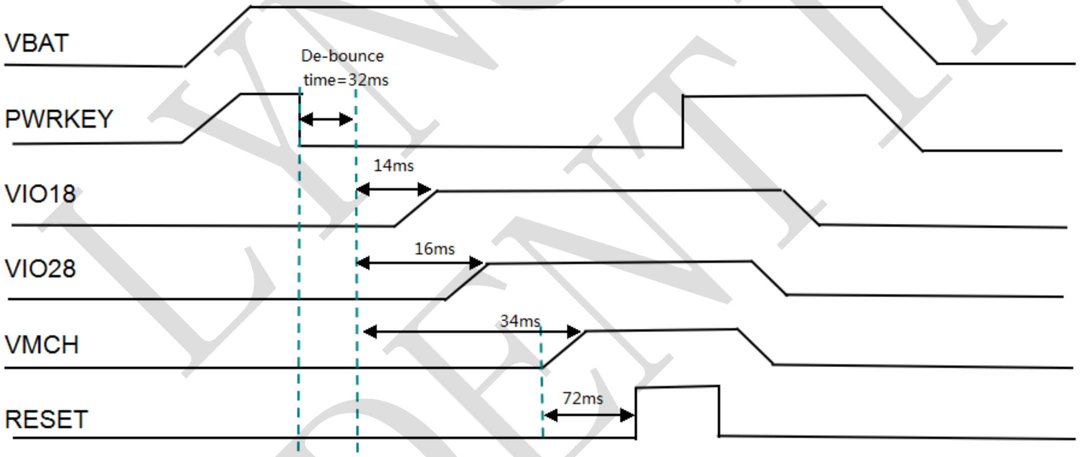


Figure 4-1: The power-on/off sequence by pressing PWRKEY

4.4 Digital IO characteristic

Table 4-3 Digital IO Voltage

Parameter	Description	Min.	Typical	Max.	Unit
VIH	High level input voltage	1.62	1.8	1.98	V
VIL	Low level input voltage	0	-	0.7	V
VOH	High level output voltage	1.62	1.8	1.98	V

VOL	Low level output voltage	0	-	0.3	V

Notes: suit to all GPIO, IIC, UART, SPI interfaces.

4.5 Power consumption

Table 4-4 Power Consumption

Parameter	Conditions	Min.	Typical	Max.	Unit
Minimal current	Power off mode	-	0.2	-	mA
	Flight mode Suspend state	-	2.12	-	mA
	Single SIM Standby (WCDMA)	1.62	3.23	-	mA
	Single SIM Standby (GSM)	1.62	3.25	-	mA
	Dual SIM Standby (WCDMA +GSM)	-	5.0	-	mA
	WiFi on Standby	-	3.46	-	mA
	GPS on standby at Flight mode	-	2.17	-	mA
	IDLE mode W/O LCM	-	37.3	-	mA
Working current	2G talking mode (GSM900 PCL=5)	-	257.8	-	mA
	2G talking mode (GSM1800 PCL=0)	-	187.5	-	mA
	3G talking mode (Band1 23dBm)	470	541	-	mA
	WiFi FTP Download (802.11n)	-	90.7	-	mA
Peak current	Max power mode burst current		-	2.5	A

4.6 ESD protection

The module contains high sensitive electronic circuits and is an Electrostatic Sensitive Device. More attentions should be paid to the procedure of handling and packaging. The ESD test results are shown in the following table.

Table 4-5 ESD Performance

PIN	Contact discharge	Air discharge
VBAT	±4KV	±8KV
GND	±4KV	±8KV
RF_ANT	±4KV	±8KV

ESD performance（Temperature:25℃,humidity:45%）

The methods to strengthen the ESD performance are as follows:

1. The metal of LCM should be connected well to GND; The FPC of LCM should be covered by shaded films which must be connected well to GND;
2. Reserve ESD on the CTP circuits.
3. If a converted board is added, it should have enough GND pins and be equally distributed. And the Layout of GND should be enough wide.
4. Floating small board (like key or led board) should be connected well to GND;
5. Keys should be increased ESD components. The routes of power key and reset key should be far away from the sides of the board.
6. The audio circuits should be added ESD components close to audio peripherals. If using TVS components, TVS should be bi-directions.
7. USB, UART and other plug-in cable should be increased ESD components. Other control signals pulled out from the machine should also be added the ESD components.
8. SIM and TF card should be added ESD protect.
9. External Antenna should be added ESD protect.

Notes: For ESD protect, please add ESD methods according to upper ways.

High speed circuits like USB, TF and SIM card should be added ESD with low capacity value. Please note the voltage of ESD used in power like VBUS.

ESD components have Varistor and TVS. For better performance, please use TVS.

5. RF Features

5.1 RF Features Introduction

The main RF characteristics of the product are as follows:

a) Support GSM/GPRS/EDGE Band 2/3/5/8;

b) Support UMTS/HSPA Band 1/2/5/8;

c) GPRS/EDGE Class12;

d) HSUPA Cat.6 / 5.76Mbps,

HSDPA Cat.14 / 21Mbps;

The operating frequency range of the product is shown in table 5-1.

Table 5-1 Working band

Working band	**Uplink**	**Downlink**
UMTS850	824 MHz — 849MHz	869 MHz — 894 MHz
UMTS900	880 MHz — 915 MHz	925 MHz — 960 MHz
UMTS1900	1850 MHz — 1910 MHz	1930 MHz — 1990 MHz
UMTS2100	1920 MHz — 1980 MHz	2110 MHz — 2170 MHz
GSM850	824 MHz — 849 MHz	869 MHz — 894 MHz
GSM900	890 MHz — 915 MHz	935 MHz — 960 MHz
GSM1800	1710 MHz — 1785 MHz	1805 MHz — 1880 MHz
GSM1900	1850 MHz — 1910 MHz	1930 MHz — 1990 MHz

5.1.1 WLAN

The main WLAN features of the product are as follows：

a) Support 802.11 b/g/n, 2.4GHz WIFI;

b) Support WIFI, Bluetooth single antenna design;

c) Support 2.4GHz max15dBm transmit power;

d) Support power control by internal detection;

e) Support self-calibration;

5.1.2 Bluetooth

a) Support Bluetooth V2.1+EDR;

b) Support Bluetooth V3.0;

c) Support Bluetooth V4.0+LE;

d) Support CLASS 1 Bluetooth transmission power rank;

5.1.3 FM

a) Support FM 65-108MHz Band，50KHz stepping;

b) Support RDS/RBDS;

c) Support FM 2-wire bus;

d) Support fast search;

5.1.4 GNSS

a) Support GPS(WAAS/MSAS/EGNOS/GAGAN)

b) Support full A-GPS capability (E911/SUPL/EPO/HotStill);

c) Support active / passive antenna;

d) 5Hz update rate;

e) With built-in LNA ;

5.2 RF Circuit Design

The connecting part of the radio frequency antenna of the product supports the PAD welding disc form;

The antenna interface between the core plate antenna and the customer main board is welded by the welding plate. Then it is connected through a microstrip line or a strip line. Which is designed by the characteristic impedance of 50 ohm, the length of the line is less than 10mm, and the L - type matching circuit is reserved.

This product antenna peripheral circuit design, the proposed RF circuit Layout program: RF line trances top layer, a reference to the second layer. Users need to pay attention to the design of the PCB line: to ensure the RF has full reference GND layer.

If the main antenna path is longer (more than 10mm), it is recommended to use the RF connector (Figure 5-1), with the cable (Figure 5-2). The corresponding RF interface cable is suggested to use W.FL-LP-04N of HRS company. By this way, the antenna RF connector can be directly clamped on the RF test seat, which can realize long distance switching between RF antenna port and the interface of module.

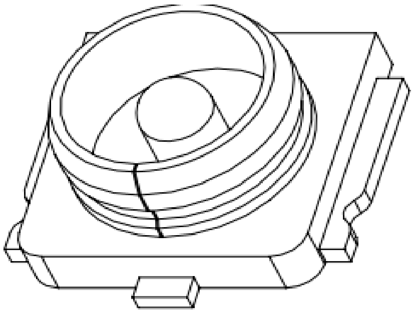


Figure 5-1 RF connector

Figure 5-2 RF cable

5.3 Initial attention to antenna design

a) Pre project evaluation

First, the choice of antenna position should ensure the antenna and the base station in the horizontal direction so produced maximum efficiency; second, Away from the switch power supply, data line, chip to place. At the same time, it should be avoided that the hand can be placed in the position of the antenna, which prevents the human body to produce attenuation; moreover, it must be considered to reduce the radiation and the structure of the realization. Therefore, in the design of the initial need for structure, ID, circuit, antenna engineers together to evaluate the layout.

b) Antenna placement

Ensure the isolation between Main_ANT and WLAN_ANT, and ensure that the isolation. It is better to put an antenna each corner.

c) Antenna occupancy space recommendations

WLAN_ANT area > 35mm (length) * 8mm (width) * 3mm (thick); the main antenna Main_ANT area > 50mm (length) * 10mm(width) * 5mm (thick), the projection zone of the antenna for clearance, the peripheral antenna without conductive material.

d) SOM Layout

The experimental results show that the module is placed in the disturbed area, resulting in poor performance. Design is best when the module and the main board PCB separation, rather than on the main board. If you cannot make the separation, the module should be as far as possible from the chip and memory, power interface, data cable interface, camera FPC, screen FPC, connector FPC, and other possible EMI modules and devices. If close to the interference, It needs to set aside EMI devices in the interface, and FPC needs double brush shield connected to the ground.

e) Antenna RF connector

Antenna RF cable traces should be as short as possible. 10mm can take the line, more than 10mm need to refer to the use of connector. Taking the transmission loss into account, we propose the use of a thick point of RF line. At the same time, it should be far away from the chip , memory, power supply interface, data interface and so on ,which may produce EMI module and device. Connect the antenna with the 3G smart module of the RF connecting line is short and straight. Can't traces at an acute angle, cannot be squeezed, wear; Traces of RF close to the ground of main board as far as possible.

f) Antenna matching circuit

If the RF antenna port of module and the antenna interface need switch, The microstrip or stripline between the test seat and the antenna interface must designed impedance 50 ohm and reserved double L type matching circuit.

g) Selection of coaxial cable and RF connector

Antenna RF connection line usually use GBE in Taiwan (TW) and Shenyu, you can also consider Japan Somitomo, Shin DIN.4G antenna RF cable is generally used 1.37mm wire diameter. Antenna RF connectors generally used in Japan IPX, but also the use of HRS, but the price is a little high.

6. Storage and Production

6.1 Storage

The rank of moisture proof of the SOM is level 3. There is an obvious sign on the table of the internal and the external packaging.

In the vacuum sealed bag, the SOM can be stored for 120 days when the temperature is 18～28℃ and the humidity is 40~65%.

6.2 Production

The SOM is a humidity sensitive device. If the device needs reflow soldering, disassembly and maintenance, we must strictly comply with the requirements of humidity sensitive device. If module is damp, a reflow soldering or using a hot-air gun maintenance will lead to internal damage, because the water vapor has the rapid expansion of the burst, causing physical injury to the device, like PCB foaming and BGA component fail. So customers should refer to the following recommendations.

6.2.1 Module confirmation and moisture

The SOM in the production and packaging process should be strictly accordance with the humidity sensitive device operation. The factory packaging is vacuum bag, desiccant, and humidity indicator card. Please pay attention to the moisture control before SMT and the confirmation of the following aspects.

Product packaging confirmation

In order to ensure quality, smart module uses vacuum packaging and shipment, to avoid the question of SMT and function for the moisture in the air. Therefore, the requirements to confirm for the packaging of products before the SMT are necessary, ensuring the packaging not damaged, vacuum packing not leaks. If there is any breakage and leakage, the Module should be baked, to avoid PCB foaming, BGA chip and RF PA chip fail.

Production cycle confirmation

The customer needs to confirm the production cycle of the product when receiving the product. If it exceed the storage period or the product has been affected with damp, the product must be baked. If the storage time not extended, and after opening the packaging, humidity indicator card is at 10% without discoloration, it indicate good packaging and can be normally used.

Humidity indicator card confirmation

If the module has according to the moisture level 3 processing, and internal packaging have been placed humidity indicator cards, customers should confirm the humidity indicator card before SMT. If the humidity indicator card has changed more than 10%, it need to carry on the material baking.

Baking condition confirmation

The moisture proof level of the smart module is level 3. And the baking conditions are as follows:

Table 6-1 Baking conditions

Baking conditions	**90°/5%RH**	**60°/5%RH（Recommended）**	**40°/5%RH**
Baking time	48 hours	72 hours	30days
Description	not use the original tray	not use the original tray	Can use the original tray

Customers can also choose baking conditions according to their own conditions. But please refer to Level 3 and device thickness 1.4 ~ 2.0mm standard.

> Note: The original anti-ESD tray temperature does not exceed 50 degree. Otherwise the tray will be deformed.
>
> The anti-ESD tray of the original packaging is only used for packaging, and can't be used as a SMT tray.

Factory life confirmation

Module SMT with good humidity control should be completed in 48 hours after opening the package. The unused Module should be vacuum packaging, and placed in a drying box. If exposure to air for more than 48 hours, the module need to be baked. Due to the larger size of the module, damp needs to bake for a long time, and the price is high, so please try to run out after opening the package.

Customer product maintenance

If maintenance module after SMT, it is easy for damp module to damage when removing, so the module disassembly and other related maintenance operations should complete within 48 hours after SMT, or need to bake and then maintenance the module.

Because the module return from the field work can't ensure the dry state, it must be baked in accordance with the conditions of baking, then for disassembly and maintenance. If it has been exposed to the humid environment for a long time, please properly extend the baking time, such as 125 degrees /36 hours.

6.2.2 SMT reflow attentions

The module has the BGA chips, chip resistances and capacitances internally, which will melt at high temperature. If module melt completely encountered a large shock, such as excessive vibration of reflux conveyor belt or hit the board, internal components will easily shift or be false welding. So, using intelligent modules over the furnace need to pay attention to:

- Modules can't be vibrate larger, namely customer requirements as far as possible in orbit (chain) furnace, furnace, avoid on the barbed wire furnace, in order to ensure smooth furnace.

- The highest temperature can’t too high. In the condition that meet the welding quality of customer motherboard and module, the lower furnace temperature and the shorter maximum temperature time, the better.

Some customer’s temperature curve in the line is not suitable, high temperature is too high, and customer motherboard melt good, but non-performing rate is on the high side. Through the analysis of the causes, it found that melt again of BGA components lead device offset and short circuit. After adjusting the temperature curve, it can ensure that the customer’s motherboard the welding quality, and also improve the pass through rate. Non-performing rate is controlled below the 2/10000.

6.2.3 SMT stencil design and the problem of less tin soldering

Part of customers found false welding or circuit short when reflowing. The main reason is module tin less, PCB distortion or tins too large. Suggestions are as follows:

- Suggest use ladder stencil 0.10-0.18mm, which means the region of module is proposed to 0.18mm stencil thickness. Please adjust validation according to the measured thickness of solder paste, the actual company conditions and experience value. The products need to strictly test.

- Stencil: Reference module package, and the user can adjust according to their company experience; Outside of the module, the stencil extends to 0.3mm outside. The GND pads use the net stencil.

In the production process, if you cannot judge the opening or process conditions, you can also contact our sales or after-sales service. We will give specific recommendations according to the actual situation.

6.2.4 SMT attentions

If customer motherboard is thin and slender with a furnace deformation, warping risks, you will be suggested to create "a furnace vehicle" to ensure the welding quality. Other production proposals are as follows:

- The solder pastes use brands like Alfa;
- The module must use the SMT machine mount (important), and do not recommend manually placed or manual welding.
- Please strictly control the pressure and speed in SMT (very important);
- We must use the reflow oven more than 8 temperature zones, and strictly control the furnace temperature curve.

Recommended temperature:

B. constant temperature zone: temperature 160-190℃, time: 60s-100s

E. recirculation zone: PEAK temperature 235-245℃, time over 220℃: 30s-60s

Note: customer's board deformation must be controlled within 0.15mm. By reducing the number of imposition or increasing patch clamp to reduce the deformation.

SOM thickness of the stencil is recommended to be thickened to 0.18mm, and the rest position can be maintained by 0.1mm.