SLM770A Module

Hardware Design Manual

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Revision History

No.	Version	Date	Reason for Revision
1	V1.0	2022-03-30	Created version
2	V1.1	2022-10-21	Modify 3.5.1, 3.6, 3.7, 3.8, 3.12, 6.4 chapter description
3	V1.2	2023-11-29	1. Modify the ADC power domain 2. Modify the RTS and CTS pin descriptions 3. Add the description of PCM interfaces 4. Add audio pin description
4	V1.3	2023-12-14	1. Add the SLM770A-SC model description 2. Improve the description of analog audio 3. Delete the RF reference circuit

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1 Introduction

This document defines the SLM770A module air interface and hardware interface for connecting to customer applications.

This document helps customers quickly understand SLM770A module interface specifications, electrical characteristics, mechanical specifications, and related product information. With the help of this document, combined with our application manual and user instructions, customers can quickly apply the SLM770A module to wireless applications.

SLM770A wireless module is suitable for TDD-LTE/FDD-LTE/WCDMA/TD-SCDMA/EVDO/CDMA/GSM wireless broadband terminal products.

SLM770A can support access rates:

- TDD-LTE:130Mbps/35Mbps;
- FDD-LTE:150Mbps/50Mbps;
- WCDMA up to DC HSPA+: 42Mbps/5.76Mbps;
- EVDO up to EVDO RevA: 3.1Mbps/1.8Mbps;
- TD-SCDMA up to HSPA: 4.2Mbps/2.2Mbps;
- CDMA1x: 153.6kbps/153.6kbps;
- GSM up to EDGE: 236.8kbps/236.8kbps.

SLM770A module can provide voice, short message, address book, GPS/Beidou and other functions while providing high-speed broadband data access. SLM770A module can be widely used in mobile broadband access, video surveillance, security, on-board equipment and other products.

1.1 Safety Information

Observing the following safety information can keep you safe and protect the product and its working environment from potential damage:

	Full attention must be given to driving at all times in order to reduce the risk of an accident. Using a mobile while driving (even with a hands-free kit) causes distraction and can lead to an accident. Stop the car before you make a call.
	Switch off the mobile terminal devices before boarding an aircraft. The operation of wireless appliances in an aircraft is forbidden, so as to prevent interference with communication systems. Ignore the note will threaten flight safety or even break the law.
	Pay attention to restrictions on the use of mobile terminal devices in hospitals or health care facilities. RF interference can cause medical equipment to run out of order, so it is necessary to turn off the mobile terminal devices.
	Mobile terminal devices cannot be guaranteed to connect in all conditions, for example no mobile fee or with an invalid SIM card. While you are in this condition and need emergent help, remember to use the emergency call. The mobile terminal device must be switched on and in a service area with adequate signal strength in order to make or receive a call.
	Your mobile terminal device receives and transmits radio frequency signals when it is on. RF interference can occur if it is used too close to TV set, radio, computer, or other electronic equipment.
	Please keep the mobile device away from areas with potentially explosive atmospheres. When you are near a gas station, oil depot, chemical plant or an explosion site, please turn off your mobile terminal. There is a potential safety hazard to operate electronic equipment at any potential explosion hazardous locations.

1.2 Purpose

In this paper, the basic functions and main features, hardware interfaces and usage methods, structural characteristics, power consumption and electrical characteristics of SLM770A wireless module are described in detail, and the design of embedding SLM770A module into various application terminals is guided.

1.3 Content List

This paper is divided into the following parts:

- Chapter 1, mainly introduces safety instructions, document purpose, content overview, etc.;
- Chapter 2, describes the basic functions and main features of SLM770A wireless module;
- Chapter 3, describes SLM770A of each hardware interface functions, features and using method in detail;
- Chapter 4, describes GNSS relevant features；
- Chapter 5, describes antenna interface related content and matters needing attention;
- Chapter 6, describes the electrical characteristics of SLM770A in detail；
- Chapter 7, describes the structural features and considerations of SLM770A in detail;
- Chapter 8, describes the storage and production considerations of SLM770A in detail;
- Chapter 9, appendix A reference documentation and terms abbreviations;
- Chapter 10, appendix B GPRS coding scheme.

2 Product Overview

2.1 Basic Description

SLM770A is support for TDD-LTE/FDD-LTE/WCDMA/GSM wireless communication module. It supports data connection of TDD-LTE and FDD-LTE networks. Can provide voice (PCM), analog voice, short message, address book and other functions for customers' special applications.

Table 1 SLM770A-C module supports the following frequency bands

Network	SLM770A-C
TDD-LTE	B38/B40/B41
FDD-LTE	B1/B3/B5/B7/B8/B20/B28
WCDMA	B1/B8
GSM	900/1800

Table 2 SLM770A-E supports the following frequency bands

Network	SLM770A-E
TDD-LTE	B38/B40
FDD-LTE	B1/B3/B7/B8/B20/B28
WCDMA	B1/B8
GSM	900/1800

Table 3 SLM770A-SC supports the following frequency bands

Network	SLM770A-S
TDD-LTE	B34/B38/B39/B40/B41
FDD-LTE	B1/B3/B5/B8

WCDMA	B1/B8
GSM	900/1800

SLM770A adopts advanced highly integrated design scheme, integrate RF and baseband on a PCB to complete wireless reception, transmission, baseband signal processing and audio signal processing functions, with a single-sided layout, module structure size: 32.0×29.0×2.4mm. It can meet almost all M2M application requirements, such as: mobile broadband access, video surveillance, hand-held terminals, on-board equipment, ultra-book and other products.

2.2 Main Performance

The following table details the performance of the SLM770A module.

Table 4 List of main features of the module

Parameter	Description
Power supply	● VBAT power supply range: 3.3~4.2V ● Typical supply voltage:3.8V ● VBAT Maximum current: 3A
Transmit power	● Class 4 (33dBm±2dB) for GSM850 ● Class 4 (33dBm±2dB) for GSM900 ● Class 1 (30dBm±2dB) for DCS1800 ● Class 1 (30dBm±2dB) for PCS1900 ● Class E2 (27dBm±3dB) for GSM850 8-PSK ● Class E2 (27dBm±3dB) for GSM900 8-PSK ● Class E2 (26dBm±3dB) for DCS1800 8-PSK ● Class E2 (26dBm±3dB) for PCS1900 8-PSK ● Class 3 (23dBm±2dB) for WCDMA bands ● Class 3 (23dBm±2dB) for FDD-LTE bands ● Class 3 (23dBm±2dB) for TDD-LTE bands
LTE features	● Maximum support non-CA CAT4 ● Support 1.4 ~ 20MHz radio frequency bandwidth ● Downlink support multi-user MIMO ● FDD: Maximum uplink rate 50Mbps, maximum downlink rate 150Mbps ● TDD: Maximum uplink rate 35Mbps, maximum downlink rate130Mbps
WCDMA features	● Support 3GPP R8 DC-HSPA+ ● Support 16-QAM, 64-QAM, and QPSK modulation ● 3GPP R6 CAT6 HSUPA: maximum uplink rate is 5.76Mbps ● 3GPP R8 CAT24 DC-HSPA+: maximum downlink rate is 42Mbps
GSM features	GPRS: ● Support GPRS multi-slot class 12（default 12） ● Coding format:CS-1/CS-2/CS-3 and CS-4 ● Maximum of four Rx time slots per frame EDGE: ● Support EDGE multi-slot class 12（default 12） ● Support GMSK and 8-PSK ● Downlink coding format: CS 1-4 and MCS 1-9 ● Uplink coding format: CS 1-4 and MCS 1-9

Network protocol features	● Support TCP/UDP/PPP/FTP/HTTP/NTP/PING/QMI protocol ● Support PAP（Password Authentication Protocol）and CHAP（Challenge Handshake Authentication Protocol）
SMS	● Text and PDU mode ● Point to point MO and MT ● Short message cell broadcast ● Short message storage: default stored in module
USIM interface	● Support USIM/SIM card:1.8V and 3V
Audio features	● Support 1 channel digital audio interface: PCM interface ● GSM:HR/FR/EFR/AMR/AMR-WB ● WCDMA;AMR/AMR-WB ● LTE:AMR/AMR-WB
PCM interface	● For audio use, need to connect the codec chip ● Support 16 bit linear coding format ● Support short frame mode ● Support master mode and slave mode
USB interface	● Compatible with USB2.0 features（slave only）, the data transfer rate can reach up to 480Mbps ● Used for AT command, data transmission, GNSS NMEA output, software debug and upgrade ● USB driver: Support Windows7, Windows 8/8.1, Windows10, Linux 2.6 or later, Android2.3/4.0/4.2/4.4/5.0/5.1/6.0/7.0
Serial port	Main serial: ● Used for AT commands and data transmission ● The maximum baud rate is 921600bps. The default baud rate is 115200bps ● Support RTS and CTS hardware flow control Debug serial: ● Used for partial log output ● Baud rate is 115200bps
SD interface	● Conforms to SD3.0 protocol
GNSS features	● Qualcomm Gen8C-Lite ● Protocol: NMEA 0183
RX- diversity	● Support LTE/WCDMA/ RX- diversity
AT commands	● Comply with 3GPP TS 27.007, 27.005, and new MeiG AT commands
Network indication	● NET_STATUS，NET_MODE two pins indicate the state of the network
Antenna interface	● Include main antenna（ANT_MAIN）, RX- diversity antenna（ANT_DIV）and GNSS antenna(ANT_GNSS）
Physical features	● Size: 32.0×29.0×2.4mm ● Weight: <5g

Temperature range	● Normal operating temperature: -35℃～+75℃ ● Limited operating temperature: -40℃～+85℃ ● Storage temperature: -40℃～+90℃
Software upgrade	● USB interface
RoHS	● All hardware components fully comply with the EU RoHS standard
Environmental humidity	● 5%~95%

3 Application Interface

3.1 Basic Description

SLM770A&SLM770A-SC adopts LCC+LGA interface, totally have 144 Pins, including 80 LCC pins and 64 LGA pins, provided with the following functional interfaces:

- Power interface
- USIM/SIM interface
- USB interface
- UART interface
- PCM interface(SLM770A-SC does not support this function)
- I2C interface
- Reset interface
- State indicator interface
- Sleep control interface
- Flight mode control interface
- Forced load interface

3.2 LCC Card Interface Definition

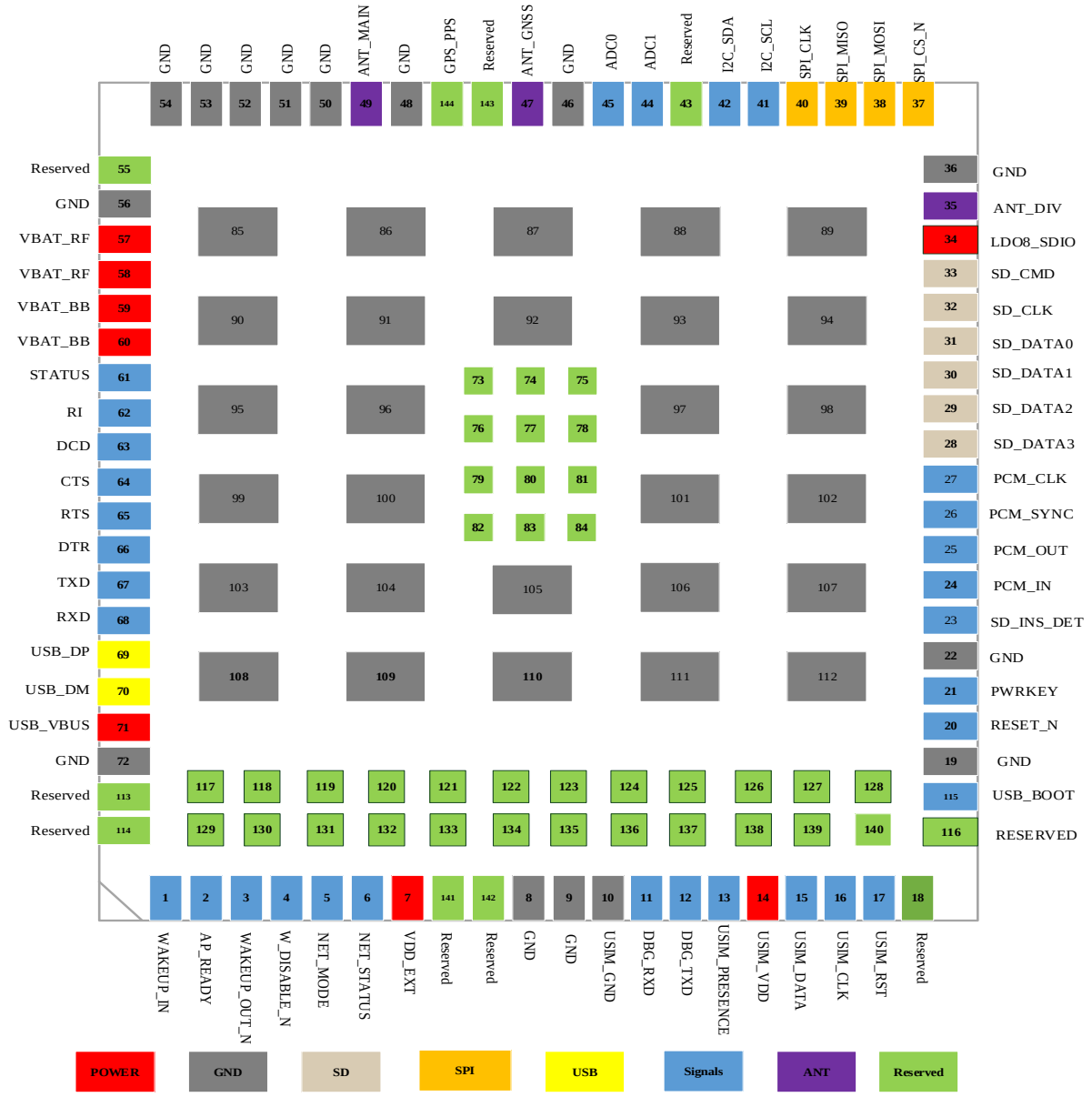


Figure 1 Module pin number diagram（TOP VIEW）

3.3 Pin Description

The following table describes the definitions of the individual pins for the SLM770A module.

SLM770A - SC 123, 124, 125, 126, 137, 138, 140 pin for the suspended state, 24-27 pin for UART2 pin the feet.

Table 5 IO parameter definition

Type	Description
AI	Analog input
AO	Analog output
AIO	Analog input/output
DI	Digital input
DO	Digital output
DIO	Digital input/output
OD	Open drain
PI	Power input
PO	Power output

Table 6 Pin description

Power					
Pin name	**Pin number**	**I/O**	**Description**	**DC features**	**Note**
VBAT_BB	59，60	PI	Power supply for module baseband	Vmax=4.2V Vmin=3.3V Vnorm=3.8V	It must be able to provide sufficient current up to 1A
VBAT_RF	57，58	PI	Power supply for module RF	Vmax=4.2V Vmin=3.3V Vnorm=3.8V	It must be able to provide sufficient current up to 2A
VDD_EXT	7	PO	1.8V output	Vnorm=1.8V $I_o$max=80mA	Power supply for external GPIO’s pull up circuits; If unused, keep it open
GND	8，9，19，22，36，46，48，50~54，56，72，85~112				
Turn On/Off					

Pin name	Pin number	I/O	Description	DC features	Note
RESET_N	20	DI	Reset the module	V_{IL}max=0.5V	1.8V power domain, effective at low level; If unused, keep it open
PWRKEY	21	DI	Turn on/off the module	V_{IL}max=0.5V	VBAT power domain, effective at low level
Status Indication					
Pin name	**Pin number**	**I/O**	**Description**	**DC features**	**Note**
STATUS	61	OD	Indicate the module operating status	The drive current should be less than 0.9mA	Require external pull up. If unused, keep it open.
NET_MODE	5	DO	Indicate the module network registration status	V_{OH}min=1.35V V_{OL}max=0.45V	1.8V power domain; If unused, keep it open
NET_STATUS	6	DO	Indicate the module network activity status	V_{OH}min=1.35V V_{OL}max=0.45V	1.8V power domain; If unused, keep it open
USB interface					
Pin name	**Pin number**	**I/O**	**Description**	**DC features**	**Note**
USB_VBUS	71	AI	USB detection	Vmax=5.25V Vmin=3.0V Vnorm=5.0V	
USB_DP	69	AIO	USB differential data positive signal	Compliant with USB2.0 standard specification	Require differential impedance of 90Ω
USB_DM	70	AIO	USB differential data negative signal	Compliant with USB2.0 standard specification	Require differential impedance of 90Ω
USIM interface					
Pin name	**Pin number**	**I/O**	**Description**	**DC features**	**Note**
USIM_DATA	15	DIO	USIM card data signal	USIM_VDD	Module internal pull up to USIM_VDD
USIM_CLK	16	DO	USIM card clock signal		

USIM_RST	17	DO	USIM card reset signal		
USIM_ PRESENCE	13	DI	USIM detection	VDD_EXT	1.8V power domain, need external pull up to 1.8V
USIM_VDD	14	PO	USIM card supply voltage	**1.8V USIM:** Vmax=1.9V Vmin=1.7V **3.0V USIM:** Vmax=3.05V Vmin=2.7V $I_o$max=50mA	Automatic module recognition 1.8V or 3.0V USIM card
USIM_GND	10		USIM ground		Connect to the ground of the module
Serial Port					
Pin name	**Pin number**	**I/O**	**Description**	**DC features**	**Note**
UART2_TXD	26	DO	Module send data	VDD_EXT	1.8V power domain. If unused, keep it open. Only applicable to SLM770A-SC
UART2_RXD	27	DI	Module receive data		
UART2_CTS	25	DI	Clear to send		
UART2_RTS	24	DO	Request to send		
RI	62	DO	Ring indicator		1.8V power domain.do not pull up to high level before the module starts successfully. If unused, keep it open
DCD	63	DO	Data carrier detection		1.8V power domain. If unused, keep it open
DTR	66	DI	Data terminal ready		1.8V power domain. If unused, keep it open
RXD	68	DI	Receive data		1.8V power domain. If unused, keep it open
TXD	67	DO	Transmit data		1.8V power domain. If unused,

					keep it open
CTS	64	DI	Clear to send		1.8V power domain. If unused, keep it open
RTS	65	DO	Request to send		1.8V power domain. If unused, keep it open
Debug Serial Port					
Pin name	**Pin number**	**I/O**	**Description**	**DC features**	**Note**
DBG_TXD	12	DO	The module sends data	VDD_EXT	1.8V power domain. If unused, keep it open
DBG_RXD	11	DI	The module receives data		1.8V power domain. If unused, keep it open
ADC Interface					
Pin name	**Pin number**	**I/O**	**Description**	**DC features**	**Note**
ADC0	45	AI	Universal analog-to-digital conversion	voltage range: 0~1.8V	If unused, keep it open
ADC1	44	AI	Universal analog-to-digital conversion	voltage range: 0~1.8V	If unused, keep it open
USB_BOOT Interface					
Pin name	**Pin number**	**I/O**	**Description**	**DC features**	**Note**
USB_BOOT	115	DI	Mandatory download mode control, High level effective	VDD_EXT	1.8V power domain. It is recommended to reserve test points.
PCM Interface*(Not support SLM770A-SC)					
Pin name	**Pin number**	**I/O**	**Description**	**DC features**	**Note**
PCM_IN	24	DI	PCM data input	VDD_EXT	1.8V power domain. If unused, keep it open.
PCM_OUT	25	DO	PCM data output		1.8V power domain. If unused, keep it open.

PCM_CLK	27	DIO	PCM clock		1.8V power domain. Module as the main device, the pin is the output signal, module as the slave device, the pin is the input signal. If unused, keep it open.
PCM_SYNC	26	DIO	PCM data synchronization signal		1.8V power domain. Module as the main device, the pin is the output signal, module as the slave device, the pin is the input signal. If unused, keep it open.
I2C Interface					
Pin name	**Pin number**	**I/O**	**Description**	**DC features**	**Note**
I2C_SCL	41	OD	I2C clock	VDD_EXT	Require external pull-up to 1.8V.If unused, keep it open.
I2C_SDA	42	OD	I2C data		Require external pull-up to 1.8V.If unused, keep it open.
RF Interface					
Pin name	**Pin number**	**I/O**	**Description**	**DC features**	**Note**
ANT_DIV	35	AI	Diversity antenna	50Ω impedance	If unused, keep it open.
ANT_MAIN	49	IO	Main antenna	50Ω impedance	
ANT_GNSS	47	AI	GNSS antenna	50Ω impedance	If unused, keep it open.
GPIO					
Pin name	**Pin number**	**I/O**	**Description**	**DC features**	**Note**
WAKEUP_IN	1	DI	Sleep mode control input	VDD_EXT	1.8V power domain. High level

					wakes up the module; in low level the module enters into sleep mode. If unused, keep it open.
AP_READY	2	DI	Application processor sleep state detection		1.8V power domain. Do not pull up to high level before the module starts successfully. If unused, keep it open.
WAKEUP_OUT_N	3	DO	Sleep mode output		1.8V power domain. If unused, keep it open. The module output low level after entering sleep.
W_DISABLE_N	4	DI	Flight mode control		1.8V power domain. The low level puts the module into flight mode, If unused, keep it open.
Wireless Connection Interface					
Pin name	**Pin number**	**I/O**	**Description**	**DC features**	**Note**
SPI_CS	37	DO	SPI chip selection signal	VDD_EXT	1.8V power domain. If unused, keep it open.
SPI_DOUT	38	DO	SPI data output		1.8V power domain. If unused, keep it open.
SPI_DIN	39	DI	SPI data input		1.8V power domain. If unused, keep it open.
SPI_CLK	40	DI	SPI clock output		1.8V power domain. If unused, keep it open.
SD Card Interface					
Pin name	**Pin number**	**I/O**	**Description**	**DC features**	**Note**

SD_INS_DET*	23	DI			Function undeveloped, keep it open.
SD_CMD*	33	IO			Function undeveloped, keep it open.
SD_CLK*	32	DO			Function undeveloped, keep it open.
SD_DATA3*	28	DIO			Function undeveloped, keep it open.
SD_DATA2*	29	DIO			Function undeveloped, keep it open.
SD_DATA1*	30	DIO			Function undeveloped, keep it open.
SD_DATA0*	31	DIO			Function undeveloped, keep it open.
Audio Interface					
Pin name	**Pin number**	**I/O**	**Description**	**DC features**	**Note**
SPK_N	123	AO	Analog audio differential Output Channel (-)		
SPK_N	124	AO	Analog Audio Differential Output Channel (+)		
MIC_P	125	AI	Microphone input channel (+)		
MIC_N	126	AI	Microphone input channel (-)		
MICBIAS	140	PO	Microphone bias voltage		
Reserved pin					
RESERVED	18,43,55,73,74,75,76,77,78,79,80,81,82,83,84,113,114,116,117,118,119,120,121,122,127,128,129,130,131,132,133,134,135,136,137,138,139,141,142,143,144				

3.4 Module Operating Mode

Table 7 Overview of operating modes

Mode	Description	
GSM mode	GSM IDLE	The module is in idle state and has registered to the GSM network, ready to send and receive data (SMS and voice service).
	GSM TALK	The module is ready for voice talk service; the power consumption is decided by network setting.
GPRS mode	GPRS IDLE	The module is ready for GPRS data transfer. No data sending or receiving at this time. The power consumption is decided by network setting and related settings of GPRS. (For example, multi-slot Class level settings).
	GPRS DATA	In GPRS data sending and receiving, the power consumption is decided by network setting (For example, power control level), data uplink and downlink rat and related settings of GPRS. (For example, multi-slot Class level settings).
EDGE mode	EDGE IDLE	The module is ready for EDGE data transfer. No data sending or receiving at this time. The power consumption is decided by network setting and related settings of EDGE. (For example, multi-slot Class level settings)
	EDGE DATA	In EDGE data sending and receiving, the power consumption is decided by network setting (For example, power control level), data uplink and downlink rat and related settings of EDGE. (For example, multi-slot Class level settings).
WCDMA mode	WCDMA IDLE	The module system is in idle state and the module has been registered to the WCDMA network, and it is ready to send and receive services at this time.
	WCDMA TALK	The module is in WCDMA voice service, the power consumption is decided by network setting.
	WCDMA DATA	WCDMA data transfer is ongoing. The power consumption is decided by network setting (For example, power control level), data uplink and downlink rate and related settings of WCDMA.
HSPA mode	HSPA IDLE	The module is ready for HSPA voice and data transfer. No data sending or receiving at this time. The power consumption is decided by network setting.
	HSPA DATA	HSPA data transfer is ongoing. The power consumption is decided by network setting (For example, power control level), data uplink and downlink rate and related settings of HSPA.
TDD-LTE mode	TDD-LTE IDLE	The module is ready for TDD-LTE data transfer. No data sending or receiving at this time. The power consumption is decided by network setting.
	TDD-LTE DATA	TDD-LTE data transfer is ongoing; the power consumption is decided by network setting (For example, power control level), data uplink and downlink rate and related settings of TDD-LTE.

FDD-LTE mode	FDD-LTE IDLE	The module is ready for FDD-LTE data transfer. No data sending or receiving at this time. The power consumption is decided by network setting.
	FDD-LTE DATA	FDD LTE data transfer is ongoing; the power consumption is decided by network setting (For example, power control level), data uplink and downlink rate and related settings of FDD LTE.
Minimum function mode	AT+CFUN=0 command can set the module to enter into a minimum functionality mode without removing the power supply of VBAT. At this time RF is closed. Use AT+CFUN=1command the module reopens sending and receiving service and registers network to the normal function mode.	
Flight mode	W_DISABLE_N pin can set the module to enter into flight mode. In this mode RF function will be invalid.	
Sleep mode	In this mode, the consumption of the module will be reduced to the minimum level. During the mode, the module can still receive paging message, SMS, voice call and TCP/UDP data from the network normally.	
Shutdown mode	VBAT low voltage shutdown. In this mode, the PMU stops supplying baseband (BB) and radio frequency (RF) power, the software stops working, and the serial port is disconnected.	

3.5 Power Saving

3.5.1 Sleep Mode

In sleep mode, the power consumption of the module is reduced to an extremely low level.

3.5.2 Flight Mode

When module into flight mode, RF function cannot be used, and all associated with RF of the AT command is inaccessible. The module can be put into flight mode through hardware interface and command control mode.

3.5.2.1 Hardware I/O interface controls flight mode

The W_DISABLE_N pin (PIN4) of SLM770A gives the module a low level signal. The module enters into flight mode and RF sending and receiving unit stops working. Pull up PIN4 and the module will enter into normal mode. The module control signal level supports 1.8V logic level.

Module control signal level supports 1.8V logical level.

3.5.2.2 AT command controls flight mode

Send AT+CFUN=4 command to let the module enter into flight mode, and RF sending and receiving unit stops working at the time. Send AT+CFUN=1 command to let the module enter into normal mode again.

3.6 Power Supply Design

3.6.1 Power Supply Pins

SLM770A has four VBAT pins for connecting an external power supply, which can be divided into two power supply domains:

- Two VBAT_RF pins are used to power the module RF;
- Two VBAT_BB pins are used to power the baseband of the module.

The following table shows the distribution of power pins and ground pins for the module:

Table 8 VBAT pin and ground pin

Pin name	Pin No.	Description	Min value	Typical value	Max value	Unit
VBAT_RF	57，58	Power supply for module baseband	3.3	3.8	4.2	V
VBAT_BB	59，60	Power supply for module RF	3.3	3.8	4.2	V
GND	8，9，10，19，22，36，46，48，50~54，56，72，85~112					

3.6.2 Decrease Voltage Drop

The power supply range of SLM770A is 3.3V~4.2V. During data transmission or call, the instantaneous high-power emission will form a current spike, resulting in large ripple of VBAT. If the instantaneous voltage drop causes the VBAT power supply voltage be too low, the module will restart or shut down. To ensure the normal operation of the module, the power supply must have sufficient power supply capacity, and the input voltage must not be lower than 3.3V.

The following figure is the module switch threshold state definition.

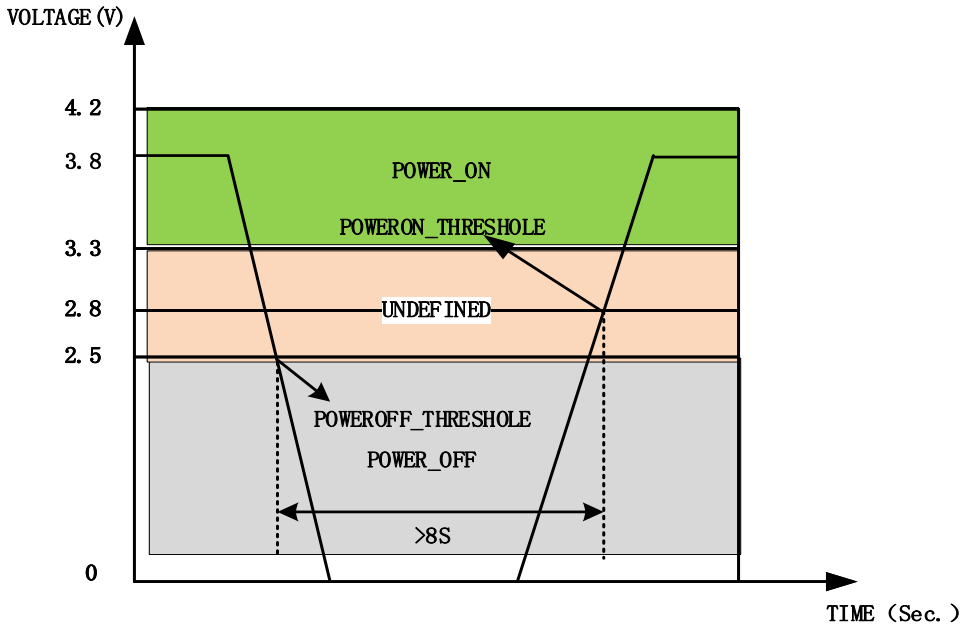


Figure 2 Switching machine threshold

The following figure shows the voltage drop during transmitting burst in 2G network. The voltage drop will be less in 3G and 4G networks.

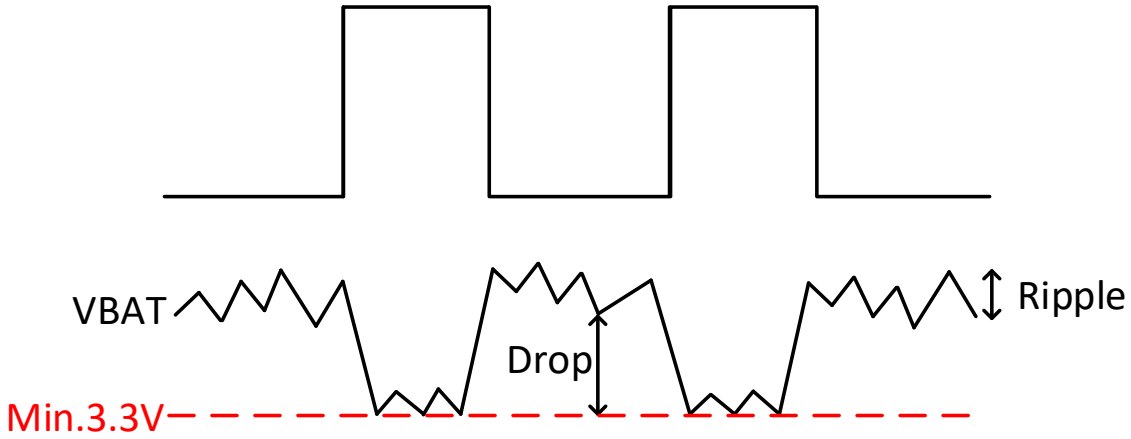


Figure 3 Power requirements for burst transmission

To reduce voltage sags, a 100uF filter capacitor with a low ESR is required. MLCC has the best ESR. It is recommended to add 3 ceramic capacitors (100nF, 33pF, 10pF) to VBAT_BB and VBAT_RF pins, and the capacitors should be placed close to the VBAT pins. At the same time, in order to ensure better power supply performance, a TVS tube is added near the input end of the module VBAT to improve the surge voltage bearing capacity of the module. It is recommended to use Changyuan Vian, model WS4.5DPV. If the VBAT has high-frequency interference, it is recommended to add magnetic bead filtering. The recommended magnetic bead model is BLM21PG300SM1D or MPZ2012S221A. When the

external power supply is connected to the module, VBAT_BB and VBAT_RF need to adopt star routing. VBAT_BB wire width shall not be less than 1mm, and VBAT_RF wire width shall not be less than 2mm. In principle, the longer the line in VBAT, the wider the line.

The reference circuit is as follows:

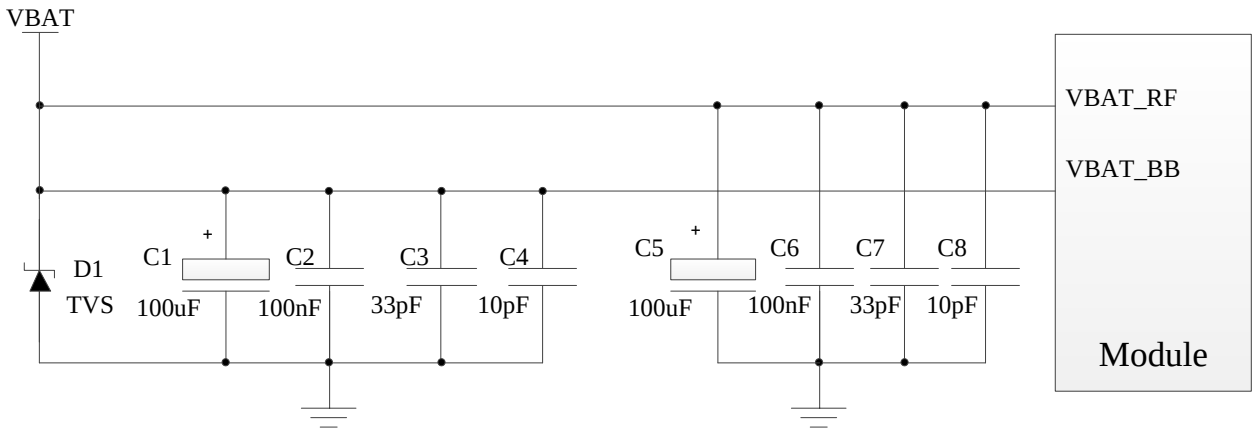


Figure 4 Reference circuit for power supply

3.6.3 Reference Design for Power Supply

The design of the module power supply is very important because the performance of the module depends largely on the power supply. The SLM770A must be supplied with at least 3A current capability. If the voltage difference between the input voltage and the module supply voltage is not large, it is recommended to use LDO as the power supply. If there is a large voltage difference between the input and output voltages, it is recommended to use DCDC as the module power supply.

The figure below is the reference design of +5V power supply circuit. The design use Micrel LDO, model MIC29302WU. Its typical output voltage is 3.8V and the peak load current reaches 3A.

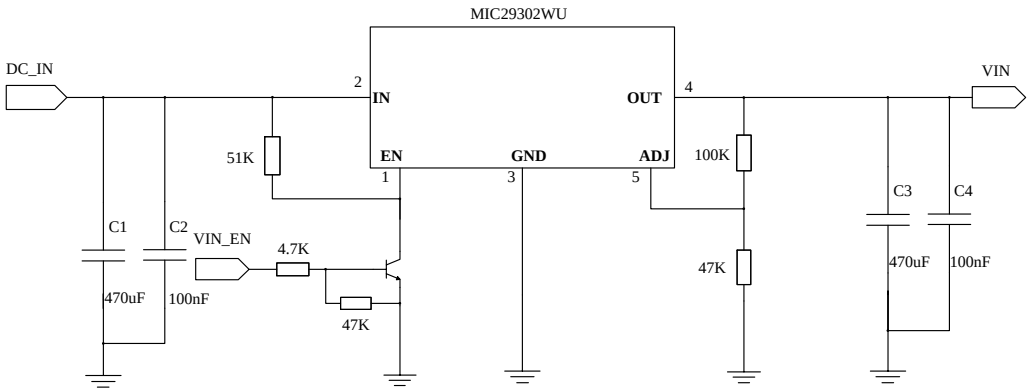


Figure 5 Reference design for power supply input

3.6.4 VDD_EXT Voltage Output

When the SLM770A module is normally started, there is a voltage output on Pin7 with an output voltage of 1.8V and a current load of 50mA. When the module is turned on, this power supply will always output, the power supply capacity is limited, can't be used for external heavy load circuit, can be used for the level conversion chip reference voltage similar to light load applications.

Note: This pin is sensitive to ESD. If this pin is used, please advised to add an ESD component to it for ESD prevention.

To prevent Flash data loss due to frequent module power outages, it is recommended that the customer reserve three 47uF capacitors (0603 or 0805) externally on VDD_EXT, and determine whether to attach capacitors based on actual conditions and scenarios.

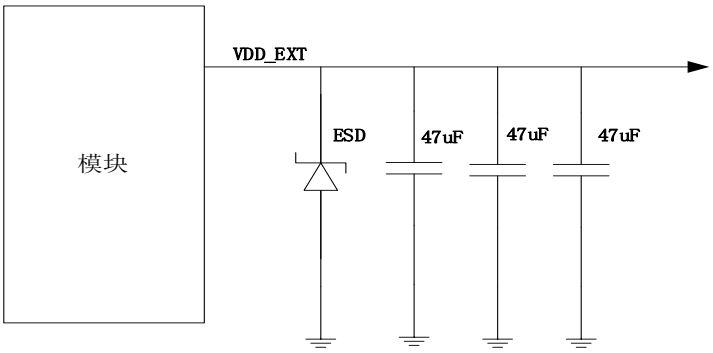


Figure 6 VDD_EXT external capacitor and ESD schematic diagram

3.7 Turn On and Off

3.7.1 Turn on module using the PWRKEY

Table 9 PWRKEY pin description

Pin name	Pin NO.	Description	DC features	Note
PWRKEY	21	Turn on/off the module	Vmax=4.2V Vmin=3.3V Vnorm=3.8V	VBAT domain

When the SLM770A module is in power down mode, it can be turned on by lowering the PWRKEY. It is recommended to use an open set drive circuit to control the PWRKEY pin. After the STATUS pin outputs the low level, the PWRKEY can be released. Reference circuit is as follows:

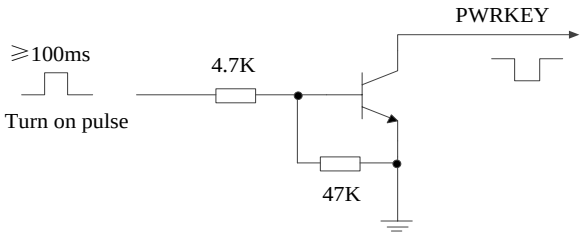


Figure 7 Turn on the module using driving circuit

The other way to control the PWRKEY is using a button directly. A TVS component is indispensable to be placed nearby the button for ESD protection. A reference circuit is shown in the following figure:

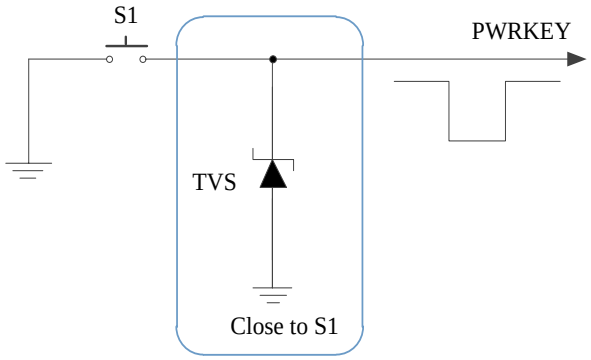


Figure 8 Turn on the module using button

Turning on time is illustrated as follows:

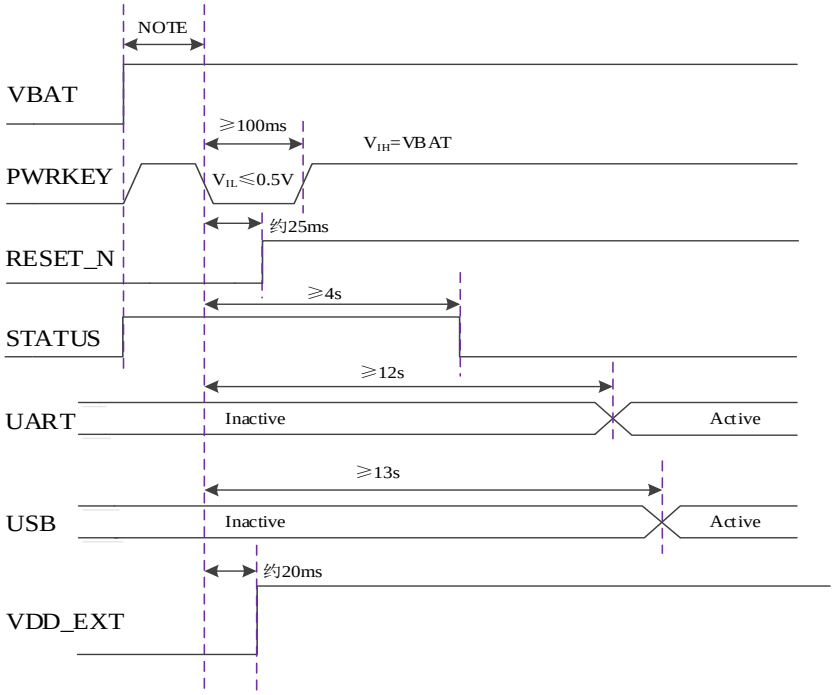


Figure 9 Timing of turning on module

Note: Before pulling down PWRKEY pin, VBAT voltage should be guaranteed to be stable. It is recommended that the time interval between powering up VBAT and pulling down PWRKEY pins should be no less than 30ms.

3.7.2 Turn Off

Module can be turn off in the following ways:

- 1: Control module shutdown with PWRKEY pin; pull down the POWERKEY pin for at least 650ms to start the power-off process
- 2: Send AT+POWEROFF command into the power-off process

3.7.2.1 AT Command to Turn Off

The AT+POWEROFF command can be used to control module power off.

3.7.2.2 PWRKEY Pin to Turn Off

When the module is turn on, pull the PWRKEY pin down for at least 7s and release it, the module will execute the power off process. The sequence is shown below:

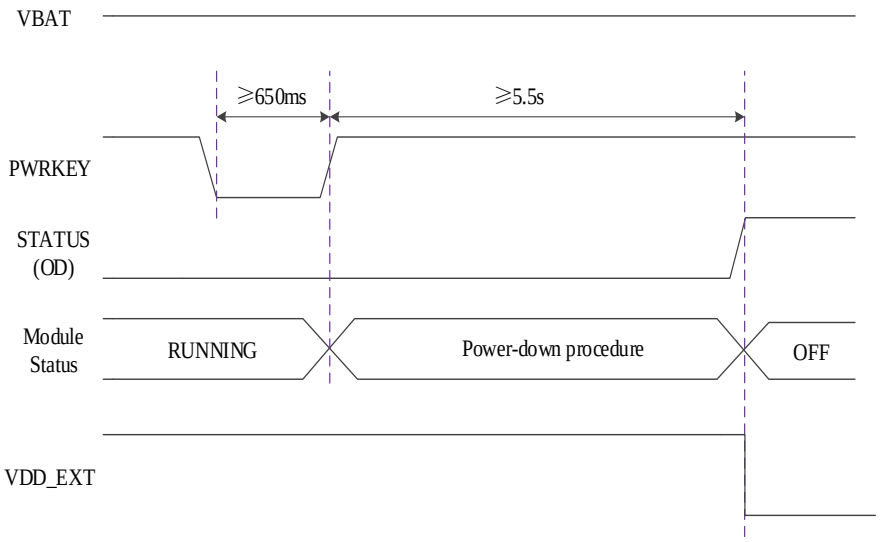


Figure 10 Timing of turning off module

Note:

1. When the module is working normally, do not immediately cut off the power supply of the module to avoid damaging the Flash data inside the module. It is recommended to close the module through the AT command before disconnecting the power.
2. When using AT command to turn off, make sure that PWRKEY is always in high level state after the turn off command is executed; otherwise, the module will start up again automatically after complete the turn off.

3.8 Reset the Module

There are two ways to restart the SLM770A: Hardware restart, AT command restart.

3.8.1 Hardware reset

When the module is working, restart the module by pulling down the RESET_N pin for at least 300ms. RESET_N signal is sensitive to interference, so it is suggested that the routing on the module interface board should be as short as possible and should be processed in package.

Table 10 RESET_N pin description

Pin name	Pin number	Description	DC features	Note
RESET_N	20	Restart the module	V_{IH}max=2.1V V_{IH}min=1.3V V_{IL}max=0.5V	

Reference circuit is as follows: you can use open set driver circuit or button to control RESET_N pin.

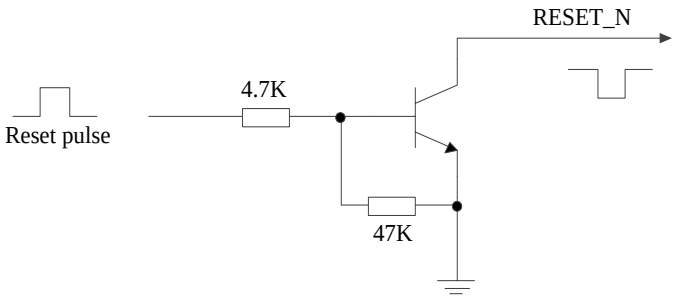


Figure 11 Reference circuit of RESET_N by using driving circuit

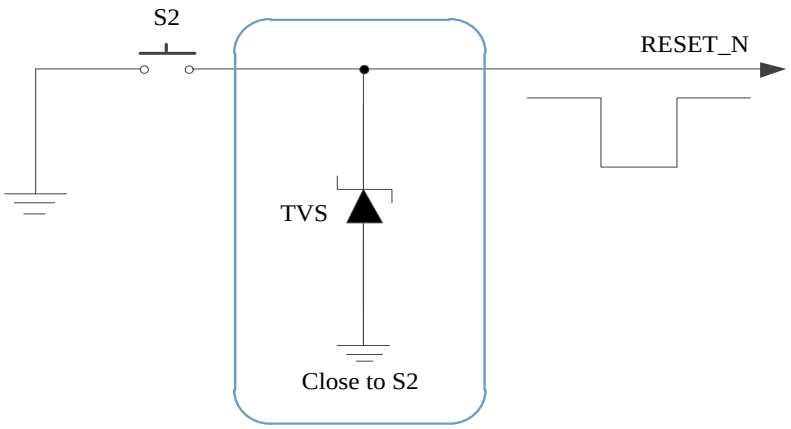


Figure 12 Reference circuit of RESET_N by using button

The reset timing figure is as follows:

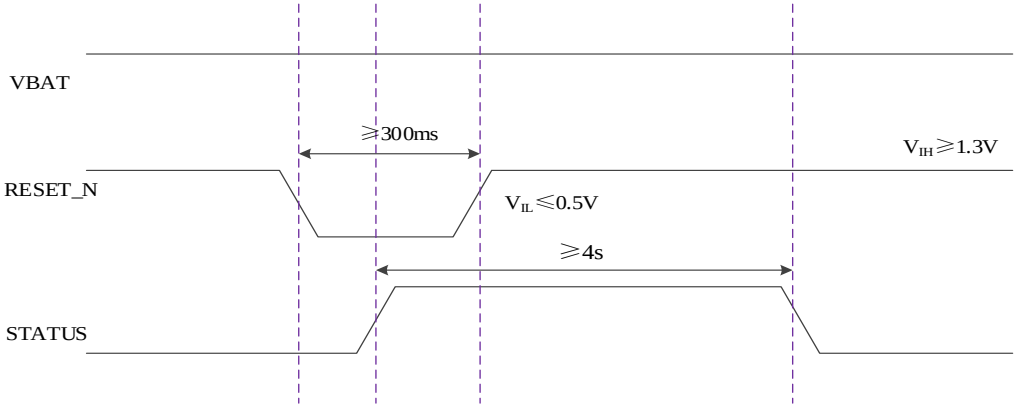


Figure 13 Reset timing of RESET_N

Note:

1. SLM770A module pulling down RESET_N only resets the baseband chip inside the module and does not reset the power management chip.
2. When the RESET_N pin of SLM770A module is pulled down, the baseband chip is in the reset state, and the chip system restarts after release.
3. Ensure that PWRKEY and RESET_N pins do not have large load capacitors, up to 10uF.

3.8.2 AT Command Reset

Enter AT+RESET command in SLM770A UART or USB AT interface to reset and restart SLM770A.

3.9 USIM/SIM Interface

USIM card interface meets ETSI and IMT-2000 SIM interface requirements. Both 1.8V and 3.0V USIM cards are supported by SLM770A.

Table 11 USIM/SIM interface

Pin name	Pin number	I/O	Description	Note
USIM_PRESENCE	13	DI	USIM card plug detection	Require to pull up to1.8V
USIM_VDD	14	PO	USIM card power supply	Support 1.8V/3.0V (U)SIM card
USIM_DATA	15	IO	USIM card data signal	Internal pull up to USIM_VDD
USIM_CLK	16	DO	USIM card clock signal	
USIM_RST	17	DO	USIM card reset signal	
USIM_GND	10	-		Connected to the ground of the module

SLM770A module supports USIM hot plug through the USIM_PRESENCE pin and supports high level detection. By default, the hot plug function is disabled. In the figure, the level of the USIM_PRESENCE pin is high after the SIM card is inserted. When no card is detected, the level of the USIM_PRESENCE pin is low.

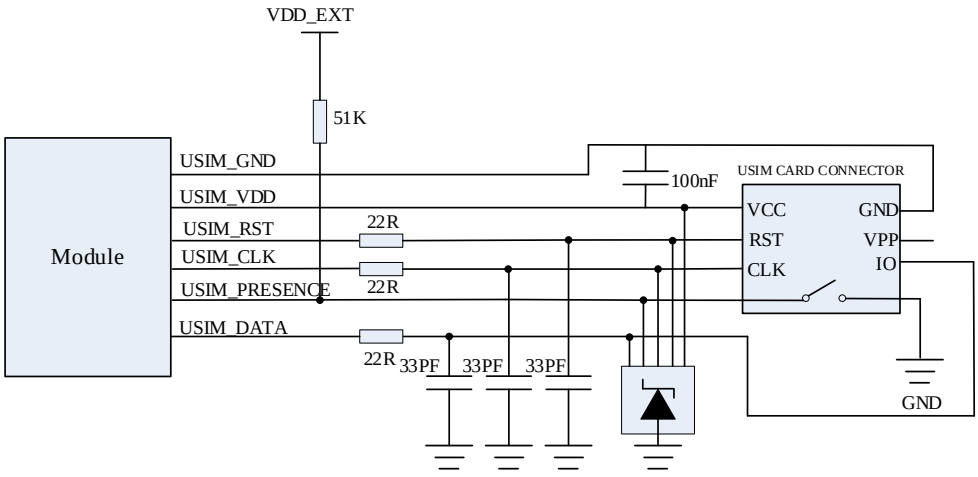


Figure 14 Reference circuit for 8-pin USIM/SIM connector

If USIM card detection is not required, keep the USIM_PRESENCE pin open. The figure below is the 6-PIN USIM connector interface reference circuit

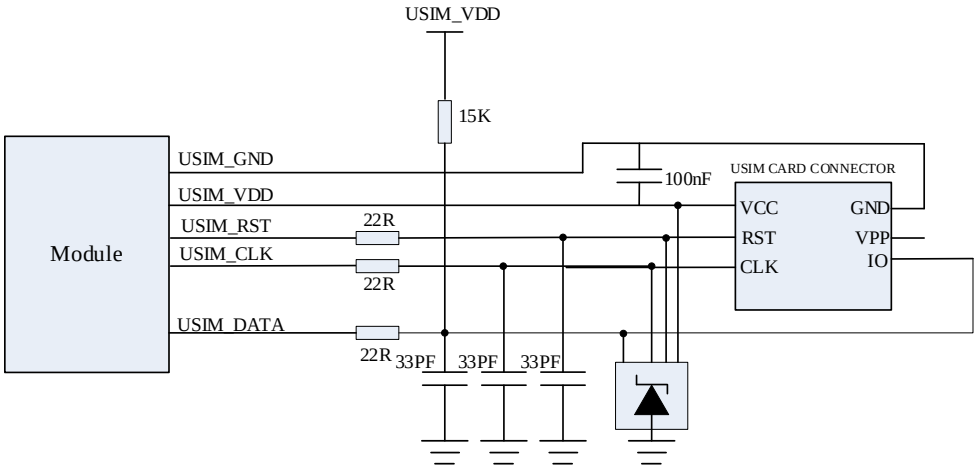


Figure 15 Reference circuit for 6-pin USIM/SIM connector

In order to enhance the reliability and availability of the USIM card in your application, please follow the criteria below in the USIM circuit design:

- USIM_DATA requires a pull-up resistor of 15kΩ to USIM_VCC; the pull-up resistor helps to increase SIM card's anti-interference ability. When USIM card trace is too long or it is close to the interference source, it is recommended that you add a pull-up resistor near the card.
- In order to suppress stray EMI and enhance ESD protection, it is recommended to connect a resistance of 22Ω on USIM_DATA, USIM_CLK and USIM_RESET line;
- In order to improve the antistatic ability and offer good ESD protection, it is recommended to add TVS whose parasitic capacitance should be less than 15pF on USIM_VCC, USIM_DATA, USIM_CLK and USIM_RESET line;
- In order to filter GSM900 interference, add a parallel 33pF resistance on USIM_VCC, USIM_DATA, USIM_CLK and USIM_RESET line;
- Keep layout of USIM card as close as possible to the module. Assure the length of signal wiring is less than 200mm;
- Keep USIM card signal away from RF and VBAT power line;
- To avoid cross-talk between USIM_CLK and USIM_DATA, keep them away from each other and shield them with surrounded ground;
- For the USIM/SIM card hot-plugging function, the hot plugging pin is used to DETECT the pin and the Pin13 pin of the module. The default hot plug function is off. Please contact us for more details.

Note: Not support hot plug SIM Connectors directly on USIM, SIM card hot plug, may cause (U) SIM card or SLM770A (U) SIM interface damage.

3.10 USB Interface

The SLM770A provides a USB 2.0 compliant interface that supports both high speed (480Mbps) and full

speed (12Mbps) modes. This interface is used for AT command interaction, data transfer, software debugging and version upgrading, etc.

3.10.1 USB Pin Description

Table 12 USB pin description

Name	Pin name	I/O	Description	Note
USB_DM	70	IO	USB differential data signal -	90Ω differential impedance is required
USB_DP	69	IO	USB differential data signal +	90Ω differential impedance is required
GND	72	-	Ground	
USB_VBUS	71	PI	USB power supply, used for USB detection	Typical value 5.0V

3.10.2 USB Reference Circuit

USB interface application reference circuit of SLM770A is shown in the following figure.

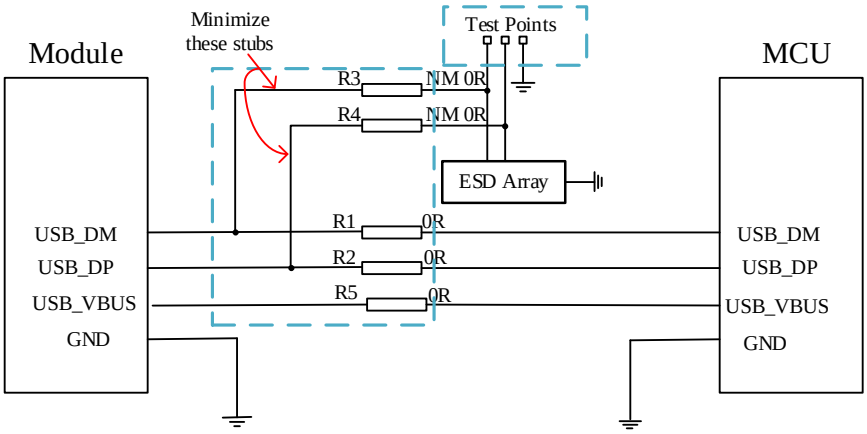


Figure 16 USB reference circuit design

In order to meet the signal integrity requirement of USB data line, R1/R2/R3/R4 resistors must be placed close to the module and between resistors close to each other. The branch connecting the test point must be as short as possible.

In USB interface circuit design, to ensure USB performance, the following principles are recommended in circuit design:

- In order to reduce the USB high speed data transmission of signal interference, in USB_DM USB_DP interface circuit and concatenated R1 and R2 can improve the accuracy of data transmission, 0Ω R1 and R2 are recommended;
- In order to improve the antistatic performance of USB interface, ESD protective devices are recommended to be added to USB_DP and USB_DM interface circuits, and ESD devices with junction capacitance less than 2pF are recommended. USB ESD protection device should be placed as close as possible to USB interface;
- In order to ensure the USB work reliable, the design still needs more consideration to the protection of USB, such as the Layout of the protection of the USB, need to do to USB_DP and USB_DM 90 Ω impedance control, strictly in accordance with the requirements of the differential line, as far as possible away from the interference signal;
- Do not use USB cable under crystal oscillator, oscillator, magnetic device and RF signal. It is recommended to use inner differential wiring and wrap the ground left, right, up and down.

3.10.3 USB Driver

SLM770A module support various operating systems, such as PC operating system: Windows 7/8, 10, Windows embedded operating system: Linux version 2.6 or higher, Android2.3/4.0/4.2/4.4/5.0/5.1/6.0

/7.0 or higher. For ordinary Internet access needs are drive free; For more requirements, such as sending and receiving AT commands and PPP dialing, the drivers are available. For details, contact support personnel.

3.11 Serial Port

The SLM770A module has two serial ports: main serial port and debugging serial port. The main features of these two serial ports are described below.

- Main support serial port, 4800, 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600, 1M baud rate, the default baud rate to 115200bps, support the RTS and CTS flow control. Used for data transmission and AT command transmission;
- The debugging serial port supports 115200bps baud rate and is used to output some logs.

Table 13 Main serial port pin description

Pin name	Pin No.	I/O	Description	Note
RXD	68	DI	Serial port data receiving	1.8V power domain
TXD	67	DO	Serial port data sending	1.8V power domain
DTR	66	DO	Data terminal preparations	1.8V power domain
RTS	65	DO	Send the request	1.8V power domain
CTS	64	DI	Clear to send	1.8V power domain
DCD	63	DI	Carrier detect	1.8V power domain
RI	62	DO	Ring indicator	1.8V power domain

Table 14 Debug serial port pin description

Pin name	Pin No.	I/O	Description	Note
DBG_RXD	11	DI	Module receive data	1.8V power supply domain
DBG_TXD	12	DO	Modules send data	1.8V power supply domain

Table 15 Serial logic level

Parameter	Min	Max	Unit
V_{IL}	-0.3	0.6	V
V_{IH}	1.2	2.0	V
V_{OL}	0	0.45	V
V_{OH}	1.35	1.8	V

The serial port level of SLM770A module is 1.8V. If the client host is 3.3V, the level converter needs to be added in the serial port application. TI's TXB0104PWR is recommended. The following picture is a reference design:

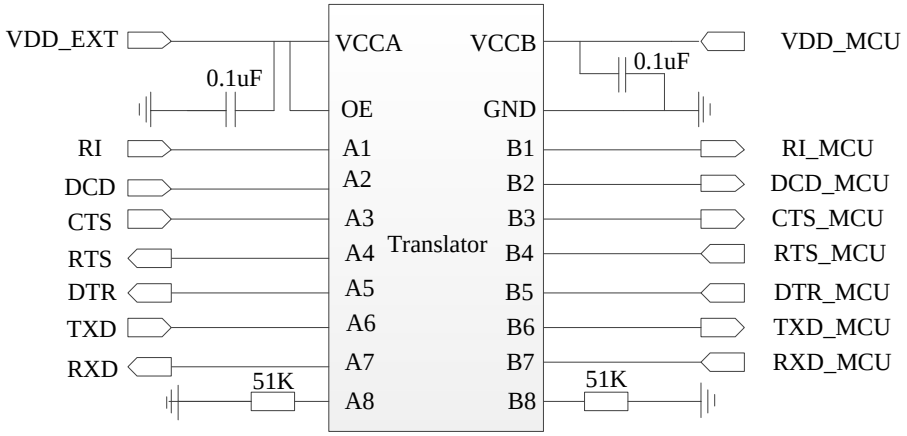


Figure 17 Level conversion chip reference circuit

Note:

1. Triode level conversion circuits should not be used for baud rate applications exceeding 460kbps.
2. Hardware flow control is disabled by default. If required, send at+ifc=2

3.12 PCM (SLM770A-SC does not support this function)

The module provides one PCM interface that supports the short frame mode: The module can be used as either the master device or the slave device.

In short frame mode, data is sampled along the falling edge of PCM_CLK and sent along the rising edge. The falling edge of PCM_SYNC indicates the high significant bit. The PCM interface supports 256kHz, 512 kHz, 1024 kHz and 2048 kHz PCM_CLK at 8kHz PCM_SYNC, as well as 16 kHz

PCM_SYNC 4096 kHz PCM_CLK.

The module supports 16-bit linear encoding format. The following is a short frame mode timing diagram (PCM_SYNC = 8 kHz, PCM_CLK = 2048 kHz).

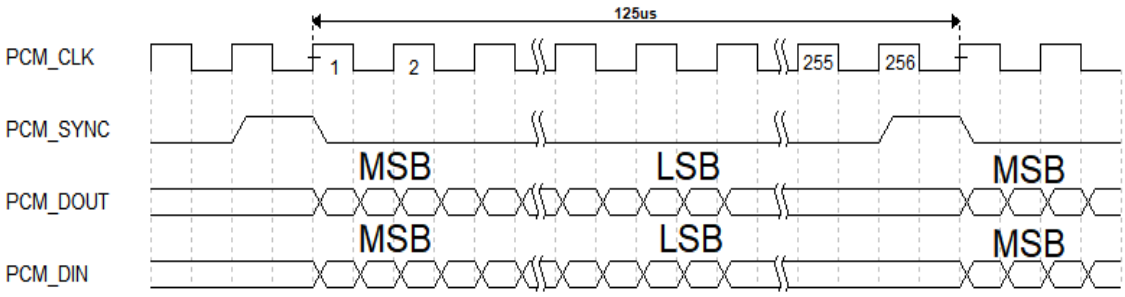


Figure 18 Short frame pattern timing diagram

Table 16 PCM interface pin description

Pin Name	Pin No.	I/O	Description	Note
PCM_SYNC	26	DIO	PCM data synchronization signal	1.8V power domain When the module is the master device, this pin is the output state When the module is the slave device, this pin is the input state If unused, keep it open.
PCM_CLK	27	DIO	PCM clock	
PCM_DIN	24	DI	PCM data input	
PCM_DOUT	25	DO	PCM data output	1.8V power domain. If unused, keep it open.

Note:

It is recommended to reserve the RC circuit (22Ω+33pF) on the signal line of the PCM, and the capacitor is as close to the module layout as possible.

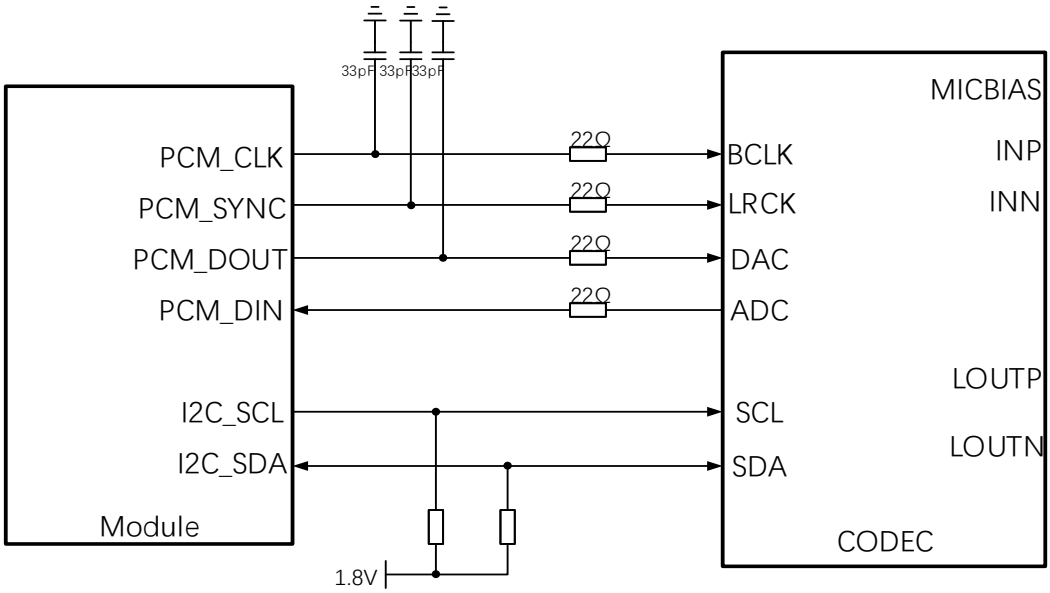


Figure 19 PCM and I2C interface circuit reference design

3.13 Network Status Indication

The network status indicator pin is mainly used to drive the network status indicator (it is necessary to power on and off the LED by controlling the on-off of the transistor to realize the LED on and off, not directly drive the LED light). SLM770A module has two network status pins: NET_MODE and NET_STATUS. The following two tables describe pin definitions and logic level changes under different network states respectively.

Table 17 Network indicator pin description

Pin name	Pin number	I/O	Description	Note
NET_MODE	5	DO	Indicate the module network registration mode.	1.8V domain
NET_STATUS	6	DO	Indicate the module network registration mode.	1.8V domain

Table 18 The network indicates the working status of pins

Mode	Status	Description
NET_MODE	High level	Register LTE network status
	Low level	Others

NET_ STATUS	Flash (100ms high/800ms low)	Search network process
	Flash (100ms high/3000ms low)	Register network success
	Flash (100ms high/300ms low)	Data business
	High level	Others
	Low level	Flight mode, no service, shutdown, etc.

The reference circuit is shown in the figure below:

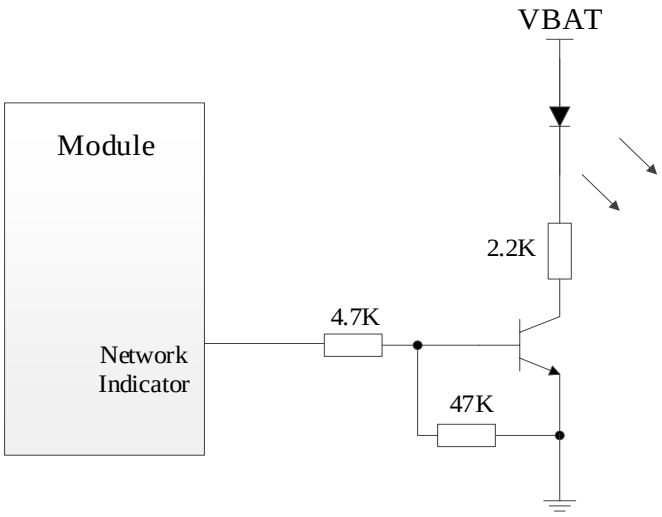


Figure 20 Network indication reference design drawing

3.14 STATUS

STATUS is used to indicate the working status of the module. It is the open-drain output pin. The customer can refer to the LED indicating circuit as shown in the following figure. When the module is normally started, the STATUS will output the low level. Otherwise, the STATUS becomes high impedance.

Table 19 STATUS pin description

Pin name	Pin number	Description	I/O	Note
STATUS	61	Indicates the working status of the module	OD	Need an external pull-up

The following figure shows the STATUS reference circuit design:

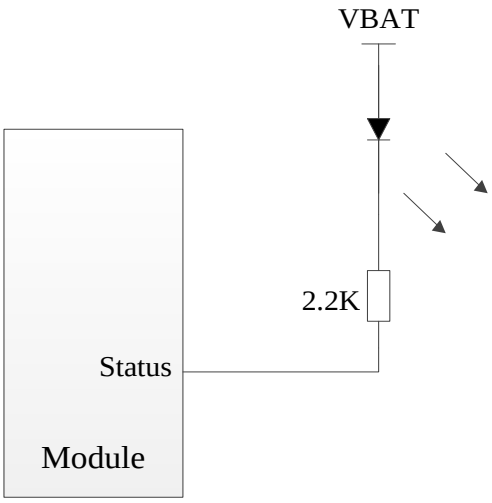


Figure 21 STATUS reference circuit

3.15 USB_BOOT Interface

The SLM770A supports USB_BOOT. The USB_BOOT function requires that the USB_BOOT pin be pulled up to 1.8V before the module VDD_EXT is powered on, and the module will enter the emergency download mode when it is powered on. In this mode, the module can be upgraded through the USB interface.

Table 20 USB_BOOT pin definition

Pin name	Pin No.	I/O	Description	Note
USB_BOOT	115	DI	Emergency download mode control, high level in effect	1.8V power domain. It is recommended to reserve test points. If unused, keep it open.

The USB_BOOT interface reference circuit is as follows:

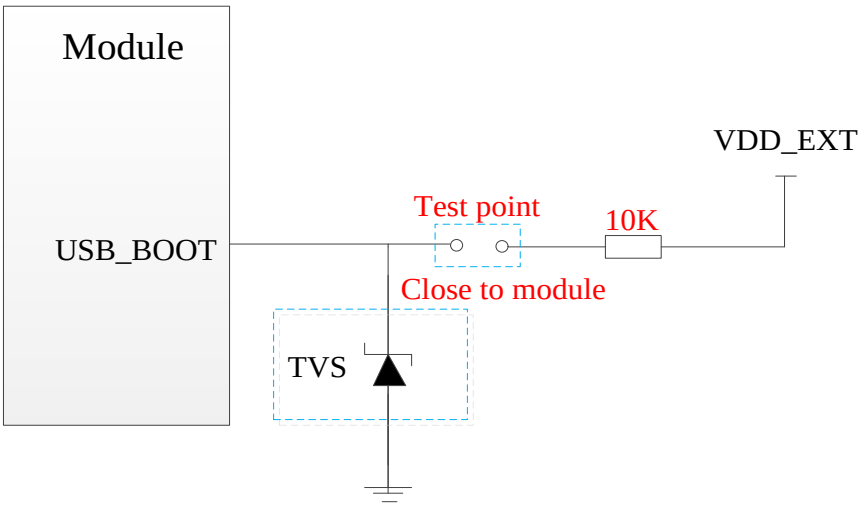


Figure 22 USB_BOOT interface reference circuit

Note:

1. Do not pull the USB_BOOT to 1.8V before powering on the VBAT module.
2. During normal startup, USB_BOOT is open without pulling up or down.

3.16 Analog audio interface

The module provides 1 analog audio input channel and 1 analog audio output channel, and the pin definition is shown in the following table:

Table 21 Analog audio interface definition

Channel	Item	Pin No.	Description	I/O
AIN	MICBIAS	140	Microphone bias voltage	PO
	MIC_P	125	Microphone input channel (+)	AI
	MIC_N	126	Microphone input channel (-)	AI
AOUT	SPK_P	124	Analog audio differential output channel (+)	AO
	SPK_N	123	Analog audio differential output channel (-)	AO

- AIN channel is a differential input used for microphone input

- AOUT channel is a differential output and is usually used for a handset

Design considerations:

It is recommended to use electret microphone to filter out RF interference from the interference source, which will greatly improve the coupled TDD noise. The 33pF capacitor is used to filter out high-frequency interference caused by the module operating at the EGSM900 frequency. If the capacitor is not added, TDD noise may be heard during calls. At the same time, the 10pF capacitor is used to filter out high-frequency interference operating at the DCS1800 frequency. It should be noted that since the resonant point of the capacitor is largely dependent on the capacitor material and the manufacturing process, it is necessary to consult the capacitor supplier when selecting the capacitor and select the most appropriate capacitance value to filter out the high-frequency noise operating at EGSM900/DCS1800.

The severity of high-frequency interference during GSM transmission usually depends mainly on the customer application design. In some cases, EGSM900 is TDD

The noise is more serious, and in some cases, the TDD noise of DCS1800 is more serious. Therefore, customers can select the required filter capacitor according to the test results. The filter capacitor on the PCB board should be placed as close as possible to the audio device or the audio interface, the line should be as short as possible, and the filter capacitor should be first passed to other connection points.

To reduce radio or other signal interference, keep the RF antenna away from the audio interface and audio wiring. The power cable should not be parallel to the audio cable and should be far away from the audio cable. Differential audio routing must follow the routing rules of differential signals.

The reference interface circuit is as follows:

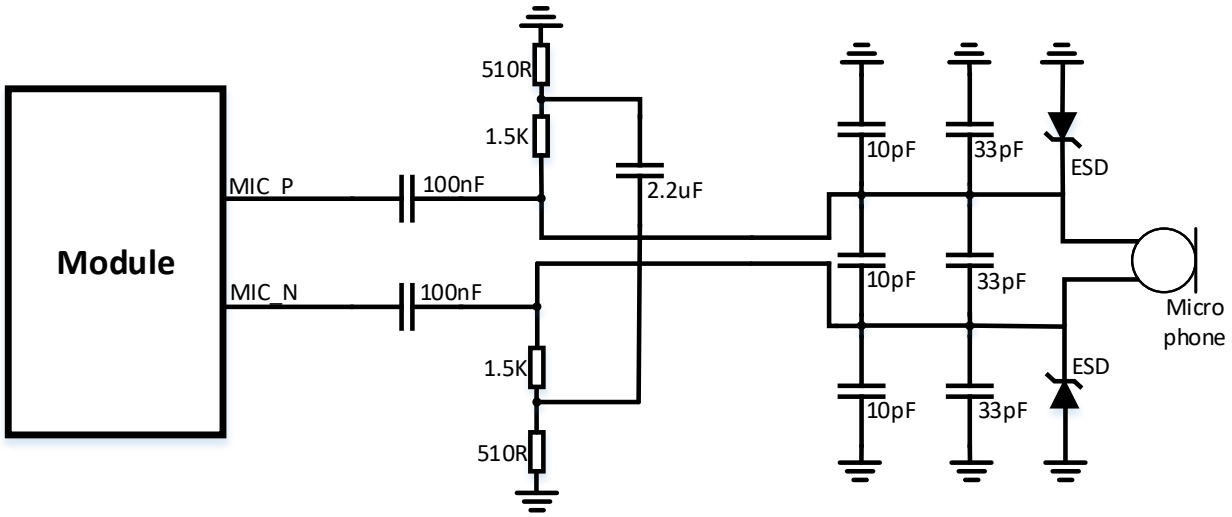


Figure 23 Microphone interface reference circuit

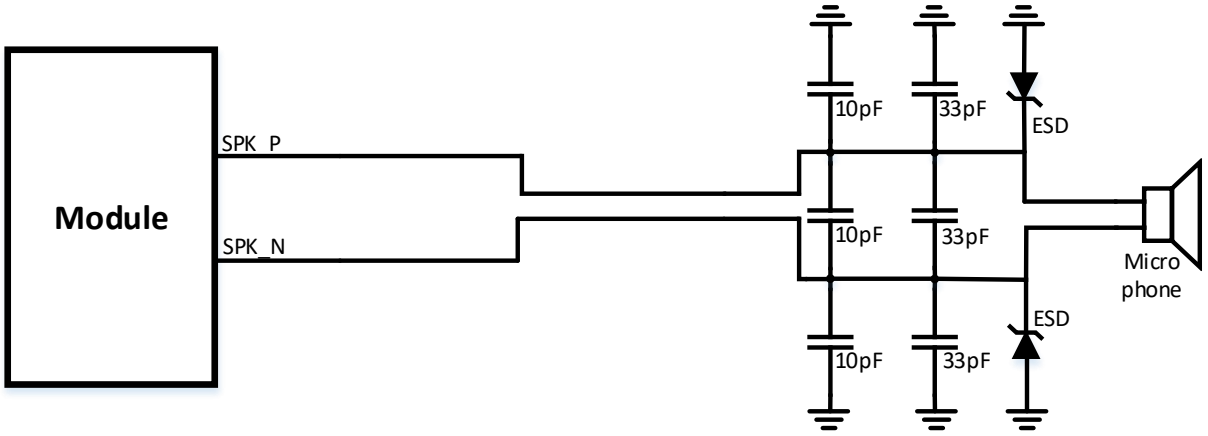


Figure 24 Handset interface reference circuit

Note:

The microphone channel is sensitive to ESD, so be sure to add a protective circuit

MIC_P/N, SPK_P/N group internal cabling complies with differential cabling requirements

4 GNSS

4.1 Basic Description

The SLM770A includes a complete built-in GNSS solution that supports Qualcomm Gen8C-Lite (GPS, GLONASS, BeiDou).

SLM770A modules support the standard NMEA-0183 protocol and output 1Hz NMEA statements via USB interface by default.

4.2 GNSS performance

The following table lists the GNSS performance of SLM770A module.

Table 22 GNSS performance list

Parameter	Description	Performance index
Positioning accuracy (open)	CEP-50	<5m
First positioning time TTFF (open)	Cold start	32s
	Warm start	29s
	Hot start	2s
Sensitivity	Cold star	-146dBm
	Capturing	-157dBm
	Tracking	-157dBm

4.3 Layout guide

Follow the layout guide in the below when designing:

- Maximize the distance between the GNSS antenna, the main antenna and the diversity antenna.
- Digital signals such as USIM card, USB interface, camera module, display interface and SD card should be far away from the antenna;
- Use ground via around the GNSS trace and sensitive analog signal traces to provide isolation and protection.
- Keep 50Ω characteristics impedance of the ANT_GNSS trace.
- In case of any static electricity or lightning strikes, reserve a place for TVS on the mainboard.

Refer to Chapter 5 for GNSS reference design and antenna considerations.

5 Antenna Interface

SLM770A module is designed with a main antenna interface, a diversity receiving antenna interface (used to suppress signal drops due to high-speed movement and multipath) and a GNSS antenna interface. The impedance of antenna interface is 50Ω.

Table 23 Definition of Antenna Interface Pin

Pin name	Pin number	Description	I/O	Note
ANT_MAIN	49	Main antenna	IO	50Ω impedance
ANT_DIV	35	Diversity receiving antenna interface	AI	50Ω impedance
ANT_GNSS	47	GNSS antenna	AI	50Ω impedance

5.1 Introduction to Antenna Interfaces

SLM770A provides 3 antenna pins, including: ANT_MAIN, ANT_DIV and ANT_GNSS. Can choose to connect diversity antenna to improve the WCDMA/TDD-LTE/FDD-LTE receptivity. It is recommended that the users use the antenna of 50Ω impedance matching the RF connector on the module.

Note: In order to ensure the communication capability of all frequency bands, please connect both the main and auxiliary antennas.

It is recommended to carefully select RF patch cord for application side. Need to choose the RF patch cord with as little loss as possible. It is recommended to use the RF patch cord with the following RF loss requirements:

- GSM900/850<1.5dB；
- DCS1800/PCS1900<1.5dB；
- WCDMA<1.5dB；
- TDD-LTE<1.5dB；
- FDD-LTE<1.5dB。

5.2 RF Reference Circuit

ANT_MAIN and ANT_DIV antenna connection is shown in the figure below. In order to obtain better RF performance, pay attention to the following four points in schematic diagram design and PCB layout:

1. In schematic diagram design, reserve π-type matching circuit near the RF port of the module, and the capacitor is not attached by default;

2. In schematic diagram design, provide redundant RF connector from the module RF port to an antenna, used for certification testing, the RF connector may not be attached after mass production and delivery (Reference: RF connector-1P-H176);

3. In schematic diagram design, reserve π-type matching circuit near the antenna and the capacitor is not attached by default;

4. In PCB layout, the routing from the module RF port to an antenna is as short as possible, and the board factory shall make 50Ω impedance control on RF routing PCB layout;

Note: Customers need to consider the impedance matching between backplane and module. The reserved matching should be optimized according to the actual situation to ensure the optimum performance.

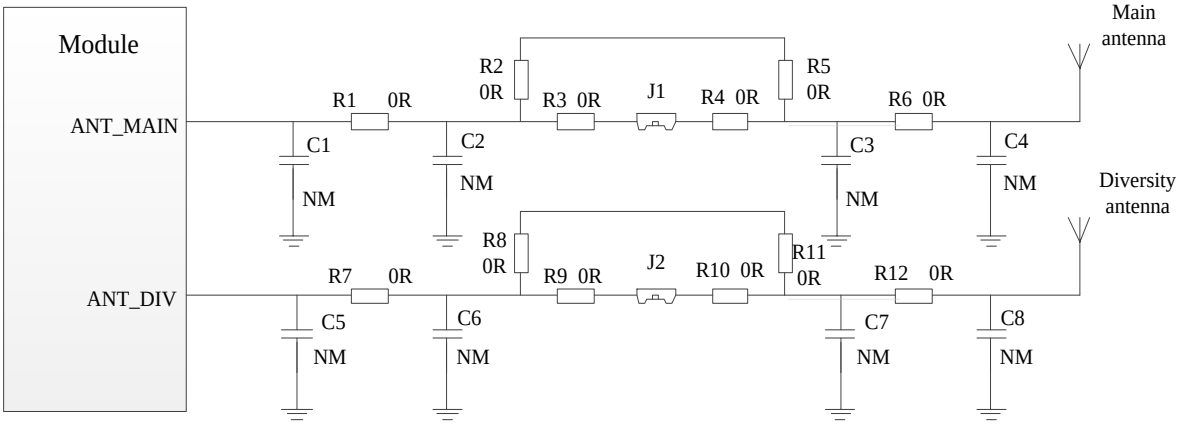


Figure 25 RF reference circuit

The reference design of GNSS antenna is shown in the following figure:

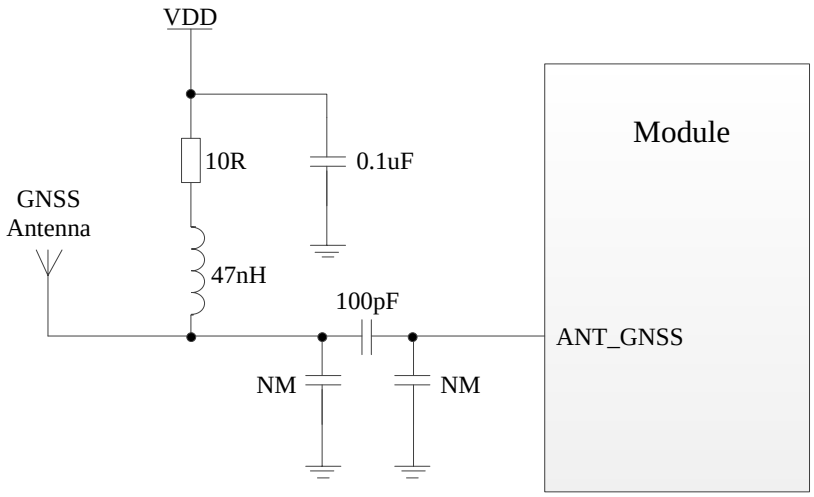


Figure 26 Reference circuit of GNSS antenna

5.3 Antenna

5.3.1 Antenna Requirements

The requirements for the main antenna, diversity receiving antenna and GNSS antenna are shown in the following table:

Table 24 Antenna requirements

Type	Requirement
GNSS	Frequency range: 1561 MHz -1615MHz
	Polarization: RHCP or linear
	VSWR：< 2 (typical value)
	Passive antenna gain: > 0 dBi
	Active antenna noise coefficient: < 1.5 dB
	Active antenna gain: >-2 dBi
	Active antenna embedded LNA gain: 18.5dB (typical value)
	Active antenna total gain: > 18.5 dB (typical value)

GSM/WCDMA / /TDD-LTE/FDD-LTE	VSWR：< 2
	Gain (dBi): 1
	Maximum input power (W): 2W
	Input impedance (ohm): 50
	Polarization type: vertical
	Cable insertion loss: < 1.5dB (GSM850/900, WCDMA B5/B8, LTE B5/B8/B12/B13/B17/B20/B26)
	Cable insertion loss: < 1.5 dB (GSM1800/1900, WCDMA B1/B2/B4, LTE B1/B2/B3/B4/B25/B39)
	Cable insertion loss: < 2dB (LTE B7/B38/B40/B41)

5.3.2 RF Output Power

RF output power of SLM770A is shown in the following table.

Table 25 SLM770A-C RF transmitted power

Frequency	Maximum Value	Minimum Value
EGSM900	33dBm±2dB	5dBm±5dB
DCS1800	30dBm±2dB	0dBm±5dB
WCDMA B1	24dBm+1/-3dB	<-49dBm
WCDMA B8	24dBm+1/-3dB	<-49dBm
LTE-FDD B1	23dBm±2.7dB	<-39dBm
LTE-FDD B3	23dBm±2.7dB	<-39dBm
LTE-FDD B5	23dBm±2.7dB	<-39dBm
LTE-FDD B8	23dBm±2.7dB	<-39dBm
LTE-FDD B34	23dBm±2.7dB	<-39dBm

LTE-TDD B38	23dBm±2.7dB	<-39dBm
LTE-TDD B39	23dBm±2.7dB	<-39dBm
LTE-TDD B40	23dBm±2.7dB	<-39dBm
LTE-TDD B41	23dBm±2.7dB	<-39dBm

Table 26 SLM770A-E RF transmitted power

Frequency	Maximum Value	Minimum Value
EGSM900	33dBm±2dB	5dBm±5dB
DCS1800	30dBm±2dB	0dBm±5dB
WCDMA B1	24dBm+1/-3dB	<-49dBm
WCDMA B8	24dBm+1/-3dB	<-49dBm
LTE-FDD B1	23dBm±2.7dB	<-39dBm
LTE-FDD B3	23dBm±2.7dB	<-39dBm
LTE-FDD B7	23dBm±2.7dB	<-39dBm
LTE-FDD B8	23dBm±2.7dB	<-39dBm
LTE-FDD B20	23dBm±2.7dB	<-39dBm
LTE-TDD B28	23dBm±2.7dB	<-39dBm
LTE-TDD B38	23dBm±2.7dB	<-39dBm
LTE-TDD B40	23dBm±2.7dB	<-39dBm

5.3.3 RF Receiving Sensitivity

Table 27 SLM770A-C Module RF receiving sensitivity

Frequency	Receiving sensitivity (typical value) -10M			
	Main	Diversity	Main + Diversity	3GPP (Main + Diversity)
EGSM900	-108.5dBm	NA	NA	-102.4dBm
DCS1800	-108.5dBm	NA	NA	-102.4dBm
WCDMA B1	-109dBm	-110dBm	-112dBm	-106.7dBm
WCDMA B8	-109.5dBm	-110dBm	-113dBm	-103.7dBm
LTE-FDD B1	-96dBm	-97dBm	-99dBm	-96.3dBm
LTE-FDD B3	-97dBm	-97dBm	-100dBm	-93.3dBm
LTE-FDD B5	-98dBm	-96dBm	-99dBm	-94.3dBm
LTE-FDD B8	-98dBm	-100dBm	-102dBm	-93.3dBm
LTE-FDD B34	-97.5dBm	-97dBm	-98dBm	-96.3dBm
LTE-TDD B38	-96dBm	-97dBm	-101dBm	-96.3dBm
LTE-TDD B39	-97.5dBm	-97.5dBm	-98dBm	-96.3dBm
LTE-TDD B40	-96dBm	-96.5dBm	-100.5dBm	-96.3dBm
LTE-TDD B41	-96.5dBm	-97dBm	-100.5dBm	-94.3dBm

Table 28 SLM770A-E Module RF receiving sensitivity

Frequency	Receiving sensitivity (typical value)			
	Main	Diversity	Main + Diversity	3GPP (Main + Diversity)
EGSM900	-108.5dBm	NA	NA	
DCS1800	-108.5dBm	NA	NA	
WCDMA B1	-109dBm	-110dBm	-112dBm	-106.7dBm

WCDMA B8	-109.5dBm	-110dBm	-113dBm	-103.7dBm
LTE-FDD B1	-96dBm	-97dBm	-99dBm	-96.3dBm
LTE-FDD B3	-97dBm	-97dBm	-100dBm	-93.3dBm
LTE-FDD B7	-97dBm	-98dBm	-101dBm	-94.3dBm
LTE-FDD B8	-98dBm	-100dBm	-102dBm	-93.3dBm
LTE-FDD B20	-98.5dBm	-98.5dBm	-101dBm	-93.3dBm
LTE-TDD B28	-98.5dBm	-98.5dBm	-101dBm	-94.8dBm
LTE-TDD B38	-98dBm	-98dBm	-101dBm	-96.3dBm
LTE-TDD B40	-96dBm	-96.5dBm	-99dBm	-96.3dBm

5.3.4 Working Frequency

Table 29 SLM770A-C working frequency

3GPP Frequency band	Transmit	Receive	Unit
EGSM900	880~915	925~960	MHz
DCS1800	1710~1785	1805~1880	MHz
WCDMA B1	1920~1980	2110~2170	MHz
WCDMA B8	880~915	925~960	MHz
LTE-FDD B1	1920~1980	2110~2170	MHz
LTE-FDD B3	1710~1785	1805~1880	MHz
LTE-FDD B5	824~849	869~894	MHz
LTE-FDD B8	880~915	925~960	MHz
LTE-TDD B34	2010~2025	2010~2025	MHz
LTE-TDD B38	2570~2620	2570~2620	MHz

LTE-TDD B39	1880~1920	1880~1920	MHz
LTE-TDD B40	2300~2400	2300~2400	MHz
LTE-TDD B41	2535~2655	2525~2655	MHz

Table 30 SLM770A-E working frequency

3GPP Frequency band	Transmit	Receive	Unit
EGSM900	880~915	925~960	MHz
DCS1800	1710~1785	1805~1880	MHz
WCDMA B1	1920~1980	2110~2170	MHz
WCDMA B8	880~915	925~960	MHz
LTE-FDD B1	1920~1980	2110~2170	MHz
LTE-FDD B3	1710~1785	1805~1880	MHz
LTE-FDD B7	2500~2570	2620~2690	MHz
LTE-FDD B8	880~915	925~960	MHz
LTE-FDD B20	832~862	791~821	MHz
LTE-TDD B28	703~748	758~803	MHz
LTE-TDD B38	2570~2620	2570~2620	MHz
LTE-TDD B40	2300~2400	2300~2400	MHz

5.3.5 Antenna Requirements

Table 31 Requirements for antenna index

Network Mode	Band	VSWR	Gain Peak	Avg.	Effi.	SAR	TRP (dBm)	TIS (dBm)
GSM	900						29	<-102
	1800(DCS)						26	<-102
WCDMA	Band1						19	<-102
	Band8						19	<-102
TDD-LTE	Band34						19	<-94
	Band38						19	<-94
	Band39						19	<-94
	Band40						19	<-94
	Band41	<2.5:1	>0dBi	>-4dBi	>40%	<1.6W/Kg	19	<-94
FDD-LTE	Band1						19	<-94
	Band3						19	<-94
	Band5						19	<-94
	Band7						19	<-94
	Band8						19	<-94
	Band20						19	<-94
	Band28						19	<-94

Table 32 Requirements for diversity antenna index

Mode	Band	VSWR	Gain /Avg.	Efficiency	ρ	Isolation
GSM	900	<2.5:1	>-7dBi	>20%	<0.5	<-8dB

	1800(DCS)
WCDMA	Band1
	Band8
TDD-LTE	Band34
	Band38
	Band39
	Band40
	Band41
FDD-LTE	Band1
	Band3
	Band5
	Band7
	Band8
	Band20
	Band28

6 Electrical Characteristics

6.1 Limiting Voltage Range

Limiting voltage range refers to the maximum voltage range that the module supply voltage and the digital and analog input / output interfaces can withstand. Working outside this range may cause damage to this product.

The limiting voltage range of SLM770A is shown in the following table.

Table 33 Limiting working voltage range of the module

Parameter	Description	Minimum	Typical	Maximum	Unit
VBAT	SLM770A power supply	3.3	3.8	4.2	V
	RMS average supply current	0		0.9	A
	VBAT_BB maximum current	0		1	A
	VBAT_RF maximum current	0		2	A
	Voltage drop during burst launch (GSM900 Maximum transmit power level)			400	mV
USB_VBUS	USB detection	3.0	5.0	5.25	V
GPIO	Level power supply voltage of digital IO	-0.3	1.8	2.0	V
	Power supply voltage of shutdown mode	-0.25		0.25	V

6.2 Environment Temperature Range

SLM770A modules are recommended to work at -30~+75℃. It is suggested that temperature control measures should be considered at the application end under adverse environmental conditions. At the same time, the module is provided with a limited operating temperature range, under which some RF indicators may exceed the standard. It is also recommended that the module application terminal be stored at a certain temperature. Modules outside this range may not work properly or may be damaged.

Table 34 Temperature range of the module

Parameter	Minimum	Typical	Maximum	Unit
Working temperature	-35	+25	+75	℃
Extended working temperature	-40		+85	℃
Storage temperature	-45		+90	℃

6.3 Electrical Characteristics of Interface in Working Status

VL: logical low level;

VH: logical high level;

Table 35 Logic Levels of ordinary digital IO signals

Signals	V_L Minimum	V_L Maximum	V_H Minimum	V_H Maximum	Unit
Digital input	-0.3	0.7*Vpin_min	0.7*Vpin_max	Vpin_max	V
Digital output	GND	0.2	Vpin_min-0.2	Vpin	V

Table 36 Electrical characteristics of power supply in working status

Parameter	I/O	Minimum	Typical	Maximum	Unit
VBAT	I	3.3	3.8	4.2	V
USIM_VDD	O	1.7/2.75	1.8/2.85	1.9/2.95	V

6.4 Environmental Reliability Requirements

Table 37 Environmental reliability requirements

Test item	Test condition
Low temperature storage test	1) TL (test temperature value) : -45℃ (adjusted according to product demand) 2) tc (sample recovery time) : 1h 3) Test time: 24H (adjusted according to product demand)
High temperature storage test	1) TH (test temperature value) : +90℃ (adjusted according to product demand) 2) tc (sample recovery time) : 1h 3) Test time: 24H (adjusted according to product demand)
Temperature shock test	TH (test temperature value) : +70℃ (according to the actual adjustment) holding time 30min 2) TL (test temperature value) : -40℃ (according to the actual adjustment) holding time 30min 3) r (transfer time) : within 20s 4) tc (recovery time) : 2h 5) Number of cycles: 24
High temperature and high humidity test	1) TH (test temperature value) : +85℃ 1) D (test set humidity value) : 85%RH 2) tc (sample recovery time) : 1h 3) Test time: 1000 hours, Remove the cover, power on, and test
Low temperature operation test	1) TL (test temperature value) : -40℃ (adjusted according to product demand) 2) Temperature stabilization time: 24h (adjusted according to product demand)
High temperature operating test	1) TH (test temperature value) : +85℃ (adjusted according to product demand) 2) Temperature stabilization time: 24h (adjusted according to product demand)
Vibration test	1) Sinusoidal sweep frequency: 5~9Hz, 1.2mm; 9~200Hz; 4m/s2 2) Sweep rate: 1oct/min. Three axes, 5 cycles per axis.
ESD test	1, the module tests the power PAD and a large area in the call state, ESD meets: ① Contact discharge should pass the test grade of ±4KV and ±5KV ② Air discharge should pass the test grade of ±8KV and ±10KV 2, the module in the shutdown state, test the EVB SIM card, ESD meets: ① Contact discharge should pass the test grade of ±4KV ② Air discharge should pass the test grade of ±8KV

Test item	Test condition
	3, module other interfaces, ESD meet: ① Contact discharge should pass the test grade of ±0.5KV ② Air discharge should pass the test grade of ±1KV

6.5 ESD Features

SLM770A module design has considered the ESD problem, and do the ESD protection, but consider SLM770A module in the transport and secondary development may also have ESD problem occurred, so developers to view the protection of the final product ESD problem, besides must consider the antistatic packaging processing. Please refer to the document interface design when the customer application recommended circuit.

Refer to the following table for the ESD allowed discharge range for SLM770A module.

Table 38 ESD performance parameter (Temperature: 25℃, Humidity: 45%)

Test point	Contact discharge	Air discharge	Unit
VBAT, GND	±5	±10	KV
Antenna interface	±4	±8	KV
Other interfaces	±0.5	±1	KV

6.6 Power Consumption

Table 39 SLM770A module scenario power consumption data

Description	Condition	Typical Value	Unit
Power off mode	Module off	18	uA
Sleep mode	AT+CFUN=0（USB disconnect）	1.35	mA
	LTE-FDD @ PF = 256（USB disconnect）	2.56	mA
	LTE-FDD @ PF = 128（USB disconnect）	2.69	mA

	LTE-FDD @ PF = 64（USB disconnect）	3.04	mA
	LTE-FDD @ PF = 32（USB disconnect）	3.82	mA
GSM basic power consumption	EGSM900 PCL=5(4UP) @ 31.7 dBm	284.7	mA
	DCS1800 PCL=0 @ 29.6 dBm	243.2	mA
WCDMA basic power consumption	WCDMA B1 @ 22.98dBm	568.8	mA
	WCDMA B1 @ 10.3 dBm	307.3	mA
	WCDMA B1 @ 0.1 dBm	268.6	mA
	WCDMA B1 @ -53.5 dBm	250.8	mA
	WCDMA B8 @ 22.98dBm	621.9	mA
	WCDMA B8 @ 10.3 dBm	315.5	mA
	WCDMA B8 @ 0.1 dBm	251.5	mA
	WCDMA B8 @ -53.5 dBm	245.6	mA
LTE basic power consumption	LTE B1@21.9dBm	626.7	mA
	LTE B1@10.9dBm	386.5	mA
	LTE B1@0.4dBm	316.9	mA
	LTE B1@-46.5dBm	304.5	mA
	LTE B8@22.7dBm	642.8	mA
	LTE B8@9.9dBm	361.5	mA
	LTE B8@0.5dBm	307.6	mA
	LTE B8@-45.5dBm	295.6	mA
	LTE B41@21.1dBm	447.2	mA
	LTE B41@10.5dBm	322.8	mA
	LTE B41@1.25dBm	253.6	mA
	LTE B41@-48.3dBm	245.1	mA

7 Mechanical Characteristics

This section describes the mechanical dimensions of the module. All dimensions are in mm, for all dimensions without tolerance indicated, the tolerance is ±0.05mm.

7.1 Mechanical Dimensions of the Module

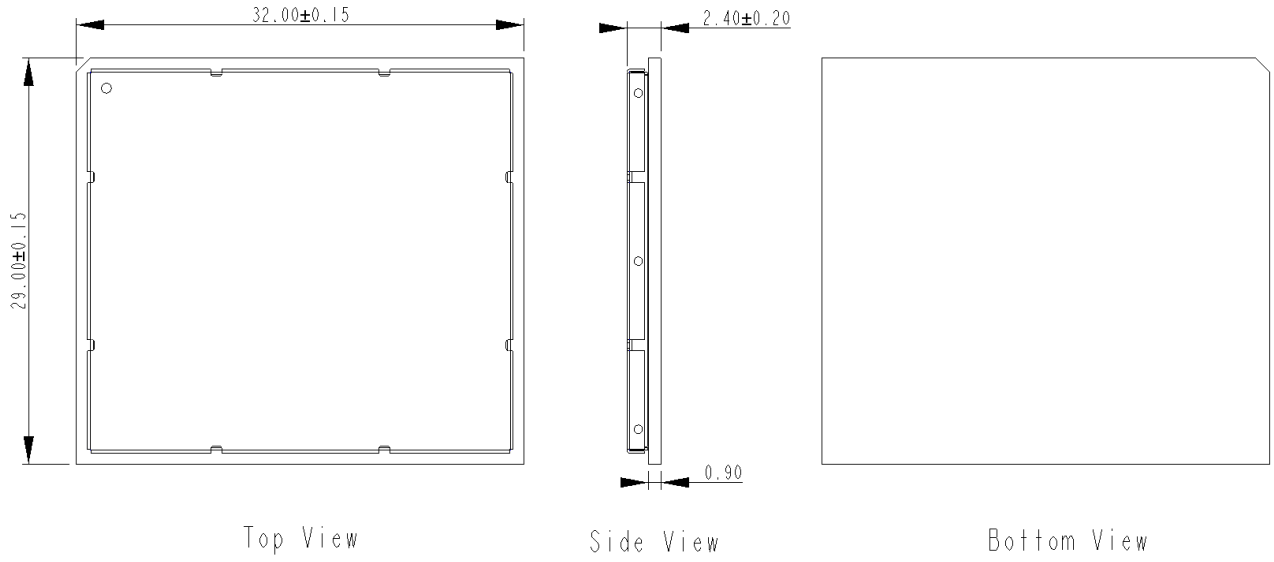
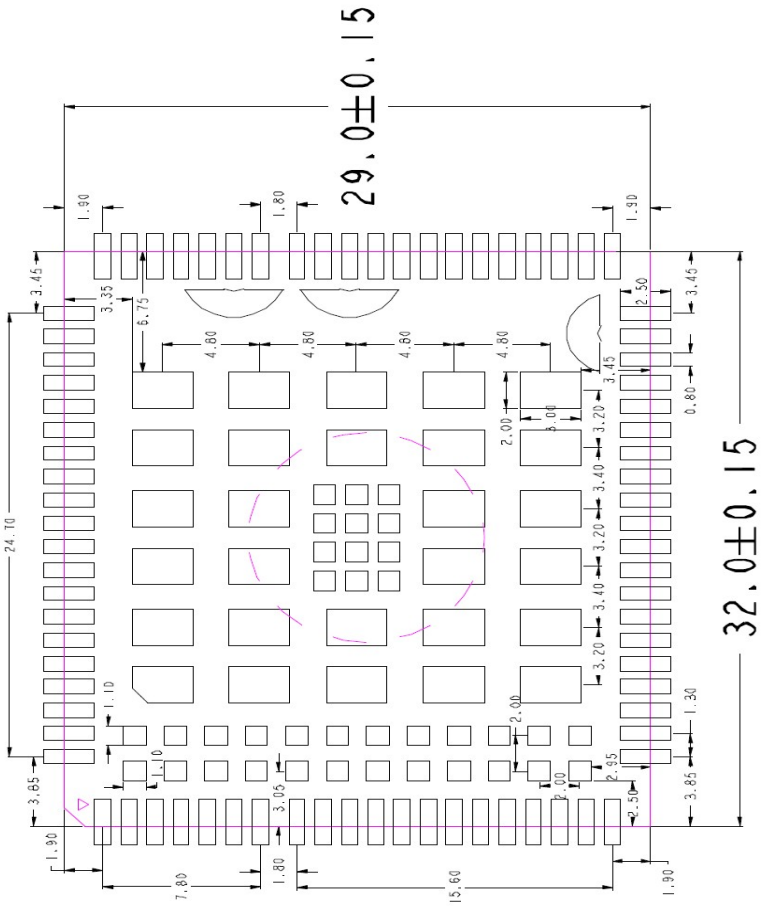


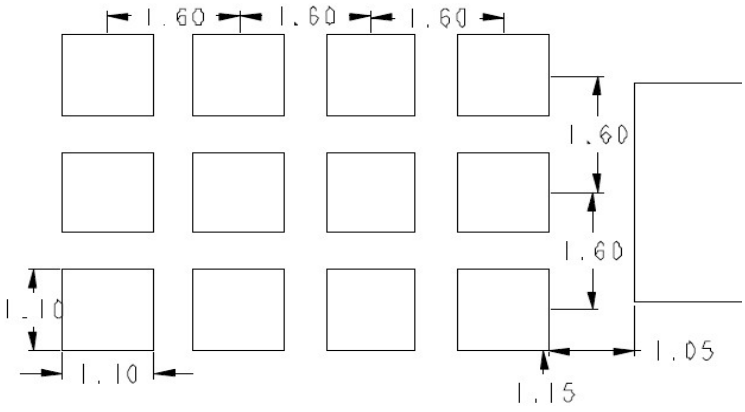
Figure 27 Top and side dimensional drawing (Unit: mm)

Module flatness standard: ≤0.12mm (Steel mesh: it is suggested that customers open the steel mesh reasonably by combining the main board, and it is suggested that customers open the stepped steel mesh to 0.18mm by combining the experience of MeiG module SMT)

7.2 Recommended Packaging



a) Recommended Packaging



b) Recommended Packaging

Figure 28 Recommended packaging (Top View) (Unit: mm)

7.3 Top View of the Module

Figure 29 Top view of the module

7.4 Bottom View of the Module

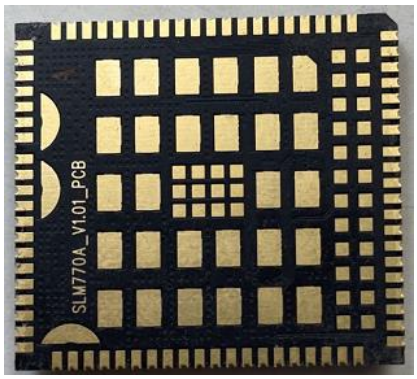


Figure 30 Bottom view of the module

7.5 Module Effect Design

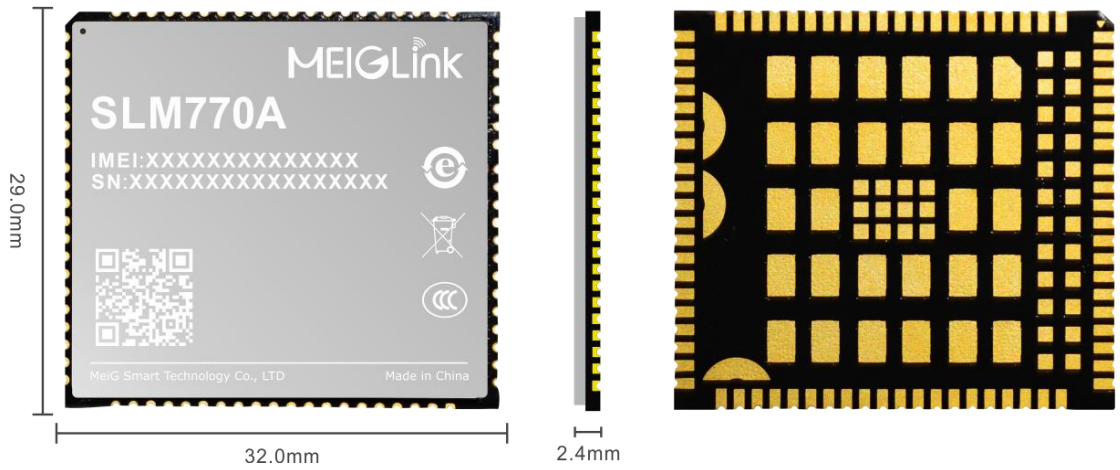


Figure 31 Module effect design

8 Storage and Production

8.1 Storage

SLM770A modules are shipped in vacuum sealed bags. The storage of modules is subject to the following conditions:

1. When the environment temperature is below 40℃ and the air humidity is less than 90%, the module can be stored in a vacuum sealed bag for 12 months.

2. After the vacuum sealing bag is opened, the module can directly carry out reflow welding or other high-temperature processes if the following conditions are met:

- The air humidity for module storage is lower than 10%;
- The ambient temperature of the module is lower than 30℃, the air humidity is lower than 60%, and the factory completes the placement within 72 hours.

3. If the module is in the following conditions, it needs to be baked before placement:

- When the environment temperature is 23℃ (±5 ℃ fluctuations are allowed), the humidity displayed by the humidity indicator card is greater than 10%;
- After the vacuum-sealed bag is opened, the ambient temperature of the module is lower than 30℃ and the air humidity is lower than 60%, but the factory fails to complete the placement within 168 hours;
- After the vacuum-sealed bag is opened, the air humidity for module storage is greater than 10%.

4. If the module needs to be baked, bake it for 8 hours at 125℃ (±5 ℃ fluctuations are allowed).

Note: The package of the module cannot withstand such high temperature, please remove the package of the module before the module is baked.

8.2 Production Welding

Figure 32 Temperature curve of solder reflow

8.3 Packaging

SLM770A modules are packed in pallets. The specifications are as follows:

Figure 33 Pallet packaging

9 Annex A Reference Documents and Abbreviations

9.1 Reference Documents

- SLM770A specifications;
- SLM770A AT command set;
- SLM770A reference design circuit;

9.2 Abbreviations

Table 40 Abbreviations

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
HSPA+	HSPA High-Speed Packet Access+
IEC	International Electro-technical Commission
IMEI	International Mobile Equipment Identity
MEID	Mobile Equipment Identifier
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
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
TD-SCDMA	Time Division-Synchronous Code Division Multiple Access
TDD-LTE	Time Division Long Term Evolution
FDD-LTE	Frequency Division Duplexing Long Term Evolution
Vmax	Maximum Voltage Value
Vnorm	Normal Voltage Value
Vmin	Minimum Voltage Value
V_{IH}max	Maximum Input High Level Voltage Value
V_{IH}min	Minimum Input High Level Voltage Value

$V_{IL}max$	Maximum Input Low Level Voltage Value
$V_{IL}min$	Minimum Input Low Level Voltage Value
$V_{OH}max$	Maximum Output High Level Voltage Value
$V_{OH}min$	Minimum Output High Level Voltage Value
$V_{OL}max$	Maximum Output Low Level Voltage Value
$V_{OL}min$	Minimum Output Low Level Voltage Value

10 Annex B GPRS Coding Scheme

Table 41 Description of different coding schemes

Mode	CS-1	CS-2	CS-3	CS-4
Code rate	1/2	2/3	3/4	1
USF	3	3	3	3
Pre-coded USF	3	6	6	12
Radio Block excl.USF and BCS	181	268	312	428
BCS	40	16	16	16
Tail	4	4	4	-
Coded Bits	456	588	676	456
Punctured Bits	0	132	220	-
Data rate Kb/s	9.05	13.4	15.6	21.4

15.19 Labeling requirements.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

15.21 Changes or modification warning.

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

15.105 Information to the user.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

-Reorient or relocate the receiving antenna.

-Increase the separation between the equipment and receiver.

-Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

-Consult the dealer or an experienced radio/TV technician for help

RF warning for Mobile device:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

This module is intended for OEM integrators only. Per FCC KDB 996369 D03 OEM Manual v01 guidance, the following conditions must be strictly followed when using this certified module:

KDB 996369 D03 OEM Manual v01r01 rule sections:

2.2 List of applicable FCC rules

This module has been tested for compliance to FCC Part 15 22 24 27

2.3 Summarize the specific operational use conditions

The module is tested for standalone mobile RF exposure use condition. Any other usage conditions such as co-location with other transmitter(s) or being used in a portable condition will need a separate reassessment through a class II permissive change application or new certification.

2.4 Limited module procedures

Not application

2.5 Trace antenna designs

Not application

2.6 RF exposure considerations

This equipment complies with FCC mobile radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20cm between the radiator & your body. If the module is installed in a portable host, a separate SAR evaluation is required to confirm compliance with relevant FCC portable RF exposure rules.

2.7 Antennas

The following antennas have been certified for use with this module; antennas of the same type with equal or lower gain may also be used with this module. The antenna must be installed such that 20 cm can be maintained between the antenna and users.

Antenna Type	Gain (dBi)	
Dipole	-1.1	GSM 850
	-1.1	WCDMA Band V
	-1.1	LTE Band 5
	-1.1	PCS 1900
	-1.1	WCDMA Band II
	-1.1	LTE Band 2
	-1.5	WCDMA Band IV
	-1.5	LTE Band 4
	1.9	LTE Band 7
	0.2	LTE Band 40 (2305-2315MHz)
	0.4	LTE Band 40

		(2350-2355MHz)
	-1.4	LTE Band 66

2.8 Label and compliance information

The final end product must be labeled in a visible area with the following: “Contains FCC ID: 2APJ4-SLM770A”. The grantee's FCC ID can be used only when all FCC compliance requirements are met.

2.9 Information on test modes and additional testing requirements

This transmitter is tested in a standalone mobile RF exposure condition and any co-located or simultaneous transmission with other transmitter(s) or portable use will require a separate class II permissive change re-evaluation or new certification. 2.10 Additional testing, Part 15 Subpart B disclaimer

This transmitter module is tested as a subsystem and its certification does not cover the FCC Part 15 Subpart B (unintentional radiator) rule requirement applicable to the final host. The final host will still need to be reassessed for compliance to this portion of rule requirements if applicable.

As long as all conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed. IMPORTANT NOTE:

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization. Manual Information to the End User:

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user’s manual of the end product which integrates this module. The end user manual shall include all required regulatory information/warning as show in this manual

OEM/Host manufacturer responsibilities

OEM/Host manufacturers are ultimately responsible for the compliance of the Host and Module. The final product must be reassessed against all the essential requirements of the FCC rule such as FCC Part 15 Subpart B before it can be placed on the US market. This includes reassessing the transmitter module for compliance with the Radio and EMF essential requirements of the FCC rules. This module must not be incorporated into any other device or system without retesting for compliance as multi-radio and combined equipment.