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FIBOCOM MA510-GL Series Hardware User Manual

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Date: 2019-08-19

Applicability type

No.	Product model	Power supply voltage range
1	MA510-GL	3.3V~4.5V

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Versions

Version	Author	Assessor	Approver	Update Date	Description
V1.0.0	Guzhaoqiang	Tumin	Chenguojiang	2019-07-16	Initial version
V1.0.1	Gaoying	Tumin	Chenguojiang	2019-07-30	Update RF parameters Update some description
V1.0.2	WangNingNing GaoWenSheng	LiuKe		2019-08-19	Update power consumption data Update Power on times Pin definition standardization
V1.0.3	WangNingNing GaoWenSheng	LiuKe		2019-10-11	SIM card hot swap function update VBUS voltage range update

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1 Introduction

1.1 Document Introduction

This document describes the electrical characteristics, RF performance, structure size, application environment, etc. of MA510-GL module. With the assistance of the document and other instructions, the developers can quickly understand the hardware functions of the MA510-GL module and develop products.

1.2 Safety Precautions

By following the safety guidelines below, you can protect the personal safety and help protect the product and work environment from potential damage. Product manufacturers need to communicate the following safety instructions to end users. In case of failure to comply with these safety rules, Fibocom Wireless will not be responsible for the consequences caused by the user's misuse.

Road safety first! When you drive, do not use the handheld devices even if it has a hand-free feature. Please stop and call!

Please turn off the mobile device before boarding. The wireless feature of the mobile device is not allowed on the aircraft to prevent interference with the aircraft communication system. Ignoring this note may result in flight safety issue or even breaking the law.

When in a hospital or health care facility, please be aware of restrictions on the use of mobile devices. Radio frequency interference may cause medical equipment to malfunction, so it may be necessary to turn off the mobile device.

The mobile device does not guarantee that an effective connection can be made under any circumstances, for example, when there is no prepayment for the mobile device or the (U)SIM is invalid. When you encounter the above situation in an emergency, remember to use an emergency call, while keeping your device turned on and in areas where signal is strong.

Your mobile device receives and transmits RF signals when it is powered on. Radio interference occurs when it is near televisions, radios, computers, or other electronic devices. Keep the mobile device away from flammable gases. Turn off the mobile device when near gas stations, oil depots, chemical plants or explosive workplaces. There is a safety hazard in operating electronic equipment in any potentially explosive environment.

2 Product Overview

2.1 Product Introduction

MA510-GL series wireless module is a IOT wireless communication module that support multi-mode such as LTE, GSM (LTE Cat.M1，LTE Cat.NB1/NB2* and EGPRS). It can provide data connection at LTE-FDD, GPRS and EGPRS network. Supports GNSS (GPS/GLONASS/BeiDou).

2.2 Submodel Difference

Product model	Network type	Power supply voltage range	Note
MA510-GL	CatM+NB2*+GSM	3.3V~4.5V	Tri mode

Table 2-1 Submodel difference

2.3 Product Specification

Specification			
Operating frequency	LTE FDD CatM1: B1/B2/B3/B4/B5/B8/B12/B13/B14/B18/B19/B20/B25/B26/B27/B28/B66/B85		
	LTE FDD Cat NB1/NB2*: B1/B2/B3/B4/B5/B8/B12/B13/B18/B19/B20/B25/B26/B28/B66/B71/B85		
	GSM/GPRS/EGPRS: 850/900/1800/1900		
Data transmission	LTE features	Cat.M1 Rel.14：Max UL 1119kbps，Max DL 589kbps	
		Cat.NB1 Rel.14：Max UL 66.6kbps，Max DL 34kbps	
		Cat.NB2* Rel.14：Max UL 150kbps，Max DL 136kbps	
	GSM features	GPRS(class33)：Max UL 85.6kbps，Max DL 107kbps EGPRS(class33)：Max UL 236.8kbps, Max DL 296kbps	
	GPS features	GPS/GLONASS/BDS/Galileo	
Power supply	MA510-GL-00	3.3V~4.5V (Recommended 3.8V)	
Temperature	Normal：-30°C ~ +75°C①		
	Extend：-40°C ~ +85°C②		
	Storage：-40°C ~ +90°C		
Physical Characteristics	Package：LCC 42pin+ LGA 44Pin，86pin in total		
	Size：22.2 x 20.2 x 2.1 mm		

	Weight：1.7±0.2g
Interface	
Antenna	Antenna：Main x 1、GNSS x 1
Functional Interface	SIM x 1　1.8V only
	USB 2.0 x 1
	UART x 3、I2S x 1、I2C x 1、GPIO x 4
	System Indicator x 1
	ANT_TUNER x 1
	ADC x 2
Software	
Protocol Stack	Support: PPP/TCP/UDP/SSL/TLS/FTP(S)/HTTP(S) protocol
AT commands	3GPP TS 27.007 and 27.005, and proprietary FIBOCOM AT
Firmware update	FOTA/USB
Voice service	Support
SMS	Support Text and PDU modes；point-to-point MO；MT; cell broadcast
MMS service	Not Support

Table 2-2 Product Specification

Note:

1. ①Indicates that the module can work normally within this temperature range, and the relevant performance meets the requirements of the 3GPP standard.
2. ②Indicates that the module can work normally in this temperature range. The baseband and RF functions are normal, but individual indicators may exceed the scope of the 3GPP standard. When the temperature returns to the normal working range of the module, the indicators of the module will still comply with the 3GPP standard.
3. * indicates that the feature is under development.

2.4 Functional Diagram

Functional diagram shows the main hardware features of the MA510-GL series module.The Baseband section contains:

- CPU
- PMIC
- Clock
- Function interface

The RF section contains:

- Transceiver
- RF PA
- RF filter
- RF switch

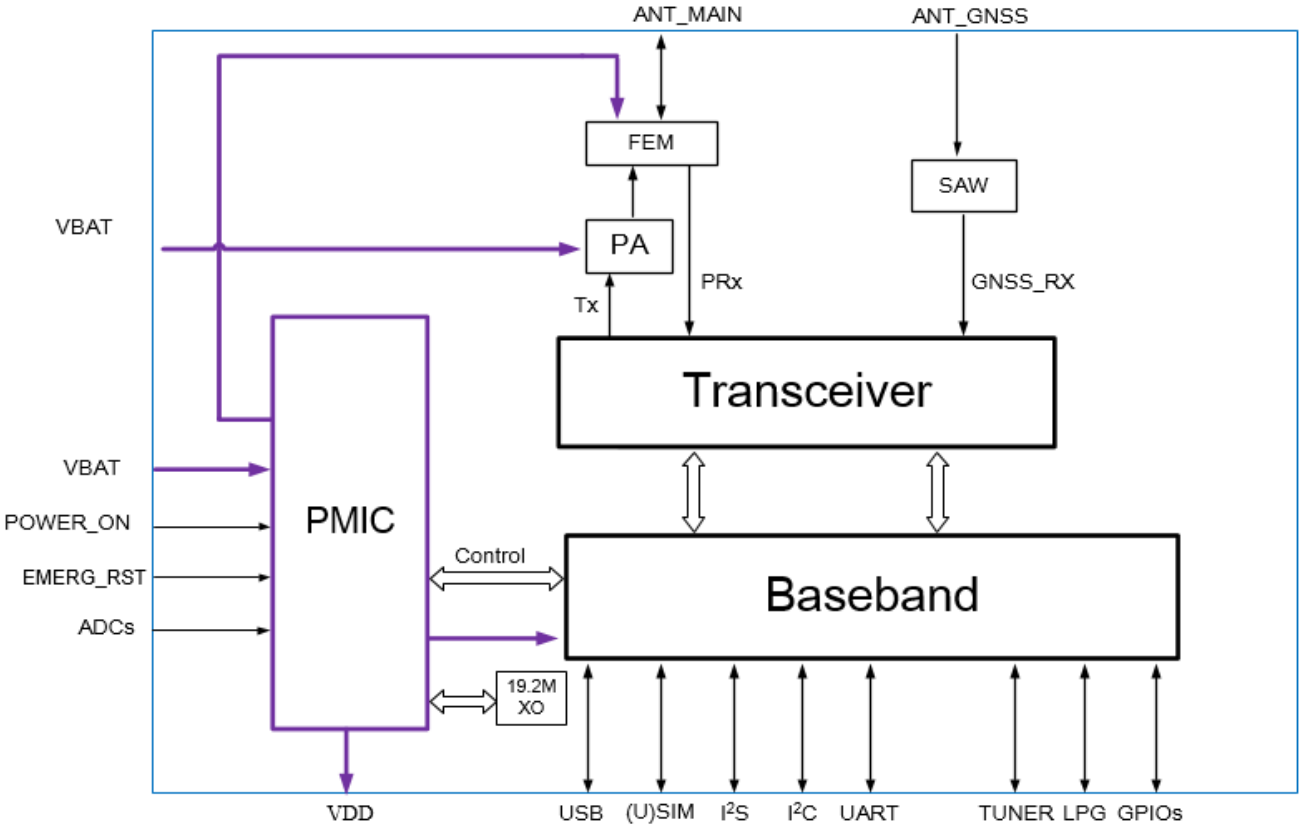


Figure 2-1 Functional Diagram

2.5 Evaluation Board

In order to help test and use the MA510-GL series modules, Fibocom provides evaluation boards. It include the EVK-GT8230-NL and ADP-MA510-GL-00-00. For details, please refer to the “ADP-MA510-GL Development Board Instructions” and “GT8230-NL User Manual”.

2.6 CE Statement

▸ EU Regulatory Conformance

Hereby, We, Manufacturer name declares that the radio equipment type MA510-GL is in compliance with the Directive 2014/53/EU.

In all cases assessment of the final product must be mass against the Essential requirements of the Directive 2014/53/EU Articles 3.1(a) and (b), safety and EMC respectively, as well as any relevant Article 3.2 requirements.

The maximum antenna gain for is 5 dBi and the antenna separation distance is 20cm.

▸ Declaration of Conformity(should include manufacturer contact info.)

Please added certification standard in your user manual which depended on the test standards your device performed., If the DoC should be a simplified version, please take below as reference, The full text of the EU declaration of conformity is available at the following internet address: http//www.fibocom.com.

MA510-GL is in conformity with the relevant Union harmonization legislation: Radio Equipment directive 2014 / 53 / EU with reference to the following standards applied: Health (Article 3.1(a) of Directive 2014/53/EU)

Applied Standard(s): EN 62311 : 2008

Safety (Article 3.1(a) of Directive 2014/53/EU) Applied Standard(s):

EN 60950-1: 2006 + A11: 2009 + A1: 2010 + A12: 2011 + A2: 2013

Electromagnetic compatibility (Article 3.1 (b) of Directive 2014/53/EU) Applied Standard(s):

Draft EN 301 489-1 V2.1.1 /-52 V1.1.0

Radio frequency spectrum usage (Article 3.2 of Directive 2014/53/EU) Applied Standard(s):

EN 301 908-1 V11.1.1

EN 301 908-13 V13.1.1_11.1.4(Draft)

EN 301511 V12.5.1

3 Pin Description

3.1 Pin Assignment

The MA510-GL series module is LCC+LGA package and has 86 pin in total, the pin assignment is shown as follows:

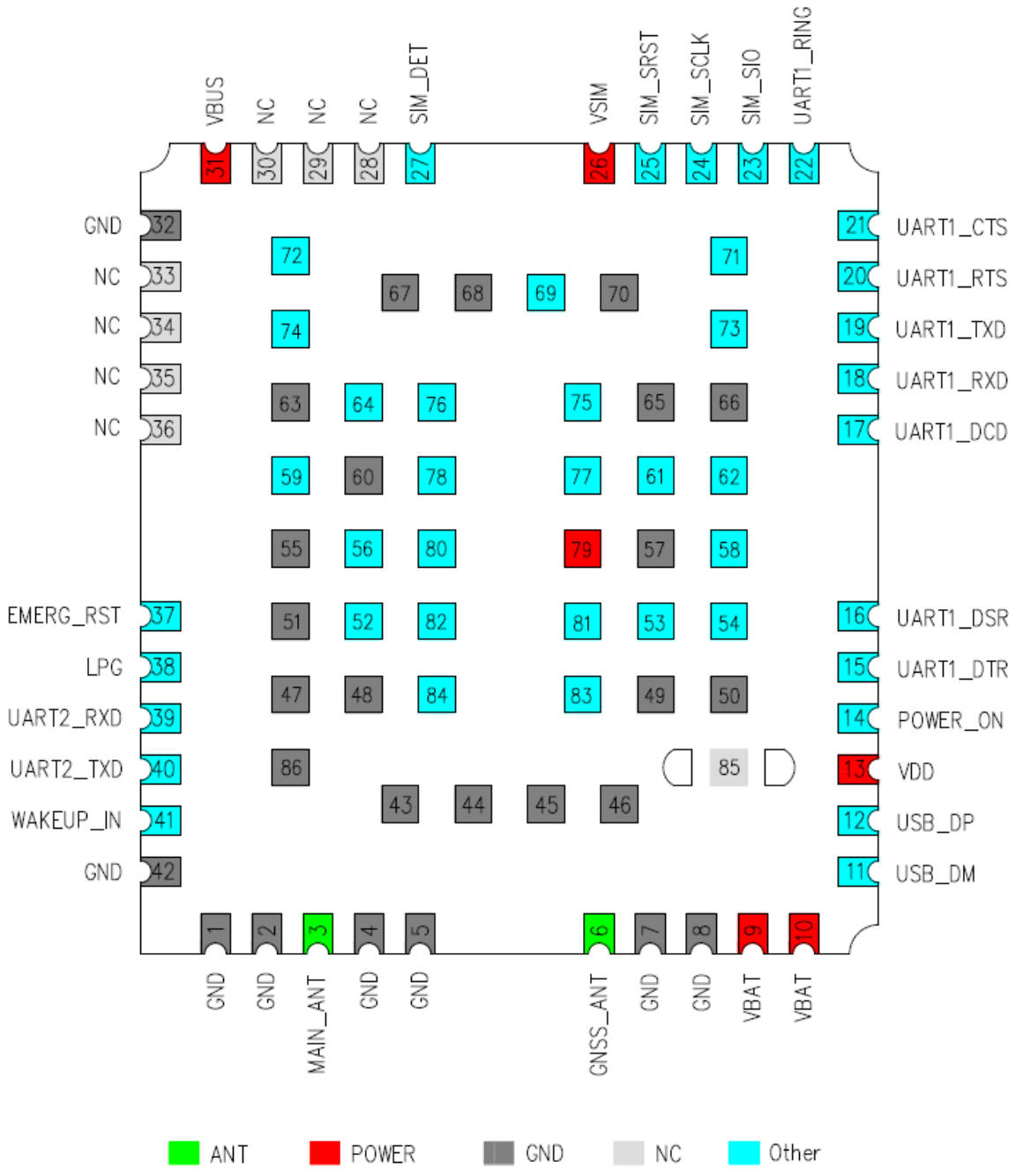


Figure 3-1 Pin Assignment

3.2 Pin function

Symbol	Description
I/O	Input/Output
DI	Digital Input
DO	Digital Output
PI	Power Input
PO	Power Output
AI	Analog Input
AO	Analog Output
OD	Open Drain
OC	Open Collector
G	GND

Table 3-1 I/O Description Parameters

The pin function description of MA510-GL series module is shown as table 3-2:

Pin Num	Pin Name	I/O	Description	Power domain	Note
1	GND	G	GND		
2	GND	G	GND		
3	MAIN_ANT	I/O	Main antenna		
4	GND	G	GND		
5	GND	G	GND		
6	GNSS_ANT	AI	GNSS antenna		
7	GND	G	GND		
8	GND	G	GND		
9	VBAT	PI	Power supply	3.8V	3.8V is Recommended voltage
10	VBAT	PI	Power supply	3.8V	
11	USB_DM	I/O	USB2.0 difference signal -		
12	USB_DP	I/O	USB2.0 difference signal +		

Pin Num	Pin Name	I/O	Description	Power domain	Note
13	VDD	PO	IO interface power domain	1.8V	80mA drive capability. Keep it floating if unused
14	POWER_ON	DI	Module power on/off	1.8V	Pull down 0.55-1.7s to power on
15	UART1_DTR	DI	UART1 module sleep/ wake-up control signal	1.8V	Keep it floating if unused
16	UART1_DSR*	I/O	UART1 data is ready	1.8V	UART1 reserved function, to be developed
17	UART1_DCD	DO	UART1 module carrier detection signal output	1.8V	Keep it floating if unused
18	UART1_RXD	DI	UART1 data reception	1.8V	Keep it floating if unused
19	UART1_TXD	DO	UART1 data transmission	1.8V	Keep it floating if unused
20	UART1_RTS	DO	UART1 request to send	1.8V	Keep it floating if unused
21	UART1_CTS	DI	UART1 clear to send	1.8V	Keep it floating if unused
22	UART1_RING	DO	UART1 ring indicator	1.8V	Keep it floating if unused
23	SIM_SIO	I/O	SIM card data signal	1.8V	
24	SIM_SCLK	DO	SIM card clock signal	1.8V	
25	SIM_SRST	DO	SIM card reset signal	1.8V	
26	VSIM	PO	SIM card power supply	1.8V	
27	SIM_DET	DI	SIM card detection	1.8V	Keep it floating if unused
28	NC	-	NC	-	floating
29	NC	-	NC	-	floating
30	NC	-	NC	-	floating
31	VBUS	AI	USB power pin	5V	USB plug detect signal, USB PHY power supply, Requires more than 100mA drive capability.
32	GND	G	GND	-	-
33	NC	-	NC	-	floating
34	NC	-	NC	-	floating

Pin Num	Pin Name	I/O	Description	Power domain	Note
35	NC	-	NC	-	floating
36	NC	-	NC	-	floating
37	EMERG_RST	DI	Module reset	1.8V	Pull down 7.5s or more to reset
38	LPG	DO	Status Indicator light control	1.8V	Need to increase the drive externally
39	UART2_RXD	DI	UART2 data reception	1.8V	Debug Uart. Keep it floating if unused
40	UART2_TXD	DO	UART 2 data transmission	1.8V	Debug Uart. Keep it floating if unused
41	WAKEUP_IN	DI	Module sleep/wake control signal input	1.8V	Keep it floating if unused
42	GND	G	GND	-	
43	GND	G	GND	-	
44	GND	G	GND	-	
45	GND	G	GND	-	
46	GND	G	GND	-	
47	GND	G	GND	-	
48	GND	G	GND	-	
49	GND	G	GND	-	
50	GND	G	GND	-	
51	GND	G	GND	-	
52	I2C_SDA	I/O	I2C data signal	1.8V	Keep it floating if unused
53	GPIO1	I/O	Reserved GPIO	1.8V	Keep it floating if unused
54	GPIO2	I/O	Reserved GPIO	1.8V	Keep it floating if unused
55	GND	G	GND	-	
56	I2C_SCL	DO	I2C clock	1.8V	Keep it floating if unused
57	GND	G	GND	-	
58	GPIO3	I/O	Reserved GPIO	1.8V	Keep it floating if unused
59	ADC1	AI	Analog digital change	1.8V	Keep it floating if unused

Pin Num	Pin Name	I/O	Description	Power domain	Note
60	GND	G	GND	-	
61	WAKEUP_OUT	DO	Module wakeup host	1.8V	Keep it floating if unused
62	GPIO_4	I/O	Reserved GPIO	1.8V	Keep it floating if unused
63	GND	G	GND	-	
64	AXUADC0	AI	Analog digital change	4.8V	Keep it floating if unused
65	GND	G	GND	-	
66	GND	G	GND	-	
67	GND	G	GND	-	
68	GND	G	GND	-	
69	CODEC_EN	DO	External codec enable	1.8V	Keep it floating if unused
70	GND	G	GND	-	
71	FORCE_BOOT	DI	Force download	1.8V	connect this pin with VDD and power on can force module enter download mode
72	I2S_DATA1	I/O	I2S data	1.8V	Keep it floating if unused
73	ANT_TUNER1*	DO	Antenna tuner interface	1.8V	In development. Keep it floating if unused
74	ANT_TUNER1*	DO	Antenna tuner interface	1.8V	In development. Keep it floating if unused
75	UART2_CTS	DI	UART2 clear to send	1.8V	Debug Uart. Keep it floating if unused
76	UART2_RTS	DO	UART2 request to send	1.8V	Debug Uart. Keep it floating if unused
77	UART3_RXD*	DI	UART3 data reception	1.8V	Keep it floating if unused
78	UART3_TXD*	DO	UART3 data transmission	1.8V	Keep it floating if unused
79	NC	-	NC	-	floating
80	I2S_MCLK	DO	I2S interface main clock	1.8V	Keep it floating if unused
81	CODEC_INTR	DI	Interrupt signal	1.8V	Can be used as GPIO. Keep it floating if unused

Pin Num	Pin Name	I/O	Description	Power domain	Note
82	I2S_DATA0	I/O	I2S data signal	1.8V	Keep it floating if unused
83	I2S_SCK	DO	I2S serial clock signal	1.8V	Keep it floating if unused
84	I2S_WS	DO	I2S word select signal	1.8V	Keep it floating if unused
85	NC	-	NC	-	floating
86	GND	G	GND	-	

Table 3-2 Pin function description

Note: The pin function with * is still under development and cannot be used temporarily.

4 Operating mode

MA510-GL offers five Operating modes as shown in the table below:

Operating modes	Description	Characteristic
Shutdown	VBAT is powered on and the module is not started.	Module is off
Standby	The module is fully booted and is already registered on the network, ready to communicate at any time. This is the default working mode after the module is powered on.	The module is active; All functions are available normally; Data transmission and reception is Normal;
Transmission mode	The module is in data transfer mode. When it completed, the module returns to standby or low power mode.	Module successfully registers the network and performs service transmission.
Sleep	The module is in a light sleep state, the modules network is connected, and a paging message can be accepted. In this mode, the module can be switched to standby mode or PSM mode.	The module is put into sleep mode by the AT command. In the DRX mode, the serial port communication of the module is normal, and the serial communication is closed in the PSM and eDRX modes. In low power mode, the module is still registered in the network, and does not need to re-register after waking up.
PSM	The objective of PSM is to make eMTC device inactive or power-down for most of the time, to save power and wake up the device only for a brief time of data transmission. PSM achieves power saving by shutting down everything except PMIC RTC block, which consumes low power.	Short duration of active communication Data transmission originated by eMTC devices, but also possible to engage in DL receive during the active duration

Table 4-1 MA510-GL offers five Operating modes

5 Electrical characteristics

5.1 Absolute Maximum Ratings

The absolute maximum value includes the limit voltage range that the module can withstand and the maximum current at which the module operates.. Working outside this range may result in damage to the product.

The limit voltage range of MA510-GL is shown in the following table:

Parameter	Description	MAX	Unit
VBAT	Supply voltage	4.8	V
		4.8	V
	Average current	0.6	A
	Instantaneous peak current	2.5	A
	Sleep current	2mA	

Table 5-1 Limit voltage range

5.2 Rated voltage

Table 5-2 show the power interface of MA510-GL series module.

Pin Num	Pin Name	I/O	Description	DC parameter (V)		
				MIN	TYP	MAX
9,10	VBAT	PI	power input	MA510-GL-00：3.3V MA510-GL-01：2.65V	3.8V	4.5V
13	VDD	PO	1.8V output（80mA）	1.75	1.8V	1.85
31	VBUS	PI	USB plug detect	3.3	-	5
26	VSIM	PO	SIM card power supply	-	1.8V	-

Table 5-2 Power Interface

5.2.1 Power supply design requirements

The MA510-GL series module needs to be powered by the VBAT pin. The recommend power design is shown in Figure 5-1:

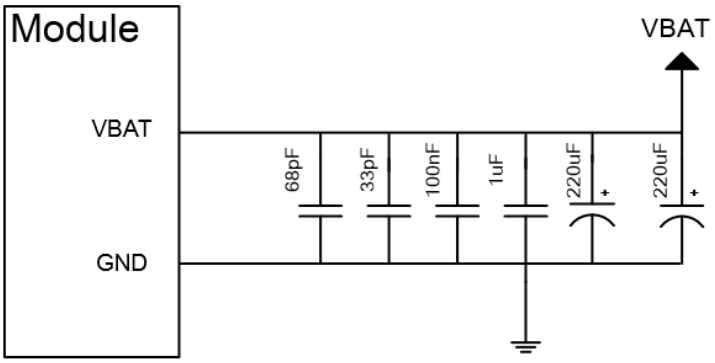


Figure 5-1 Recommend Power Design

Capacitance combination design for power supply is described in the following table:

Recommended Capacitor	Function	Instruction
220uF	Voltage stabilizing capacitor	Low ESR capacitance is required to reduce power fluctuation when the module is working. The capacitance requirements are as follows: MA510-GL-00：Not less than 440uF MA510-GL-01：Not less than 220uF
1uF、100nF	Digital Signal Noise	Eliminate interference from clocks and digital signals
33pF、8pF	900,1800 MHz Frequency Band	Elimination of Low and Medium Frequency Radio Frequency Interference

Table 5-3 Capacitance Design Description of External Power Supply Circuit

The power stability can ensure the normal operation of MA510-GL. Customers need specially attention that the power supply ripple limit for the module is no more than 150mV (the circuit ESR < 50mΩ). When the module is operating in GSM mode (Burst transmit), the maximum operating current can reach 2.5A, and must ensure that the power voltage is not less than the minimum power supply voltage. Otherwise, the module may power off or restart. The power limit is shown in Figure 5-2:

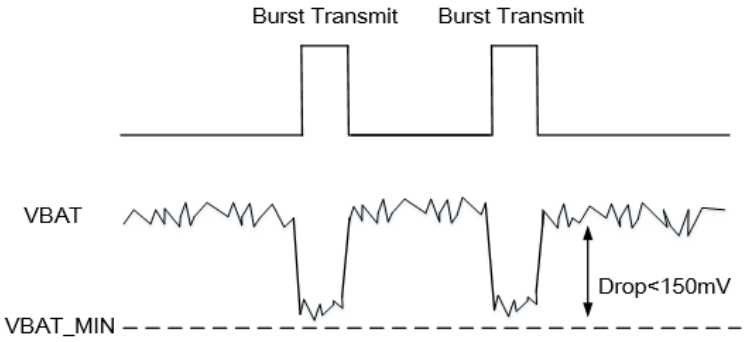


Figure 5-2 Power Limit

5.3 Logic level

The MA510-GL series module supply a 1.8V voltage through the VDD for the use of the internal digital circuit. The voltage is the logic level of the module and can be used to indicate module Power on/off, or for external low current (<80mA) circuits such as GPIO pull up. Please leave the signal floating if not used. The logic level of IO is defined as follows:

Parament	Minimum	Typical	Maximum	Unit
V_{OH}	VDD -0.45	-	VDD	V
V_{OL}	0	-	0.45	V
V_{IH}	0.65 x VDD	-	VDD + 0.3	V
V_{IL}	-0.3	-	0.35 x VDD	V

Table 5-4 IO Logic Level

5.4 Power consumption

The power consumption of MA510-GL series module measured at 3.8V power supply is shown as follow:

Parameter	Mode	Condition	Maximum Current Typ. (mA)
I_{off}	Power off	Module power off	0.015
$I_{airplane}$	Airplane mode	At+cfun=4	0.9
I_{psm}	Cat.M1	PSM mode	0.0032
	Cat.NB	PSM mode	0.0032
I_{sleep}	Cat.M1	eDRX Cycle Length = 81.92s	0.81
		DRX Cycle Length =2.56s	2.61
	Cat.NB	eDRX Cycle Length = 91.92s	0.85
		DRX Cycle Length =2.56s	1.73

Parameter	Mode	Condition	Maximum Current Typ. (mA)
$I_{GPRS-RMS}$ CS4	GPRS	GSM850@Gamma=3 (4UL/1DL)	600
		GSM900@Gamma=3 (4UL/1DL)	600
		DCS1800@Gamma=3 (4UL/1DL)	500
		PCS1900@Gamma=3 (4UL/1DL)	470
$I_{EGPRS-RMS}$ MCS9	EGPRS	GSM850@Gamma=6 (4UL/1DL)	560
		GSM900@Gamma=6 (4UL/1DL)	560
		DCS1800@Gamma=5 (4UL/1DL)	500
		PCS1900@Gamma=5 (4UL/1DL)	470
$I_{LTE-RMS}$	LTE FDD	Cat.M1 B1 @+20dBm	200
		Cat.M1 B2 @+20dBm	200
		Cat.M1 B3 @+20dBm	200
		Cat.M1 B4 @+20dBm	200
		Cat.M1 B5 @+20dBm	220
		Cat.M1 B8 @+20dBm	220
		Cat.M1 B12 @+20dBm	220
		Cat.M1 B13 @+20dBm	220
		Cat.M1 B14 @+20dBm	220
		Cat.M1 B18 @+20dBm	220
		Cat.M1 B19 @+20dBm	220
		Cat.M1 B20 @+20dBm	220
		Cat.M1 B25 @+20dBm	170
		Cat.M1 B26 @+20dBm	220
		Cat.M1 B27 @+20dBm	220
		Cat.M1 B28 @+20dBm	220
		Cat.M1 B66 @+20dBm	180

Parameter	Mode	Condition	Maximum Current Typ. (mA)
		Cat.M1 B85 @+20dBm	200
		Cat.NB B1 @+20dBm	270
		Cat.NB B2 @+20dBm	260
		Cat.NB B3 @+20dBm	250
		Cat.NB B4 @+20dBm	260
		Cat.NB B5 @+20dBm	290
		Cat.NB B8 @+20dBm	290
		Cat.NB B12 @+20dBm	280
		Cat.NB B13 @+20dBm	290
		Cat.NB B18 @+20dBm	290
		Cat.NB B19 @+20dBm	290
		Cat.NB B20 @+20dBm	290
		Cat.NB B25 @+20dBm	250
		Cat.NB B26 @+20dBm	290
		Cat.NB B28 @+20dBm	280
		Cat.NB B66 @+20dBm	260
		Cat.NB B71 @+20dBm	260
		Cat.NB B85 @+20dBm	270

Table 5-5 Power Consumption

Note: Instrument configuration is as follows

Uplink Configuration		
Modulation	**CH BW**	**RB allocation**
QPSK	10Mhz	1
Modulation	**Ntones**	**Sub-carrier spacing(kHz)**
QPSK	1@0	15

6 Functional interface

6.1 Control interface

Control interfaces are used for module power on/off and reset operations. The pin definitions are as follows:

Pin Num	Pin name	I/O	Description	Power domain
14	POWER_ON	I	Module power on/off signal control pin	1.8V
37	EMERG_RST	I	Module reset signal control pin	1.8V

Table 6-1 Control Signal

6.1.1 Power on

6.1.1.1 Boot circuit reference design

MA510-GL can be normally powered on by controlling the POWER_ON pin. The module will start to work after Clients set POWER_ON to low and keep it 550ms~1.7s. It is recommended to use the open-collector drive circuit for control. The reference circuit is as follows:

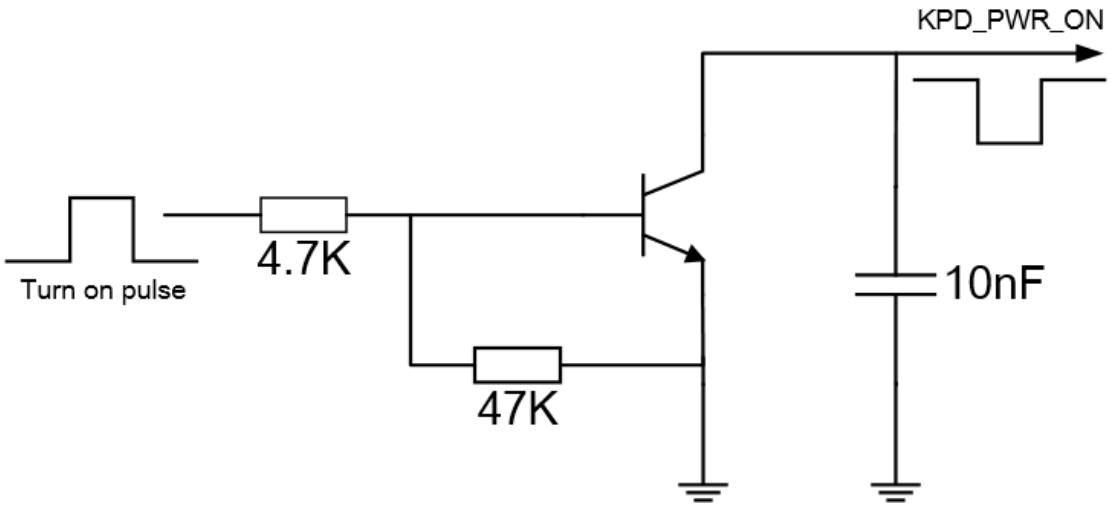


Figure 6-1 OC Drive Power on Reference Circuit

Another way to control the POWER_ON pin is to use a push button switch directly. A TVS needs to be placed near the button for ESD protection. The reference circuit is as follows:

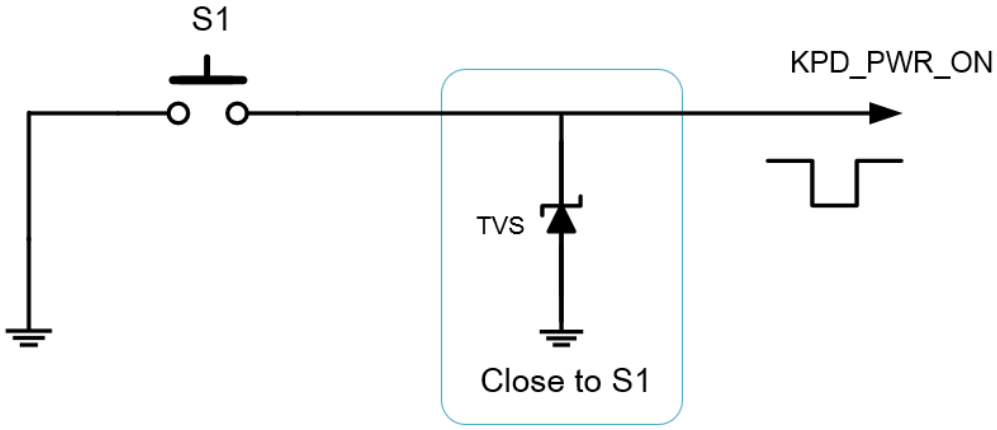


Figure 6-2 Button Switch Power on Reference Circuit

6.1.1.2 Power on sequence

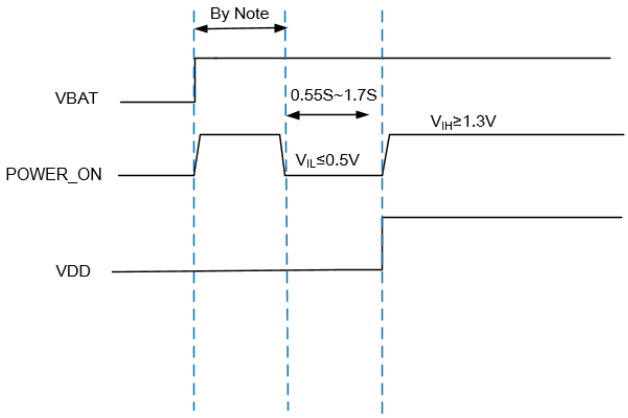


Figure 6-3 Power on Timing

Note:

Before pulling down the POWER_ON pin, ensure that the VBAT voltage is stable. It is recommended that the time interval from the power-on of VBAT to the lowering of POWER_ON is not less than 100ms.

The POWER_ON pull-down time should be between 0.55s and 1.7s.

6.1.2 Power off

There are three ways to get the module off:

Power off mode	Power off methods	Applicable scenarios
Hardware power off	Pull down POWER_ON 3.5s~7s	Hardware normal power off
AT power off	AT+ CPWROFF	Software normal power off
Low-voltage shut down	The module will shut down when the VBAT voltage is too low (below VBAT_MIN) or when power is lost.	Module is abnormally closed

Table 6-2 Power off

6.1.2.1 power off sequence

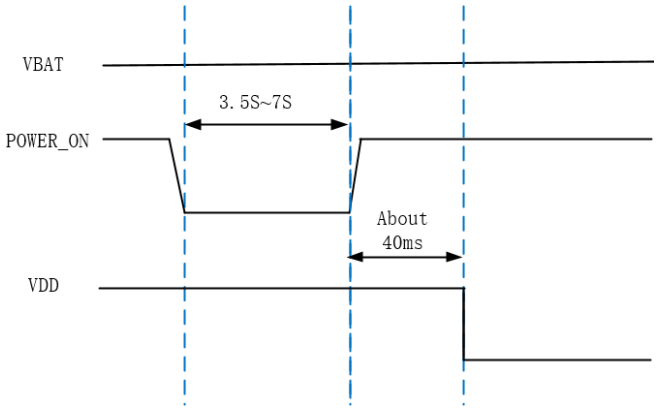


Figure 6-4 Power off Timing

Note:

1. When the module is working normally, do not cut off the power of the module immediately to avoid damage to the Flash inside the module. It is strongly recommended to turning off the module with the POWER_ON or AT command before turn off the power supply.

2. When using the AT command to shut down, please make sure that the POWER_ON pin is not pulled low after the shutdown command is executed, otherwise the module will automatically turn on again after the module is shut down.

6.1.3 Module reset

The module supports hardware reset and software reset.

Reset mode	Reset method
Hardware reset	Pull down EMERG_RST pin at least 7.5S, then release it
Software reset	Sent AT commands AT+RESET

Table 6-3 Reset

6.1.3.1 Module reset circuit

Clients can control EMERG_RST pin by OC drive circuits or button switch. Corresponding reference circuit as Figure 6-5 and Figure 6-6:

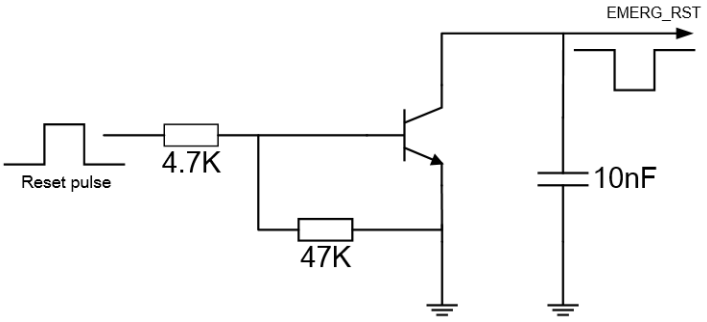


Figure 6-5 OC Driven Reset Reference Circuit

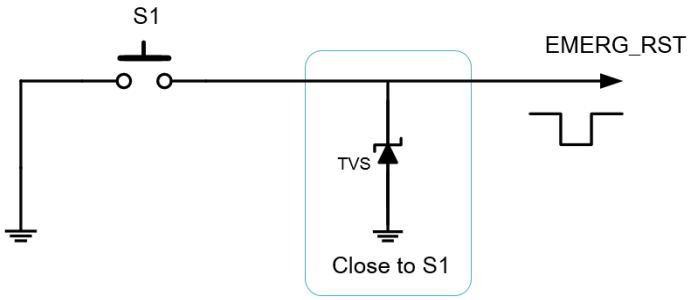


Figure 6-6 Button Reset Reference Circuit

The reset timing is shown as follows:

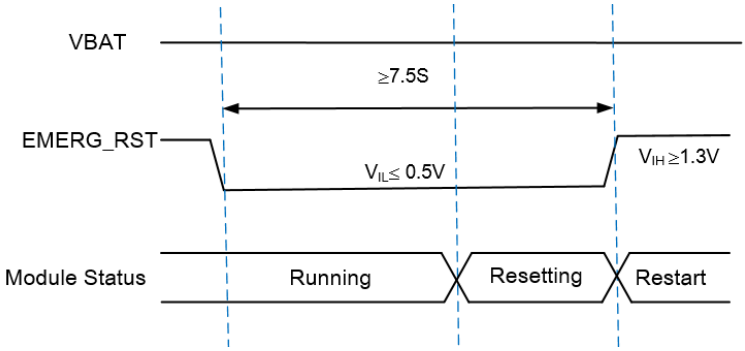


Figure 6-7 Reset Timing

Note:

The reset signal is a sensitive signal. Please keep it away from RF interference and Shielding it with GND signals, and avoid routing it on the edge of the PCB and the surface (to avoid module reset caused by ESD).

6.2 Network status indicate interface

MA510-GL series module provides a network status indicate pin, the pin definition is shown as follows:

PIN Num.	I/O	PIN Name.	Description	Power domain
38	O	LPG	Network statue indicator	1.8V

Table 6-4 Network Statue Indicate

6.2.1 Interface status description

Network status indicate pins are used to drive indicate light and describe module's network status, MA510-GL series module network indicate light and network status description are as follows:

Mode	Module Network indicator pin status	Indicator light flash/off status	Description
1	600ms High/600ms Low	Flash	No SIM card Request SIM PIN Registering network (T<15S) Register network failed
2	3000ms High /75ms Low	Slow flash	Standby
3	75ms High / 75ms Low	Speed flash	Data link established
4	Low	Always on/off	Voice call
5	High	Always off/on	Sleep

Table 6-5 Network Indicate Light Work Status

MA510-GL series module network indicates light reference design circuits shown as follows:

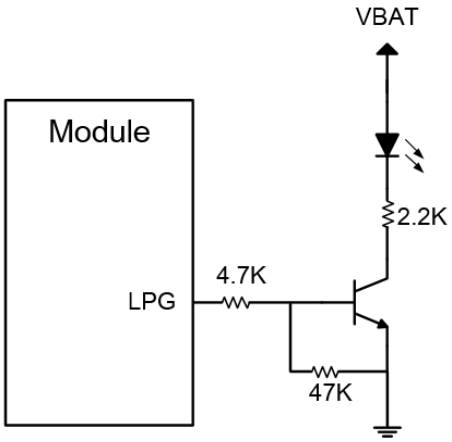


Figure 6-8 Network Indicate Light Reference Circuits

6.3 (U)SIM card interface

MA510-GL series module has SIM card interface, and only supports 1.8V SIM card.

6.3.1 (U)SIM pin definition

(U)SIM pin definition is shown in the following table:

Pin Num	Pin name	I/O	Description	Power domain
25	SIM_SRST	DO	Reset signal	1.8V
23	SIM_SIO	I/O	SIM DATA	1.8V

26	VSIM	PO	SIM Power	1.8V
27	SIM_DET	DI	SIM card hot plug detection	1.8V
24	SIM_SCLK	DO	Clock Signal	1.8V

Table 6-6 (U) SIM Card Pin

6.3.2 (U)SIM interface circuit

6.3.2.1 (U)SIM card connector with card detection signal

(U)SIM card connector should be selected for SIM design. It is recommended to use (U)SIM card connector with hot plug detection function (Fibocom recommend: SIM016-8P-220P).

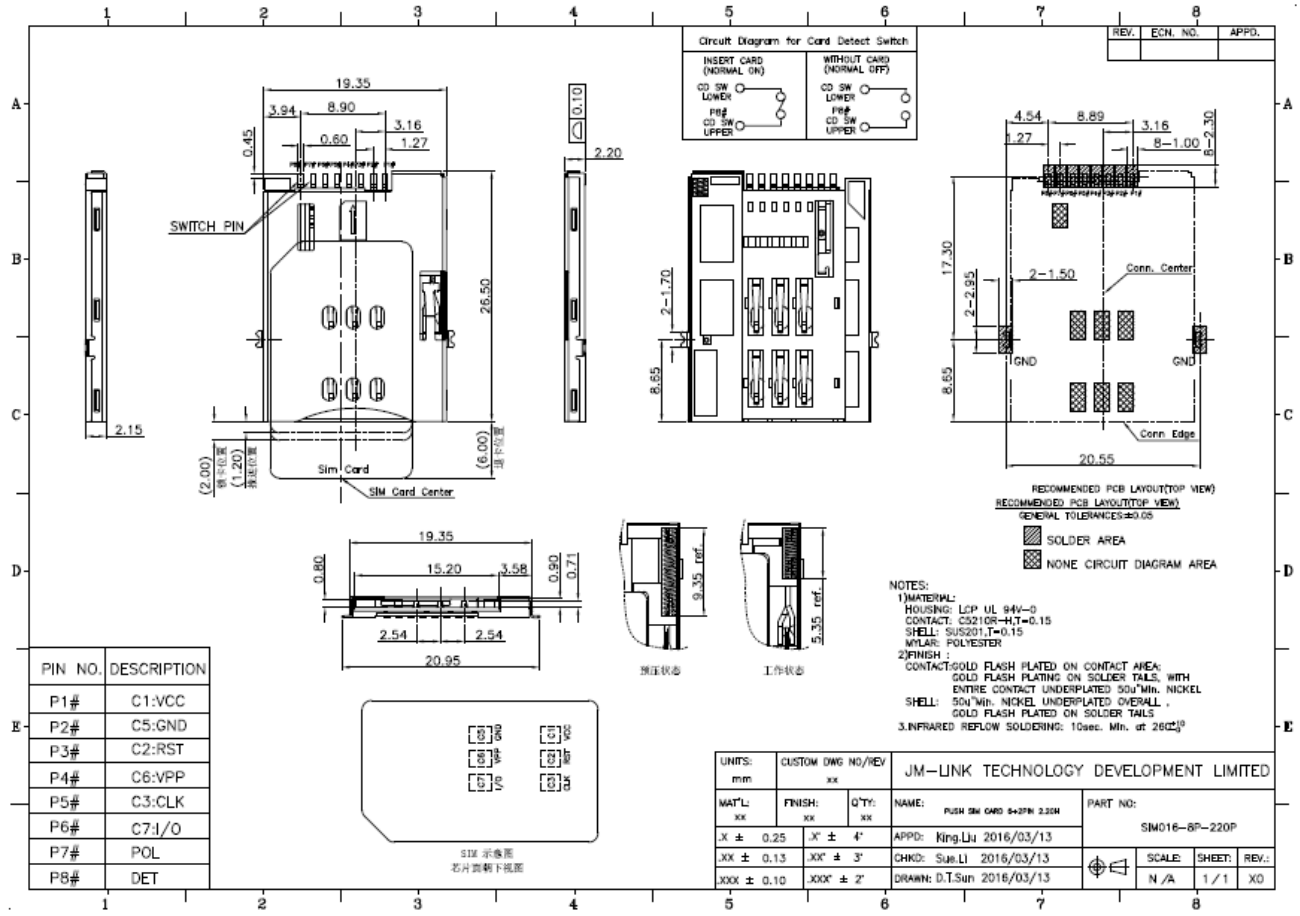


Figure 6-9 (U) SIM Card Connector (SIM016-8P-220P)

SIM016-8P-220P card connector, DET and POL are short connected when the card is inserted; DET and POL are disconnected when there is no card. The following is the reference design circuit, (U) SIM card insert, SIM_DET pin is high level; (U)SIM card pull out, SIM_DET pin is low level.

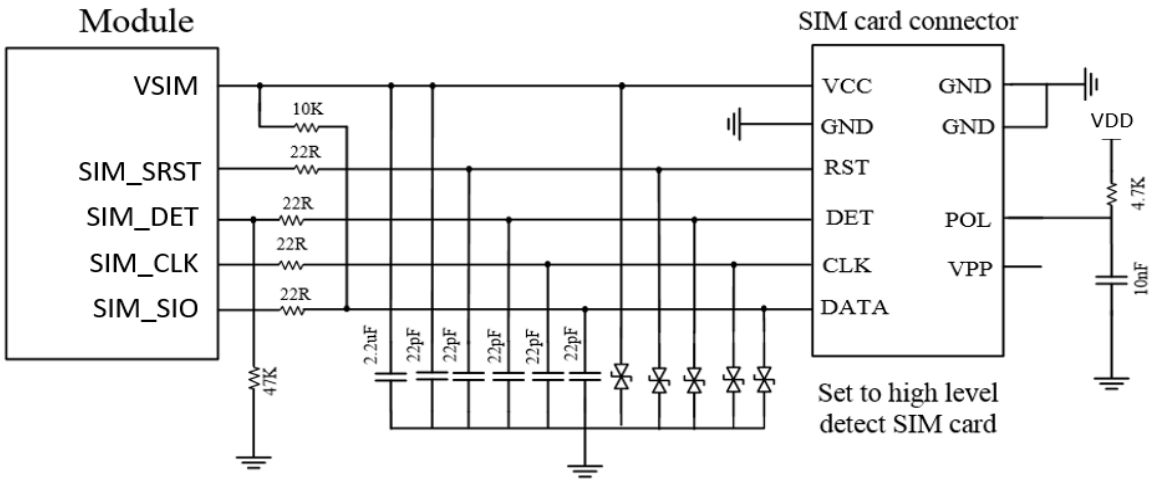


Figure 6-10 (U)SIM Card Connector with Detection Signal Reference Circuit

6.3.2.2 (U)SIM card connector without detection signal

Using the card holder without detection signal, the SIM_DET pin remains floating while the hot-swap function is turned off by the AT command. Reference circuit as shown below:

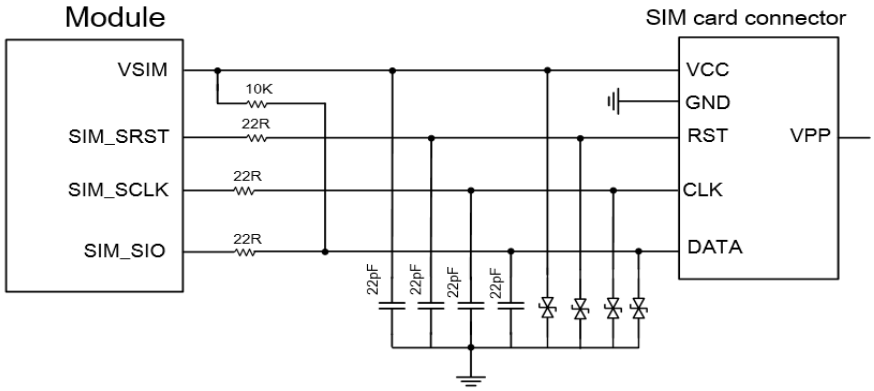


Figure 6-11 (U) SIM Card Connector without Detection Signal Reference Circuit

6.3.3 (U)SIM hot plug

MA510-GL series module support (U)SIM hot plug function, it determines the insertion and removal of (U)SIM card by detect the SIM_ DET pin state.

The card hot plug function can be configured by the “AT+MSMPD” command, and the AT commands are shown in the following table:

AT command	(U)SIM card hot plug detection	Function description
AT+MSMPD=1	Enabled	(U)SIM card hot plug detection is enabled by default.
AT+MSMPD=0	Disabled	(U)SIM card hot plug detection function is disabled. The module read the (U)SIM card when module power on, and does not detect the SIM_DET state.

Table 6-7 (U) SIM Card Hot Plug Function Configuration

After the hot plug detection function of the (U)SIM card is enabled, if SIM_DET is in high level, the module will detect the (U)SIM card insertion and execute card initialization program. After reading the (U)SIM card information, the module will register network. When the SIM_DET is in low level, the module detects (U)SIM card removed, and it will not read the (U)SIM card.

Note:

The SIM_DET pin active high by default, and can be switched to active low by AT command.

AT command	Function description
AT+GTSET=" SIMPHASE",1	Default, high level detect
AT+GTSET=" SIMPHASE",0	Low level detect

Table 6-8 (U) SIM_PRESENCE Effective Level Switched

6.3.4 (U)SIM design requirements

SIM card circuit design shall meet EMC standards and ESD requirements, and at the same time, shall improve anti-interference ability to ensure that the SIM card can work stably. The design needs to strictly observe the following rules:

- SIM card connector is placed as close to the module as possible, away from the RF antenna, DCDC power, clock signal lines and other strong interference sources;
- Adopt the SIM card connector with metal shield shell to improve anti-interference ability;
- The length of cable from the module to the SIM card connector shall not exceed 100mm. Longer cable reduces signal quality.
- SIM_SCLK and SIM_SIO signals are ground isolated to avoid mutual interference. If it is difficult to do so, SIM signal needs to be ground protected as a set;
- The filter capacitor and ESD device of SIM card signal cable should place close to the SIM card connector.
- Please select equivalent capacitor is less than 22pF for ESD device.
- SIM_SIO should pull up to VSIM with a 10K resistor.

6.4 USB interface

MA510-GL series module supports USB2.0. For USB bus timing and electric features, please refer to "Universal Serial Bus Specification 2.0".

6.4.1 USB Pin definition

Pin Num.	Pin name	I/O	Description
11	USB_DM	IO	USB differential data bus D-
12	USB_DP	IO	USB differential data bus D+

Pin Num.	Pin name	I/O	Description
31	VBUS	AI	USB plug detect, USB PHY power supply, Requires more than 100mA drive capability.

Table 6-9 USB Pin Definition

Note:

It is recommended to reserve USB port for download software.In order to ensure USB performance, when design USB interface circuit, following rules must be followed:

- USB_DM and USB_DP signal cable's control differential impedance is 90 ohm
- USB signal cable must not under crystal, oscillator, magnetic device, RF signal. It is recommended to take the inner differential cable and the cable shall be grounded at all directions;
- The model selection for ESD protection of USB data cable requires special attention, and the parasitic capacitance must not exceed 1pF;
- ESD protector of USB should be placed close to the USB interface.
- VBUS be used as USB plug detect and USB PHY power supply, its driven strength should more than 100mA.

6.5 UART Interface

6.5.1 UART interface definition

MA510-GL series module has three serial ports: serial port 1, serial port 2 and serial port 3. The serial ports 1 supports 4800bps，9600bps，19200bps，38400bps，57600bps，115200bps，230400bps，460800bps and 921600bps baud rate. The default baud rate is 115200bps. The serial ports 1 is used for data transmission and AT command transmission. The pin definition of serial port 1 is shown as follows:

Pin Num	Pin Name	I/O	Description	Note
18	UART1_RXD	DI	UART1 data reception	1.8V
19	UART1_TXD	DO	UART1 data transmission	1.8V
20	UART1_RTS	DO	UART1 request to send	1.8V
21	UART1_CTS	DI	UART1 clear to send	1.8V
22	UART1_RING	DO	UART1 Ring indicator	1.8V
15	UART1_DTR	DI	UART1 module sleep/ wake-up control signal	1.8V
16	UART1_DSR	I/O	UART1 Reserved, to be developed	1.8V
17	UART1_DCD	DO	UART1 module carrier detection signal output	1.8V

Table 6-10 Serial Port 1

The port 2 is debug serial port by default, can used for module debug but cannot for AT function. The pin definition of serial port 2 is show as follows:

Pin Num	Pin Name	I/O	Description	Note
39	UART2_RXD	DI	UART2 data reception	1.8V
40	UART2_TXD	DO	UART2 data transmission	1.8V
75	UART2_CTS	DI	UART2 clear to send	1.8V
76	UART2_RTS	DO	UART2 request to send	1.8V

Table 6-11 Serial Port 2

The function of serial port 3 is developing and not for AT function.

Pin Num	Pin Name	I/O	Description	Note
77	UART3_RXD	DI	UART3 data reception	1.8V
78	UART3_TXD	DO	UART3 data transmission	1.8V

Table 6-12 Serial Port 3

6.5.2 UART port application

The serial port level of MA510-GL series module is 1.8V, if the level of the client host system is 3.3V or other, level translator is needed between the module and the host. The reference design circuit of level translator is shown as follows:

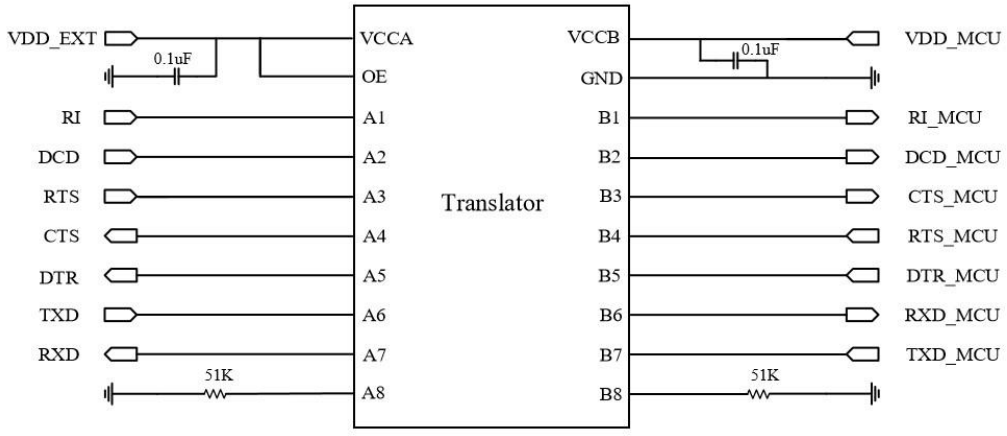


Figure 6-12 UART Level Translate Reference 1

Another level shifting circuit is shown below. The input and output circuit design of the dotted line below can refer to the solid line part, but pay attention to the connection direction.

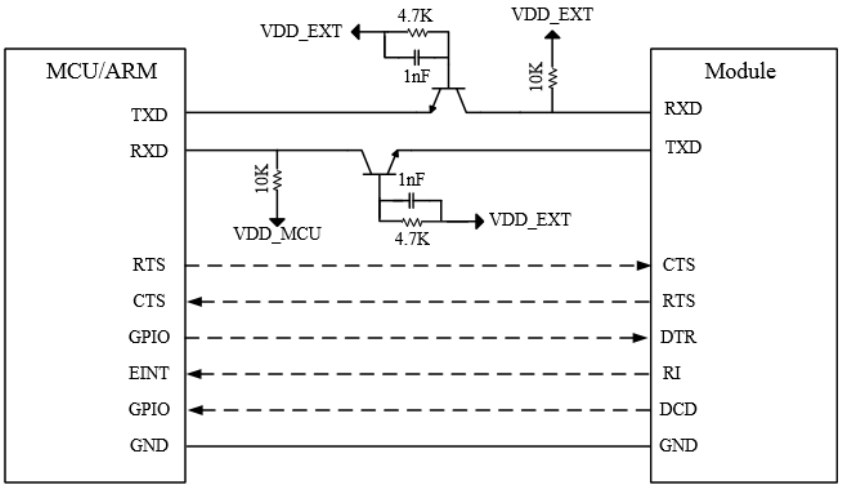


Figure 6-13 UART Level Translate Reference 2

Note:

Transistor level conversion circuit is not suitable for applications of baud rates above 460Kbps.

6.6 I2C Interface

The MA510-GL series modules provide an I2C interface that can be used to control external codec and other slave devices. External pull-up resistors must be added during use.

PIN Num.	PIN Name	I/O	Description	Note
52	I2C_SDA	I/O	I2C data signal	1.8V Need External pull-up
56	I2C_SCL	DO	I2C clock signal	1.8V Need External pull-up

Table 6-13 I2C Interface

6.7 ADC interface

MA510-GL series module support two channels ADC interface, can used for voltage detect and other external circuit.

Pin Num.	PIN Name	I/O	Description	Note
59	ADC1	AI	Analog ADC voltage input, detect voltage range: 0~1.8V	Accuracy is ±15mV
64	ADC0	AI	Analog ADC voltage input, detect voltage range:0~VBAT	Accuracy is ±120mV

Table 6-14 ADC Pin Definition

Note:

It is recommended to ground shielding when routed to increase voltage detect accuracy and input

voltage must not exceed voltage range.

6.8 IIS digital audio interface

The MA510-GL provides a digital voice interface (I2S) that uses the domestic mainstream European E1 standard to enable communication with digital audio devices such as external CODECs.

6.8.1 Digital audio interface definition

PIN Num.	PIN Name	I/O	PIN Num.	Note
82	I2S_DATA0	I/O	I2S data signal0	1.8V
83	I2S_SCK	DO	I2S serial clock signal	1.8V
84	I2S_WS	DO	I2S word select signal	1.8V
72	I2S_DATA1	I/O	I2S data signal1	1.8V
80	I2S_MCLK	DO	I2S main clock signal	1.8V

Table 6-15 Digital Audio Interface

6.8.2 Interface application

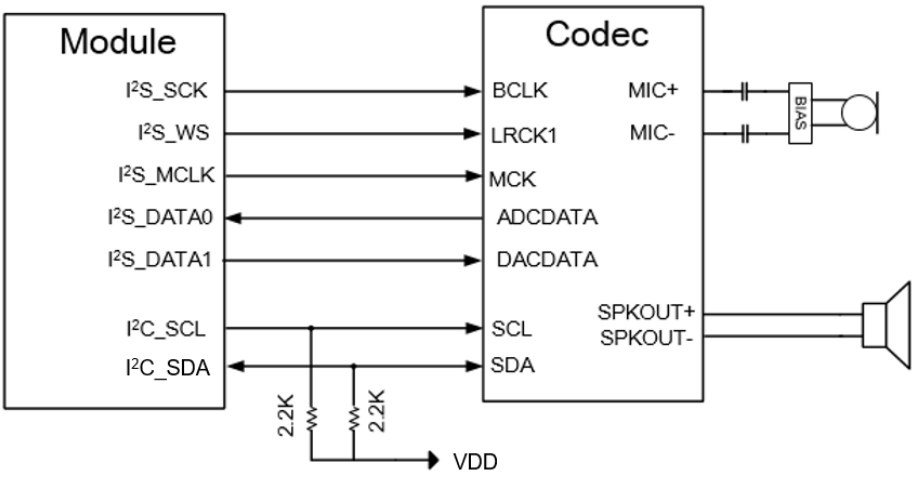


Figure 6-14 Audio interface Reference Design

6.9 Antenna tuner interface

The MA510-GL series modules can use ANT_TUNER1 and ANT_TUNER2 as antenna tuning interfaces:

PIN Num.	PIN Name	I/O	Description	Note
73	ANT_TUNER1	DO	GRFC function reserved	can be used as normal GPIO
74	ANT_TUNER1	DO	GRFC function reserved	can be used as normal GPIO

Table 6-16 Antenna tuned interface

6.10 Other interfaces

MA510-GL series module also provide interface such as GPIO, WAKEUP_IN, WAKEUP_OUT to clients.

PIN Num.	PIN Name	I/O	Description	
41	WAKE_UP	DI	Host wakeup module	
61	WAKEUP_OUT	DO	Module wakeup host	
71	FORCE_USB_BOOT	DI	Force download	connect this pin with VDD_IO and Power on can force module enter download mode
69	CODEC_EN	DO	External codec enable control	
81	CODEC_INTR	DI	Interrupt signal	can be used as normal GPIO
53	GPIO1	I/O	Reserved GPIO	
54	GPIO2	I/O	Reserved GPIO	
58	GPIO3	I/O	Reserved GPIO	
62	GPIO4	I/O	Reserved GPIO	

Table 6-17 Other Interfaces

7 Low power consumption

7.1 Airplane mode

When MA510-GL module enters airplane mode, RF function are closed and all commands related to RF cannot be used. The way to control module to enter airplane mode is shown as follows:

Send AT+CFUN=<fun> commands, paraments <fun> can be 0,1 or 4;

0: minimum function mode; close RF function and (U)SIM card function;

1: all function mode(by default);

4: close RF function(airplane mode);

7.2 Sleep mode

Sleep mode is also called low power mode. In order to minimize battery loss, when the module is idle, it enters sleep mode to save power. When the module is in sleep mode, if there is a wakeup source, the corresponding module should also be woken up to normal operation mode.

The sleep of the MA510-GL can be divided into two parts, one is USB and the other is UART. The module goes to sleep after the USB and UART are simultaneously sleeping.

7.2.1 USB sleep

USB sleep is mainly divided into two sleep modes:

a. The Vbus signal of the USB bus controls sleep;

b. USB suspend;

7.2.1.1 VBUS control sleep

If the product does not support USB suspend, but VUBS detection is supported. It can be judged whether the USB is put into hibernation by detecting the VBUS pin level. The specific judgment criteria are as follows:

Vbus level status	Module status	Note
High	Active	-
low	Sleep	

Table 7-1 VBUS control sleep state configuration table

7.2.1.2 USB suspend

If the host supports USB Suspend/Resume, by setting the level and control of the USB in the Linux system to auto, the module and the host are left for about 2 seconds, and the module automatically

enters the Suspend state.

7.2.2 UART Application (ATS24 Command)

The sleep mode controlled by ATS24 command is light sleep. When the RXD of the UART has a message, the system will wake up. The power consumption in sleep mode by this way is slightly higher than using the UART1_DTR control mode.

The ATS24 automatically sleeps down. It does not strictly sleep in time. It is attempted to go to sleep after timeout. If the system does not support hibernation after timeout, it will automatically re-time.

7.2.3 UART1_DTR/WAKEUP_IN level control sleep

When the host and the MA510-GL module are connected through the serial port, you can set the UART1_DTR /WAKEUP_IN to control the serial port sleep function by sending an AT command. Client refer to the serial port sleep command configuration example for details.

The serial port sleep configuration command is shown in the following table:

No	Command configuration	Explanation
1	AT+GTLPMMODE=0 ATS24=5	Choose to sleep through the ATS24 command. The serial port will go to sleep in 5S if there are no data interaction.
2	AT+GTLPMMODE=2,0	Select to control sleep through UART1_DTR. Pull the pin high then the serial port sleep.
3	AT+GTLPMMODE=2,1	Select to control sleep through UART1_DTR. Pull the pin low then the serial port sleep.
4	AT+GTLPMMODE=1,0	Select to control sleep through WAKEUP_IN. Pull the pin high then the serial port sleep.
5	AT+GTLPMMODE=1,1	Select to control sleep through WAKEUP_IN. Pull the pin low then the serial port sleep.

Table 7-2 Serial port sleep command configuration example

7.3 Wake Introduction

7.3.1 Module is awakened

When the module is in the sleep state, it can be woken up in the following ways.

7.3.1.1 USB wake up

If the module is USB_VBUS control to sleep, the USB will be woken up when USB_VBUS is pulled high;

If the module support USB suspend, any active (non-idle signal) on the bus can wake up the device and exit the low power mode.

7.3.1.2 UART wake up

If the module enter to sleep through DTR/WAKEUP_IN, controlling DTR/WAKEUP_IN can wake up the serial port;

If the module uses ATS24 to automatically sleep, when the serial port sends data, the serial port will be awakened and will automatically go to sleep when timeout.

7.3.2 The host is woken up

When the host is in sleep state, the module needs to output the pulse waveform through the UART1_RING/WAKEUP_OUT pin to wake up the host in order to detect the module's phone, SMS, data service and URC report. At this point, the host must configure the connection UART1_RING/WAKEUP_OUT pin as the wake-up source.

7.4 PSM

Power Saving Mode (PSM) is a feature for eMTC devices and applications that have the following requirements:

- Infrequently active
- Short duration of active communication
- Data transmission originated by eMTC devices, but also possible to engage in DL receive during the active duration
- Power constraint, battery-operated
- Long battery life

The objective of PSM is to make eMTC device inactive or power-down for most of the time, to save power and wake up the device only for a brief time of data transmission.

PSM achieves power saving by shutting down everything except PMIC RTC block, which consumes low power.

The MA510-GL module can enable the PSM function with AT command (AT+CPSMS=1) and do as follows If you want to exit PSM.

The method of wake up the module from the PSM state as follows:

1. Pull down the POWER_ON pin and keep it 0.55-1.7s;

2. Wait for the timer (T3412) expires, the module will automatically wake up.

Note:

For more information about AT command please refer to document《FIBOCOM AT Commands User

7.5 DRX

The MA510-GL supports the DRX mode. The module will automatically enter the DRX mode with lower power consumption if the module does not apply for PSM and eDRX, and there is no data service interaction. In this mode, the bottom current of the module is reduced to about 700uA, and the average power consumption is 1.7mA.

7.6 eDRX

The MA510-GL has access to the eDRX low-power mode, which significantly reduces power consumption to less than 700uA. When the module needs to enter eDRX, it will send the request in the request message. The network configures the request value of the module in the response message, and the module enters the eDRX mode. In this mode, the internal part of the module is powered off, and the module has been registered on the network, it can quickly enter the standby state after waking up.

To enter eDRX, you need to send the following AT command:

AT+CEDRXS=1 or AT+CEDRXS=2,5,”0011”

Note:

The module saves the eDRX configuration. Once eDRX is successfully set, you can still enter eDRX mode after restarting the module unless you have sent an exit command. The user can enter the eDRX mode by sending an AT command and request the period of the network side eDRX. When the eDRX period sent by the network side is greater than 81.92s, the module enters the deep sleep mode, otherwise it is the light sleep mode. 0011 indicates that the eDRX period requested by the user to the network is 40.96s, and the user can set it according to the protocol.

You can use the AT+CEDRXRDP command to query the period value of the eDRX and the PTW window time delivered by the network.

To exit eDRX, you need to send the following AT command:

AT+CEDRXS=0

Note:

The module will save the eDRX configuration. Once the command is successfully sent to exit the eDRX mode, if the command to enter the eDRX is not resent, the module will not enter the eDRX mode, and the restart will be the same.

8 RF interface

MA510-GL series module has MAIN_ANT and GNSS_ANT two antenna interfaces, its pin definition is shown as table 8-1:

Pin Name	I/O	Pin Num.	Description
MAIN_ANT	I/O	3	Main antenna
GNSS_ANT	I	6	GNSS antenna

Table 8-1 RF Interface

8.1 Operating band

Network mode	Band	Receive	Transmit	Unit
GSM	GSM850	869~894	824~849	MHz
	EGSM900	925~960	880~915	MHz
	DCS1800	1805~1880	1710~1785	MHz
	PCS1900	1930~1990	1850~1910	MHz
FDD-LTE	Band1	2110~2170	1920~1980	MHz
	Band2	1930~1990	1850~1910	MHz
	Band3	1805~1880	1710~1785	MHz
	Band4	2110~2155	1710~1755	MHz
	Band5	869~894	824~849	MHz
	Band8	925~955	880~910	MHz
	Band12	728~746	699~716	MHz
	Band13	746~756	777~787	MHz
	Band14（only CatM1）	758~768	788~798	MHz
	Band18	860~875	815~830	MHz
	Band19	875~890	830~845	MHz
	Band20	791~821	832~862	MHz
	Band25	1930~1995	1850~1915	MHz
	Band26	859~894	814~849	MHz
	Band27（only CatM1）	852~869	807~824	MHz
	Band28	758~803	703~748	MHz
	Band66	2110~2180	1710~1780	MHz
	Band71（only NB）	617~652	663~698	MHz
	Band85	728~746	698~716	MHz

Table 8-2 Operating Band

8.2 Output power

The RF output power of MA510-GL show as follows:

Network mode	Band	Max	Min
GPRS	GSM850	32.5dBm±1dB	5dBm±3.5dB
	EGSM900	32.5dBm±1dB	5dBm±3.5dB
	DCS1800	29.5dBm±1dB	0dBm±3.5dB
	PCS1900	29.5dBm±1dB	0dBm±3.5dB
EGPRS	GSM850	26dBm±1dB	5dBm±3.5dB
	EGSM900	26dBm±1dB	5dBm±3.5dB
	DCS1800	25dBm±1dB	0dBm±3.5dB
	PCS1900	25dBm±1dB	0dBm±3.5dB
FDD-LTE	Band1	20dBm±1dB	<-44dBm
	Band2	20dBm±1dB	<-44dBm
	Band3	20dBm±1dB	<-44dBm
	Band4	20dBm±1dB	<-44dBm
	Band5	20dBm±1dB	<-44dBm
	Band8	20dBm±1dB	<-44dBm
	Band12	20dBm±1dB	<-44dBm
	Band13	20dBm±1dB	<-44dBm
	Band14(only CatM1)	20dBm±1dB	<-44dBm
	Band18	20dBm±1dB	<-44dBm
	Band19	20dBm±1dB	<-44dBm
	Band20	20dBm±1dB	<-44dBm
	Band25	20dBm±1dB	<-44dBm
	Band26	20dBm±1dB	<-44dBm
	Band27(only CatM1)	20dBm±1dB	<-44dBm
	Band28	20dBm±1dB	<-44dBm
	Band66	20dBm±1dB	<-44dBm
	Band71 （only NB）	20dBm±1dB	<-44dBm
	Band85	20dBm±1dB	<-44dBm

Table 8-3 Output Power

8.3 Receive Sensitivity

Network mode	Band	Cat.M1 Sensitive/3GPP(dBm)	Cat.NB1 Sensitive/3GPP(dBm)
FDD-LTE	Band1	-106.6/-102.3	-118.2/-107.5
	Band2	-106.9/-100.3	-118.2/-107.5
	Band3	-104.5/-99.3	-119.2/-107.5
	Band4	-105/-102.3	-118.2/-107.5
	Band5	-104.5/100.8	-118.2 /-107.5
	Band8	-105.2/-99.8	-118/-107.5
	Band12	-104/-99.3	-118.2/-107.5
	Band13	-103.2/-99.3	-118.2/-107.5
	Band14（only CatM1）	-103.3/-99.3	nonsupport
	Band18	-106/-102.3	-118.2/-107.5
	Band19	-103.7/-102.3	-117.2/-107.5
	Band20	-105.2/-99.8	-118.2/-107.5
	Band25	-107.3/-99.3	-118.2/-107.5
	Band26	-104.6/-100.3	-117.2/-107.5
	Band27（only CatM1）	-106.4/-100.8	nonsupport
	Band28	-105.6/-100.8	-118.2/-107.5
	Band66	-106.2/-101.7	-118.2/-107.5
	Band71（only NB）	nonsupport	-117.2/-107.5
	Band85	-106/-99.2	-118.2/-107.5

Table 8-4 Receive Sensitivity

8.4 GNSS Receiver

MA510-GL series module support GNSS/GLONASS and GPS/BeiDou function and adopts Qualcomm Gen9 technology.

Description		Condition	Typ.	Note
Power Consumption （AT+CFUN=0）		GNSS fixing	75mA	USB plug in
		GNSS tracking	73mA	USB plug in
		Standby	31	USB plug in
TTFF	GNSS	Cold start （XTRA enable）	45s	

Description		Condition	Typ.	Note
		Warm start（XTRA enable）	40s	
		Hot Start （XTRA enable）	5s	
Sensitivity	Acquisition	Open Sky	-144dbm	
	tracking	Open Sky	-160dbm	
	CN0	GNSS Signal@-130dBm	37dB-HZ	
Positional Accuracy	CEP	GNSS Signal @-130dBm	4m	

Table 8-5 GNSS Specification

8.5 Antenna design

8.5.1 Antenna index

1) Antenna efficiency

Antenna efficiency is the ratio of antenna input power to radiated power. Due to the antenna return loss, material loss, and coupling loss, the radiated power is always lower than the input power. Recommend> 40% (-4dB).

2) S11 or VSWR

S11 shows that the matching degree of the antenna's 50 ohm impedance, to a certain extent, affects the antenna efficiency. VSWR test methods can be used to measure this parameter. Recommend S11 <-10dB.

3) Polarization

Polarization is the rotation direction of the electric field in the maximum radiation direction of the antenna.

It is recommended to use linear polarization.

4) Radiation pattern

Radiation pattern refers to the antenna's electromagnetic field strength in the far field in all directions. Half-wave dipole antenna is the most suitable terminal antenna. For built-in antenna, PIFA antennas or IFA antennas are recommended:

Antenna area: 6mm high*10mm wide*100mm long.

Antenna radiation direction: Omni_directional(all direction).

5) Gain and directivity

Antenna directivity refers to the electromagnetic field strength of electromagnetic wave in all directions. Gain is a collection of antenna benefits and antenna directivity.

Recommended antenna gain ≤2.5dBi.

6) Interference

In addition to the antenna performance, other interferences on the PCB also affect the performance of the module. In order to ensure the high performance of the module, interference must be controlled. Suggestions: For example, LCD, CPU, FPC cable, audio circuit, power supply should be away from the antenna as far as possible, and make the appropriate isolation and shielding, or filtering on the path.

7) Antenna index requirements

MA510-GL series module main antenna requirements	
Frequency range	It must use the most suitable antenna to adapt to the relevant frequency band
Bandwidth (GSM/EDGE)	GSM850: 70 MHz GSM900: 80 MHz GSM1800(DCS): 170 MHz GSM1900(DCS): 140 MHz
Bandwidth (LTE)	LTE band 1(2100): 250 MHz LTE band 2(1900): 140 MHz LTE Band 3(1800): 170 MHz LTE Band 4(2100): 445 MHz LTE Band 5(850): 70 MHz LTE Band 8(900): 80 MHz LTE Band 12(700): 47 MHz LTE Band 13(700): 41 MHz LTE Band 14(700): 40 MHz LTE Band 18(700): 60 MHz LTE Band 19(700): 60 MHz LTE Band 20(700): 71 MHz LTE Band 25(700): 145 MHz LTE Band 26(700): 80 MHz LTE Band 27(700): 62 MHz LTE Band 28(700):100 MHz LTE Band 66(2100):470 MHz LTE band 71(2600): 81 MHz LTE band 85(2300):48 MHz
50 ohm	50 ohm

MA510-GL series module main antenna requirements	
Input power	> 33dBm (2 W) peak power GSM > 20dBm average power LTE
Standing wave ratio recommended	≤ 2:1

Table 8-6 Main Antenna Requirements

8.5.2 Antenna reference design

The antenna is a sensitive device that is susceptible to the external environment. For example, the antenna position, the size of the occupied space, and the surrounding grounding may affect the antenna performance. In addition, the position of the fixed antenna and RF cable connected to the antenna will also affect the antenna performance of the. The two antennas of the MA510-GL series module adopt the pad lead-out method. It is recommended that customers use the U.FL-R-SMT-1 antenna connector and use the matching RF adapter cable. Figure 8-1 is the reference circuit design for the main antenna:

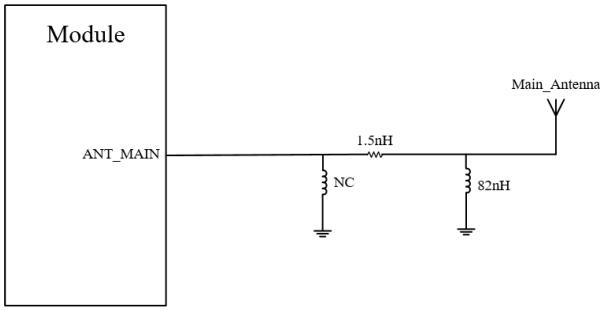


Figure 8-1 Main and diversity Antenna Reference Circuit

Figure 8-2 is reference design of GNSS antenna.

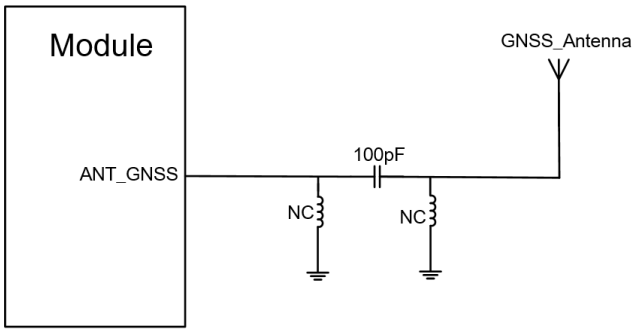


Figure 8-2 Passive GNSS Antenna Reference Circuit

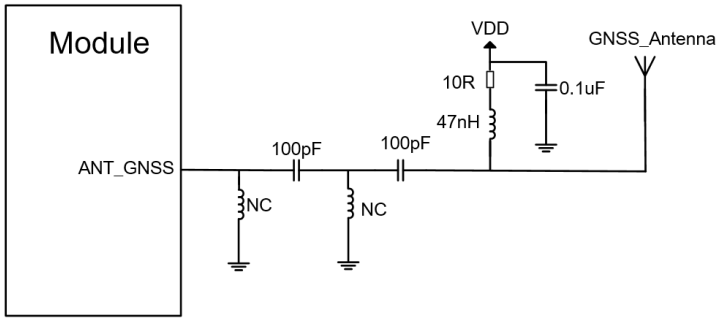


Figure 8-3 Active GNSS Antenna Reference Circuit

Note:

- All matches must be placed close to antenna to make sure the characteristic impedance of transmission cable is 50 ohms.
- Since the antenna loss should be less than 0.3dB, keep PCB cable as short as possible.
- Keep the PCB LAYOUT straight, and reduce holes on the route to another layer; also avoid right-angle and acute-angle wiring.
- PCB cable should have a good reference ground to avoid other signal cable near the antenna.
- Recommend a complete ground level, and use this complete ground level as a reference ground.
- Ground around antenna must be keep connect with main ground.
- For more design information please refer to《FIBOCOM RF Antenna Application Design Instruction》

9 Reliability

9.1 Environment temperature range

The recommended operating temperature range of MA510-GL series module.is -30℃~+75℃. It is suggested that the application terminal should consider the temperature control measures under bad environment and provide module's limited operating temperature range, within this range, some RF indexes may exceed the criteria. The module application terminal is recommended storage in certain temperature conditions. Exceed the temperature range module may not operate or may be damaged.

Temperature	Min	Typ.	Max	Unit
Operating temperature	-30	25	75	℃
Limited operating temperature	-40	-	85	℃
Storage temperature	-40	-	90	℃

Table 9-1 Environment Temperature Range

9.2 Environmental reliability requirements

Test items	Test conditions
Low temperature storage test	Temperature -40℃±3℃, 24 hours in shutdown state
High temperature storage test	Temperature +85℃±3℃, 24 hours in shutdown state
Temperature shock test	In shutdown state, 0.5 hour at -40℃ and +85℃ environment respectively, the temperature conversion time <3min, for 24 cycles
High temperature and humidity test	Temperature +85℃±3℃, humidity 90 ~ 95% RH, 24 hours in shutdown state
Low temperature operating test	Temperature -30℃±3℃, 24 hours in operating state
High temperature operating test	Temperature +75℃±3℃, 24 hours in operating state
Vibration test	Conduct vibration test according to the requirements shown in the table below: Frequency: Random vibration ASD (Acceleration Spectral Density) 5~20Hz: 0.96m^2/s^3 20~500Hz: 0.96m^2/s^3(20Hz), other -3dB/octave
Connector life test	30 times of insertion/removal for RF antenna interface cable

Table 9-2 Environmental Reliability Requirements

9.3 ESD characteristics

MA510-GL series module design has considered ESD issue and provided ESD protect measurements, but take ESD issue taken by module carrier and secondary development into consideration, developers should care ESD protection of module application terminal. In addition to considering anti-static treatment of packaging, please refer to recommended circuit of interface design in the document.

The ESD discharge range allowed by the MA510-GL series module refers to the following table:

Interface	Air discharge	Contact discharge
VBAT, GND	±10KV	±5KV
Antenna port	±8KV	±4KV
Other port	±1KV	±0.5KV

Table 9-3 ESD Allowable Discharge Range

10 Structure specification

10.1 Product appearance

The product appearance of MA510-GL series module is shown in Figure 10-1:

Figure 10-1 Product Appearance

10.2 Structure dimension

The structure dimension of MA510-GL series module is shown as Figure 10-2:

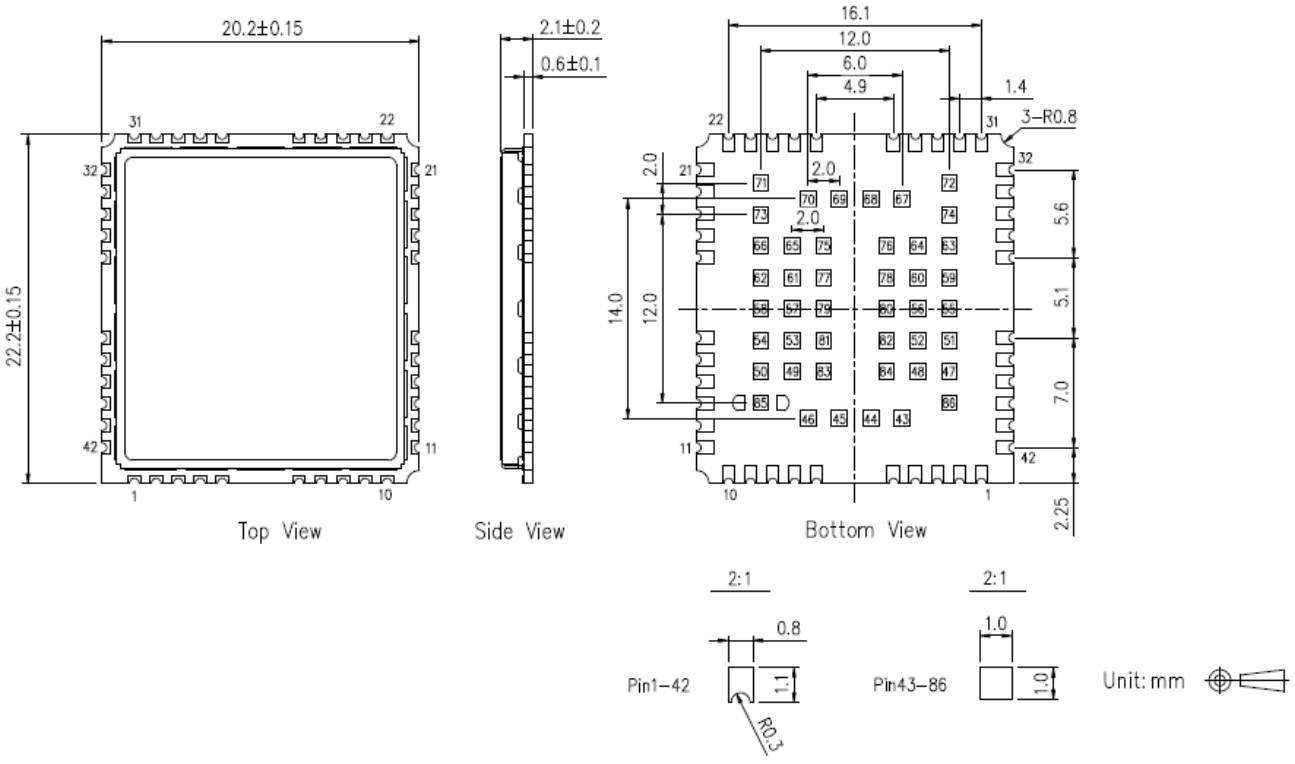


Figure 10-2 Structure Dimension (Unit: mm)

10.3 PCB Soldering Pad and Stencil Design

PCB soldering pad and stencil design please refer to《FIBOCOM MA510 LCC SMT Design Description》.

10.4 SMT

SMT production process parameters and related requirements please refer to《FIBOCOM MA510 LCC SMT Design Description》.

10.5 Carrier and storage

Carrier and storage please refer to《FIBOCOM MA510 LCC SMT Design Description》.

11 Approval

MA510-GL series module approval is shown as table 11-1:

Certification Scheme	MA510-GL
TBD	TBD
TBD	TBD
TBD	TBD
TBD	TBD
TBD	TBD

Table 11-1 Approval

For more information please refer to Fibocom net.

12 Default information

12.1 Serial Port Default Settings

UART1 defaults to an 8-wire AT serial port and can send AT commands. The default baud rate is 115200. UART1 shares some pins with the SPI interface.

UART2 is a four-wire debug serial port with a default baud rate of 115200.

12.2 Low power mode default setting

The eDRX and PSM modes are turned off by default. Client can switch the specific working mode of the module by the AT command.

13 Appendix

13.1 GPRS and EGPRS Encoding Scheme

Encoding method	CS-1	CS-2	CS-3	CS-4
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

Table 13-1 GPRS Encoding Scheme

In the GPRS standard, 29 types of GPRS multislot modes are defined for use by mobile stations. The multislot class defines the maximum rate of uplink and downlink. The expression is 3+1 or 2+2, the first number indicates the number of downlink timeslots, and the second number indicates the number of

uplink timeslots. Active timeslots indicate the total number of timeslots that the GPRS device can use for both uplink and downlink communications.

Multislot Class	Downlink Slots	Uplink Slots	Active Slots
1	1	1	2
2	2	1	3
3	2	2	3
4	3	1	4
5	2	2	4
6	3	2	4
7	3	3	4
8	4	1	5
9	3	2	5
10	4	2	5
11	4	3	5
12	4	4	5
33	5	4	6

Table 13-2 Multilevel Multislot Allocation

Coding Scheme	Modulation	Coding Family	1 Timeslot	2 Timeslot	4 Timeslot
CS-1	GMSK	/	9.05kbps	18.1kbps	36.2kbps
CS-2	GMSK	/	13.4kbps	26.8kbps	53.6kbps
CS-3	GMSK	/	15.6kbps	31.2kbps	62.4kbps
CS-4	GMSK	/	21.4kbps	42.8kbps	85.6kbps
MCS-1	GMSK	C	8.80kbps	17.6kbps	35.2kbps
MCS-2	GMSK	B	11.2kbps	22.4kbps	44.8kbps
MCS-3	GMSK	A	14.8kbps	29.6kbps	59.2kbps

MCS-4	GMSK	C	17.6kbps	35.2kbps	70.4kbps
MCS-5	8-PSK	B	22.4kbps	44.8kbps	89.6kbps
MCS-6	8-PSK	A	29.6kbps	59.2kbps	118.4kbps
MCS-7	8-PSK	B	44.8kbps	89.6kbps	179.2kbps
MCS-8	8-PSK	A	54.4kbps	108.8kbps	217.6kbps
MCS-9	8-PSK	A	59.2kbps	118.4kbps	236.8kbps

Table 13-3 EGPRS Modulation and Encoding Method

13.2 Terms and acronyms

Term	Definition
AMR	Adaptive Multi-rate
bps	Bits Per Second
CS	Coding Scheme
DRX	Discontinuous Reception
EGSM	Extended GSM900 Band
FDD	Frequency Division Duplexing
GMSK	Gaussian Minimum Shift Keying
GSM	Global System for Mobile Communications
HSDPA	High Speed Down Link Packet Access
IMEI	International Mobile Equipment Identity
Imax	Maximum Load Current
LED	Light Emitting Diode
LSB	Least Significant Bit
LTE	Long Term Evolution

Term	Definition
CA	Carrier Aggregation
DLCA	Downlink Carrier Aggregation
SCell	Secondary Cell for CA
ME	Mobile Equipment
MS	Mobile Station
MT	Mobile Terminated
PCB	Printed Circuit Board
PDU	Protocol Data Unit
PSK	Phase Shift Keying
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
RHCP	Right Hand Circularly Polarized RMS
RMS	Root Mean Square
RTC	Real Time Clock
Rx	Receive
SMS	Short Message Service
TDMA	Time Division Multiple Access
TE	Terminal Equipment
TX	Transmitting Direction
TDD	Time Division Duplexing
UART	Universal Asynchronous Receiver & Transmitter
UMTS	Universal Mobile Telecommunications System

Term	Definition
URC	Unsolicited Result Code
(U)SIM	(Universal) Subscriber Identity Module
USSD	Unstructured Supplementary Service Data
Vmax	Maximum Voltage Value
Vnorm	Normal Voltage Value
Vmin	Minimum Voltage Value
VIHmax	Maximum Input High Level Voltage Value
VIHmin	Minimum Input High Level Voltage Value
VILmax	Maximum Input Low Level Voltage Value
VILmin	Minimum Input Low Level Voltage Value
VImax	Absolute Maximum Input Voltage Value
VImin	Absolute Minimum Input Voltage Value
VOHmax	Maximum Output High Level Voltage Value
VOHmin	Minimum Output High Level Voltage Value
VOLmax	Maximum Output Low Level Voltage Value
VOLmin	Minimum Output Low Level Voltage Value
VSWR	Voltage Standing Wave Ratio
WCDMA	Wideband Code Division Multiple Access

Table 13-4 Terms and Acronyms

13.3 Related Document

- FIBOCOM RF Antenna Application Design Instruction
- FIBOCOM ADP-MA510-GL Evaluation board instructions
- FIBOCOM MA510 AT Command Manual
- FIBOCOM EVK-GT8230-NL User Manual

- FIBOCOM MA510 LCC SMT Application Design Instruction

13.4 Reference Standards

The design of the product complies with the following standards:

- 3GPP TS 51.010-1 V10.5.0: Mobile Station (MS) conformance specification; Part 1: Conformance specification
- 3GPP TS 34.121-1 V14.4.0: User Equipment (UE) conformance specification; Radio transmission and reception (FDD); Part 1: Conformance specification
- 3GPP TS 36.521-1 V14.3.0: User Equipment (UE) conformance specification; Radio transmission and reception; Part 1: Conformance testing
- 3GPP TS 21.111 V10.0.0: USIM and IC card requirements
- 3GPP TS 51.011 V4.15.0: Specification of the Subscriber Identity Module -Mobile Equipment (SIM-ME) interface
- 3GPP TS 31.102 V10.11.0: Characteristics of the Universal Subscriber Identity Module (USIM) application
- 3GPP TS 31.11 V10.16.0: Universal Subscriber Identity Module (USIM) Application Toolkit (USAT)
- 3GPP TS 36.124 V10.3.0: Electro Magnetic Compatibility (EMC) requirements for mobile terminals and ancillary equipment
- 3GPP TS 27.007 V10.0.8: AT command set for User Equipment (UE)
- 3GPP TS 27.005 V10.0.1: Use of Data Terminal Equipment - Data Circuit terminating Equipment (DTE - DCE) interface for Short Message Service (SMS) and Cell Broadcast Service (CBS)

13.5 Contact

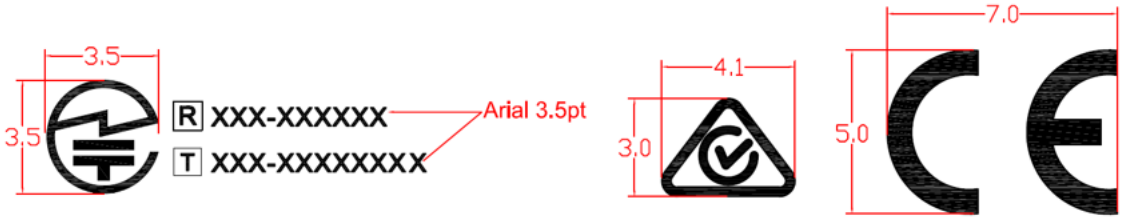
URL：http://www.fibocom.com.cn/

HQ Address：5 F Shekou Science and Technology Building, Nanhai Ave 1057, Shenzhen,Guangdong P.R.China

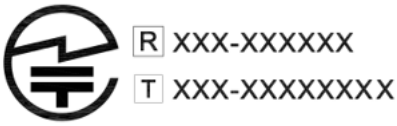
TEL：+86 755-26733555

Fax：+86 755-26520841

14 Certification mark



1. GITEKI MARK



2. RCM

3. CE

15 Warnning

The statements should be displayed in the user manual:

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

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.

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. End user must follow the specific operating instructions for satisfying RF exposure compliance. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Host manufacturer is responsible for ensuring that the host continues to be compliant with the Part 15 subpart B unintentional radiator requirements after the module is installed and operational.

IMPORTANT NOTE: In the event that these conditions can not 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 can not 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.

End Product Labeling

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: “Contains FCC ID: ZMOMA510GL”.The grantee's FCC ID can be used only when all FCC compliance.

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.

This device is intended only for OEM integrators under the following conditions:

1) The antenna must be installed such that 20 cm is maintained between the antenna and users, and the Max allowed antenna gain please refer to the MPE report.

2) The transmitter module may not be co-located with any other transmitter or antenna.

As long as 2 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

To comply with FCC regulations limiting both maximum RF output power and human exposure to RF radiation, maximum antenna gain (including cable loss) must not exceed:

Operating Band	FCC Max Antenna Gain（dBi）	IC Max Antenna Gain（dBi）
GSM850	8.1	8.1
GSM1900	3	3
LTE NB1 Band 2	12	12
LTE NB1 Band 4	9	9
LTE NB1 Band 5	13.41	12.25
LTE NB1 Band 12	12.69	11.76
LTE NB1 Band 13	13.15	12.08
LTE NB1 Band 25	12	12
LTE NB1 Band 26(814~823.9)	13.35	NA
LTE NB1 Band 26(824~849)	13.41	12.25
LTE NB1 Band 66	9	12.27
LTE NB1 Band 71	12.46	11.61
LTE NB1 Band 85	12.69	11.76
LTE Cat M1 Band 2	11	11
LTE Cat M1 Band 4	8	8
LTE Cat M1 Band 5	12.41	11.25
LTE Cat M1 Band 12	11.7	10.76
LTE Cat M1 Band 13	12.16	11.09
LTE Cat M1 Band 14	12.23	11.13
LTE Cat M1 Band 25	11	11
LTE Cat M1 Band 26(814~824)	12.36	NA
LTE Cat M1 Band 26(824~849)	12.41	11.25
LTE Cat M1 Band 66	8	8
LTE Cat M1 Band 85	11.7	10.77

IC Statement

IRSS-GEN

"This device complies with Industry Canada′ s licence-exempt RSSs. Operation is subject to the following two conditions: (1) This device may not cause interference; and (2) This device must accept any interference, including interference that may cause undesired operation of the device." or "Le présent appareil est conforme aux CNR d′ Industrie Canada applicables aux appareils radio exempts de licence. L′ exploitation est autorisée aux deux conditions suivantes :

1) l′ appareil ne doit pas produire de brouillage; 2) l′ utilisateur de l′ appareil doit accepter tout

brouillage radioélectrique subi, même si le brouillage est susceptible d′ en compromettre le fonctionnement." Déclaration sur l'exposition aux rayonnements RF

L'autre utilisé pour l'émetteur doit être installé pour fournir une distance de séparation d'au moins 20 cm de toutes les personnes et ne doit pas être colocalisé ou fonctionner conjointement avec une autre antenne ou un autre émetteur.

The host product shall be properly labeled to identify the modules within the host product.

The Innovation, Science and Economic Development Canada certification label of a module shall be clearly visible at all times when installed in the host product; otherwise, the host product must be labeled to display the Innovation, Science and Economic Development Canada certification number for the module, preceded by the word ″Contains″ or similar wording expressing the same meaning, as follows: ″Contains IC: 21374-MA510GL″ or ″where: 21374-MA510GL is the module′s certification number″.

Le produit hôte doit être correctement étiqueté pour identifier les modules dans le produit hôte. L'étiquette de certification d'Innovation, Sciences et Développement économique Canada d'un module doit être clairement visible en tout temps lorsqu'il est installédans le produit hôte; sinon, le produit hôte doit porter une étiquette indiquant le numéro de certification d'Innovation, Sciences et Développement économique Canada pour le module, précédé du mot «Contient» ou d'un libellé semblable exprimant la même signification, comme suit:

"Contient IC: 21374-MA510GL " ou "où: 21374-MA510GL est le numéro de certification du module".