Fibocom

Perfect Wireless Experience
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L816-AM Hardware User Manual

Version: 2.0.4

Update date: 2016.09.18

Applicability Table

No.	Product model	Description
1	L816-AM	N/A

Copyright

Notice

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Trademark

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Version Record

Version	Update Date	Description
V2.0.0	2016-04-28	Initial version
V2.0.1	2016-07-19	Sections describe modifications
V2.0.2	2016-07-26	Modified description
V2.0.3	2016-07-28	Update part chart
V2.0.4	2016-09-18	Add product certification of warnings

Contents

1 Foreword

1.1 Introduction

The document describes the electrical characteristics, RF performance, dimensions and application environment, etc. of L816-AM-00 (hereinafter referred to as L816-AM). With the assistance of the document and other instructions, the developers can quickly understand the hardware functions of L816-AM modules and develop products.

1.2 Reference Standard

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 V10.8.0: User Equipment (UE) conformance specification; Radio transmission and reception (FDD);Part 1: Conformance specification
- 3GPP TS 36.521-1 V10.6.0: 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 36.124V10.3.0: ElectroMagnetic Compatibility (EMC) requirements for mobile terminals and ancillary equipment
- 3GPP TS 27.007 V10.0.8: AT command set for User Equipment (UE)
- 3GPPTS27.005 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)

1.3 Related Documents

- RF Antenna Application Design Specification
- FIBOCOM_L8 Family System Driver Integration and Application Guidance
- L816-AM AT Commands Manual
- L816-AM SMT Application Design Specification

2 Overview

2.1 Introduction

The L816-AM module are highly integrated 4G wireless communication LGA modules, which supports LTE FDD/WCDMA/GSM systems (3 modes and 7 bands).

2.2 Specification

Specification		
Operating Band	LTE FDD: Band II,IV, XII	
	WCDMA/HSPA+: Band I,II,V(VI),VIII	
	GSM/GPRS/EDGE: 850/900/1800/1900MHz	
Data Transmission	LTE FDD	Rel.9, 10Mbps DL/5Mbps UL (Cat 1)
	WCDMA / HSDPA / HSUPA:	UMTS:384 kbps DL/384 kbps UL
		HSDPA CAT 7:7.2 Mbps Down;HSUPA CAT 6:5.76 Mbps Up
	GPRS/EDGE	GPRS:MSC 10, CS-4 80 Kbps Down/20Kbps Up
Power Supply	DC 3.3V～4.5V	
Temperature	Operating: -10°C ～+55°C	
	Storage: -40°C ～+85°C	
Physical characteristics	Package: LGA 115 pins	
	Dimension:30.0 x 21.0 x 1.55mm	
	Weight:~2.4g	
Interfaces		
Antenna	WWAN Main Antenna x 1	
	WWAN Diversity Antenna x 1	
Function Interface	USIM 3V/1.8V	
	USB 2.0 x 1	
	EINT, GPIO	
	USIM x 1	
	RF MIPI,RF GPO	

Software	
AT commands	3GPP TS 27.007 and 27.005, and proprietary FIBOCOM AT commands
Firmware update	USB

2.3 Warnings

2.3.1 CE Statement

EU Regulatory Conformance:

Hereby, We, FIBOCOM Wireless Inc. declares that this device L816-AM is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC.

CE 0560

R&TTE Regulation:

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

The maximum antenna gain for frequency 900 is 3dBi; for frequency 1800 is 5dBi and the antenna separation distance is 20cm.

2.3.2 FCC Statement

Federal Communication Commission Interference Statement

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.

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 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.

FCC Caution:

- Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.
- This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Radiation Exposure Statement:

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 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 maximum antenna gain allowed for use with this device is 5dBi.
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

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: ZMOL816AM and IC:21374-L816AM**". The grantee's FCC ID & IC ID can be used only when all FCC&IC compliance requirements are met.

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.

2.3.3 IC Statement

Industry Canada statement

❶ This device complies with Industry Canada license-exempt RSS standard(s). 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.

❶ 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, et
2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

❷ This Class B digital apparatus complies with Canadian ICES-003.

❷ Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.

❸ This device complies with RSS-310 of Industry Canada. Operation is subject to the condition that this device does not cause harmful interference.

❸ Cet appareil est conforme à la norme RSS-310 d'Industrie Canada. L'opération est soumise à la condition que cet appareil ne provoque aucune interférence nuisible.

❹ This device and its antenna(s) must not be co-located or operating in conjunction with any other antenna or transmitter, except tested built-in radios.

❹ Cet appareil et son antenne ne doivent pas être situés ou fonctionner en conjonction avec une autre antenne ou un autre émetteur, exception faites des radios intégrées qui ont été testées.

❺ The County Code Selection feature is disabled for products marketed in the US/ Canada.

❺ La fonction de sélection de l'indicatif du pays est désactivée pour les produits commercialisés aux États-Unis et au Canada.

Radiation Exposure Statement:

This equipment complies with IC 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.

Déclaration d'exposition aux radiations:

Cet équipement est conforme aux limites d'exposition aux rayonnements IC établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec un minimum de 20 cm de distance entre la source de rayonnement et votre corps.

2.4 Application Framework

The peripheral applications for L816-AM module are shown in Figure 2-1:

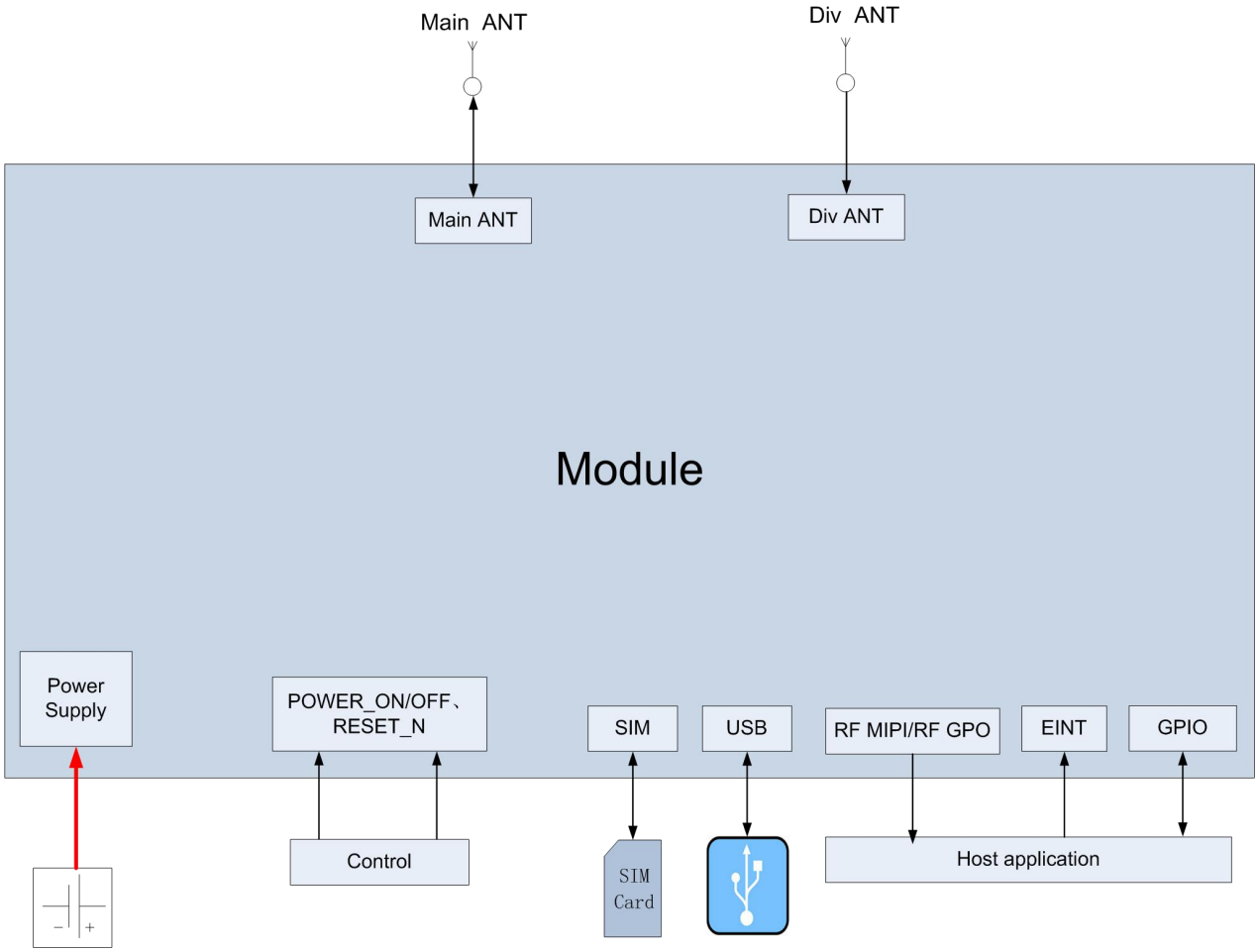

Figure2-1 Application Framework

2.5 Hardware Framework

The hardware framework in Figure 2-2 shows the main hardware functions of L816-AM module, including base band and RF functions.

Baseband contains the followings:

- GSM/UMTS/LTE FDD controller/Power supply
- NAND+LPDDR2 RAM
- Application interface

RF contains the followings:

- RF Transceiver
- RF Power/PA
- RF Front End
- RF Filter

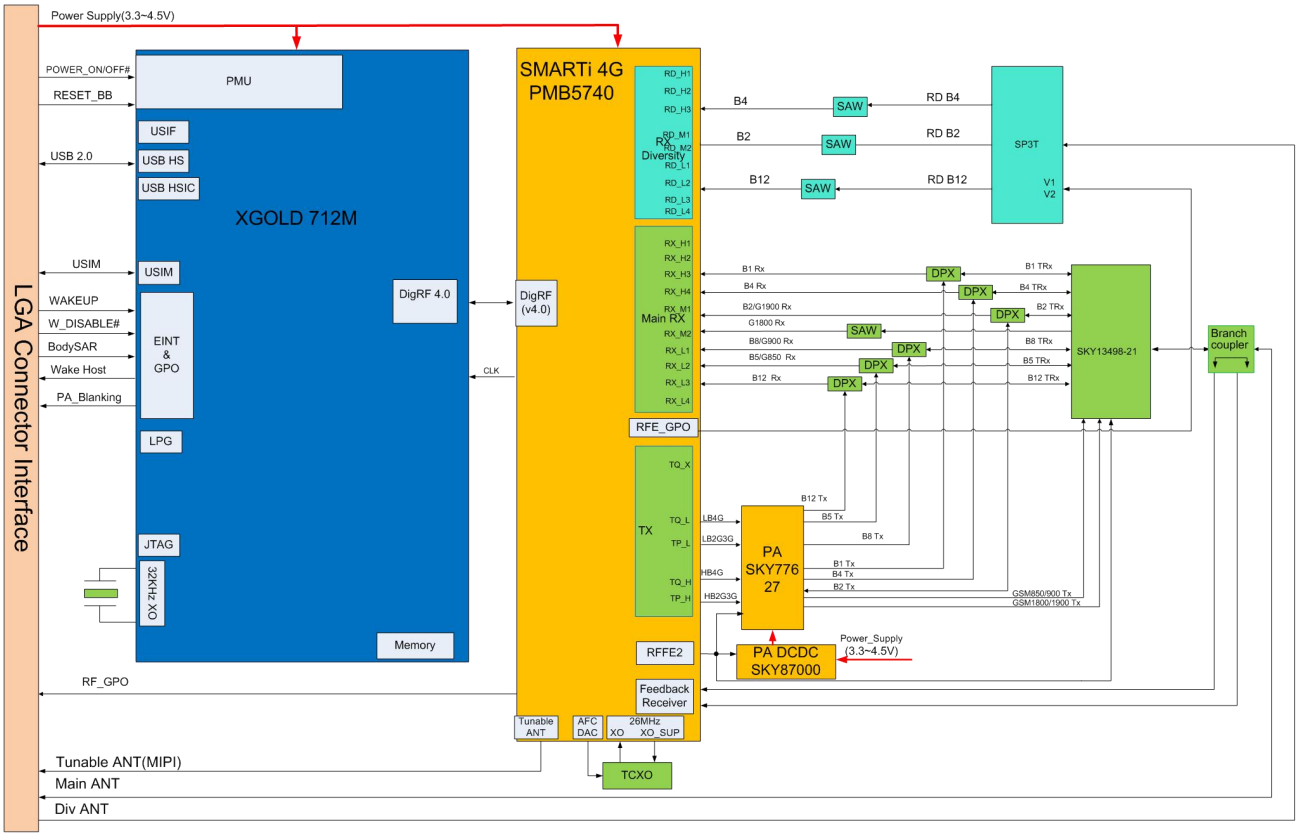

Figure 2-2 Hardware Framework

3 Application Interface

3.1 LGA Interface

The L816-AM module applies LGA packaging, with a total of 115 pins.

3.1.1 Pin Distribution

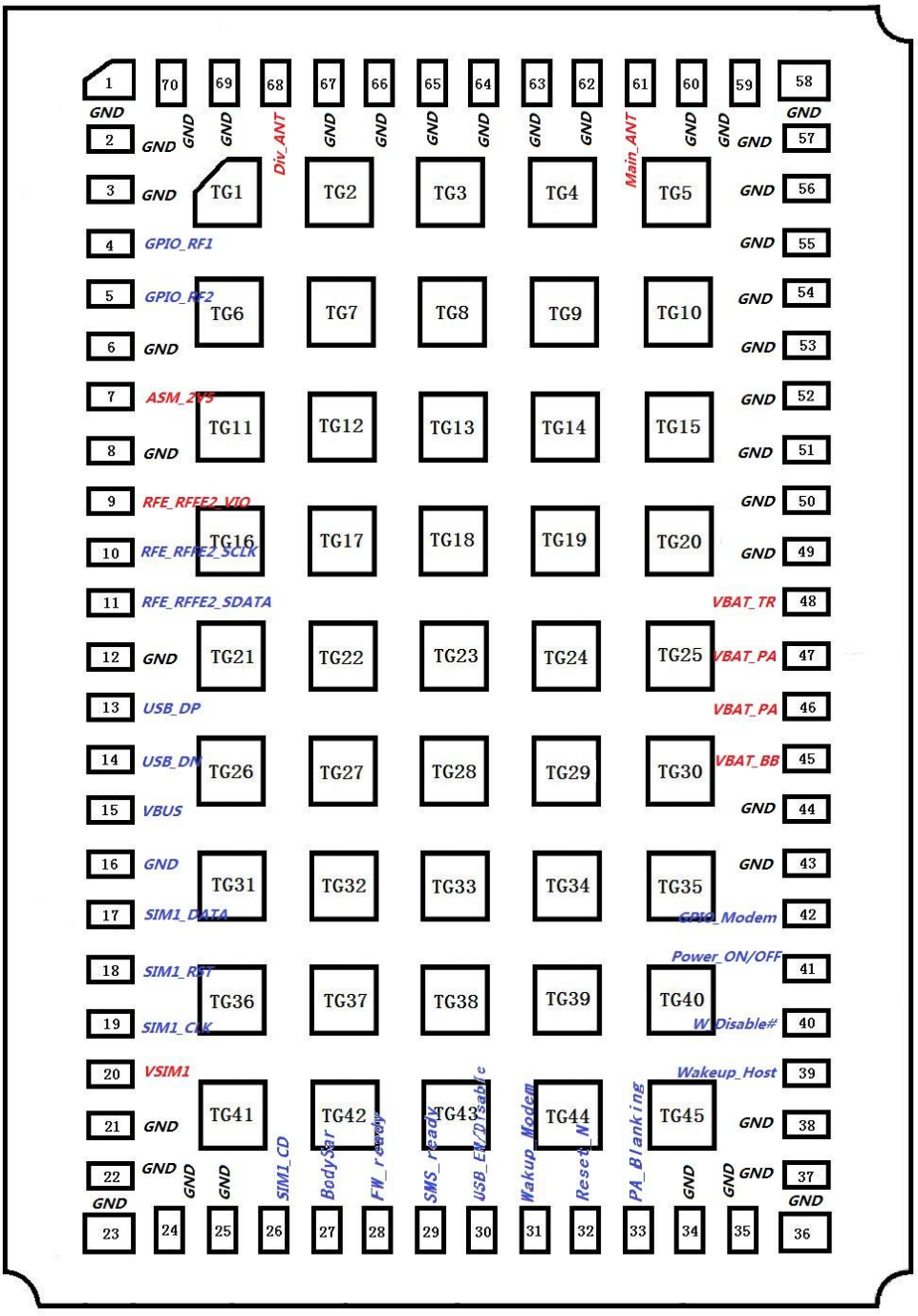

Figure 3-1 Pin Map (TOP Perspective View)

3.1.2 Pin Definition

The L816-AM pin definition is as follows:

Pin	Pin Name	I/O	Reset Value	Pin Description	Type
USB2.0					
13	USB_DP	I/O	T	USB Data Positive	0.3---3V
14	USB_DN	I/O	T	USB Data Negative	0.3---3V
15	VBUS	PI		USB VBUS Supply	2.0---5.25V
SIM					
17	SIM1_DATA	I/O	L	USIM data, internal 4.7KΩ pull-up	1.8V/3V
18	SIM1_RST	O	L	USIM reset	1.8V/3V
19	SIM1_CLK	O	L	USIM clock	1.8V/3V
20	VSIM1	PO		USIM power supply	1.8V/3V
26	SIM1_CD	I		USIM card detection with 390KΩ pull-up, active high	1.8V
EINT					
31	Wakeup_Modem	I	PD	Reserved	CMOS 1.8V
40	W_Disable#	I	PD	Disable WWAN	CMOS 1.8V
27	BodySar	I	PD	Body SAR detection	CMOS 1.8V
GPIO					
28	FW_Ready	O	PD	FW_Ready output	CMOS 1.8V
29	SMS_Ready	O	PD	SMS_Ready output	CMOS 1.8V
30	USB_En/Disable	O	PD	Enable_Disable-USB Signal Output	CMOS 1.8V
33	PA_Blanking	O	PD	PA_Blanking output	CMOS 1.8V
42	GPIO_Modem	I/O	PD	Reserved	CMOS 1.8V
39	Wakeup_Host	O	PD	Wakeup_Host output	
ANT					
61	Main_ANT	I/O		Main antenna	
68	DIV_ANT	I		Diversity antenna	
ANT Tunable					

Pin	Pin Name	I/O	Reset Value	Pin Description	Type
9	RFE_RFFE2_VIO	PO		RFFE2 VIO for tunable ANT	1.8V
10	RFE_RFFE2_SCLK	O		Reserved	1.8V
11	RFE_RFFE2_SDATA	I/O		Reserved	1.8V
RF GPO					
4	GPIO_RF1	O		RF_GPIO_1	2.3V
5	GPIO_RF2	O		RF_GPIO_2	2.3V
7	ASM_2V5	PO		ASM_2V5	2.5V
Module Control					
32	Reset_N	I		Module reset input with 100KΩ pull-up	1.8V
41	Power_On/Off	I		Module power on/off signal. Advise the customer to increase the 200KΩ pull-down	1.8V
Power					
45	VBAT_BB	PI	-	Power input	Power supply
46	VBAT_PA	PI	-	Power input	Power supply
47	VBAT_PA	PI	-	Power input	Power supply
48	VBAT_TR	PI	-	Power input	Power supply
GND					
1	GND	-	-	GND	Ground
2	GND	-	-	GND	Ground
3	GND	-	-	GND	Ground
6	GND	-	-	GND	Ground
8	GND	-	-	GND	Ground
12	GND	-	-	GND	Ground
16	GND	-	-	GND	Ground
21	GND	-	-	GND	Ground
22	GND	-	-	GND	Ground
23	GND	-	-	GND	Ground
24	GND	-	-	GND	Ground

Pin	Pin Name	I/O	Reset Value	Pin Description	Type
25	GND	-	-	GND	Ground
34	GND	-	-	GND	Ground
35	GND	-	-	GND	Ground
36	GND	-	-	GND	Ground
37	GND	-	-	GND	Ground
38	GND	-	-	GND	Ground
43	GND	-	-	GND	Ground
44	GND	-	-	GND	Ground
49	GND	-	-	GND	Ground
50	GND	-	-	GND	Ground
51	GND	-	-	GND	Ground
52	GND	-	-	GND	Ground
53	GND	-	-	GND	Ground
54	GND	-	-	GND	Ground
55	GND	-	-	GND	Ground
56	GND	-	-	GND	Ground
57	GND	-	-	GND	Ground
58	GND	-	-	GND	Ground
59	GND	-	-	GND	Ground
60	GND	-	-	GND	Ground
62	GND	-	-	GND	Ground
63	GND	-	-	GND	Ground
64	GND	-	-	GND	Ground
65	GND	-	-	GND	Ground
66	GND	-	-	GND	Ground
67	GND	-	-	GND	Ground
69	GND	-	-	GND	Ground
70	GND	-	-	GND	Ground

Pin	Pin Name	I/O	Reset Value	Pin Description	Type
TG1	GND	-	-	Thermal Ground	Ground
TG2	GND	-	-	Thermal Ground	Ground
TG3	GND	-	-	Thermal Ground	Ground
TG4	GND	-	-	Thermal Ground	Ground
TG5	GND	-	-	Thermal Ground	Ground
TG6	GND	-	-	Thermal Ground	Ground
TG7	GND	-	-	Thermal Ground	Ground
TG8	GND	-	-	Thermal Ground	Ground
TG9	GND	-	-	Thermal Ground	Ground
TG10	GND	-	-	Thermal Ground	Ground
TG11	GND	-	-	Thermal Ground	Ground
TG12	GND	-	-	Thermal Ground	Ground
TG13	GND	-	-	Thermal Ground	Ground
TG14	GND	-	-	Thermal Ground	Ground
TG15	GND	-	-	Thermal Ground	Ground
TG16	GND	-	-	Thermal Ground	Ground
TG17	GND	-	-	Thermal Ground	Ground
TG18	GND	-	-	Thermal Ground	Ground
TG19	GND	-	-	Thermal Ground	Ground
TG20	GND	-	-	Thermal Ground	Ground
TG21	GND	-	-	Thermal Ground	Ground
TG22	GND	-	-	Thermal Ground	Ground
TG23	GND	-	-	Thermal Ground	Ground
TG24	GND	-	-	Thermal Ground	Ground
TG25	GND	-	-	Thermal Ground	Ground
TG26	GND	-	-	Thermal Ground	Ground
TG27	GND	-	-	Thermal Ground	Ground
TG28	GND	-	-	Thermal Ground	Ground

Pin	Pin Name	I/O	Reset Value	Pin Description	Type
TG29	GND	-	-	Thermal Ground	Ground
TG30	GND	-	-	Thermal Ground	Ground
TG31	GND	-	-	Thermal Ground	Ground
TG32	GND	-	-	Thermal Ground	Ground
TG33	GND	-	-	Thermal Ground	Ground
TG34	GND	-	-	Thermal Ground	Ground
TG35	GND	-	-	Thermal Ground	Ground
TG36	GND	-	-	Thermal Ground	Ground
TG37	GND	-	-	Thermal Ground	Ground
TG38	GND	-	-	Thermal Ground	Ground
TG39	GND	-	-	Thermal Ground	Ground
TG40	GND	-	-	Thermal Ground	Ground
TG41	GND	-	-	Thermal Ground	Ground
TG42	GND	-	-	Thermal Ground	Ground
TG43	GND	-	-	Thermal Ground	Ground
TG44	GND	-	-	Thermal Ground	Ground
TG45	GND	-	-	Thermal Ground	Ground

H: High Voltage Level

L: Low Voltage Level

PD: Pull-Down

PU: Pull-Up

T: Tri-State

OD: Open Drain

PP: Push-Pull

PI: Power Input

PO: Power Output

Note:

The unused pins can be left floating.

3.2 Power Supply

The power interface for L816-AM module is as follows:

Pin	Pin Name	I/O	Pin Description	DC Parameters （V）		
				Minimum Value	Typical Value	Maximum Value
45	VBAT_BB	PI	Power input to BB	3.3	3.8	4.5
46	VBAT_PA	PI	Power input to RF PA DC-DC	3.3	3.8	4.5
47	VBAT_PA	PI	Power input to RF PA DC-DC	3.3	3.8	4.5
48	VBAT_TR	PI	Power input to transceiver	3.3	3.8	4.5
15	VBUS	PI	USB power supply	2.0	3.8	5.25
20	VSIM1	PO	SIM1 power supply		1.8V/3V	

3.2.1 Power Supply

The L816-AM module should be powered through the VBAT pins, and the power supply design is shown in Figure 3-2:

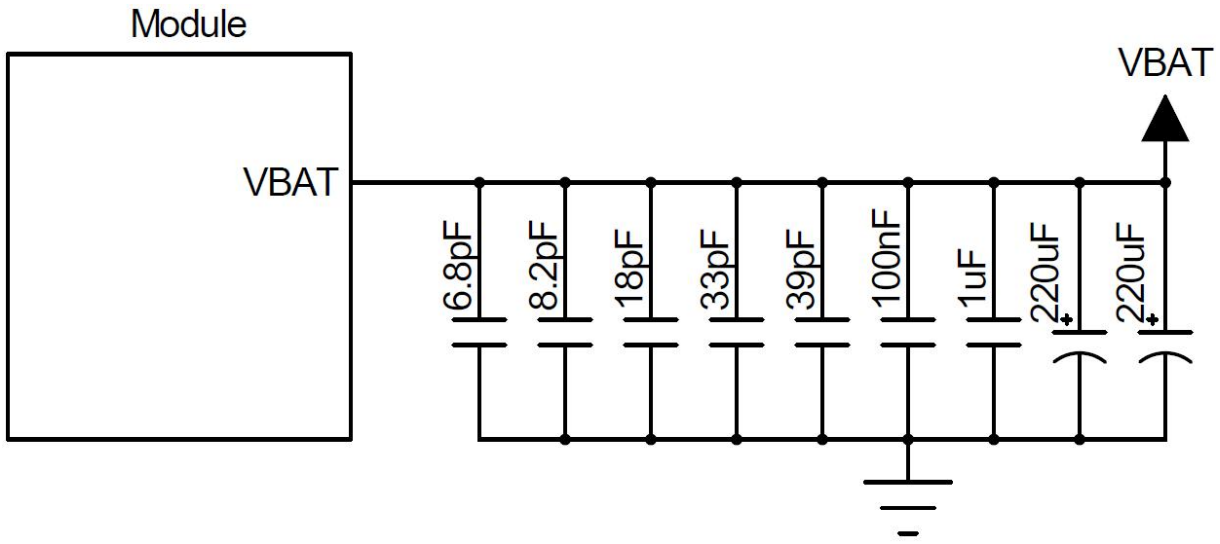

Figure 3-2 Power Supply Design

The filter capacitor design for power supply is shown in the following table:

Recommended capacitance	Application	Description
220uF x 2	Voltage-stabilizing capacitors	Reduce power fluctuations of the module in operation, requiring capacitors with low ESR ● LDO or DC/DC power supply requires the capacitor of no less than 440uF ● The capacitor for battery power supply can be reduced to 100～220uF
1uF,100nF	Digital signal noise	Filter out the interference generated from the clock and digital signals
39pF,33pF	850/900 MHz frequency band	Filter out low frequency band RF interference
18pF,8.2pF,6.8pF	1800/1900,2100MHz frequency band	Filter out medium/high frequency band RF interference

The stable power supply can ensure the normal operation of L816-AM module; and the ripple of the power supply should be less than 165mV in design. When the module operates under GSM mode (Burst transmit), the maximum operating current can reach 2A, so the power source should be not lower than 3.135V, or the module may shut down or reboot. The power supply limits are shown in Figure 3-3:

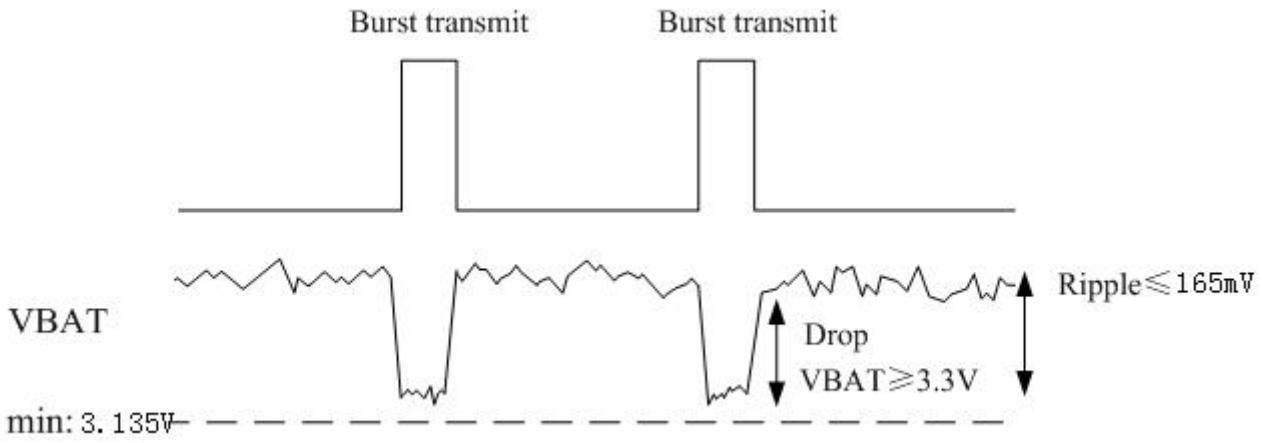

Figure 3-3 Power Supply Limit

3.2.2 Power Consumption

In the case of 3.8V power supply, the power consumption for L816-AM module is shown in the following table:

Parameter	Mode	Condition	Average Current(mA)
I_{off}	Power off	Power supply, module power off	TBD
I_{Idle}	GPRS	MFRMS=5	TBD
	WCDMA	DRX=8	TBD
	LTE FDD	DRX=8	TBD
	Radio Off	AT+CFUN=4, Flight mode	TBD
I_{Sleep}	GPRS	MFRMS=2	TBD
		MFRMS=5	TBD
		MFRMS=9	TBD
	WCDMA	DRX=6	TBD
		DRX=8	TBD
		DRX=9	TBD
	LTE FDD	Paging cycle #64 frames (0.64 sec DRx cycle)	TBD
	Radio Off	AT+CFUN=4,Flight mode	TBD
IGPRS-RMS CS4	GPRS 1Rx slot nTX slot	GPRS Data transfer GSM850; PCL=5; 1Rx/2Tx	TBD
		GPRS Data transfer GSM900; PCL=5; 1Rx/2Tx	TBD
		GPRS Data transfer DCS1800; PCL=0; 1Rx/2Tx	TBD
		GPRS Data transfer PCS1900; PCL=0; 1Rx/2Tx	TBD
$I_{EGPRS-RMS}$ MCS9	EDGE	EDGE Data transfer GSM850; PCL=8; 1Rx/2Tx	TBD
		EDGE Data transfer GSM900; PCL=8; 1Rx/2Tx	TBD
		EDGE Data transfer DCS1800; PCL=2; 1Rx/2Tx	TBD
		EDGE Data transfer PCS1900; PCL=2; 1Rx/2Tx	TBD
$I_{WCDMA-RMS}$	WCDMA	WCDMA Data transfer Band I @+23dBm	TBD
		WCDMA Data transfer Band II @+23dBm	TBD

Parameter	Mode	Condition	Average Current(mA)
		WCDMA Data transfer Band V(VI) @+23dBm	TBD
		WCDMA Data transfer Band VIII @+23dBm	TBD
$I_{LTE-RMS}$	LTE FDD	LTE FDD Data transfer Band 2 @+23dBm	TBD
		LTE FDD Data transfer Band 4 @+23dBm	TBD
		LTE FDD Data transfer Band 12 @+23dBm	TBD

3.3 Control Signal

The L816-AM module provides two control signals to execute the power on/off and reset operations, the pin definition is as follows:

Pin	Pin Name	I/O	Reset Value	Functions	Type
41	Power_On/Off	I		Power on/off signal with internal 200KΩ pull-down. High: Power on Low or floating: Power off	1.8V
32	Reset_N	I		Reset signal with 100KΩ internal pull-up, active low.	1.8V

3.3.1 Module Start-up

3.3.1.1 Start-up Circuit

The VRTC output from the module can be used as the pull up voltage and the module has two start-up modes:

- AP (Application Processor) controls the module start-up, and the circuit design is shown in Figure 3-4:
- Automatically start-up when powered on, and the circuit design is shown in Figure 3-5:

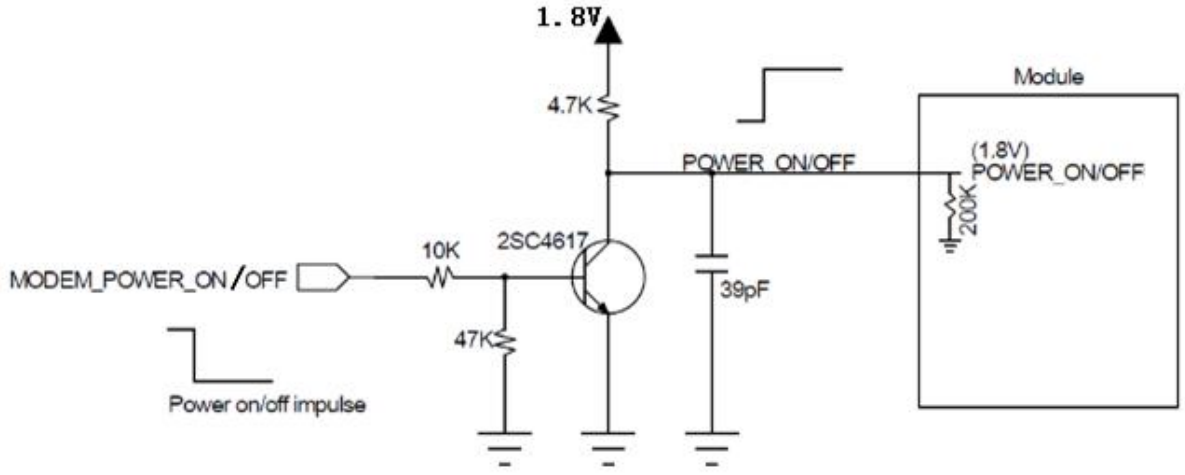

Figure 3-4 Circuit for Module Start-up Controlled by AP

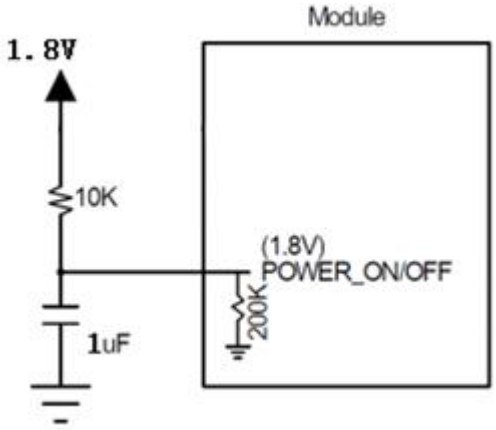

Figure 3-5 Circuit for Automatic Start-up

3.3.1.2 Start-up Timing

After powering on, the module will start-up by pulling up the Power_On/Off signal for more than 20ms (100ms is recommended).The start-up timing is shown in Figure 3-6:

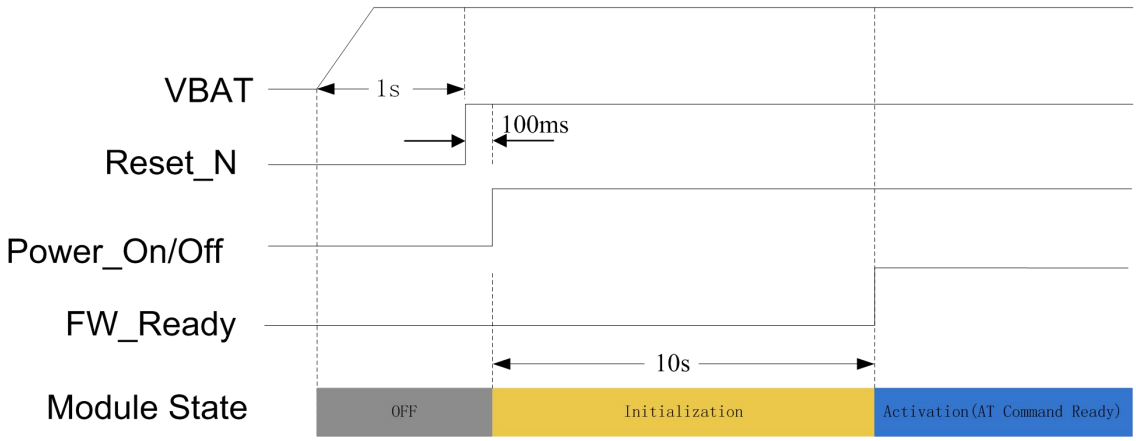

Figure 3-6 Timing Control for Start-up

Note:

The Reset_N is required to pull high with a 1s delay after the VBAT, because it takes some time to charge the capacitors for +3.3V power supply. If the VBAT power supply is already stable before starting up the module, the delay time can be ignored.

3.3.2 Module Shutdown

The L816-AM module can be shut down by software or hardware control.

Control mode	Action	Condition
Software	Sending AT+CPWROFF command	Normal shutdown.
Hardware	Pull down Power_On/Off pin	Only used when a hardware exception occurs and the software control cannot be used.

The module can be shut down by sending AT+CPWROFF command. When the module receives the shutdown command, the module will plug Low the FW_Ready and start the finalization process (the reverse process of initialization), and it will be completed after 3s. In the finalization process, the module will save the network, SIM card and some other parameters from memory, then clear the memory and PMU will be powered off. The control timing is shown in Figure 3-7:

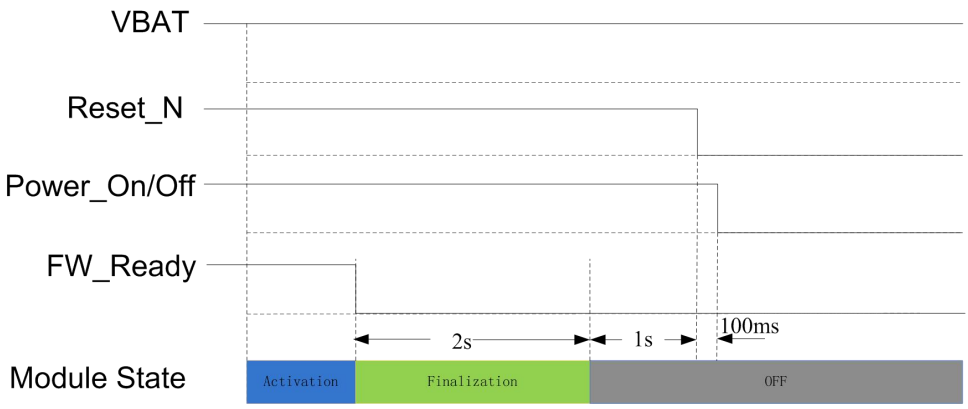

Figure 3-7 Software Shutdown Timing Control

After the software shutdown, the Power_On/Off pin will remain high which prevents the module from restarting again. To enable the next restart, the Power_On/Off pin should be pulled low after shutting down.

3.3.3 Module Reset

The L816-AM module can reset to its initial status by pulling down the Reset_N signal for more than 10ms (100ms is recommended), and the module will restart after the Reset_N signal is released. When the customer executes Reset_N function, the PMU remains its power inside the module. The recommended circuit design is shown in the Figure 3-8:

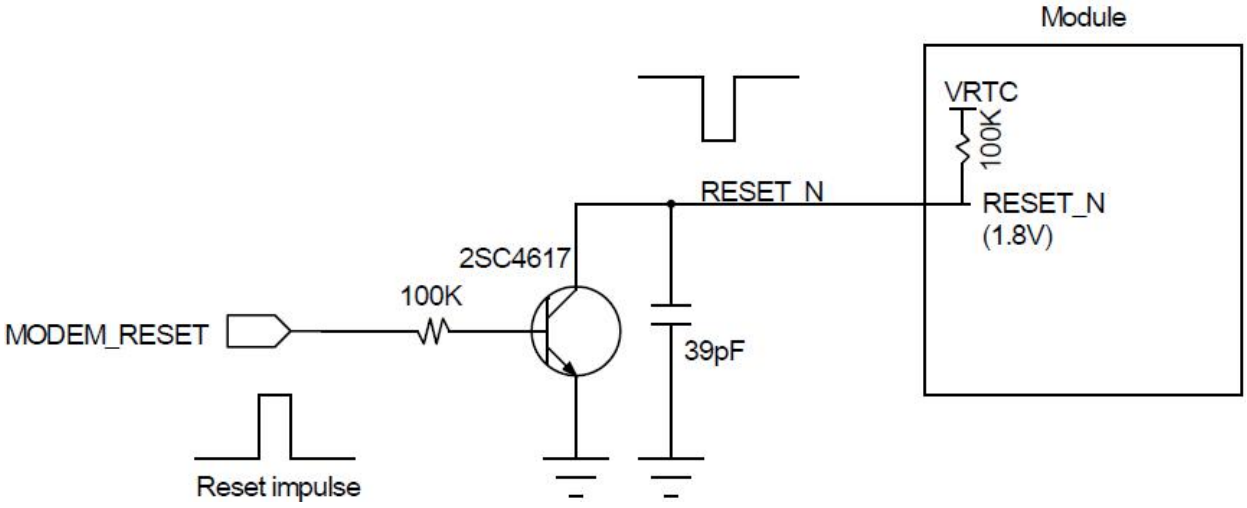

Figure 3-8 Recommended Design for Reset Circuit

The reset control timing is shown in Figure 3-9:

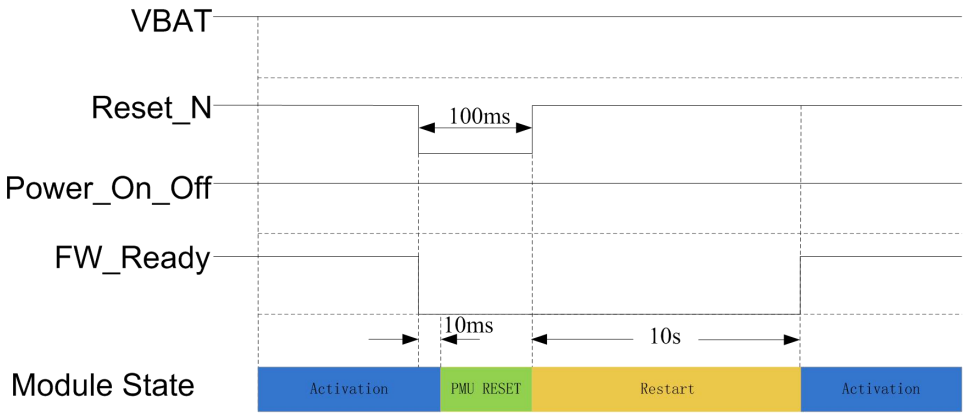

Figure 3-9 Reset Timing Control

Note:

Reset_N is a sensitive signal, it's recommended to add a filter capacitor close to the module. In case of PCB layout, the Reset_N signal lines should keep away from the RF interference and protected by GND. Also, the Reset_N signal lines shall neither near the PCB edge nor route on the surface planes to avoid module from reset caused by ESD problems.

3.4 USB Interface

The L816-AM module supports USB 2.0 which is compatible with USB High-Speed (480 Mbit/s) and USB Full-Speed (12 Mbit/s). For the USB timing and electrical specification of L816-AM module, please refer to "Universal Serial Bus Specification 2.0".

3.4.1 USB Interface Definition

Pin	Pin Name	I/O	Reset Value	Pin Description	Type
15	VBUS	PI		USB power supply	2.0---5.25V
14	USB_DN	IO	T	USB Data Negative	0.3---3V
13	USB_DP	IO	T	USB Data Positive	0.3---3V

The VBUS power supply is used as the detection of the USB port; after VBUS is powered on, the USB function of the module will be enabled and the enumeration will begin. The VBUS pin is only used for the detection of USB port, and the supply current is about 1mA. When USB_DN & USB_DP are disconnected, the module will not enter sleep mode for the case if VBUS power is supplied.

The USB driver will map 3 COM ports and 4 NCM ports, which are described as follows:

- 2 COM ports are used to send AT Commands.
- 1 COM port is used to capture LOG information with debugging softwares.
- 4 NCM ports are virtual network ports, which are used to initiate the data service.

Note:

One COM port can be used as the Modem COM port to initiate the data service. Since the speed of the Modem COM port is not sufficient for the 150 Mbps peak downlink speed requirement for LTE, so it is not recommended to be used.

3.4.2 USB Interface Application

The reference circuit is shown in Figure 3-10:

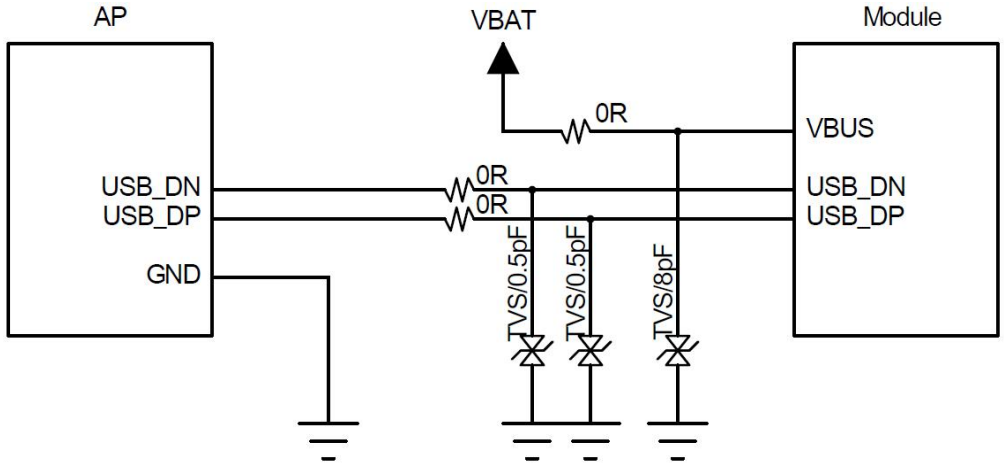

Figure 3-10 Reference Circuit for USB Interface

Since the module supports USB 2.0 High-Speed, it is required to use TVS diodes with equivalent capacitance of 1pF or smaller ones on the USB_DN/DP differential signal lines, it is recommended to use 0.5pF TVS diodes. There is no special requirement for TVS diodes on VBUS pin, normally the 8 ~ 10pF TVS diodes can be used.

USB_DN and USB_DP are high speed differential signal lines with the maximum transfer rate of 480 Mbit/s, so the following rules shall be followed carefully in the case of PCB layout:

- USB_DN and USB_DP signal lines should have the differential impedance of 90 ohms.
- USB_DN and USB_DP signal lines should be parallel and have the equal length, the right angle routing should be avoided.
- USB_DN and USB_DP signal lines should be routed on the layer that is next to the ground layer, and be wrapped with GND on both sides and layers.

3.5 USIM Interface

The L816-AM module has a built-in USIM card interface, which supports 1.8V and 3V SIM cards.

3.5.1 USIM Pins

The USIM pins are described as follows:

Pin	Pin Name	I/O	Reset Value	Pin Description	Type
20	VSIM1	PO		USIM power supply	1.8V/3V
18	SIM1_RST	O	L	USIM reset	1.8V/3V
19	SIM1_CLK	O	L	USIM clock	1.8V/3V
17	SIM1_DATA	I/O	L	USIM data with internal 4.7KΩ pull-up	1.8V/3V
26	SIM1_CD	I		USIM card detection with 390KΩ pull up. Active-high, and high level means SIM card is inserted; and low level means SIM card is detached.	1.8V

3.5.2 USIM Interface Circuit

3.5.2.1 N.C. SIM Card Slot

The reference circuit design for N.C. (Normally Closed) SIM card slot is shown in Figure 3-11:

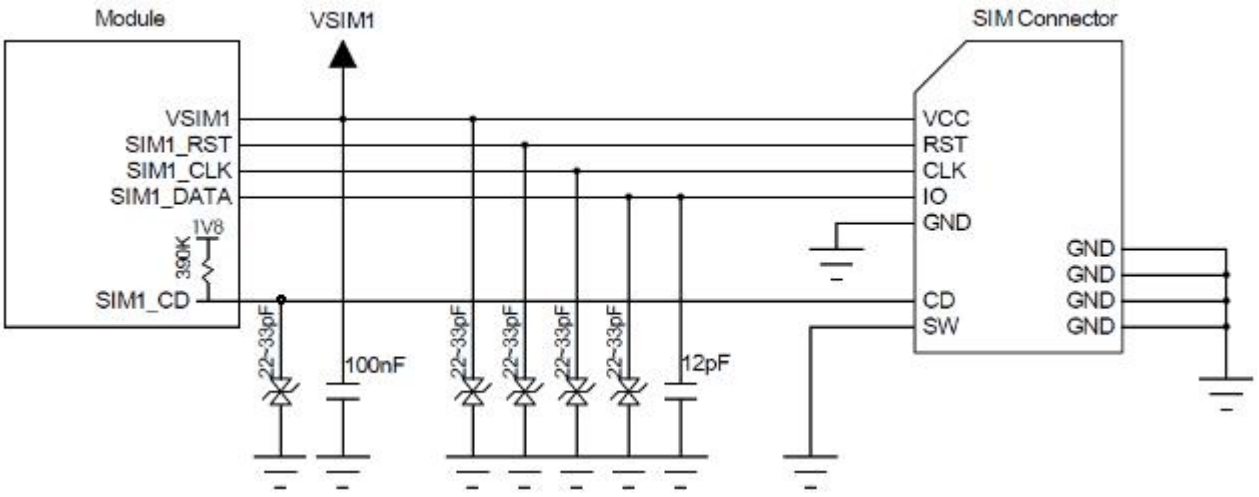

Figure 3-11 Reference Circuit for N.C. SIM Card Slot

The principles for N.C. SIM card slot design are described as follows:

- When the SIM card is detached, it connects the short circuit between CD and SW pins, and drives the SIM1_CD pin low.
- When the SIM card is inserted, it connects an open circuit between CD and SW pins, and drives the SIM1_CD pin high.

Suggested SIM1_CD pin increase TVS to protect the pin.

3.5.2.2 N.O. SIM Card Slot

The reference circuit design for N.O. (Normally Open) SIM card slot is shown in Figure 3-12:

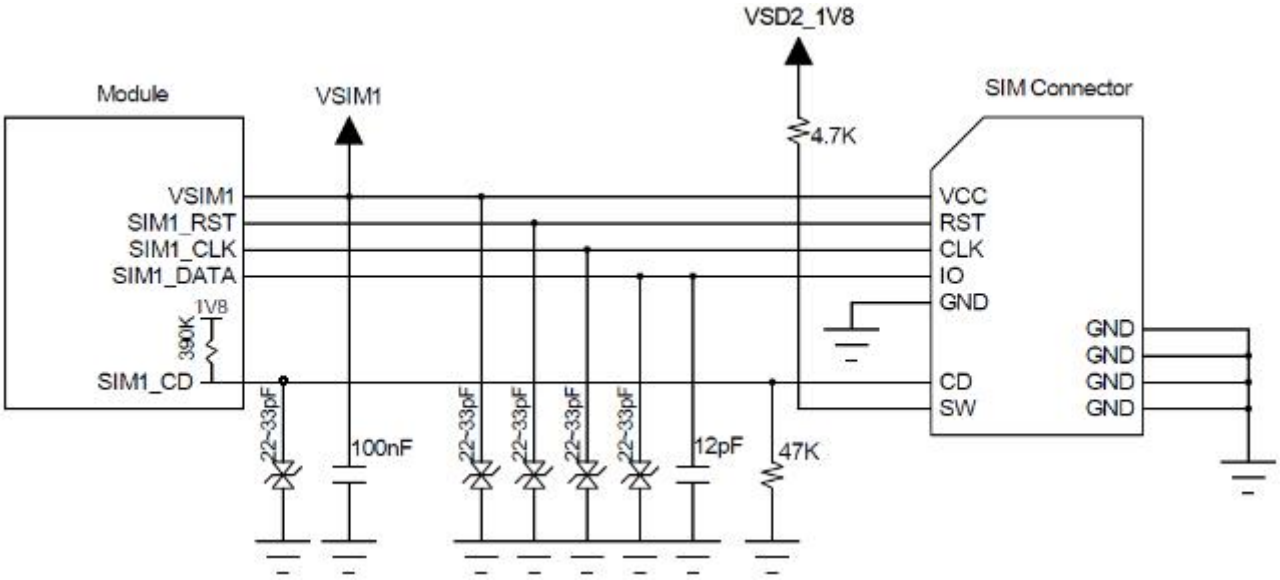

Figure 3-12 Reference Circuit for N.O. SIM Card Slot

The principles for N.O. SIM card slot design are described as follows:

- When the SIM card is detached, it connects an open circuit between CD and SW pins, and drives the SIM1_CD pin low.
- When the SIM card is inserted, it connects the short circuit between CD and SW pins, and drives the SIM1_CD pin high.
- Suggested SIM1_CD pin increase TVS to protect the pin.

3.5.3 USIM Hot-Plugging

The L816-AM module supports the SIM card hot-plugging detection function, which determines whether the SIM card is inserted or detached by detecting the SIM1_CD pin state of the SIM card slot.

The SIM card hot-plugging detection function can be configured by “AT+MSMPD” command, and the description for AT command is as follows:

AT Command	Hot-plugging Detection	Function Description
AT+MSMPD=1	Enable	Default value, the SIM card hot-plugging detection function is enabled. The module can detect whether the SIM card is inserted or not through the SIM1_CD pin state.
AT+MSMPD=0	Disable	The SIM card hot-plugging detection function is disabled. The module reads the SIM card when starting up, and the SIM1_CD status will not be detected.

After the SIM card hot-plugging detection function is enabled, the module detects that the SIM card is inserted when the SIM1_CD pin is high, then executes the initialization program and finish the network registration after reading the SIM card information. When the SIM1_CD pin is low, the module determines that the SIM card is detached and does not read the SIM card.

Note:

By default, SIM1_CD is active-high, which can be switched to active-low by the AT command. Please refer to the AT Commands Manual for the AT command.

3.5.4 USIM Design

The SIM card circuit design shall meet the EMC standards and ESD requirements with the improved capability to resist interference, to ensure that the SIM card can work stably. The following guidelines should be noted in case of design:

- The SIM card slot placement should near the module as close as possible, and away from the RF antenna, DC/DC power supply, clock signal lines, and other strong interference sources.
- The SIM card slot with a metal shielding housing can improve the anti-interference ability.
- The trace length between the SIM card slot and the module should not exceed 100mm, or it could reduce the signal quality.
- The SIM1_CLK and SIM1_DATA signal lines should be isolated by GND to avoid crosstalk interference. If it is difficult for the layout, the whole SIM signal lines should be wrapped with GND as a group at least.
- The filter capacitors and ESD devices for SIM card signals should be placed near to the SIM card slot, and the ESD devices with 22~33pF capacitance should be used.

3.6 GPIO

The L816-AM module provides four signals to indicate the operating status of the module, the status indicator pins are as follows:

Pin	Pin Name	I/O	Reset Value	Pin Description	Type
28	FW_Ready	O	PD	Modem SMS Ready Inform HOST 1.8V	CMOS 1.8V
29	SMS_Ready	O	PD	Modem FW Ready Inform HOST 1.8V	CMOS 1.8V
30	USB_En/Disable	O	PD	Reserved	CMOS 1.8V
39	Wakeup_Host	O	PD	Module wakes up Host (AP).	CMOS 1.8V
33	PA_Blanking	O	PD	PA Blanking output, external GPS control signal.	CMOS 1.8V
42	GPIO_Modem	O	PD	Reserved	CMOS 1.8V

3.6.1 FW_Ready

Firmware ready is a modem driven GPIO, which on power on reset, it should be low. Once the firmware in the modem is ready after boot, it should assert (high) GPIO. In an unlikely event of a firmware/modem crash, if a crash/exception handler is to be run, FW ready GPIO should be de-asserted.

FW_Ready timing is shown in Figure 3-6，3-7，3-9。

3.6.2 SMS_Ready

SMS ready is a modem driven GPIO, which should be low while power up/off and reset sequences. Whenever modem receives an SMS from the network, it should assert (high) GPIO during 100msec, then de-assert (low).

SMS ready GPIO should be triggered by non-class 2 “SIM card data” messages regardless message storage status (even the storage is full and not be able to store new received message).

SMS_Ready timing is shown in Figure 3-13:

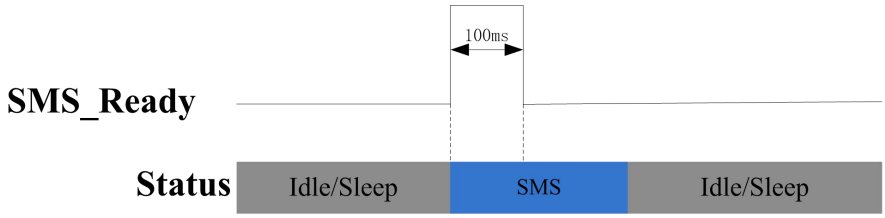

Figure 3-13 SMS_Ready Timing

3.6.3 Wakeup_Host

The Wakeup_Host signal is used to wake the Host (AP) when there is an incoming call, SMS or other data requests. The definition of Wakeup_Host signal is as follows:

Operating Mode	Wakeup_Host Signal
Ringing /SMS or data requests	Pull high 100ms then pull low (pulse signal).
Idle/Sleep	low level

Wakeup_Host timing is shown in Figure 3-14:

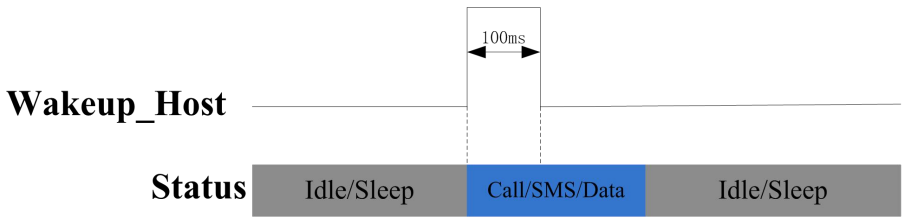

Figure 3-14 Wakeup_Host Timing

3.6.4 PA_Blanking

While the module works in GSM frequency band, the PA_Blanking pin will output the pulse signals that synchronize with the GSM burst TX timing. As the GSM TX may interfere the receiving of the GPS signal, AP can disable GPS or stop receiving GPS data when it detects the PA_Blanking pulse signals, to avoid GPS working abnormally.

Operating modes	PA_BLANKING signal
Default	Low level
GSM burst TX	Output the pulse signals that synchronize with the GSM burst TX.

PA_BLANKING timing is shown in Figure 3-15:

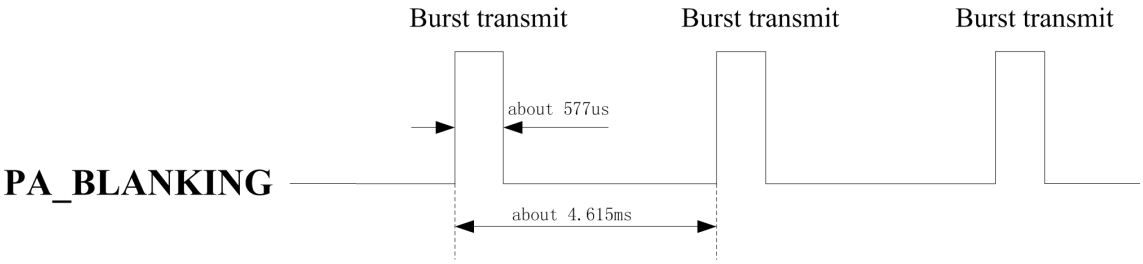

Figure 3-15 PA_Blanking Timing

3.7 Interrupt Control

The L816-AM module provides four interrupt signals, and the pin definition is as follows:

Pin	Pin Name	I/O	Reset Value	Pin Description	Type
31	Wakeup_Modem	I	PD	Reserved	CMOS 1.8V
40	W_Disable#	I	PD	Enable/Disable RF network	CMOS 1.8V
27	BodySar	I	PU	Body SAR detection	CMOS 1.8V

3.7.1 W_Disable#

The module provides a hardware pin to enable/disable WWAN RF function, and the function can also be controlled by the AT command. The module enters the Flight mode after the RF function is disabled. The definition of W_Disable# signal is as follows:

W_Disable# signal	Function
High/Floating	WWAN enable, the module exits the Flight mode.
Low	WWAN disable, the module enters Flight mode.

3.7.2 BodySar

The L816-AM module supports the BodySar detection function. The voltage level is high by default for BodySar, and when the SAR sensor detects the closing human body, the BodySar signal will be pulled down. As the result, the module then lowers down its emission power to its default threshold value, thus reducing the RF radiation on the human body. The threshold of emission power can be set by the AT Commands. The definition for BodySar function is as follows:

BodySar signal	Function
High/Floating	The module keeps the default emission power.
Low	Lower the maximum emission power to the threshold value of the module.

3.8 Other Interfaces

ANT Tunable, and RF_GPO.

Pin	Pin Name	I/O	Reset Value	Pin Description	Type
9	RFE_RFFE2_VIO	PO	PD	RF LOGIC SWITCH	1.8V
10	RFE_RFFE2_SCLK	O	PD	Reserved	1.8V
11	RFE_RFFE2_SDATA	I/O	PD	Reserved	1.8V

Pin	Pin Name	I/O	Reset Value	Pin Description	Type
4	GPIO_RF1	O	PD	RF LOGIC SWITCH	2.3V
5	GPIO_RF2	O	PD	RF LOGIC SWITCH	2.3V

The RFFE port will be re-purposed to be GPO, with GPO1/GPO2, they can be used control external DPDT, SPxT.

4 RF Interface

4.1 Operating Band

The L816-AM module provides main and diversity antenna interfaces; main antenna is used to transmit and receive RF signals, and the diversity antenna is only used to receive RF signals. The operating bands of the antennas are as follows:

Operating Band	Description	Mode	Tx (MHz)	Rx (MHz)
Band 1	IMT 2100MHz	WCDMA	1920 - 1980	2110 - 2170
Band 2	PCS 1900MHz	LTE FDD/WCDMA/GSM	1850 - 1910	1930 - 1990
Band 3	DCS 1800MHz	GSM	1710 - 1785	1805 - 1880
Band 4	AWS 1700MHz	LTE FDD	1710 - 1755	2110 - 2155
Band 5	CLR 850MHz	WCDMA/GSM	824 - 849	869 - 894
Band 6	850MHz	WCDMA	830 - 840	875 -885
Band 8	E-GSM 900MHz	WCDMA/GSM	880 - 915	925 - 960
Band 12	Lower SMH/LSMH blocks A/B/C	LTE FDD	699 - 716	729 - 746

4.2 Transmitting Power

The transmitting power for each band of the L816-AM module is as follows:

Mode	Band	Tx Power(dBm)	Note
GPRS (1 slot Tx)	GSM850	32.5±1dBm	
	GSM900	32.5±1dBm	
	DCS1800	29.5±1dBm	
	PCS1900	29.5±1dBm	
WCDMA	Band I	23±1dBm	
	Band II	23±1dBm	
	Band V	23±1dBm	
	Band VI	23±1dBm	

Mode	Band	Tx Power(dBm)	Note
	Band VIII	23±1dBm	
LTE FDD	Band 2	23±1dBm	10MHz Bandwidth, 1 RB
	Band 4	23±1dBm	10MHz Bandwidth, 1 RB
	Band 12	23±1dBm	10MHz Bandwidth, 1 RB

4.3 Receiver Sensitivity

The receiver sensitivity for each band of the L816-AM module is as follows:

Mode	Band	Rx Sensitivity(dbm)-typical	Note
GPRS	GSM850	TBD	BLER<10%
	GSM900	TBD	BLER<10%
	DCS1800	TBD	BLER<10%
	PCS1900	TBD	BLER<10%
WCDMA	Band I	TBD	BER<0.1%
	Band II	TBD	BER<0.1%
	Band V	TBD	BER<0.1%
	Band VI	TBD	BER<0.1%
	Band VIII	TBD	BER<0.1%
LTE FDD	Band 2	TBD	10MHz Bandwidth
	Band 4	TBD	10MHz Bandwidth
	Band 12	TBD	10MHz Bandwidth

Note:

The above LTE values are measured for the Dual-Antenna situation (Main + Diversity). For single main antenna (without Diversity), the sensitivity will drop around 3dBm for each band of LTE. The WCDMA and GSM have not diversity function.

4.4 RF PCB Design

4.4.1 Trace Routing Principle

The L816-AM module supports dual antennas, which meets the requirements for LTE of 3GPP. The MAIN_ANT is used to transmit and receive RF signals, while the DIV_ANT is used to receive RF signals. Using diversity antenna to improve the receiving sensitivity of RF antenna and double the download rate. Since L816-AM is an LTE module, dual antennas should be applied to meet the performance requirements.

The L816-AM module does not provide RF connector itself, so routing RF traces are required for the connection with RF connectors or antenna feed points on the application mainboard. It is recommended to use the microstrip line for RF trace, with the insertion loss controlled within 0.2dB and impedance controlled at 50Ω.

It is recommended to reserve a π circuit (the parallel inductors should connect to the RF trace) between the L816-AM module and the antenna connectors (or the feed points). The parallel devices are directly across the RF lines and no branch is allowed.

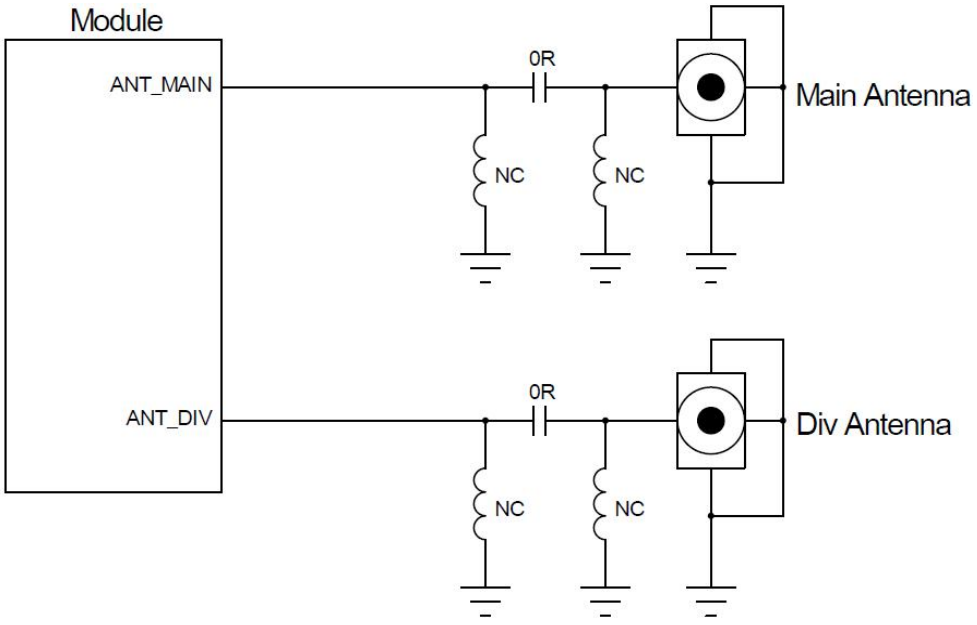

Figure 4-1 L816-AM Antenna π Circuit

4.4.2 RF Impedance Design

The RF traces impedance of the antenna interface shall be controlled at 50Ω.

4.5 Antenna Design

4.5.1 Antenna Design Requirements

The L816-AM module provides Main and Diversity antenna interfaces, and the antenna design requirements are as follows：

Main antenna requirements for L816-AM module	
Frequency range	The most proper antenna to adapt the frequencies should be used.
Bandwidth (GPRS/EDGE)	GSM850 : 70 MHz GSM900 : 80 MHz GSM1800(DCS) : 170 MHz GSM1900(PCS) : 140 MHz
Bandwidth (WCDMA)	WCDMA band I(2100) : 250 MHz WCDMA band II(1900) : 140 MHz WCDMA band V(850) : 70 MHz WCDMA band VI(850): 55MHz WCDMA band VIII(900) : 80 MHz
Bandwidth (LTE)	LTE band 2(1900): 140 MHz LTE Band 4(1700): 445 MHz LTE band 12(700): 50 MHz
Impedance	50 Ohm
Input power	> 35dBm(2W) peak power GSM > 25dBm average power WCDMA & LTE
Recommended standing-wave ratio (SWR)	≤ 2:1

5 Structure Specification

5.1 Product Appearance

The product appearance for L816-AM module is shown in Figure 5-1:

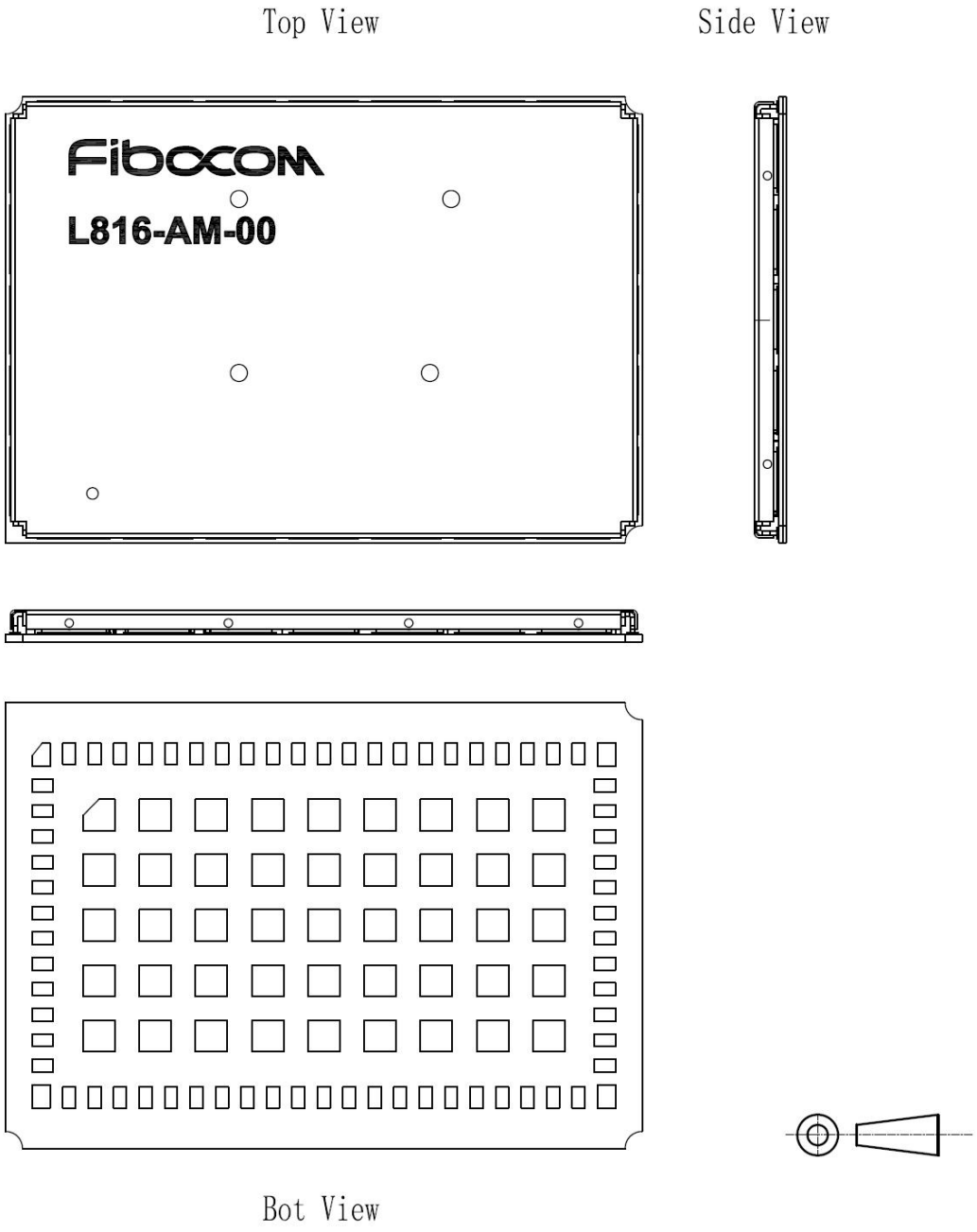

Figure 5-1 Module Appearance

5.2 Dimension of Structure

The structural dimension of the L816-AM module is shown in Figure 5-2:

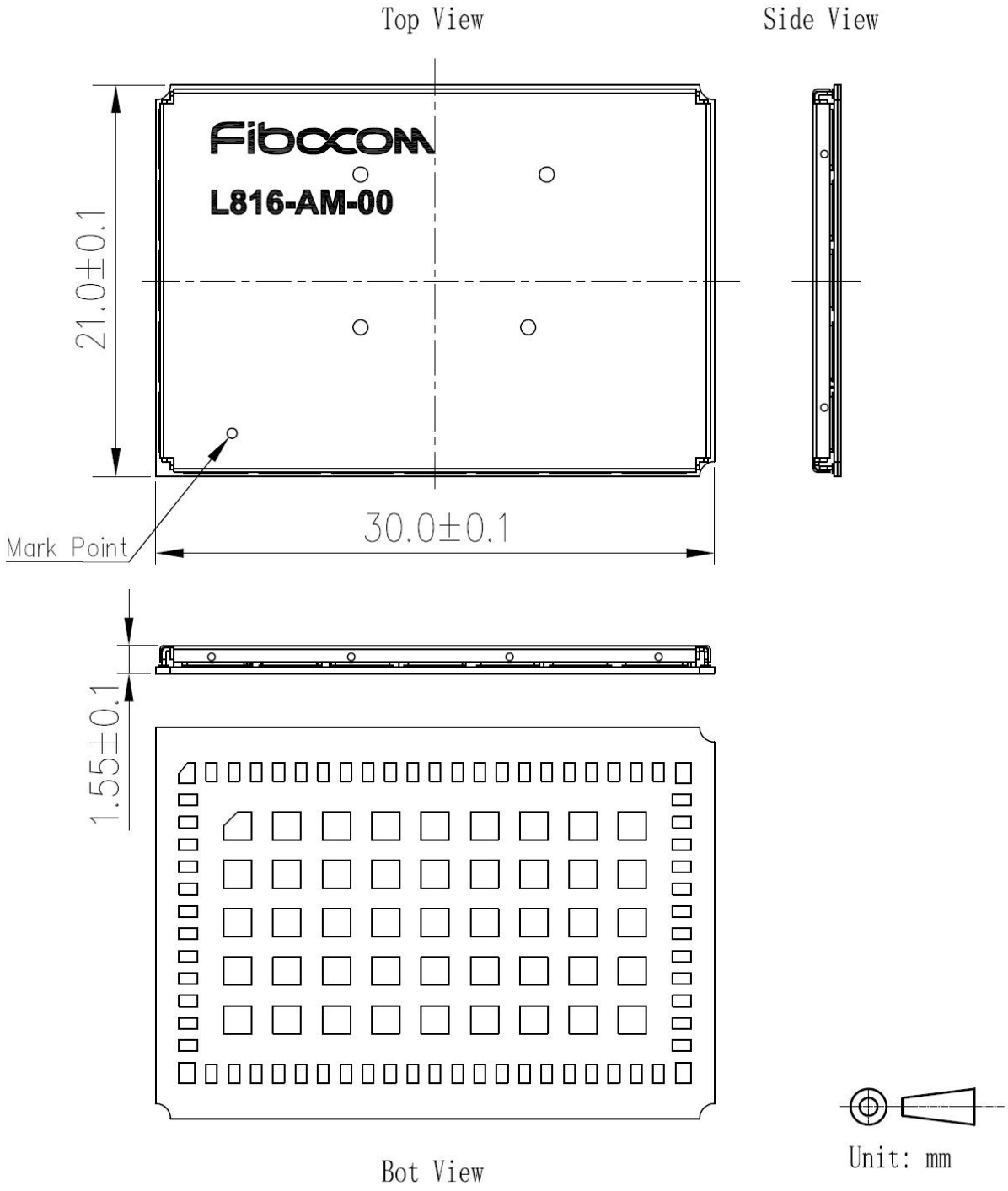

Figure 5-2 Dimension of Structure

5.3 Recommended Design for PCB Bonding Pad

Recommended Design for PCB Bonding Pad of the L816-AM module is shown in Figure 5-3

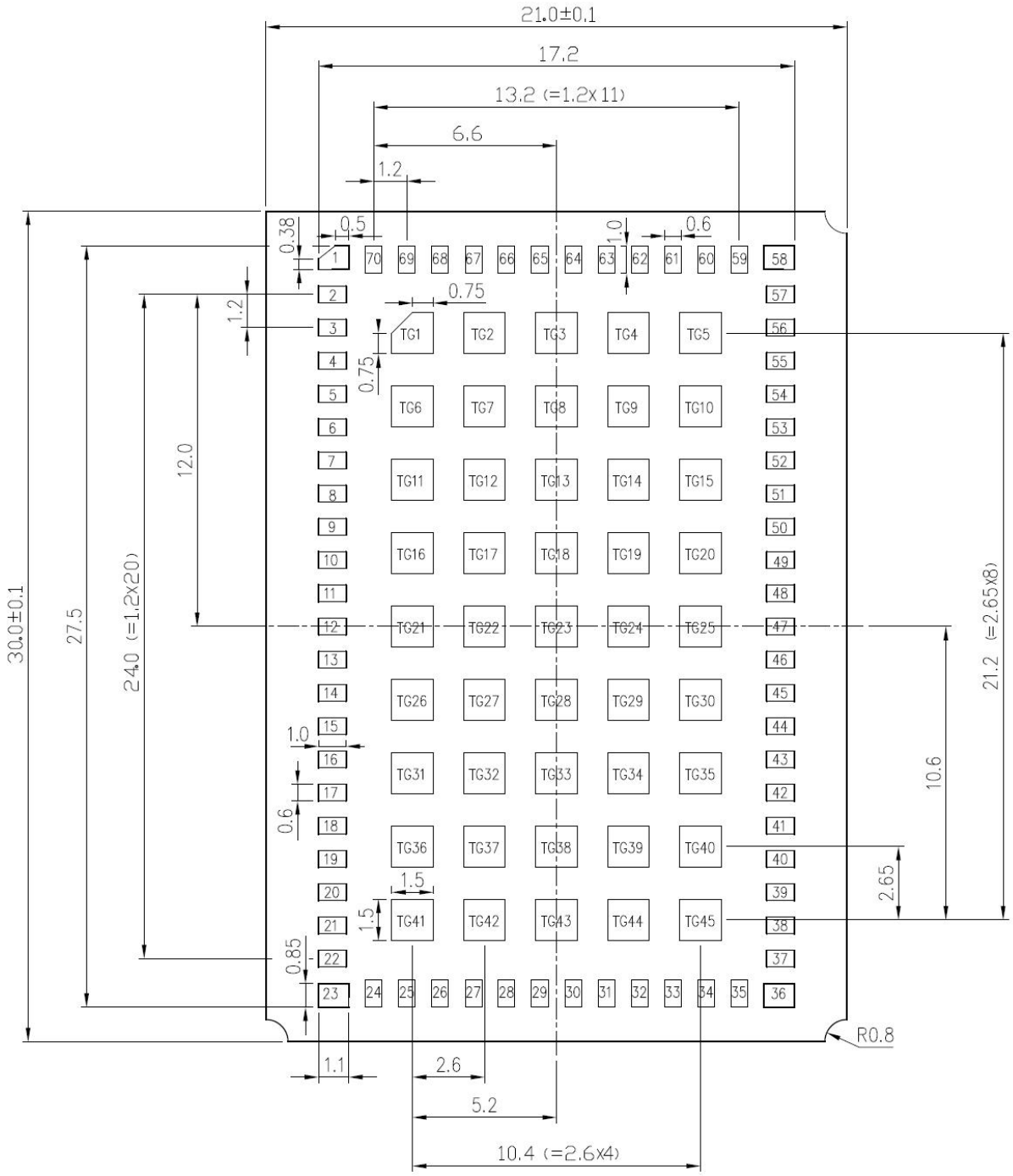

Figure5-3 Recommended Design for PCB Bonding Pad (Unit: mm)

5.4 SMT Paster

SMT Paster of the L816-AM module is shown in Figure Figure5-4

Please refer to L816-AM SMT Application Design Specification

Stencil thickness≥0.12mm

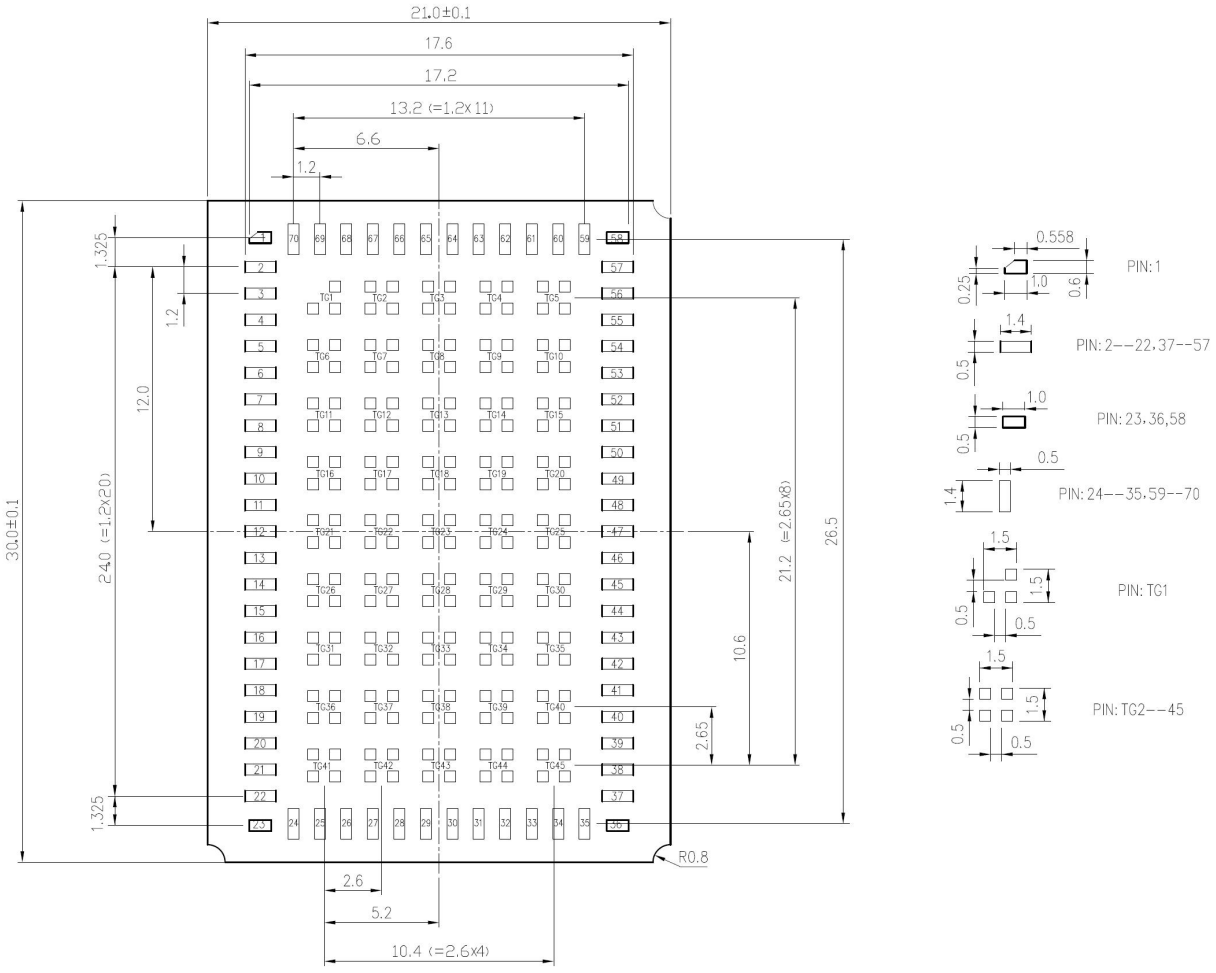

Figure5-4 Recommended Design for stencil (Unit: mm)

5.5 Storage

5.5.1 Storage Life

Storage Conditions (recommended): Temperature is 23 ± 5 ℃, relative humidity is RH 35-70%.

Storage period (sealed vacuum packing): Under the recommended storage conditions, the storage life is 12 months.

5.5.2 Workshop Life

For the module integrated some components for “Class 3” humidity-sensitive ,the workshop life need 24hours. After unpacking and under the environment with the room temperature of 23±5℃ and the relative humidity of less than 60%, the reflow production or other high-temperature operations shall be conducted within 24 hours for products, or products shall be stored in the environment with the relative humidity of less than 10%, in order to keep products dry.

5.5.3 Recommended baking standards:

- Continuous baking time: 24 hours.
- Temperature: 125±5℃.
- Oven: Heat convection oven.
- Component tray can NOT be baked on high temperature, Need use high temperature tray baking

5.6 Packing

The L816-AM module uses the tray sealed vacuum packing, combined with the outer packing method using the hard cartoon box, so that the storage, transportation and the usage of modules can be protected to the greatest extent.

Note:

The vacuum package bag includes the humidity card and a desiccant. The module is the humidity sensitive device, and the humidity sensitivity level is Class 3, which meets the requirements of the American Electronic Component Industry Association (JEDEC). Please read the relevant application guidance and precautions referred to herein, to avoid the permanent damage to the product caused by humidity.

5.6.1 Tray Package

Please read the L816-AM packing instructions of Fibocom company 《FIBOCOM-SAL-WI-63 L816-AM Packing Instruction A0》.