ZTEWelink

Welink your smart

Hardware Development Guide of Module Product

MW3650

Version V1.0, 2015-09-28

ZTE

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Revision History

Version	Date	Description
1.0	2015-09-28	1st released version

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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.

CE 0560

Hereby, ZTE CORPORATION declares that this product is in complies with the essential requirements of Article 3 of the R&TTE 1999/5/EC Directive.

1 About This Document

1.1 Application Range

This document is applicable as the hardware development guide of MW3650 module produce. Users need to design products according to the requirement and guide of this document. This document only can be applied to the hardware application development of MW3650 module product.

1.2 Purpose

This document provides the hardware solutions and development fundamentals for a product with the module. By reading this document, the user can have an overall knowledge of the module and a clear understanding of the technical parameters. With this document, the user can successfully fulfill the application and development of 3G wireless Internet product or equipment.

Besides the product function features and technical parameters, this document also provides the product reliability tests and related testing standards, business function realization process, RF performance indexes and a guide on the design of user circuits, to provide the user with a complete design reference.

NOTE:

At present, our company has a large number of module products. Users may come across many module board welding problems when using the module. To ensure the module board welding first pass yield and guarantee the module manufacturing and welding quality in the following integration process, please do as the chapter 9 of Manufacturing Guide in this document.

1.3 Supported & Reference Documents List

Besides this hardware development guide, we also provide the Datasheet document, software development guide and AT command reference guide. Table 1-1 is the support document list.

Table 1-1 Support Documents List

Document NO.	Document Name
1	ZTEWelink Software Development Guide of Module Product(MG3732_V2A&MW3650).pdf
2	ZTEWelink MW3650 Datasheet.pdf
3	AT Command reference guide for ZTEWelink MG3732_V2A,MW3650 Module.pdf

1.4 Abbreviations

Table 1-2 is a list of abbreviations involved in this document, as well as the English full names.

Table 1-2 Abbreviation List

Abbreviations	Full Name
ADC	Analog-Digital Converter
ARP	Antenna Reference Point
BER	Bit Error Rate
BTS	Base Transceiver Station
CDMA	Code Division Multiple Access
CS	Coding Scheme
CSD	Circuit Switched Data
CPU	Central Processing Unit
DAC	Digital-to-Analog Converter
DCE	Data Communication Equipment
DSP	Digital Signal Processor
DTE	Data Terminal Equipment
DTMF	Dual Tone Multi-Frequency
DTR	Data Terminal Ready
EGSM	Enhanced GSM
EMC	Electromagnetic Compatibility

Abbreviations	Full Name
EMI	Electro Magnetic Interference
ESD	Electronic Static Discharge
ETS	European Telecommunication Standard
FDMA	Frequency Division Multiple Access
FR	Full Rate
GPRS	General Packet Radio Service
GSM	Global Standard for Mobile Communications
IC	Integrated Circuit
IMEI	International Mobile Equipment Identity
ISO	International Standards Organization
ITU	International Telecommunications Union
LCD	Liquid Crystal Display
LED	Light Emitting Diode
MCU	Machine Control Unit
PCB	Printed Circuit Board
PCL	Power Control Level
PCS	Personal Communication System
PDU	Protocol Data Unit
PPP	Point-to-point protocol
RAM	Random Access Memory
RF	Radio Frequency
ROM	Read-only Memory
RTC	Real Time Clock
SIM	Subscriber Identification Module
SMS	Short Message Service
SPI	Serial Peripheral Interface
TE	Terminal Equipment also referred it as DTE
UART	Universal asynchronous receiver-transmitter
UIM	User Identifier Management
USB	Universal Serial Bus
UMTS	Universal Mobile Telecommunication System
WCDMA	Wideband Code Division Multi Access

2 Product Overview

MW3650 is a WCDMA/HSDPA/GSM/GPRS/EDGE industry module developed by our company, and it is a wireless Internet module with LCC interface. The module has voice(optional), short message and data service functions. The downlink peak data rate is 3.6Mbps and the uplink peak data rate is 384Kbps, so it can supply the users with economical high speed internet access business, wireless data business and so on. It is widely applied to but not limited to the various products and equipment such as modem, embedded module, wireless phone, multimedia phone and touch screen communication device, PAD, vehicle-mounted terminals and electric consumed devices, using the MW3650 module.

The function features of this module are described as bellow:

1) Support UMTS/HSDPA 850(900)/1900/2100MHz frequency band, GSM/GPRS/EDGE 850/900/1800/1900MHz frequency band.
2) Can supply GSM/GPRS/EDGE and UMTS/HSDPA high speed data access service in a mobile environment.
3) Support SMS and voice functions.
4) Supply (U)SIM card interface (3.0V/1.8V), USB2.0 interface, 8-wire UART (compatible with 2-wire UART), power on/off, reset and so on.

Taking MW3650 module as an example, this document introduces the logical structure, hardware interfaces and main function in detail. It also supplies the corresponding design reference of hardware and structure.

NOTE:

At present, the frequency band of MW3650 module in UMTS mode can take proper tailoring or configuration according to the corresponding requirement of customers as is shown blow.

Table 2-1 Module Frequency band configuration

Configuration	GSM Bands	WCDMA Bands
MW3650V1A	850/1900MHz	1900/850MHz
MW3650V1B	900/1800MHz	2100/900MHz
MW3650V1C	900/1800MHz	2100MHz

2.1 Technical Parameters

The major features of the module can be described from the aspects of mechanic feature, base band, radio frequency, technical standard, environment features and so on. Table below is a list of the major technical parameters and features supported by module.

Table 2-2 Major Technical Parameters

Type	Item	Specifications	
Mechanical Feature	Dimensions (L × W × H)	30.0mm × 30..0mm × 2.3mm	
	Weight	About 5g	
	Encapsulation type	LCC with 80 pins	
Baseband	(U)SIM/SIM	Standard SIM card interface 3V SIM card and 1.8V SIM card	
	USB interface	USB 2.0 HIGH SPEED	
	UART interface	8-wire UART	
	Max Power Dissipation	About 2.2W	
	Power Supply	DC 3.3~4.2V, typical value is 3.8V	
	Working Current[2]	Peak current	About 0.6A
		The average current in normal working	About 540mA@UMTS 2100 About 239mA@GSM 900
		Standby current	About 5mA@UMTS About 5mA@GSM
RF	GSM Frequency Band	EDGE/GPRS/GSM：1900/1800/900/850MHz	
	UMTS Frequency Band	HSDPA/WCDMA：2100/1900/850(900)MHz;	
	Diversity Reception Frequency Band	NA[1]	
	Max. Transmitter Power	UMTS2100/1900/900/850: Power Class 3 (+24dBm +2.5/-1.5dBm) GSM/GPRS 850MHz/900MHz: Power Class 4 (+33dBm + 2.5/-0.5 dBm) GSM/GPRS 1800MHz/1900MHz: Power Class 1 (+30dBm +2.5/-0.5 dBm) EDGE 850MHz/900MHz: Power Class E2 (+27dBm +4.5/-1.5dBm) EDGE 1800MHz/1900MHz: Power Class E2 (+26dBm +4.5/-2.5dBm)	

Type	Item	Specifications
	Receiving sensitivity	WCDMA2100 : ≤-108dBm WCDMA1900 : ≤-109dBm WCDMA900 : ≤-109dBm WCDMA850 : ≤-109 dBm
		GSM850/900/1800/1900 : ≤-107dBm
	Main Antenna	External, Provide Antenna PAD
Technical Standard	Data Rate	GSM CS: UL 9.6kbps/DL 9.6kbps GPRS: Multi-slot Class 10 EDGE: Multi-slot Class 12 WCDMA CS: UL 64kbps/DL 64kbps WCDMA PS: UL 384kbps/DL 384kbps
	HSDPA	HSDPA: DL 3.6Mb/s(Category 6)
	Protocol	HSDPA/WCDMA/EDGE/GPRS/GSM
	3GPP Protocol	R5, R4, R99
	OS	Windows XP (SP2 and later)
		Windows Vista & 7
		WinCE
		Linux
		Android
Environment Feature[3]	Working Temperature	-30 ~ 75° C
	Storage Temperature	-40 ~ 85° C
	Humidity	5%~ 95%
Application	DATA	Support
	SMS	Support ultra-long SMS Support Text and PDU mode Point to point MO and MT
	Voice	Support
	MMS	Support (Not support built-in MMS protocol stack temporarily)
	TCP/IP	Support
	UDP/IP	Support
	Phonebook	Support
	Upgrade	Support

NOTE:

"NA" indicates nonsupport.

Working current value is the average value tested under the max transmitter power. The value may be different in different condition and environment. Please take the actual measurement as the reference.

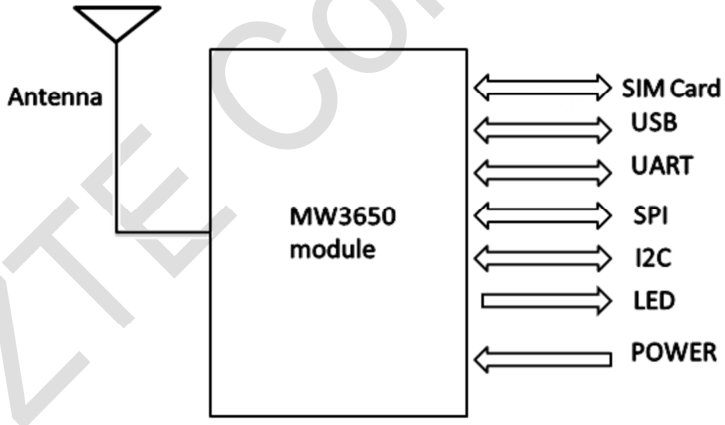
Please make sure that the module is started up in the recommended working current range and working temperature to avoid the damage or the abnormal working of the module.

2.2 Function Overview

2.2.1 Baseband Function

When connected with the system board, the module mainly includes the following signal groups: USB signal, (U)SIM card signal, status querying signal, UART signal, module power-on/resetting signal, main antenna interface and power-supply interface. Figure below is the system connection structure.

Figure 2-1 System Connection Structure



2.2.2 Radio Frequency Function

The working frequency band of module is shown in the table below.

a) Support HSDPA/WCDMA 850(900)/1900/2100MHz.

b) Support GSM/EDGE/GPRS 850/900/1800/1900MHz.

c) The highest downlink rate supported by HSDPA is 3.6Mbit/s.

d) PS domain supports EDGE CLASS12/GPRS CLASS10 bearer service.

e) CS domain supports 64Kbit/s data service in WCDMA mode.

Table 2-3 Working Frequency Band

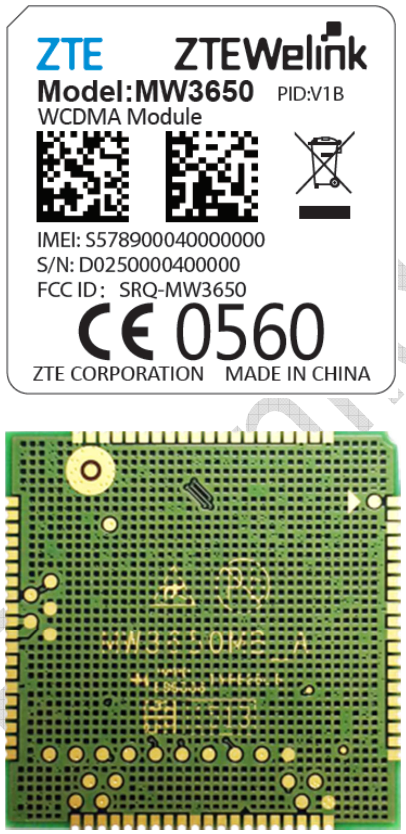
Working Frequency Band	Uplink Frequency Band	Downlink Frequency Band
UMTS850 (band V)	824 MHz — 849 MHz	869 MHz — 894 MHz
UMTS900 (band VIII)	880 MHz — 915 MHz	925 MHz — 960 MHz
UMTS1900 (band II)	1850 MHz — 1910 MHz	1930 MHz — 1990 MHz
UMTS2100 (band I)	1920 MHz — 1980 MHz	2110 MHz — 2170 MHz
GSM850	824 MHz — 849MHz	869 MHz — 894 MHz
GSM900	890 MHz — 915MHz	925 MHz — 960MHz
GSM1800	1710 MHz — 1785MHz	1805 MHz — 1880MHz
GSM1900	1850 MHz — 1910MHz	1930 MHz — 1990MHz

3 Mechanic Features

3.1 Module Illustration

The Product Illustration of module is shown in the Figure 3-1.

Table 3-1 Product Illustration



NOTE:

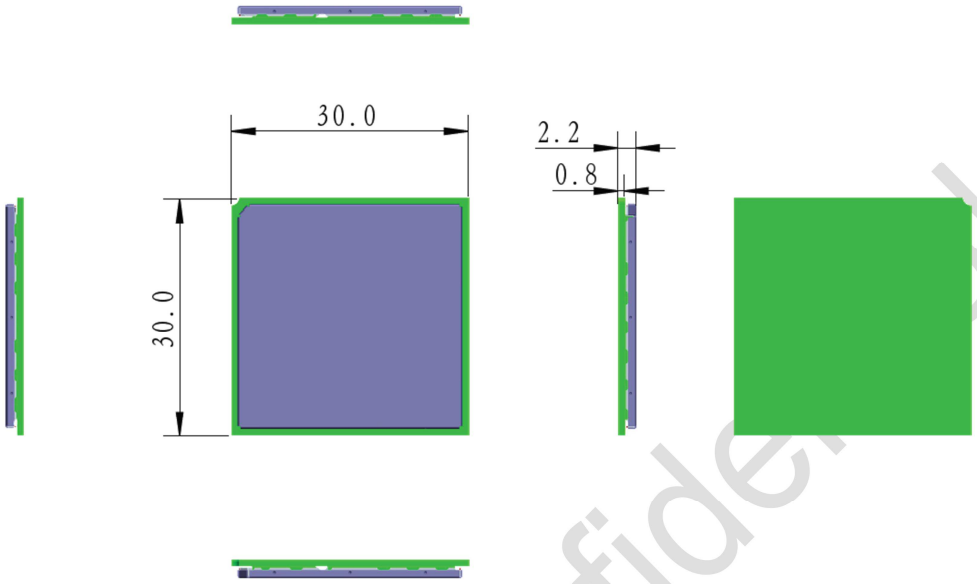
The picture above is just for reference; please take the actual products as the reference.

- Dimensions (L × W × H): 30.0 mm × 30.0mm ×2.3mm
- Weight: about 5g.

3.2 Module hex-vision images

The module hex-vision images are shown in figure 3-2 (units: mm).

Figure 3-2 module hex-vision images



Note: the height in the figure above is without the module label, so it is 2.2mm.

3.3 Module Main Board PCB Encapsulation Dimension Diagram

The detailed dimension of PCB welding panel is shown in figure 3-3 (units: mm).

Figure 3-3 The detailed dimension of PCB welding panel

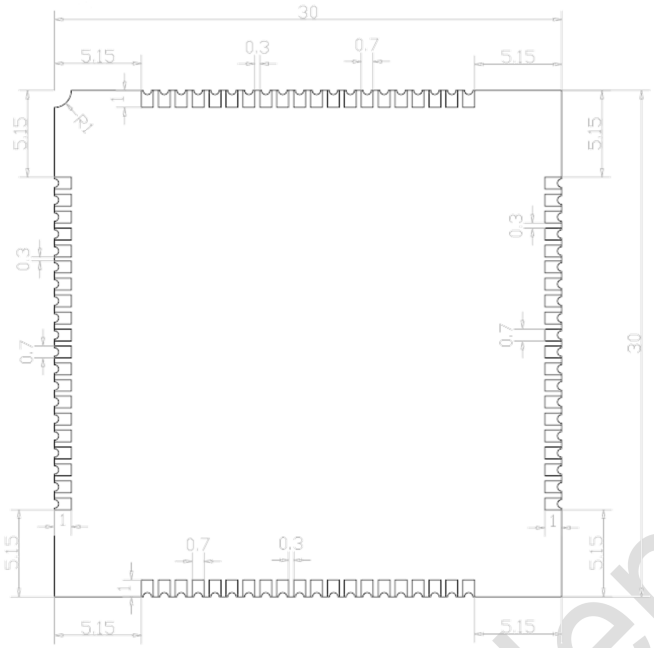


Figure 3-4 Recommended Welding Panel Design Dimension of Customer Interface Board

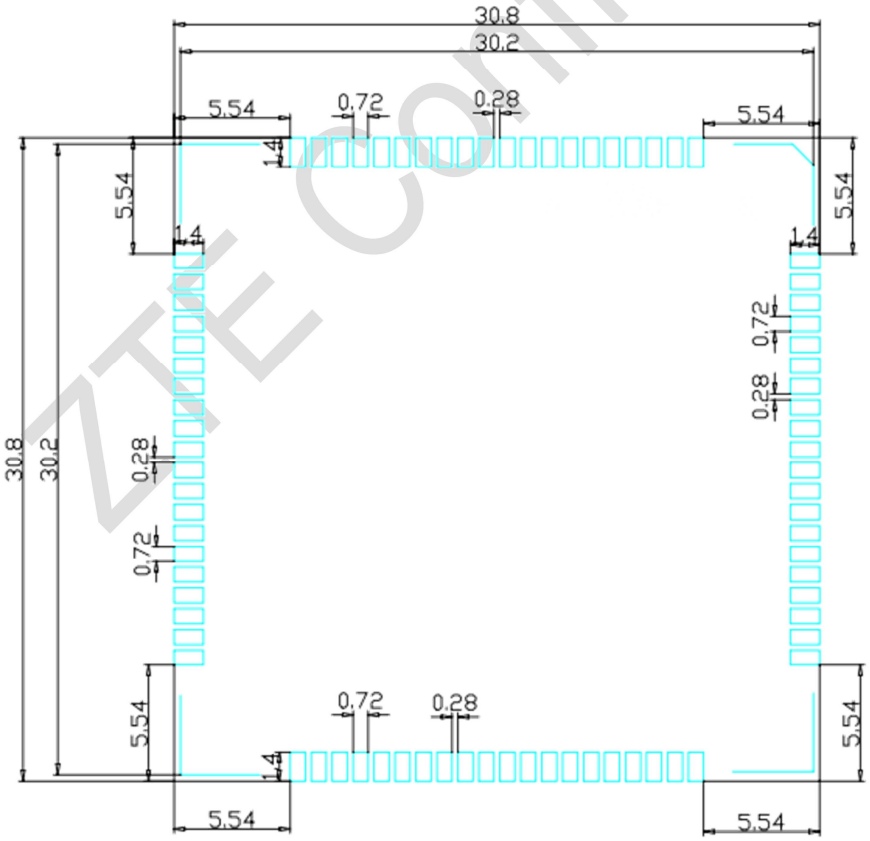
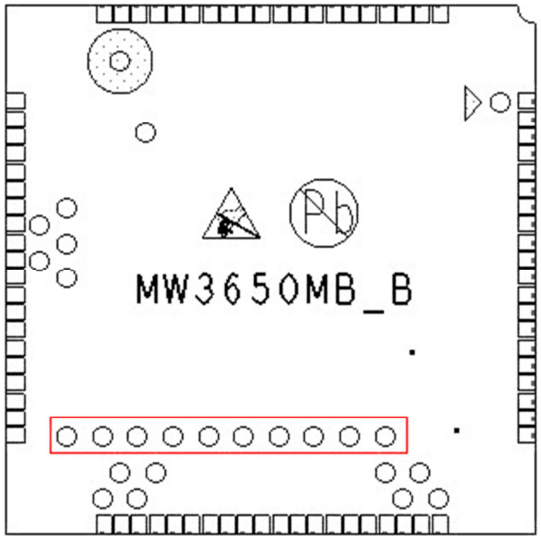


Figure 3-5 PCB Bottom Welding Panel



3.4 PCB Design Guidelines

To ensure the module has good performance in the application process, the users of modules should do as the following guidelines in the process of PCB wire designing:

1) For testing and maintenance convenience, the customer dev board PCB should be hollowed out to show the test pionts as is shown in the red box in figure 3-5 so as to do JTAG installation and debugging.
2) The rest round test points are used for module power supply and calibration in SMT production process. Do not short out these test points when connect the module to main board.
3) In the design process, the strongly disturbing signals such as clock signal, high-frequency digital signal and switching signal of switch power supply should be placed far away from the module.
4) Please pay attention to the protection of RF and audio analog signal. If condition permits, it is better to separate the analog ground and digital ground. After the separation, the signal line or power line should not pass over the separation channel.
5) To ensure the integrity and circulation ability, if condition permits, it is better to adopt planar form.
6) Please ensure the integrity of the module ground to reduce the leak of disturbing signal.

3.5 Suggestions for Heat-dissipation Design

The module will dissipate heat during the working process, and might also be affected by other high-temperature devices. When do the heat-dissipation design, please pay attention to the following items:

1) Place this product far away from the switch power supply and high speed signal line, and protect the wiring of these interference sources.

2) Place the antenna and coaxial-cable connecting the network card and antenna far away from these interference sources.

3) Place the module far away from the devices that have high calorific power such as CPU and Southbridge to avoid the influencing the RF performance because of the temperature rise.

4 Interfaces

4.1 Definition of PINs

The definition of interface PINs on module is shown in figure 4-1.

Figure 4-1 PIN Configuration Diagram

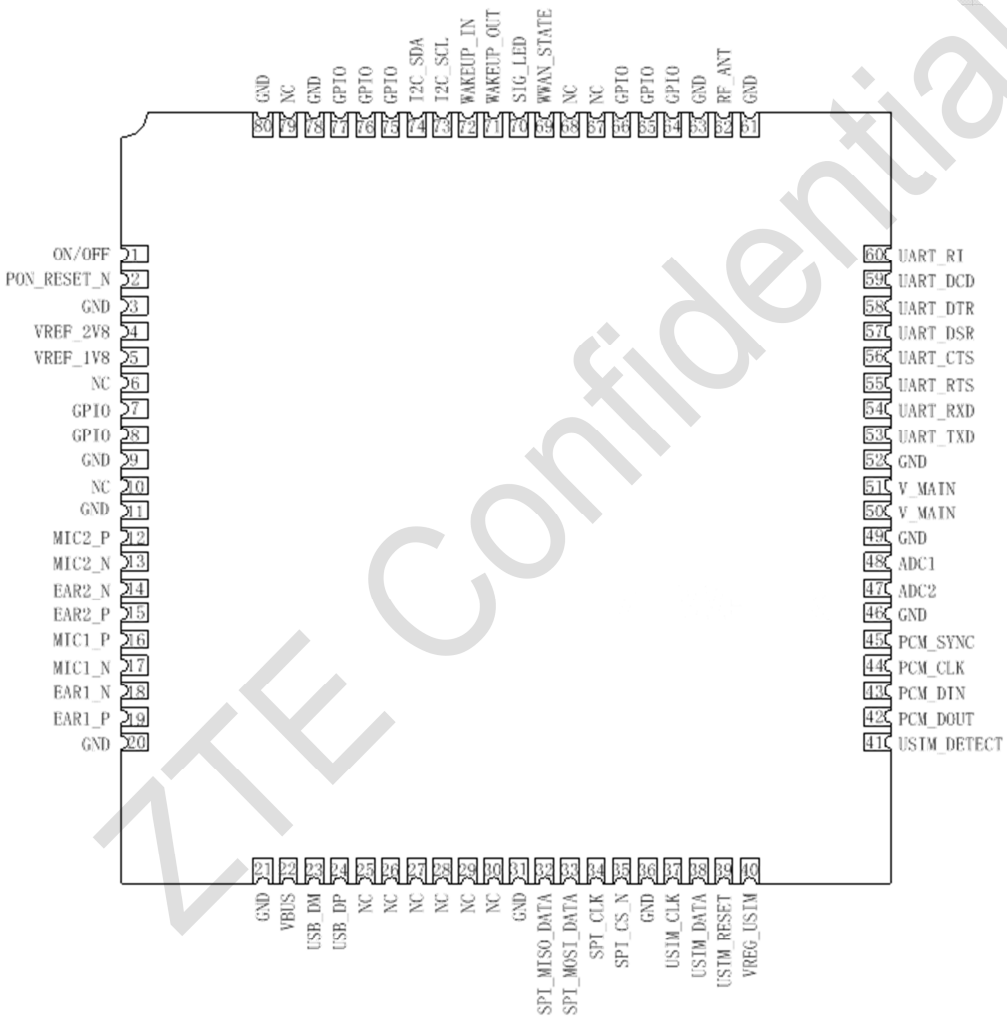


Table 4-1 PIN Interface Definition

PIN	Classification	Signal Definition	I/O	Description	Remark
1	POWER_ON	ON/OFF	I	Power on/off	Pull-up internally, low pulse active

PIN	Classification	Signal Definition	I/O	Description	Remark
2	RESET	PON_RESET_N	I	Reset signal	1.8V low level active
3		GND	--	GND	--
4		VREF_2V8	O	Voltage output	2.85V
5		VREF_1V8	O	Voltage output	1.8V
6		NC	--	--	--
7		GPIO	I/O	GPIO	--
8		GPIO	I/O	GPIO	--
9		GND	--	GND	--
10		NC	--	--	--
11		GND	--	GND	--
12	Reserved	Reserved	--	--	--
13		Reserved	--	--	--
14		Reserved	--	--	--
15		Reserved	--	--	--
16		Reserved	--	--	--
17		Reserved	--	--	--
18		Reserved	--	--	--
19		Reserved	--	--	--
20		GND	--	GND	--
21		GND	--	GND	--
22	USB	VBUS	I	USB power	5V
23		USB_DM	I/O	USB data-	--
24		USB_DP	I/O	USB data +	--
25		NC	--	--	--
26		NC	--	--	--
27		NC	--	--	--
28		NC	--	--	--
29		NC	--	--	--
30		NC	--	--	--
31		GND	--	GND	--
32	SPI	SPI_MISO_DATA	--	Main input, slave output	1.8V
33		SPI_MOSI_DATA	--	Main input, slave output	1.8V
34		SPI_CLK	I/O	SPI interface clock signal	1.8V
35		SPI_CS_N	I/O	SPI strobe signal	1.8V
36		GND	--	GND	--
37	USIM	USIM_CLK	O	USIM card clock line	1.8V/3.0V

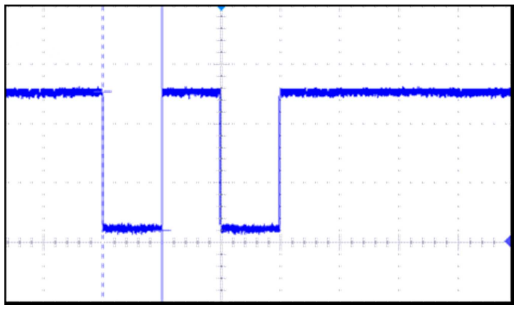
PIN	Classification	Signal Definition	I/O	Description	Remark
38		USIM_DATA	I/O	USIM card data line	1.8V/3.0V
39		USIM_RST	O	USIM card reset signal	1.8V/3.0V
40		VREG_USIM	O	USIM 1.8/3V power supply	1.8V/3.0V
41		USIM_DETECT	I	USIM card detect signal	1.8V
42	Reserved	Reserved	--	--	--
43		Reserved	--	--	--
44		Reserved	--	--	--
45		Reserved	--	--	--
46		GND	--	GND	--
47	ADC	ADC2	I	ADC	0-VCC
48		ADC1	I	ADC	0-VCC
49		GND	--	GND	--
50		V_MAIN	I	Module main power supply	3.3V-4.2V
51		V_MAIN	I	Module main power supply	3.3V-4.2V
52		GND	--	GND	--
53	UART	UART_TXD	O	UART Transmit Data	DTE receive serial data
54		UART_RXD	I	UART Receive Data	DTE transmit serial data
55		UART_RTS	O	Ready for sending	DCE Request to send
56		UART_CTS	I	Ready for receiving	--
57		UART_DSR	O	UART DCE get ready	DCE get ready
58		UART_DTR	I	UART DTE get ready	DTE get ready
59		UART_DCD	O	UART Carrier detects	
60		UART_RI	O	UART Ring Indicator	Notify DTE the remote call
61		GND	--	GND	--
62	ANT	RF_ANT	I/O	Antenna interface	--
63		GND	--	GND	--
64		GPIO	I/O	GPIO	--

PIN	Classification	Signal Definition	I/O	Description	Remark
65		GPIO	I/O	GPIO	--
66		GPIO	I/O	GPIO	--
67		NC	--	--	--
68		NC	--	--	--
69		WWAN_STATE	O	Network status index signal	
70		SIG_LED	O	Module status indicator light	1. Power-on status: indicator light off; 2. network searching status: indicator light flickers with the frequency of 3Hz; 3.Standyby status: indicator light flickers with the frequency of 1Hz; 4.Service status: indicator light flickers with the frequency of 5Hz.
71		WAKEUP_OUT	O	output wakeup signal	--
72		WAKEUP_IN	I	Input wakeup signal	--
73	I2C	I2C_SCL	I	I2C clock line	1.8V
74		I2C_SDA	I/O	I2C data line	1.8V
75		GPIO	I/O	GPIO	--
76		GPIO	I/O	GPIO	--
77		GPIO	I/O	GPIO	--
78		GND	--	GND	--
79		NC	--	--	--
80		GND	--	GND	--

NOTE:

WAKEUP is USB wake-up PIN in default. If the main controller needs to be waked up after a trigger event (such as SMS arrive) happens, a “low-high-low” PWL change is generated and each state lasts 1s. Then the level of this pin changes to high level. Then main controller needs to issues USB wake-up command to wake up the module.

Figure 4-2 Wakeup Waveform



4.2 Hardware interface description

The interfaces and peripheral circuit should be designed reasonably in the process of hardware development. The interface voltages of peripheral circuit must match with voltages of product pins., otherwise the performance may be influenced or the module cannot work normally or even be damaged.

This section mainly describes related interfaces of the module including interface logic function, interface description, design example and match circuit. According to the interfaces description in this section, customers can make secondary developments about embedded system and consumer electronics.

Interfaces of MW3650 module includes as following aspects.

- UART interface
- (U)SIM card (compatible with 1.8V/3.0V)
- USB2.0 full-speed interface
- External power supply
- Power on/off and RESET control
- I2C interface
- SPI interface
- ADC
- Module status indicator

4.3 Ground

GND is the Ground signal of this product, and needs to be well connected to the ground on system board. If the GND signal is not connected completely, the performance of module will be affected. Well ground handing is important to module performance guarantee such as guaranteeing signal integrity, improving RF performance, reducing EMI interference and heat dissipation.

In module ground handing process:

1. The module ground welding panel should have full access to mainboard welding panel;
2. All GND pins must be accessed to ground panel with shortest ground wire. All GND pins should be connected together effectively using plenty of vias;
3. For RF signal, please pay attention to the resistance wire structure (micro strip line, strip line) and ensure the integrity of reference ground;
4. It is wise to surround (on both sides) the PCB transmission line such as audio and clock signal with Ground, and isolate the interference source from sensitive source;
5. Line geometry should have uniform characteristics, constant cross section, avoid meanders and abrupt curves.

4.4 Power Interface

4.4.1 V_MAIN PINS

According to the definition, power supply pins of module are described as V_MAIN signal group including pin50&51. Power supply pins V_MAIN are positive poles and input signals.

When design the external circuit, firstly, ensure external power supply circuit has sufficient power supply ability and the power voltage range is strictly controlled between 3.4V and 4.2V (typical value 3.8V). If the voltage is higher than the voltage range, the main chip will be damaged while if the voltage is lower than the voltage range, the working of RF circuit will be influenced or shutdown/restart phenomenon will happen.

When the network signal is weak, RF transmit power and module transient current will increase and transient peak current value will reach about 2A. So when design the power supply circuit, choose DC/DC

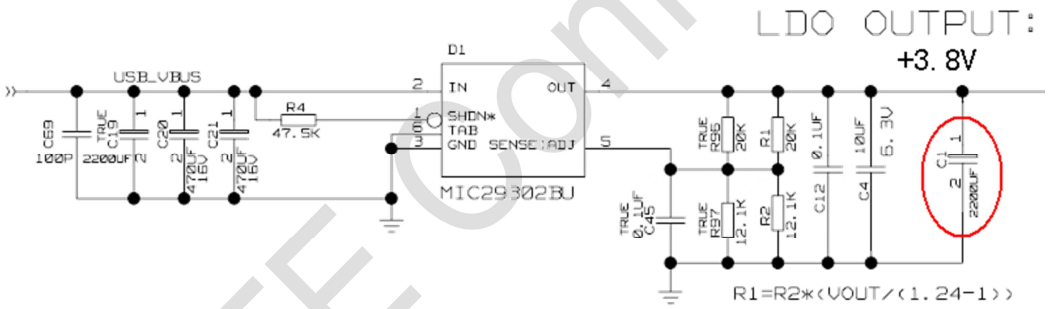
or LDO of that lager than 2A. In addition, considering that the transient current needed by high-power transmit is large under GSM model, so in the circuit design process, please add a large capability (lager than 470uF) in the output of DC/DC or LDO to avoid voltage decline abruptly. Sufficient line width of power line on system board should be guaranteed, and at the same time, the power line should form a well circumfluence with ground panel. Moreover, in the power supply circuit design process, large capacitance at kilo uF level should be added to guarantee the transient power supply ability. It is recommended that on system side DC/DC power supply is adopted and power ripple is controlled within 100mV.

Table 4-2 Voltage Current Characteristic

Type	Minimum value	Typical value	Maximum value (transient)
Input voltage	3.3 V	3.8 V	4.2 V

As is shown in the following figure, using LDO power supply circuit as a reference, over-current capability of LDO needs to be above 3A. As the poor transient response of linear regulator, large capacitors should be placed at the input and output of LDO to avoid resetting or power off resulted from that too large voltage fluctuation in high-power transmitting process under GSM mode. The reference power supply circuit design with LDO is as shown in Figure below.

Figure 4-3 LDO Power Supply



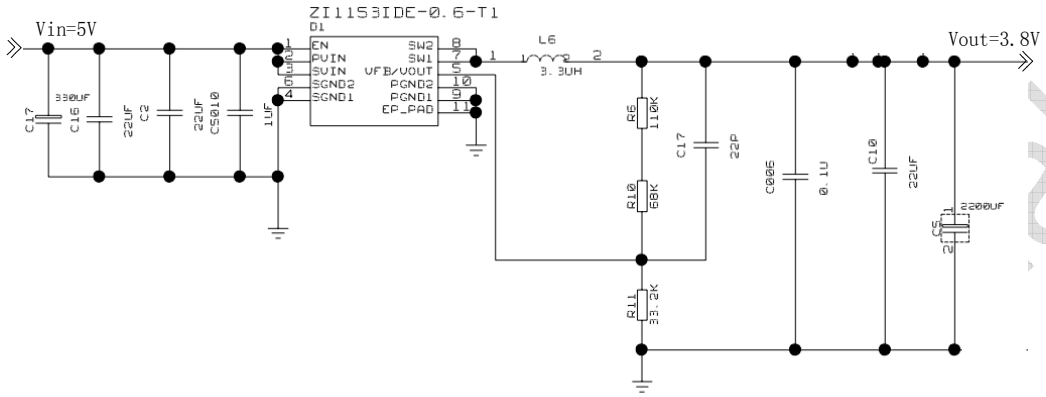
As is shown in the following figure, use DC/DC switch power and large capacitors (lager than 1000uF) to ensure the normal working of RF PA (power amplifier) and sufficient transient current under GSM Burst mode.

The advantage of this reference design is that it can provide well transient current under 2G weak signal environment to satisfy modules requirements, to prevent device shutdown and Ports re-enumeration as a consequence of the supply voltage drop.

The over-current ability of DC/DC switch power should be larger than 3A such as ZI1153, AAT2138 and so on. The input voltage range of ZI1153 is 2.5V~5.5V and the output voltage range is 0.6V to VIN (input). The input voltage range is 2.7V~5.5V and the output voltage range is 3.3V~5.5V.

As shown in the Figure below, use DC/DC switching power supply ZI1153 as the buck chip. Place a tantalum capacitor of 330UF at the input of the chip. Place a 2200UF capacitor or place several 330UF tantalum capacitors in parallel. This circuit fully meets the module power requirements. (If the user's PCB size is limited, the output of buck chip can place three more 330UF tantalum capacitors of which the total capacity is more than 1000uF)

Figure 4-4 DC/DC Switching Power Supply



4.4.2 VREF PINS

MW3650 module has 2 power output pins used to supply power for external circuit on the mainboard. The voltages of these pins and the voltages of baseband processor and storage come from the same internal voltage regulator. They output voltage only when the module is powered on. The normal output voltage is PIN5 (VREF_1V8,1.8V) and PIN4(VREF_2V8,2.85V). Users should draw current as less as possible from these pins. Generally, users are suggested that these power pins are only used for pulling up chip pins in level matching process.

4.4.3 PCB Layout Guideline of Power Supply

When design the power supply of module, the layout and wiring of related components in power supply part is very important. If they are not designed appropriately, it will have effects on many aspects, such as the EMC performance , the transmission modulation spectrum, receive sensitivity and so on.

The users of Modules should do as the following guidelines in the process of power supply PCB line designing:

The use of a good common ground plane is suggested.

Because the power switch has strong EMC interference, place the circuit lines far away from antenna.

Considering the module power supply requirements, the PCB traces from the input connector to the power regulator IC must be wide enough to ensure no voltage drops occur when the 2A current peaks are absorbed. The recommended power wiring width is more than 100mil.

The wiring of power supply should be far away from the circuit which is sensitive for noise such as microphone/earphone, RF cable and so on.

The PCB wiring between module and bypass capacitor should be wide enough and as short as possible to ensure there is no significant voltage decline abruptly when the current is peak 2A.

4.5 Power-on/Power-off & Reset

4.5.1 Power On

After the module been normally electrified, it is in power-off status.

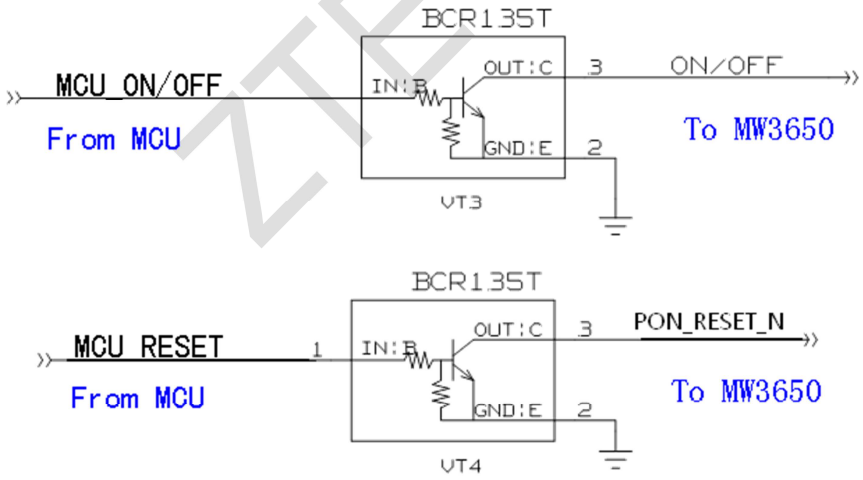
To turn on the module, the ON/OFF pin must be tied low for at least 3 seconds and then released.

4.5.2 Power Off

To turn off the module the ON/OFF pin must be tied low for at least 3 seconds and then released.

The power on/off part circuit reference design is shown in the following figure.

Figure 4-5 Power On & Reseting Circuit Reference Diagram



4.5.3 Reset

You can reset the module by driving the PON_RESET_N to a low level voltage for more than 100ms and then releasing. After resetting, the module will shut down first and then enter power-on status automatically.

- Other advises

To ensure that the data of module is well saved a, please do not cut off the module power during the module runtime. It is strongly recommended that use AT command (+ZPWROFF) to shut down the module in application.

The PON_RESET_N and ON/OFF signals are sensitive. When designing a circuit on the PCB of the main board, it is recommended that the circuit length not exceed 20 mm and the circuit be kept at a distance of 2.54 mm (100 mil) at least from the PCB edge. Furthermore, you need to surround (on both sides) the signals with Ground. Otherwise, the module may be reset due to interference.

4.5.4 Power-on/Power-off Flow

To guarantee the user can power on and power off stably, you can refer to the power-on sequence chart as shown in Figure 4-6 and the power-off sequence chart as shown in Figure 4-7. Table 4-3 shows the power-on and power-off time. During the process of power on the module, pay attention to the following items:

1) The power on time that the module supplies to external interfaces cannot be earlier than the module power on time.

2) Once the V_MAIN is powered on, the ON/OFF signal will be synchronized and established as the high PWL.

3) The time interval between the V_MAIN is electrified normally and ON/OFF signal is valid could not be too short. For details see T2 parameter. It is recommended not to disconnect the power supply after V_MAIN is powered off.

4) The failing edge of ON/OFF is the start of power-on time. ON/OFF should be released after being kept at low PWL for a period of time.

5) VBUS supplies power for USB PHY. It is not recommended to connect VBUS to power supply before V_MAIN.

During the process of power-off, pay attention to the following items:

1) To power off by the ON/OFF signal, the T4 period needs to be designed as required.

2) After VPH_PWR and USB_VBUS are powered off, it is recommended not to disconnect the power supply.

Figure 4-6 Power-on Sequence Chart of Module

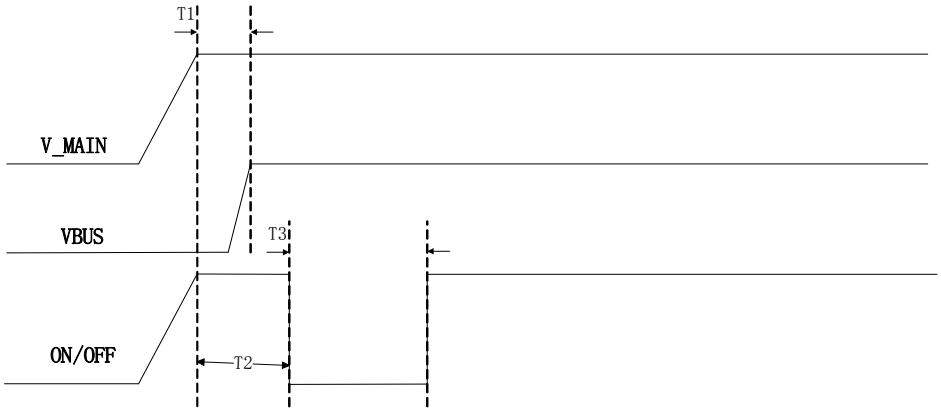


Figure 4-7 Power-off Sequence Chart of Module

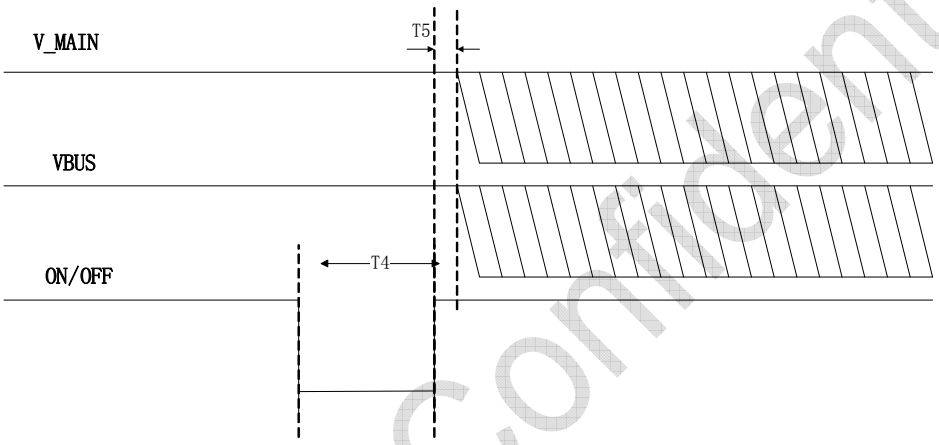


Table 4-3 Power-on/Power-off Time

Parameter	Description	Min	Typical	Max	Unit
T1	The time from power-on issue to VBUS ready	0	0.5	1	second
T2	From powering on V_MAIN to ON/OFF ready	1	1.5	--	second
T3	The time of active low level impulse of ON/OFF pin to power on module	--	3	--	second
T4	The time of active low level impulse of ON/OFF pin to power off module	--	3	--	second
T5	The time from power-off issue to V_MAIN and VBUS off	1	2	--	second

4.6 UART Interface

The module provides a series of UART interfaces. The highest speed is 230.4Kbps and the typical speed is 115.2Kbps. The external interface PWL is 1.8V CMOS PWL signal used for UART communication.

The definition and interface mode of UART are shown as followed.

Table 4-4 The Definition of UART Signal

PIN No.	Type	Definition	I/O	Description
53	UART(1.8V)	UART_TXD	O	UART Send
54		UART_RXD	I	UART Receive
55		UART_RTS	O	Send get ready
56		UART_CTS	I	Receive get ready
57		UART_DSR	O	Data equipment get ready
58		UART_DTR	I	Data terminal get ready
59		UART_DCD	O	Data carrier wave detect
60		UART_RI	O	Ring indication

NOTE:

1) When the module communicates with PC or MCU trough UART, please pay attention to the direction of TX and RX. TX and RX is named in the reference direction of module.

2) The sleep of UART is realized through UART_DTR pin. When the module needs sleep, please set this pin as high PWL while when the module needs to be waked-up, please set this pin as low PWL.

3) When there is SMS, the RI pin will generate low PWL interrupt.

4) MW3650 UART interface supports 1.8V voltage, so the external UART interface which is not 1.8V needs PWL conversion. As is shown in the following figure, audion can be used to realize the PWL conversion. The resistance is only an example in the figure. Please recount it during designing. The diode in the figure is Schottky diode (whose forward voltage drop is 0.3V). If other diodes are chosen, please choose the one whose forward voltage drop is small to ensure the PWL of RXD_1V8 is below the low PWL input threshold when the low PWL is input.

Figure 4-8 UART Interface PWL Conversion Reference Design

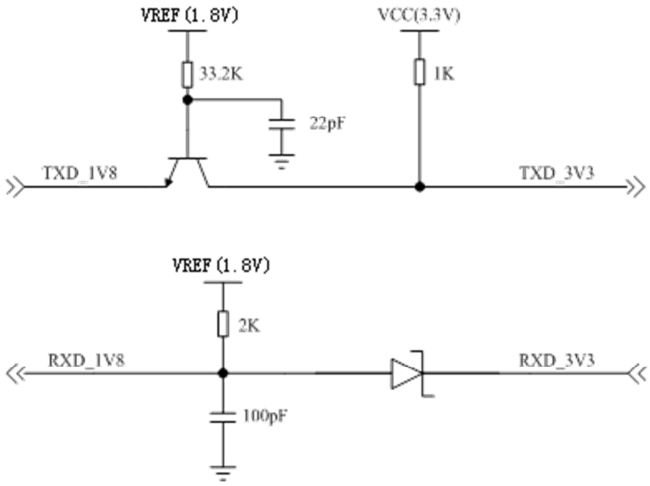
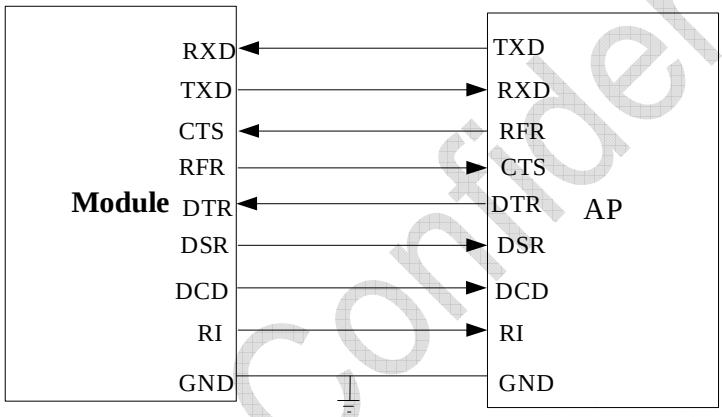
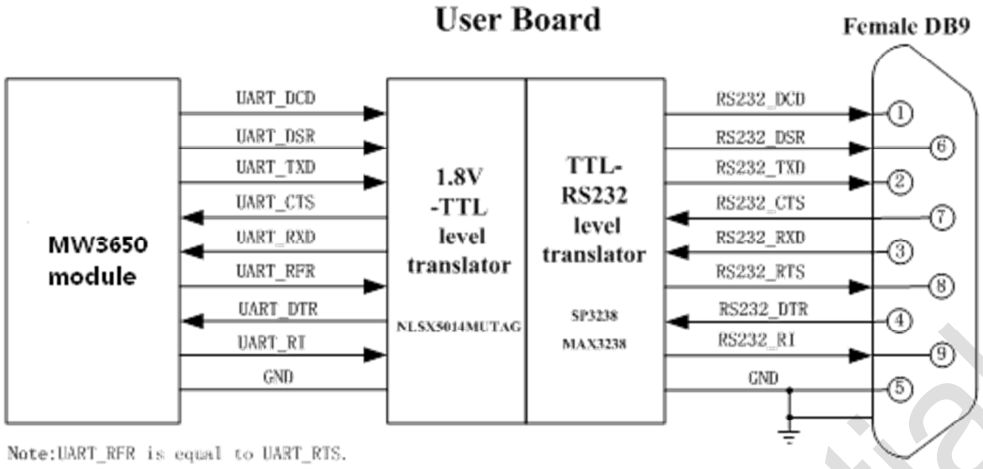


Figure 4-9 Module Serial Port & AP Application Processor



To catch LOG during the software debugging process, it is recommended for users to keep this interface and reserve testing points. If the module is connected with the application processor whose PWL is 1.8V, the connection way is as shown in figure 4-9. 8-line or 2-line connection way can be adopted. The PWL of module interface is 1.8V. If it does not match with the AP interface, the PWL switching circuit is suggested to be added. MW3650 module can connected with standard RS-232-C interface through chips of 232 type. If the design is related to the interconverting between TTL PWL and EIA PWL, the NLSX5014MUTAG chip is recommended to be used. For example, when 2-line UART is used, the MAX3232 chip is recommended and when 8-line UART is used, SP3238 or MAX3238 chip is recommended to design the interface. The connection way is shown in the following figure.

Figure 4-10 The Connection of UART and Standard RS-232-C Interface



The module support standard 8-wire UART interfaces and transfer digital signals, please isolate them from sensitive signals to avoid influencing other analog signal and RF signal.

4.7 (U)SIM Card Interface

Module baseband processor integrates the (U)SIM card interface to compliance with ISO 7816-3 standards, and supports 3.0V/1.8V (U)SIM cards. The signals on SIM card interface is as shown in Table below.

Table 4-5 The Definition of USIM Card Interface

PIN No.	Type	Definition	I/O	Description
37	USIM	USIM_CLK	O	USIM card clock line
38		USIM_DATA	I/O	USIM card data line
39		USIM_RST	O	USIM card reset signal
40		VREG_USIM	O	USIM 1.8/3V power supply

Notes about designing SIM card:

1) Because the typical speed of (U)SIM card interface is about 3.25MHz, it is recommended to place (U)SIM card console close to the (U)SIM card interface, to prevent the wiring from being too long (the wiring is recommended not to be longer than 100mm) to influence the normal communication of (U)SIM signal.

2) The wiring of SIM card signal wire should be placed far away from RF wire and V_MAIN power supply line.

3) The GND of SIM card console wiring and the module GND wiring should be short and thick, meanwhile the electric potential of them should be the same. The line width of SIM_VDD and GND should be ensured not less

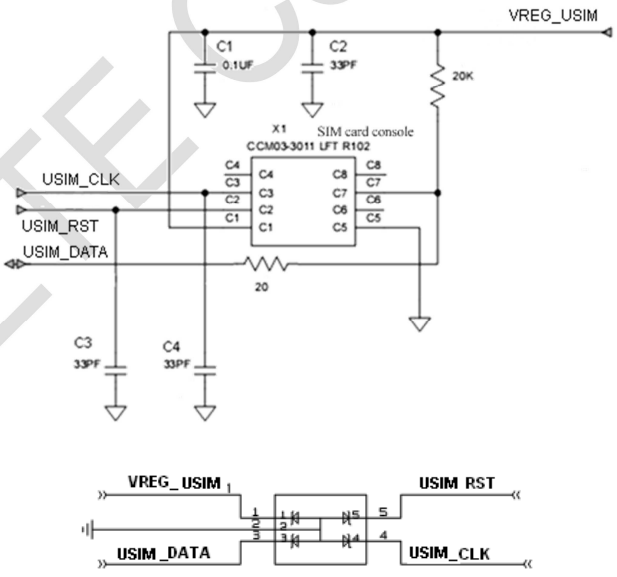
than 0.5mm. The bypass circuit between VREG_USIM and SIM_GND should not be bigger than 1uF, and be placed near the SIM card console.

4) To avoid the potential interference between USIM_CLK and USIM_DATA signal, please do not place the wiring of them too near, and USIM_CLK and USIM_DATA signal need to be surrounded by Ground. USIM_RST signal also needs ground protection. Add a 0.1uF or 0.22uF capacitance of 0402 encapsulation on VREG_USIM, and cascade a 0Ω resistance and parallel a 33pF capacitance with USIM_CLK, USIM_DATA and USIM_RST for the convenience of matching of latter electrical performance and to avoid the interference because of too long wiring. Besides, USIM_DATA signal should be pulled up to VREG_USIM. The pull-up resistor value is about 10K to avoid the identification problem of SIM card.

5) Besides, these four signal wires should parallel TVS to avoid electrostatic discharge. The recommended reference design circuit of ESD protection of wireless module SIM card interface is shown in the following figure.

6) The wiring related to (U)SIM card need to be put together. The wiring width of VREG_USIM is related to its length. The recommended value is 10 mil wiring width. The wiring of (U)SIM card can refer the wiring of BUS. Please pay attention to the wiring protection to avoid the interference of high-speed signal and strong reference signal of clock to (U)SIM card signal. Otherwise the restart of (U)SIM card may be caused. The ESD protection components of (U)SIM card should be placed near (U)SIM card console to avoid the electrostatic interference to module.

Figure 4-11 (U)SIM Card Console Circuit Reference Design



4.8 USB Interface

MW3650 module has the high-speed USB2.0 interface. It is connected to the system board side by LCC interface, which is the path for communication between the processor on the system board side and module of which the pins are PIN23(USB_DM) and PIN24(USB_DP). The definition of USB pins is shown in table 4-6.

Table 4-6 The Definition of USB PINS

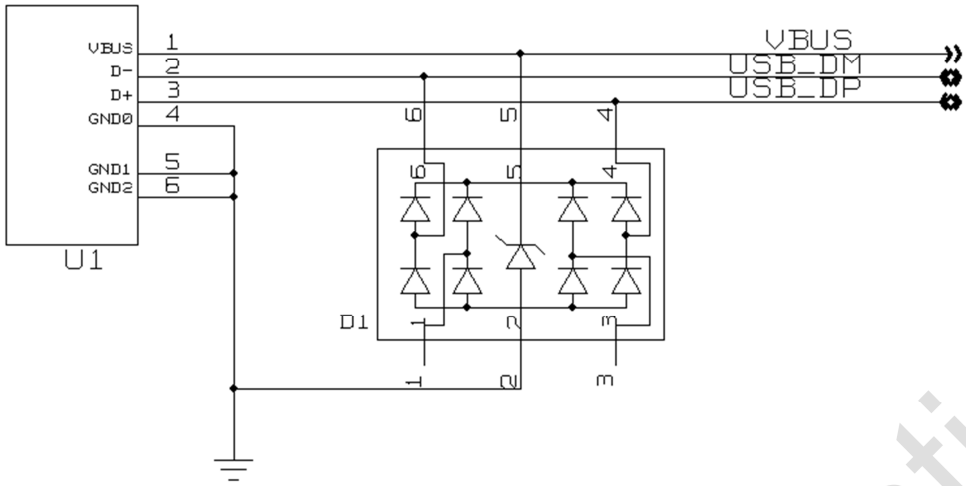
PIN NO.	Type	Definition	I/O	Description	Remark
22	USB	VBUS	I	USB power	5V
23		USB_DM	I/O	USB data-	--
24		USB_DP	I/O	USB data+	--

VBUS is the module USB power supply pin. The working current of USB is 4.75V~5.25V and typical value is 5V.This power supply can supply the module with 3.8V voltage after transition by the power supply circuit mentioned in the previous section. USB_DM/USB_DP is differential data line. During PCB wiring, it should meets the requirements of differential line and surrounded by Ground. If it is too close to antenna, to avoid the influence of antenna radiation, high-speed common mode suppression filter can be concatenated on the USB differential signal wiring circuit.

USB interface needs to add TVS components to avoid damage of module components because of static electricity. The load capacitance value of TVS should be less than 3pF, to satisfy the transmission of USB2.0 high-speed signal. In the following figure, D1 is USB2.0 anti-static protective components.

Meanwhile, USB_VBUS pin is vulnerable to voltage shock which can damage the pin. It is recommended to adopt appropriate OVP measure to avid the voltage higher than 5.25V. Besides, the power-off leakage current exists on USB_VBUS. It is suggested to add power switch on power supply branch circuit or cascade a resistance with the resistance value between 200kΩ and 400kΩ to reduce the leakage current when the module is powered off but does not cut off the power.

Figure 4-12 USB Interface Circuit Reference Design Schematic Diagram



Usually, USB interface of module can be enumerated to several ports, such as AT port, DIAG port, Modem port and so on. These ports are enumerated in order during the load process. For example, during the load process of module under Linux system, if the enumeration of DIAG port is ttyUSB0, the ports maps on PC are shown in the following table.

Table 4-7 The Correspondence of Port Map

Module	VID&PID	Dial-up port	AT Command Port	DIAG Port	Audio Port
		USB Modem	Service Port	Diagnostics Port	Voice Port
MW3650	VID_19D2&PID_FFEB	Windows: 03 /Linux: ttyUSB3	Windows: 02 /Linux: ttyUSB2	Windows: 00 /Linux: ttyUSB0	Windows: 01 /Linux: ttyUSB1

USB Modem port, bearing AT commands, is mainly used for initiating data business.

Service Port, bearing AT commands, is mainly used for AT command operation when MODEM port is occupied by data business.

Diagnostics Port, bearing DIAG task, can be connected to the tool for catching LOG or updating to catch software LOG information or update the firmware.

4.9 Working Status Indicator Interface

The SIG_LED pin is constant current output interface whose current driver capability is 20mA. It is connected with LED to indicate the working status of module.

The indicator light reference design is shown in the following figure. The luminance of LED can be regulated by the value of resistance. The indicator status of network is as defined in table below

Table 4-8 Indicator Light Reference Design Schematic Diagram

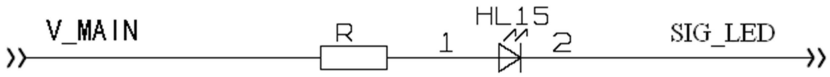


Table 4-9 The Description of Working Status Indicator Light

Module status	Indicator light status	Frequency
Power-on status	Indicator light off	
Network searching status	Standard flicker	3Hz
Free status	Slow flicker	1Hz
Data business status	Fast flicker	5Hz

4.10 SPI Bus Interface

The SPI interface signal definition of this product is shown in the following table.

Table 4-10 The Definition of SPI Interface

PIN NO.	Type	Definition	I/O	Description
32	SPI	SPI_MISO_DATA	--	Main input, slave output
33		SPI_MOSI_DATA	--	Main output, slave input
34		SPI_CLK	I/O	SPI interface clock signal
35		SPI_CS_N	I/O	SPI gating signal

SPI interface electric features:

The SPI bus of this product is configured as the main equipment, which has three modes:

Running mode—basic running mode;

Waiting mode— The waiting mode of SPI is a configurable low-power mode, enabled by the byte of the control registered. In the waiting mode, if the waiting byte is cleared, SPI works under the similar running mode. However, if SPI waits for the position byte, SPI clock stops and enters the low-power status.

Stop mode—Under the stop mode, SPI is not available, so the power consumption is reduced. If SPI is configured as the master equipment, any transmission process will be stopped, but it can enter the running mode when the waiting mode stops.

4.11 I2C Bus

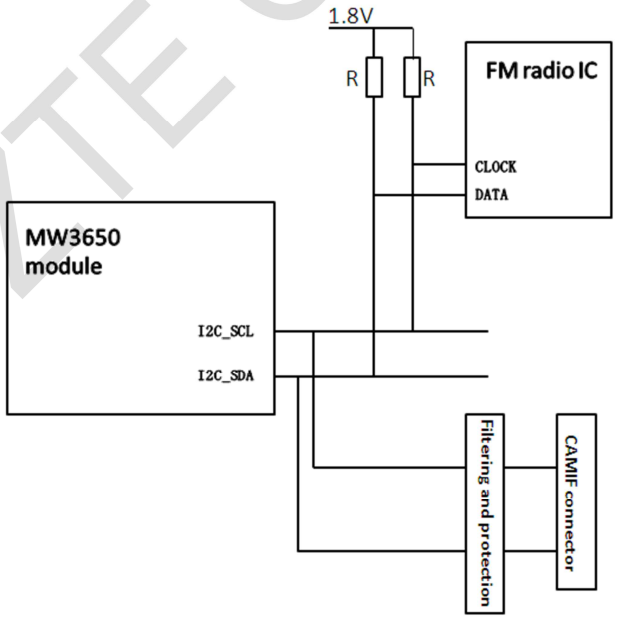
I2C is the two-wire bus for the communication between ICs, which supports any IC process (NMOS, CMOS, dual-polarity). The two signal wires, serial data (I2C_SDA) and serial clock (I2C_SCL), can transmit information between the connected equipment. Each equipment is identified by the unique address (such as the micro controller, storage, LCD driver or keyboard interface). Due to the different functions of the equipment, it can be used as both the sender and the receiver.

The I2C interface has the following electric features:

1) The two-wire bus is used for the communication between chips.
2) It supports any external equipment of any manufacturing technology (1.8V).
3) It supports the external functions, such as the image sensor, micro controller, LCD driver and keyboard interface.

The I2C interface has two working modes with different transmission ratios: standard mode with a speed as high as 100kbps; high-speed mode with a speed as high as 400kbps. Figure 4-11 is the I2C reference circuit design diagram.

Table 4-11 I2C Reference Circuit Design



4.12 User Interface

AT commands are mainly used for communication between users and the module. AT commands comply with ITU-T V.250, 3GPP 27.007 and 3GPP 27.005 standards. Moreover, the module also supports ZETWelink expanding AT commands.

5 Antenna

5.1 Preliminary Antenna Evaluation

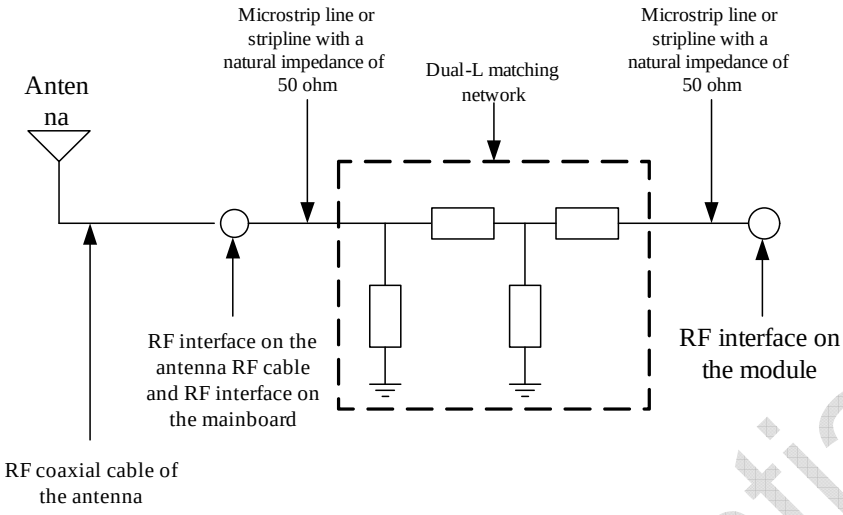
The antenna is a sensitive device and its performance is greatly affected by external environments. The radiation performance of the antenna is affected by the mainboard dimensions, antenna position, occupied space size of the antenna, and the grounding of surrounding components of the antenna. Besides, the fixed assembly of the antenna, the wiring of RF cables on the antenna, and the fixed position of the antenna all are related to the problem whether the antenna exists the interference problem with structure. Thus, during the preliminary design phase of an antenna, it is critical that antenna engineers, RF engineers, baseband engineers, structure engineers, and ID engineers work together to make estimation for both 2D and 3D design.

5.2 Antenna Design Guidance

Well shielding measure should be added between external antenna and RF PAD of module, and external cables should be far away from all interference source, especially high-speed digital signal, DC/DC power and so on.

According to mobile equipment standard, the standing-wave ratio of antenna the module uses should be between 1.1 and 1.5. Input resistance is 50Ω. Under different environments, the requirements of antenna gain are different. Usually, antenna performance is better if intraband gain is larger and out-of-band gain is smaller. When using the multi-ports antenna, the isolation between the ports should be larger than 30dB. For example, the isolations between the two different polarization ports on polarization antenna, the two different frequency ports on dual-frequency antenna and the four ports on dual-frequency dual-polarization antenna should be larger than 30dB.

Figure 5-1 Translation Circuit Diagram



PIN62 is antenna pin. The following items should be noticed when this pin is used an antenna feed pin.

1) The feed cable connected with PIN 62 is microstrip line or strip line with resistance value of 50Ω. Near the module, π-shaped or inverted-F-shaped matching network should be added for latter tuning.

2) The RF wiring should be kept certain distance with GND. Usually the distance is 3 times the line width of RF wiring.

3) Do not pile the interference sources near the RF wiring or RF ports, such as DCDC, WIFI module and so on.

5.3 Suggested Antenna Location

Mainboard area has serious interference. The experiments result shows that the module performance will be poor If the module is placed in these interference regions. During the laptop design, it is better to separate the module from the mainboard PCB, instead of installing the module on the mainboard. If they cannot be separated, the module should be far from modules and components that might generate EMI, such as chip and memory, power interface, and data cable interface.

For Internet laptops products, the ideal position of antennas is on the top left corner or top right corner of the LCD, which is relatively far from the mainboard, so the electromagnetic interference is relatively small. Besides, because it is far from human bodies, it is easy to satisfy SAR indexes. The other choice is on the left or right of LCD. Other products such as router, e-book and so on should be evaluated specifically according to the features of product itself.

Because different antenna manufacturers may adopt different antenna modes and different terminal products have different external dimension and different requirements for antenna performance, the reserved spaces as well as antenna dimension and location are all different. Take the 3G internet laptops as an example, the recommended antenna space dimension is larger than 7mm*10mm*100mm, and it is recommended to place the antenna at the top of LCD screen.

5.4 RF PCB wire guidelines

The RF wiring of antenna should be kept as short as possible. It is suggested to choose thicker RF cables considering the transmission consumption. Meanwhile, RF cables should be far away from modules and components that might generate EMI, such as chip and memory, power interface, and data cable interface. The RF wiring connecting the antenna and 3G module should not be right angle, squeezing and abraded.

Keep, if possible, at least one layer of the PCB used only for the Ground plane; If possible, use this layer as reference Ground plane for the transmission line;

5.5 EMC Requirements

Electronic communications have more EMC requirements than non-communication products. It is very important that baseband engineer, RF engineer and antenna engineer must fully communicate during the design process of circuit and wiring to reduce the electromagnetic interference of produces. The following items are common problems and solutions that can be referred during the product design process.

1) During the product design, it is better to separate the module from the mainboard PCB, instead of installing the module on the ground of the mainboard. If they cannot be separated, the module should be far from modules and components that might generate EMI, such as chip and memory, power interface, and data cable interface.

2) Because the mainboard of PAD, CPE, and Internet laptops does not have a shielding cover, as that of mobile terminals, to shield most circuits to avoid overflow of electromagnetic interference, you can spray conductive paint on the surface on non-antenna areas within the structural components above and below the mainboard, and the conductive paint should be connected to the ground on the mainboard by several points to shield electromagnetic interference.

3) Besides, data cables of the LCD and the camera might introduce interference signals, which affect the receiving performance of the antenna. Thus, it is necessary to wrap conductive cloth around the two data cables and connected them to the ground.

4) RF cables of the antenna should be far from modules and components that might generate EMI, such as chip and memory, power interface, and data cable interface. The wiring of RF cables should be close to the ground of the mainboard.

5.6 Index Requirement of Antenna

Module supported electronic communications pay more and more attention to collect radiation performance test. At present there are two methods to investigate the radiation performance: one method is investigating the radiation performance of antenna which is a traditional antenna test method, i.e. passive test; the other method is testing the radiation power and receiving sensitivity in a specific microwave darkroom, i.e. active test.

The index requirement of antenna involves passive index requirement and active index requirement. Passive indexes include S11, antenna efficiency, antenna gain, antenna pattern and so on which can used as parameters weighing the performance of antenna itself. Active indexes usually mean OTA indexes, including TPR (all-round radiation power), TIS (all-round receiving sensitivity), radiation pattern and so on which are important indexes weighing the whole device (including antenna, module, circuit main board) radiation performance.

5.6.1 Passive Index of Antenna

Different products have different requirements about antenna performance. The following is the passive reference index about PAD products while the antenna radiation performance is weighed by the active index. The passive index requirements are only for the main antenna as is shown in table below.

Table 5-1 The Passive Index Reference of Main Antenna about PAD product

Frequency band	824-960MHz	1710-2170MHz
VSWR	<3.5:1	<3.5:1
Maximum gain	>0dBi	>0dBi
Average gain	>-3.5dBi	>-3.5dBi
Efficiency	>40%	>40%

It is recommended that the passive index reference of diversity antenna should be decided by the requirements of its performance. If it is required that the performance of diversity antenna is the same as the performance of main antenna, the requirement about passive index of diversity antenna is shown in table above. If it is required that the performance of diversity antenna reach half of performance of main antenna, see table below for passive index.

Table 5-2 The Passive Index Reference of Diversity Antenna about PAD product

Frequency band	824-960MHz	1710-2170MHz

VSWR	<3.5:1	<3.5:1
Maximum gain	>-3dBi	>-3dBi
Average gain	>-6.5dBi	>-6.5dBi
Efficiency	>20%	>20%

NOTE:

MW3650 module does not support diversity reception.

5.6.2 Active Index of Antenna

Active index is an important index weighing the radiation performance of whole device (including antenna, module and circuit main board), so the active index decides the final radiation performance of product. Because different products have different active index and different operators have different requirements about active index, it is suggested that antenna engineer, RF engineer, baseband engineer, structure engineer and ID engineer evaluate the performance the whole device can achieve according to the requirements customer provides about the product performance in the beginning of a project to decide the active index. For mobile terminal product, there is no international general standard. The standards are all customized according to the requirements of operator. Table 5-4 is the active index provided by our company for mobile terminal products for reference.

Table 5-3 Recommended Product OTA Index Requirement

Mode	Frequency band	TRP(dBm)	TIS(dBm)
		Free space	Free space
GSM	GSM850MHz	28	-104
	GSM900MHz	28	-104
	GSM1800MHz	26	-102
	GSM1900MHz	26	-102
WCDMA	Band I	19	-106
	Band II	19	-104.5
	Band V	19	-104.5
	Band VIII	19	-104.5

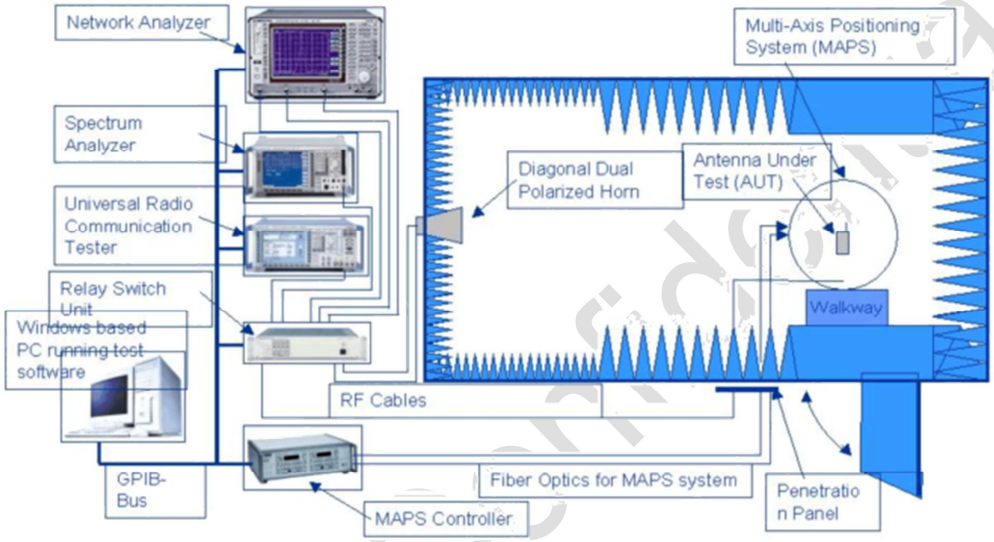
The active index reference of diversity antenna should be decided by the performance of diversity antenna.

5.6.3 OTA Test method of Whole Machine Antenna

Refer to the OTA test method of corresponding products in CTIA. Figure 5-6 is the structure of OTA test system in CTIA. This system mainly consists of darkroom, high-precision location system and its controller, RF test instrument and PC with automatic test program. The main RF instruments involve integrated testing instrument, frequency spectrograph and network analyzer.

The frequency spectrograph, swivel table controller and PC with automatic test program communicate with each other through GPIB interface.

Figure 5-2 OTA Test System



6 Electric Feature

This section mainly introduces the electric features of the module, including module interface PWL, power dissipation, reliability and so on.

6.1 Interface PWL

See table 6-1 for the main outward interface PWL of the module.

Table 6-1 Main Out ward Interface PWL of Module

Interface	PWL	Min	Typical	Max
UART	0	--	0	0.1*V_UART
	1	0.9*V_UART	V_UART	--
UIM	0	--	0	0.1*VREG_USIM
	1	0.9*VREG_USIM	VREG_USIM	--

V_UART is 1.8V, VREG_USIM is 1.8V or 3V. Please design according to the CMOS interface PWL.

6.2 Power Supply

The input voltage range of MODULE is DC 3.4V~4.2V, and the typical value is 3.8V as shown in Table6-2.

Table 6-2 Input Voltage

Parameter	Min	Typical	Max
Input voltage	3.3V	3.8V	4.2V

6.3 Working Current

The working current range of module is as shown in Table 6-3. The Sleep mode indicates the power consumption of the module in standby and sleep mode. The table also provides the working current range under GSM and WCDMA mode when there is data service.

Table 6-3 The Current Consumption under Sleep Mode

Mode	Frequency Band	Test value (mA)	Remark
WCDMA	Band I (IMT2100)	<5	Sleep mode
	Band II (PCS1900)	<5	
	BandV(850)	<5	
	BandVIII(900)	<5	
GSM	GSM1900	<5	
	GSM1800	<5	
	GSM900	<5	
	GSM850	<5	
Note:USB bus is fully suspended under this mode. In this mode, the module can also accept SM from the network. The power consumption is decreased to the lowest level. The above test value is the average current acquired under the maximum transmission power. Under different environments, the testing results might be slightly different. Take the actual situation as the reference.			

Table 6-4 The Working Current of MODULE

Mode	Frequency Band	Test value (mA)	Remark
UMTS	Band I (IMT2100)	540	The module in state of working.
	Band II (PCS1900)	530	
	BandV(850)	389	
	BandVIII(900)	537	
GSM/GPRS	GSM1900	226	The module in state of working.
	GSM1800	169	
	GSM900	239	
	GSM850	239	
Note: The above test value is the average current acquired under the maximum transmission power. Under different environments, the testing results might be slightly different. Take the actual situation as the reference.			

7 Technical Index of Radio Frequency

Test Environment:

Test instrument: Agilent 8960

Power supply: Agilent 66319D

RF cable length: About 15 cm

WCDMA 850 MHz/900 MHz compensation: 0.6dB

WCDMA 2100 MHz/1900 MHz compensation: 0.8dB

NOTE:

The compensation value is set by the frequency characteristic of corresponding RF cable. The compensation mode is related to the equipment.

7.1 Index of RF under UMTS Mode

The RF index should be tested strictly in accordance with the related testing specifications of 3GPP. The RF indexes of UMTS2100/1900/850/900 should satisfy the requirements of 3GPP TS 34.121 protocol.

7.1.1 Maximum Transmission Power

Maximum transmission power is another very important index to weigh the module performance. It is the maximum transmission power the module can transmit tested at the antenna port. Under the normal testing environment, the test value and reference value of the maximum transmission power of UMTS2100/1900/850/900 are shown in the table 7-1.

Table 7-1 Maximum Transmission Power

Operating Band	Level	3GPP Protocol Claim	Test value
UMTS850	Class 3	+24dBm +1/-3dBm	23.04
UMTS900	Class 3	+24dBm +1/-3dBm	23.04
UMTS1900	Class 3	+24dBm +1/-3dBm	22.89

UMTS2100	Class 3	+24dBm +1/-3dBm	22.45

7.1.2 Receiving Sensibility

The receiving sensitivity is a key parameter that indicates the weakest signal strength the module can receive and work well with it. At the same time the BER (Bit Error Rate) must meet the 3GPP TS 34.121protocol requirements in case of the minimum signal. The test value of UMTS2100/900 receiving sensibility is shown in the Table 7-2.

Table 7-2 Reference of Receiving Sensitivity

Operating Band	Unit	3GPP Protocol Claim	Test value
UMTS850	dBm/3.84 MHz	≤-103.7dBm	-109.9
UMTS900	dBm/3.84 MHz	≤-103.7dBm	-109.2
UMTS1900	dBm/3.84 MHz	≤-104.7dBm	-110.3
UMTS2100	dBm/3.84 MHz	≤-106.7dBm	-109.9

7.1.3 Spurious Emission Index

The spurious emission is the signals the transmitter transmits beyond the frequency band the spectrum emission mask describes. The spurious emission will interfere other wireless communication systems. The aims of meeting the spurious emission requirements are improving the electromagnetic compatibility performance of the system for better coexisting of other systems and ensuring the normal running of the system itself. The spurious emission index of UMTS2100/1900/850(900) should comply with the requirements in 3GPP TS 34.121 protocol, as illustrated below. And the test result of module in UMTS mode meets the requirement in Table 7-3.

Table 7-3 Spurious Emission Index

Frequency Band	Resolution Bandwidth	Minimum Requirement
9 kHz ≤ f < 150 kHz	1 kHz	-36 dBm
150 kHz ≤ f < 30 MHz	10 kHz	-36 dBm
30 MHz ≤ f < 1000 MHz	100 kHz	-36 dBm
1 GHz ≤ f < 12.75 GHz	1 MHz	-30 dBm

7.2 Index of RF under GPRS/GSM/EDGE Mode

The RF indexes of GSM/GPRS/EDGE 900/1800 should satisfy the requirements of 3GPP TS 05.05 protocol.

7.2.1 Maximum Transmission Power

Maximum transmission power is another very important index to weigh the module performance. It is the maximum transmission power the module can transmit tested at the antenna port. Under the normal testing environment, the test value and reference value of the maximum transmission power of GSM850/900/1800/1900 (GMSK/8PSK) are shown in the table 7-4.

Table 7-4 Maximum Transmission Power of GSM850/900/1800/1900 (GMSK/8PSK)

Frequency Band	Power Level	3GPP Protocol Claim	Test value
GSM850	Class 4	+33dBm±2dBm	32.61 dBm
GSM900	Class 4	+33dBm±2dBm	32.9 dBm
GSM1800	Class 1	+30dBm ±2dBm	30.08dBm
GSM1900	Class 1	+30dBm ±2dBm	29.55 dBm

7.2.2 Receiving Sensibility

The receiving sensitivity is a key parameter that indicates the weakest signal strength the module can receive and work well with it. At the same time the BER (Bit Error Rate) must meet the 3GPP TS 34.121protocol requirements in case of the minimum signal. The test value of GSM850/900/1800/1900 (GMSK/8PSK) receiving sensibility is shown in the Table 7-5.

Table 7-5 Receiving Sensitivity

Frequency Band	Unit	3GPP Protocol Claim	Test value
GSM850	dBm/3.84 MHz	≤-102dBm	-110.3dBm
GSM900	dBm/3.84 MHz	≤-102dBm	-110.2 dBm
GSM1800	dBm/3.84 MHz	≤-102dBm	-108.3dBm
GSM1900	dBm/3.84 MHz	≤-102dBm	-107.3 dBm

7.2.3 Spurious Emission Index

The spurious emission is the signals the transmitter transmits beyond the frequency band the spectrum emission mask describes. The spurious emission will interfere other wireless communication systems. The aims of meeting the spurious emission requirements are improving the electromagnetic compatibility performance of the system for better coexisting of other systems and ensuring the normal running of the system itself. The spurious emission index of GSM850/900/1800/1900 (GMSK/8PSK) should comply with the requirements in 3GPP TS 34.121 protocol. And the test result of module meets the requirement in following.

The test power should be less than -36dBM tested under the frequency band between 9kHz and 1GHz.

The test power should be less than -30dBm tested under the frequency between 1GHz and 12.75GHz.

8 Related Test & Test Standard

8.1 Testing Reference

The related tests of MODULE comply with the IEC standard, including the equipment running under high/low temperature, storage under high/low temperature, temperature shock and EMC. Table 8-1 is the list of testing standard, which includes the related testing standards for MODULE.

Table 8-1 Testing Standard

Test Standard	Document Reference
IEC6006826	Environmental testing-Part2.6:Test FC: Sinusoidal Vibration
IEC60068234	Basic environment testing procedures part2.
IEC60068264	Environmental testing-part2-64: Test FH: vibration， broadband random and guidance.
IEC60068214	Environmental testing-part 2-14: Test N:change of temperature.
IEC60068229	Basic environmental testing procedures-part2: Test EB and guidance.
IEC6006822	Environmental testing-part2-2:Test B:dry heat
IEC6006821	Environment testing-part2-1: Test A: cold.
GB/T 15844.2	MS telecommunication RF wireless phone-set environment requirement & experimental method – part 4: Strict level of experimental condition
GB/T 2423.11	Basic environment experiment of electronic products-Part2:Experiment method Try Fd: Broad frequency band random vibration (General requirement)
TIA/EIA 603 3.3.5	TIA Standard-part3-5:Shock Stability

NOTE:

1. IECL International Electro technical Commission;

2. GB/T: Recommended national standard.

8.2 Description of Testing Environment

The working temperature range of MODULE is divided into the normal working temperature range and the extreme working temperature range. Under the normal working temperature range, the testing result of RF complies with the requirements of 3GPP specifications, and its function is normal. Under the extreme temperature range, the RF index basically complies with the 3GPP specifications, and the quality of data communication is affected to a certain extent, but its normal function is not affected. MODULE has passed the EMC test. Table 8-2 is the requirement for the testing environment, and Table 8-3 lists out the instruments and devices that might be used during the test.

Table 8-2 Testing Environment

Working Condition	Min Temperature	Max Temperature	Remark
Normal working condition	-30°C	+75°C	All the indexes are good.
Extreme working condition	-40°C	+85°C	Some indexes become poorer.
Storage	-40°C	+85°C	Storage environment of module

Table 8-3 Testing Instrument & Device

Testing Item	Instrument & Device
RF test	Comprehensive testing device
	RF cable
	Tower antenna
	Panel antenna
High/Low-temperature running & storage test	High/Low-temperature experimental box
Temperature shock test	Temperature shock experimental box
Vibration test	Vibration console

8.3 Reliability Testing Environment

The reliability test includes the vibration test, high/low-temperature running, high/low-temperature storage and temperature shock experiment test. Refer to Table 8-4 for the specific parameters.

Table 8-4 Reliability Features

Test Item	Test Condition	Test Standard
Random vibration	Frequency range: 5-20Hz, PSD:1.0m2/s3 Frequency range: 20-200Hz, -3dB/oct 3 axis, 1 hour for each axis	IEC 68-2-6

Temperature shock	Low temperature: -40°C ±2°C High temperature: +90°C ±2°C Temperature changing period: less than 30s Test duration: 2 hours Cycle: 10	IEC 68-2-14 Na
High-temperature running	Normal high temperature: 75 °C Extreme high temperature: 80°C Duration: 4 hours	ZTE standard
Low-temperature running	Normal low temperature: -30°C Extreme low temperature: -40°C Duration: 4 hours	ZTE standard
High temperature & high humidity	Temperature: +60°C Humidity: 95% Duration: 48 hours	ZTE standard
High temperature storage	Temperature: 85°C Duration: 24 hours	IEC 68-2-1 Ab
Low temperature storage	Temperature: -40°C Duration: 24 hours	IEC 68-2-2 Bb

8.4 Reliability Testing Result

Table 8-5 The Temperature Testing Result Under Windless Condition

Mode	Environment temperature	Voltage	Transmit power	Duration	Testing result
GPRS Class 10	+25°C	(3.8±10%)V	Max	≥1hour	Pass
EDGE Class 12	+25°C	(3.8±10%)V	Max	≥1 hour	Pass
WCDMA	+25°C	(3.8±10%)V	Max	≥1 hour	Pass

Table 8-6 The High/low Temperature Running and Storage Testing Result

Test Item	Test Condition & Standard	Test Content	Test result
Random vibration	Refer to Table 8-4	RF test & function test	Pass
Temperature shock	Refer to Table 8-4	RF test & function test	Pass
Low temperature running	Refer to Table 8-4	RF test & function test	Pass
High temperature running	Refer to Table 8-4	RF test & function test	Pass
Extreme low temperature running	Refer to Table 8-4	RF test & function test	Pass
Extreme high temperature running	Refer to Table 8-4	RF test & function test	Pass
Low temperature storage	Refer to Table 8-4	RF test & function test	Pass
High temperature storage	Refer to Table 8-4	RF test & function test	Pass

8.5 ESD Characteristic

Module is sensitive to ESD in the process of storage, transporting and assembling. Especially, the module is mounted on the users' mother board, The ESD components should be placed beside the connectors which human body might touch, such as USIM card holder, audio jacks, switches and keys, etc. The measured ESD values of module at the normal temperature are shown as the following table.

Table 8-7 Module ESD Features

Interface	Test program	Test requirements
Antenna Interface	Air discharge	±8 kV
	Contact discharge	±6kV
Shielding case	Air discharge	±8 kV
	Contact discharge	±6kV

9 SMT Process and Baking Guide

Now there are more and more products in our company. Customers may meet a lot of welding problems. So, we provide this SMT process and baking guide particularly for customers to ensure the first pass yield of the module on customer side.

9.1 Storage Requirements

Storage conditions: temperature<40℃, relative humidity<90% (RH), 12 months weldability guaranteed under this circumstances of excellent sealing package.

The Moisture sensitivity level for all modules is level 3 (Conforming to IPC/JEDEC J-STD-020). After opening the package, mount within 168 hours under the environment conditions of temperature<30℃, relative humidity<60% (RH); if it doesn't meet the above requirements, perform the baking process. See the baking parameters in Table below:

Table 9-1 Baking parameters

Temperature	Baking conditions	Baking time	Remarks
125±5℃	Moisture≤60%RH	8 hours	The accumulated baking time must be less than 96 hours
45±5℃	Moisture≤5%RH	192 hours	

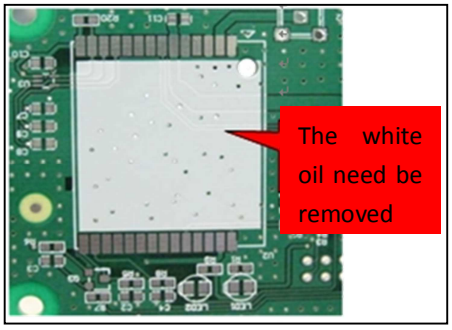
The product's transportation, storage and processing must conform to IPC/JEDEC J-STD-033.

When in the process of PAD designing of module, refer to IPC-SM-782A and following instructions.

9.2 Module's Position Requirements on Main board

It is recommended that the thickness of green oil at the module's position on main board should be less than 0.02mm. Do not cover with white oil or cover white oil on the green oil layer to avoid excessive thickness. As the excessive thickness may cause the module cannot be effective contact with the solder paste thus affecting the quality of welding.

Figure 9-1 Green oil and white oil at module's position on main board



(The figure is just for reference; it doesn't represent the actual module encapsulation)

In addition, do not lay out other components within 2mm around the module's position on main board to ensure the maintenance of the module.

9.3 Module Planeness Standard

The module's planeness is required to be 0.15mm. Measurement method: put the module on the marble plane, use the feeler gage to measure the gap width at the position of maximum warp, and do not exert force on the module during the measurement.

9.3.1 Process Routing Selection

The modules are manufactured with the lead-free process and meet the ROHS requirements, therefore it's recommended to follow the lead-free manufacturing process upon the selection of process routing for module board and main board.

9.3.2 Solder Paste Selection

The solder pastes with metal particle TYPE3 and TYPE4 can fulfill the welding requirements. It is accordingly recommended to use the no-clean solder paste. If the solder paste which needs cleaning is used, we cannot guarantee the components on the module board could withstand the washing of the cleaning solvents. This might cause the functional problems of such components and affect the appearance of the module. During the printing process, make sure the solder paste's thickness at the position of module's PAD is within 0.18mm -0.20mm.

9.3.3 Design of module PAD's steel mesh opening on main board

The thickness of the steel mesh on main board is selected according to the encapsulation type of components on the main board. Pay attention to the following requirements:

1) Make sure to design the module PAD on main board according to the third item as below.

2) The thickness of steel mesh is 0.15mm or 0.18mm, but the thickness at the position of module pad can be increased to 0.18~0.20mm or the thickness of steel mesh is directly 0.18mm~0.20mm on main board.

3) Requirements on the thickness of solder paste: control the thickness between 0.15mm and 0.18mm.

4) See the LCC module PAD's steel mesh opening in the following table:

Table 9-2 LCC module PAD's steel mesh opening

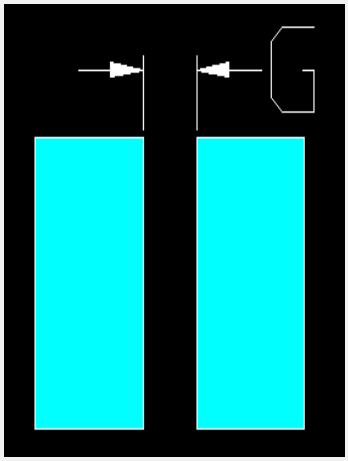
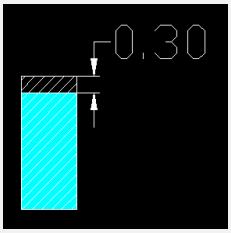
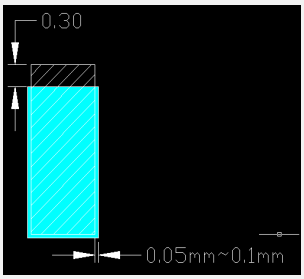
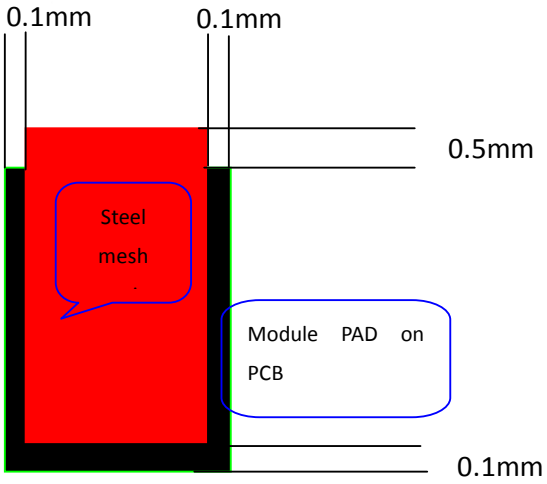
Module PAD GAP (G)=Center Distance (e)—PAD width (X)		Steel mesh opening	
	G≥0.5mm	Drill holes at 100% scale in the direction of width; extend 0.3mm outward in the direction of length	
	G＜0.5mm	Contract 0.05~0.1mm in the direction of width; Contract 0.05~0.1mm inward in the direction of length, extend 0.5mm outward in the direction of length.	

Figure 9-2 Module Board's Steel Mesh Diagram



9.3.4 Module Board's SMT process

1) **SMT Pallets:**

The pallets, which are suitable for SMT, have been made for most ZTE modules. If the module has provided the pallets itself and meets the SMT requirements, customers can directly use it for module SMT.

Figure 9-3 Material Module Pallet

(The figure is just for reference; it doesn't represent the actual Material Module Pallet)

Otherwise, customers need make a loading tool similar to the pallet. Customers can take out the module from the packaging box, put them into the pallet according to the sequence and direction, and then start SMT.

2) **Mounting Pressure:**

In order to ensure a good contact between the module and the solder paste on main board, the pressure of placing the module board on main board should be 2-5N according to our experiences. Different modules have different numbers of pads, therefore the pressure selected are different. Customers can select proper pressure based on their own situations to suppress the module paste as little as possible, in order to avoid the surface tension of the solder paste melts too much to drag the module during reflow.

9.3.5 Module Soldering Reflow Curve

Module soldering furnace temperature curve is:

Peak value: 245+0/-5□

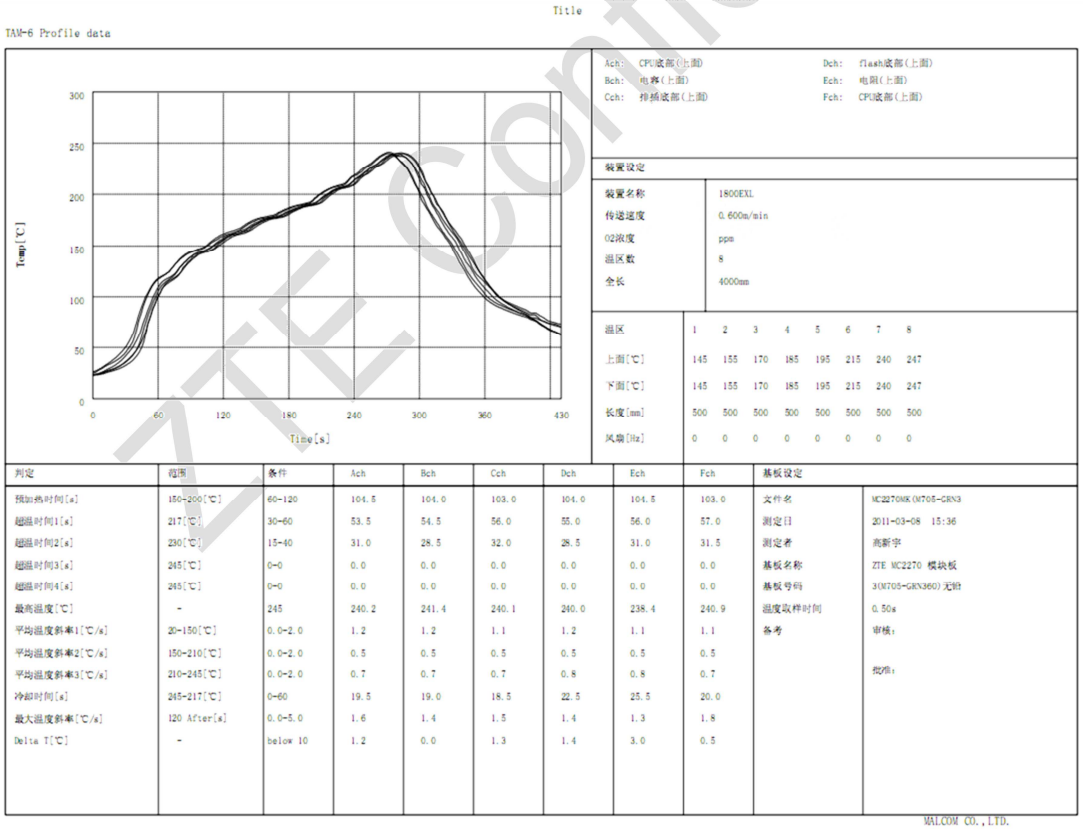
≥217□: 30～～60S

150～200℃: 60～～120S

Temperature rise slope: <3℃/S

Temperature drop rate: －2～－4℃/S

Figure 9-4 Module Furnace Temperature Curve Diagram



Note: The test board of furnace temperature must be the main board with the module board mounted on, and there must be testing points at the position of module board.

9.3.6 Reflow method

If the main board used by customers is a double-sided board, it is recommended to mount the module board at the second time. In addition, it is preferable for the main board to reflow on the mesh belt when mounting at the first time and the second time. If such failure is caused by any special reason, the fixture should be also used to make such main board reflow on the track so as to avoid the deformation of PCB during the reflow process.

9.3.7 Maintenance of defects

If poor welding occurs to the module board and main board, e.g., pseudo soldering of the module board and main board, the welder can directly use the soldering iron to repair welding according to the factory's normal welding parameters.

9.4 Module's Baking Requirements

The module must be baked prior to the second reflow.

9.4.1 Module's Baking Environment

The operators must wear dust-free finger cots and anti-static wrist strap under the lead-free and good static-resistant environment. Refer to the following environment requirements:

The product's transportation, storage and processing must conform to IPC/JEDEC J-STD-033.

9.4.2 Baking device and operation procedure

Baking device: any oven where the temperature can rise up to 125°C or above.

Precautions regarding baking: during the baking process, the modules should be put in the high-temperature resistant pallet flatly and slightly to avoid the collisions and frictions between the modules. During the baking process, do not overlay the modules directly because it might cause damage to the module's chipset.

9.4.3 Module Baking Conditions

See the baking parameters in Table 9-1.

10 Safety Warnings and Notes

During the process of the module secondary development, use and repair, all the safety warnings and notes in this section should be followed. The module integrator must pass the following safety information to users and operators or integrate the information into product operating manual:

- When RF devices including the module are used, the electronic devices whose shielding performance is not good may be interfered. Please keep far away from ordinary telephones, televisions, radios and places of office automatic, to avoid interaction with the module.
- Please consult the product manufacturer before the devices containing the module is used beside medical equipment such as hearing-aid, cochlear implant and heart pacemaker.
- Please do not use the devices containing the module in the environment which has potential explosion hazard such as oil depot and chemical plant and which has special requirements such as hospital and airport.
- Please do not expose the module to the strong sunshine to avoid being excessive heated and damaged.
- The module does not have waterproof performance, so please avoid liquid entering the module. Please do not use it in the high humidity environment such as the bathroom to avoid being damaged.
- Non-professionals please do not detach the module to avoid people and devices been injured or damaged.
- When cleaning the module, please shut down it first and use clean antistatic fabric.

Users have responsibility to follow the relevant regulations and specific operating environment regulations about wireless communication module and equipment. Our company is not responsible for the relevant loss since the customer do not follow the rules.

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 1.6dBi.
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:SRQ-MW3650”. The grantee's FCC ID can be used only when all FCC 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.

