MG815+ Module Hardware Design User Manual

Version：V1.4

ZTE Corporation

This manual is also applicable for ME3000/ME3006/MG615+/MG415+/MG416+ modules.

Preface

Summary

This manual is applicable for ME3000/ME3006/MG815+/MG615+/MG415+/MG416+ modules. This manual takes MG815+ and ME3000 as examples to instruct the users how to design the hardware and how to quickly and conveniently design different kinds of wireless terminals based on the modules.

Target Readers

- System designing engineers
- Mechanical engineers
- Hardware engineers
- Software engineers
- Test engineers

Brief Introduction

Chapter	Contents
1 General Description	Introduces technical specs of the modules and relevant documents and abbreviations.
2 Product Introduction to MG815+	Introduces the principle charts and relevant standards of both MG815+ and ME3000 modules.
3 PIN Definitions	Introduces the name and function of PIN.
4 Hardware Interfaces and design reference	Introduces the hardware interface designing of the modules.
5 Mechanical	Introduces the module's appearance, assembly line, main board PCB layout and fixing.
6 Peripherals components	Introduces the peripherals components.

Update History

V1.4 （June-25-2007）

This is the fifth time to release the new version. The update contents include:

1.1.4 Modifications in Technical parameters

1.2 Modifications in Relevant Documents

4.2 Power and Reset Add ON/OFF timing

5.1 Change the modules weight a more accurate value.

V1.3 （May-31-2007）

This is the fourth time to release the new version. The update contents include:

4.2 Modifications in Section Power and Reset

4.4 Change user ID card interface to SIM/UIM card interface

4.5 Audio Interface: Deleted x05，x06，x07 in the picture, and just kept receiver, handset, and line out. Change CDMA and GSM audio interface design

4.6 Change RF interface as antenna interface.
5.1 Appearance: Add ME3000's appearance.
5.3 Change PCB Layout.
6 Change Key components as peripherals.

V1.2 (April-24-2007)

This is the third time to release the version. The update contents include:
6.4 Audio Interface
Add Auto power-on/off, audio interface design

V1.1 （April-13-2007）

The update contents include:
5 PIN definitions
Change fig5-1 PIN Diagram
6 Hardware Interface and Reference Design
Change R12 impedance in Fig6-1 as 1K
6.4 Audio Interface
Add the design of audio interface
Add section 6.6 Module Layout

V1.0 （Feb-09-2007）

This is the first to formally release the document.

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1 General Description

This manual is applicable for ME3000/ME3006/MG815+/MG615+/MG415+/MG416+ modules. Except for antenna design, the hardware/mechanical design is completely compatible with the applications of CDMA 800M, Sec800MHz, 450M and GSM/GPRS. All above modules have voice, SMS and data service function, which could be used for data transmission, wireless POS, security, lottery, intelligent metering, wireless fax, small exchangers, tobacco network, campus network, wireless AD, wireless media, medical surveillance, relay station surveillance, railway terminal, intelligent home appliances, vehicle-mounted surveillance, etc.
Taking MG815+ and ME3000 module as examples, this manual describes the module's logic structure, hardware interface and main functions, and provides reference design for the hardware and mechanics.

1.1 Technical Specification

1.1.1 Module Specification

Please refer to table 1-1 for the specifications of 5 types of modules ME3000, MG815+, MG615+, MG415+ and MG416+.

Table 1-1 module specification

Module Models	Standard	Frequency(MHz)
ME3000	GSM/GPRS	Quad Band: GSM 850/EGSM 900/DCS 1800/PCS 1900
MG815+	CDMA 2000 1X	800MHz
MG615+	CDMA 2000 1X	Sec800MHz
MG415+	CDMA 2000 1X	450MHz block A
MG416+	CDMA 2000 1X	450MHz block C

Remarks: *The modules are compatible on hardware and mechanical design except for frequency. Below is just an example for MG815+ and ME3000 modules.*

1.1.2 Main Functions and Features

Please refer to Table 1-2 for the Main Functions and Features.

Table 1-2 Main functions and features

Item	Description	
	CDMA	GSM
Voice	EVRC and 13kQCELP High-quality voice	
SMS	Support TEXT	Support TEXT and PDU
Data	✓ Support internal TCP/IP stack ✓ Support virtual keep on-line(VKL) CDMA maximum up/down link data rate 153.6kbps; GSM maximum up-link data rate 42.8kbps, maximum down-link data rate 85.6kbps.	

1.1.3 Interfaces

Please refer to Table 1-3 for the Interfaces.

Table 1-3 Interfaces of the modules

Item	Description	
	CDMA	GSM
UART interface	Download software to update Data communication Maximum data rate 230.4kbps through the port	
Audio interface	Double audio I/O channel.	
UIM card interface	Built-in UIM/R-UIM	UIM card interface
Antenna interface	50 Ohm input impedance control	
RTC	none	RTC

1.1.4 Technical parameters

Please refer to Table 1-4 for the Technical parameters of MC8530.

Table 1-4 Technical parameters of MC8530

Item	Description	
	CDMA	GSM
Working temperature	-30°C ~ +75°C	-20°C ~ +80°C
Input voltage	3.3V-4.25V	
Maximum current	560mA @ -104 dBm	500mA @ -102 dBm
Idle current	5mA @ -75 dBm	10mA @ -75 dBm
Call current	230mA @ -75 dBm	150mA @ -75 dBm
sensitivity	104 dBm	102dBm
Tx power	23dBm ~ 30dBm (Class III)	GSM850,EGSM900:Class4(2W) GSM1800, PCS1900:Class1(1W)
Frequency range	800MHz Tx：824~849 MHz Rx：869~894 MHz	GSM850 Tx：824~849 MHz Rx：869~894MHz
	Sec800MHz Tx：806~821 MHz Rx：851~DL866 MHz	EGSM900 Tx：880~915 MHz Rx：925~960MHz
	450MHz A 段 Tx：450~460 MHz Rx：460~470 MHz Preferred channel：160，210，260	DCS1800 Tx：1710~1785MHz Rx 1805~1880MHz
	450MHz C 段 Tx：450~460 MHz Rx：460~470 MHz Preferred channel：47，97，147	PCS1900 Tx：1850~1910MHz Rx：1930~1990MHz

1.2 Relevant Documents

- 《ZTE Dragon tooth wireless module series product catalog》
- 《AT Command Manual for ZTE Corporation's MG815+ Modules》
- 《AT Command Manual for ZTE Corporation's ME3000 Modules》
- 《ZTE MG815+ Module Development Board User Guide》
- 《FAQ for ZTE Corporation's CDMA Modules》
- 《FAQ for ZTE Corporation's GSM/GPRS Modules》
- 《Test References of ZTE Corporation's CDMA Wireless Modules》

1.3 Abbreviations

Abbr.	Full name
ADC	Analog-Digital Converter
AFC	Automatic Frequency Control
AGC	Automatic Gain Control
ARFCN	Absolute Radio Frequency Channel Number
ARP	Antenna Reference Point
ASIC	Application Specific Integrated Circuit
BER	Bit Error Rate
BTS	Base Transceiver Station
CDMA	Code Division Multiple Access
CDG	CDMA Development Group
CS	Coding Scheme
CSD	Circuit Switched Data
CPU	Central Processing Unit
DAI	Digital Audio interface
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
EFR	Enhanced Full Rate
EGSM	Enhanced GSM
EMC	Electromagnetic Compatibility
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

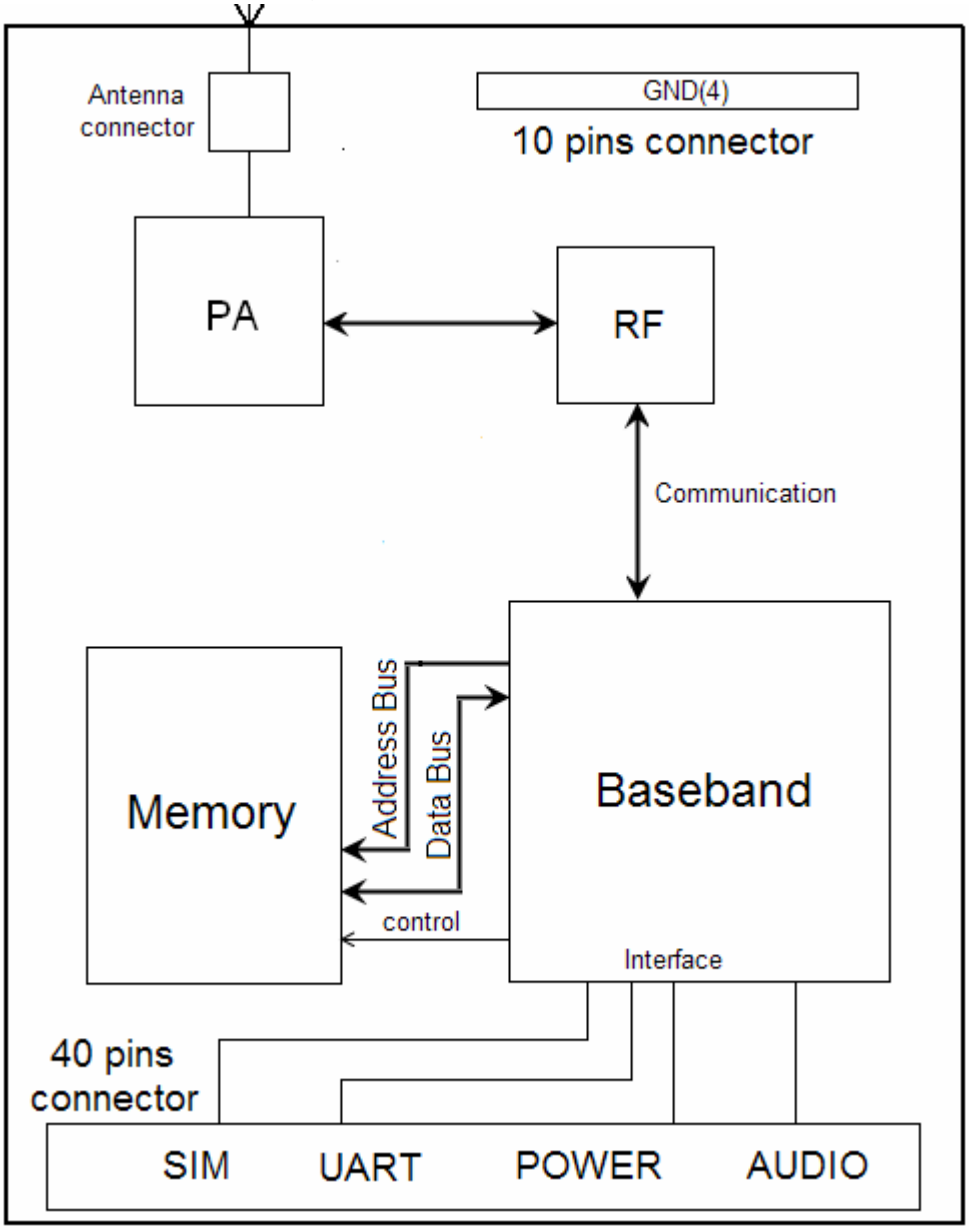
GSM	Global Standard for Mobile Communications
HR	Half Rate
IC	Integrated Circuit
IMEI	International Mobile Equipment Identity
ISO	International Standards Organization
ITU	International Telecommunications Union
LCD	Liquid Crystal Display
LED	Light Emitting Diode
MCU	Machine Control Unit
MMI	Man Machine Interface
MS	Mobile Station
PCB	Printed Circuit Board
PCL	Power Control Level
PCS	Personal Communication System
PDU	Protocol Data Unit
PLL	Phase Locked Loop
PPP	Point-to-point protocol
RAM	Random Access Memory
RF	Radio Frequency
ROM	Read-only Memory
RMS	Root Mean Square
RTC	Real Time Clock
SIM	Subscriber Identification Module
SMS	Short Message Service
SRAM	Static Random Access Memory
TA	Terminal adapter
TDMA	Time Division Multiple Access
TE	Terminal Equipment also referred it as DTE
UART	Universal asynchronous receiver-transmitter
UIM	User Identifier Management
USB	Universal Serial Bus
VSWR	Voltage Standing Wave Ratio
ZTE	ZTE Corporation

2 Brief Introduction to MG815+

2.1 Brief Introduction to MG815+

Please refer to Figure 2-1 for the Technical parameters of MG815+.

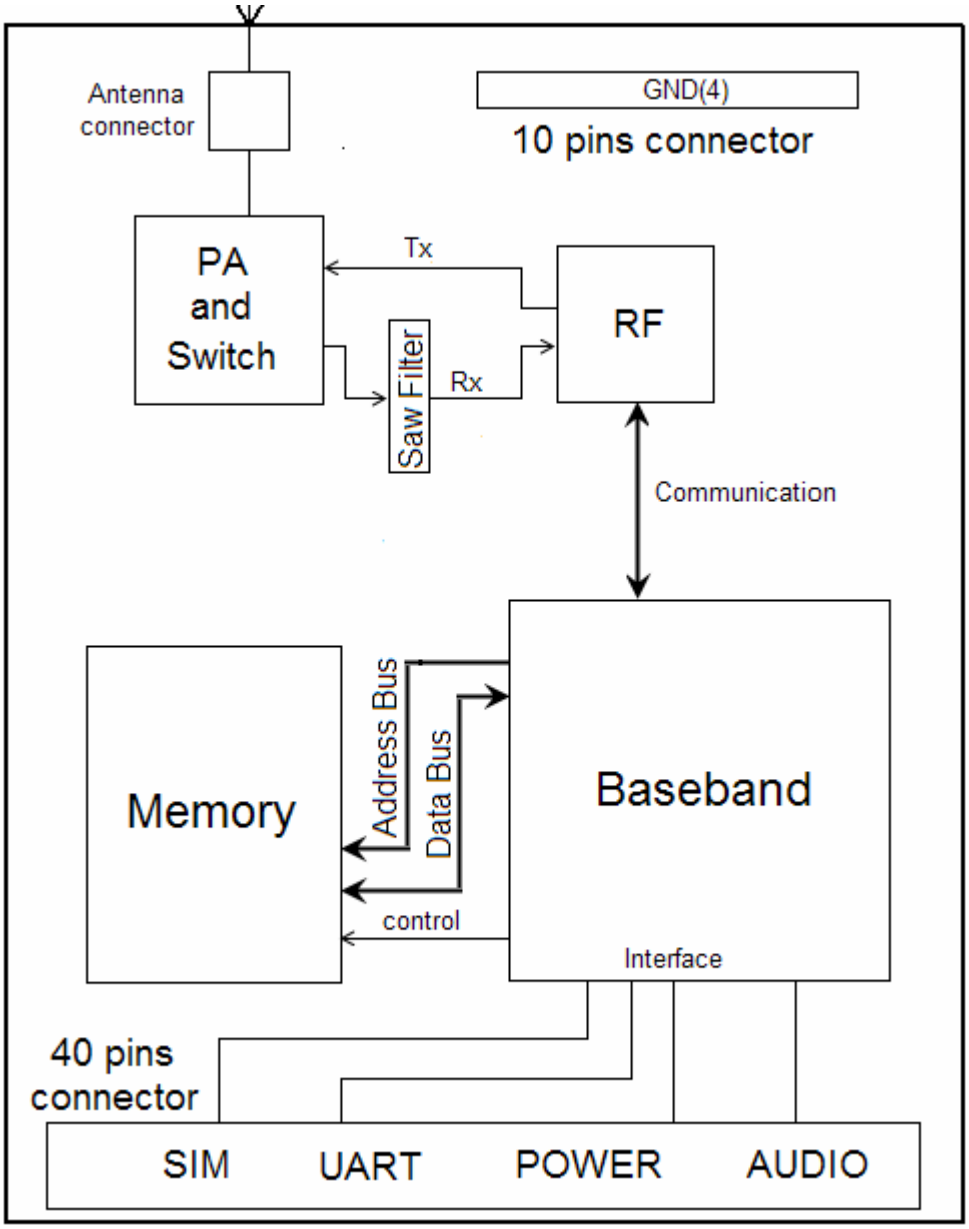
Figure 2-1 MG815+ principle



2.2 Brief Introduction to ME3000

Please refer to Figure 2-2 for the Technical parameters of ME3000.

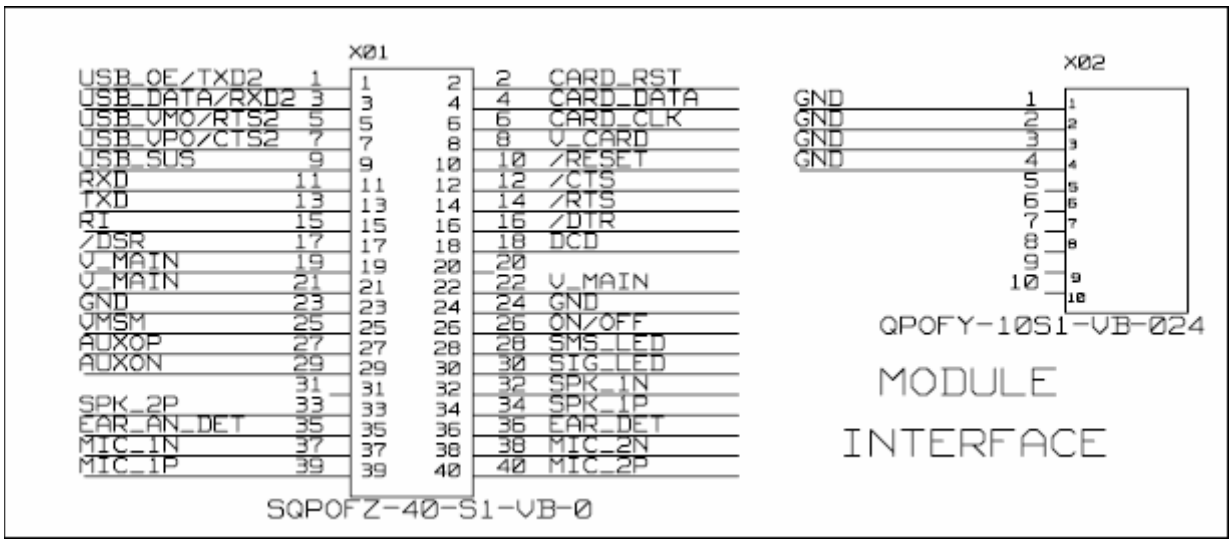
Figure 2-2 ME3000 principle


Antenna connector
GND(4)
10 pins connector
PA and Switch
Tx
RF
Saw Filter
Rx
Communication
Memory
Address Bus
Data Bus
Baseband
control
Interface
40 pins connector
SIM
UART
POWER
AUDIO

3 PIN definitions

The main connector of MG815+ or ME3000 is 40-PIN connector and 10-PIN connector. The distance between two PINS is 1.27mm. Refer to the figure below:

Figure 3-1 PIN



Refer to table 3-1/3-2 below for PIN definitions:

Table 3-1 PIN definitions of 40 PIN connector

Function	Pin No.	Signal name	I/O	Basic functions	Remarks
Audio	39	MIC_1P	I	MIC 1 Anode	MIC 1 is the default configuration for audio I/O when power on, generally MIC 1 is used for handset, MIC 2 for earphone
	37	MIC_1N	I	MIC 1 Cathode	
	34	SPK_1P	O	Receiver 1 Anode	
	32	SPK_1N	O	Receiver 1 Cathode	
	40	MIC_2P	I	MIC 2 Anode	
	38	MIC_2N	I	MIC 2 Cathode	
	33	SPK_2P	O	Receiver 2 Anode	
	35	EAR_AN_DET	I	Earphone button test	draw up internal，low level valid
	36	EAR_DET	I	Earphone inserting test	draw down internal， low level valid
	27	AUXOP	O	Line output, anode	
	29	AUXON	O	Line output, Cathode	
Serial port 1	12	/CTS	O	Clear to send	low level valid.
	14	/RTS	I	Request to send	low level valid
	13	TXD	O	Transmit data	
	11	RXD	I	Receive data	
	15	RI	O	Ring indicating signal	TTL level. 1. high level when

							initialized; 2. producing a periodic signal(100ms low,5.9s high) when received a ring indicating signal; 3. Back to high level when the ring indicating signal is terminated.
	17	/DSR	O	Module is ready			low level valid
	18	DCD	O	Carrier signal testing			
	16	/DTR	I	User circuit is ready			low level valid
UIM card interface	4	CARD_DATA	I/O	Data cable			
	6	CARD_CLK	O	Clock wire			
	8	V_CARD	O	3V power output			
	2	CARD_RST	O	Reset wire			
Serial port 2 or USB interface	PIN number	Signal name	USB	UART	USB	UART	GSM module supports UART but not USB.CDMA module supports both UART and USB, but software should be changed with different interface. Pin 5 and pin 7 are available at low level within UART.
	1	USB_OE/TXD2	O	O	To USB Transceiver	The same to serial port 1	
	3	USB_DATA/RXD2	I	I	To USB Transceiver		
	5	USB_VMO/RTS2	O	I	To USB Transceiver		
	7	USB_VPO/CTS2	O	O	To USB Transceiver		
	9	USB_SUS	O	NC	Suspend status indicating	suspend	
LED	28	SMS_LED	O	Call/message indicator			Draw down internal, LED will be turned on at high level(with external driver)
	30	SIG_LED	O	Signal indicator			Draw down internal, LED will be turned on at high level (with external driver). -Turn on: LED off -Searching for network: LED flashes, and it lasts for about 50ms when it is on, and the time is flexible when it is off; -Idle: LED blinks per 100ms. --Traffic (call, data): LED blinks per 500ms

Reset	26	ON/OFF	I	switch control	Draw up internal，Low level valid. For details, please refer to section 4.2 Power and Reset
	10	/RESET	I	Reset signal	Low level valid Need to connect an open collector or an open drain switch. For details, please refer to section 4.2 Power and Reset
power	19	V_MAIN	Power input	Main power of module	
	21	V_MAIN	Power input	Main power of module	
	22	V_MAIN	Power input	Main power of module	
	23	GND		Ground	
	24	GND		Ground	
	25	V_MSM	power output	Digital power	MG815+ module has a voltage output pin with current limited adjuster. It can be used to supply external circuit on main board. the voltage of this pin, baseband processor and storage come from the same voltage adjuster. voltage output is 2.85V when power on. Users should distribute current as little as possible from this pin(less than 10mA). Generally, we suggest this pin is used to pull up chips' pin only when it needs level match.
reserved	20	NC			Used for module inside, need to be suspended
	31	NC			Used for module inside, need to be suspended

Table 3-2 PIN definitions of 10 PIN connector

Function	PIN No.	Signal Name	I/O	Basic functions	Remarks
power	1	GND	GND		
	2	GND	GND		
	3	GND	GND		

	4	GND	GND		
reserved	5	NC			Used for module inside, need to be suspended
	6	NC			
	7	NC			
	8	NC			
	9	NC			
	0	NC			

4 Hardware Interfaces and Design Reference

4.1 Summary

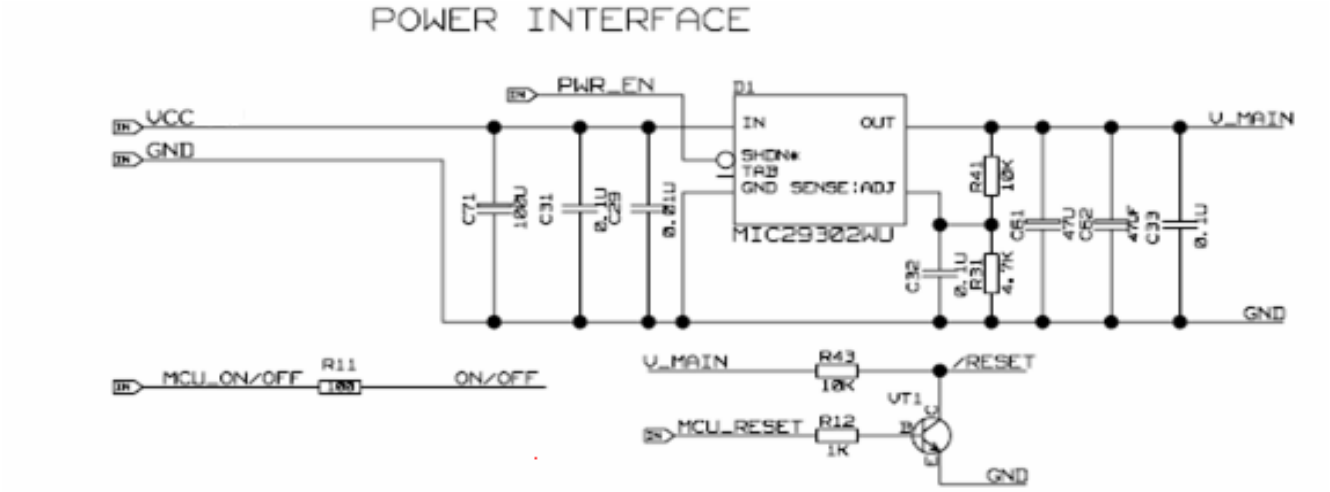
This section describes the function interfaces and usage of MG815+ modules in details, and provides the designing sample.

- Power and Reset Interface
- Serial Port
- SIM/UIM Card Interface
- Audio Interface
- Antenna Interface

Remarks: *In the system, the module layout should be far away from high-speed circuit, switch power, power transformer, large power inductor, or single chip microcomputer's clock circuit.*

4.2 Power and Reset

Figure 4-1 power and reset circuit design reference



- **Power design**

The module is powered by V-MAIN, and the voltage feature is below:

Table 4-1 Voltage features

Category	Min.	Typical	Max.
Input voltage	3.3 V	3.9 V	4.25 V

D1 is a LDO with low-valid control, making V_MAIN supplies power to module through adjusting R31and R41 at 3.9V. Modules have very high requirements on power and ground processing, signals must be filtered. Power ripple needs to be controlled under 50Mv. Do not supply power to any other part of system, otherwise RF performance will be compromised. Finally, select the power cables with at least 40mil traces during the layout and keep the integrality of ground line.

- **Power ON**

The module will be turned off after power-on normally. To turn on the module, firstly put /RESET at high level, and then provide a 1500-2000mS low level pulse to ON/OFF PIN. /Reset needs to connect an open collector or open drain gate.

- **Power OFF**

To turn off the module, firstly provide a 1500-2000mS low level pulse to ON/OFF PIN, after 5s or 6s, and put /RESET at low level.

- **Reset**

You could turn off the module firstly and then turn it on to reset the module.

ON/OFF timing figure is as follows:

Figure 4-2 ON/OFF timing

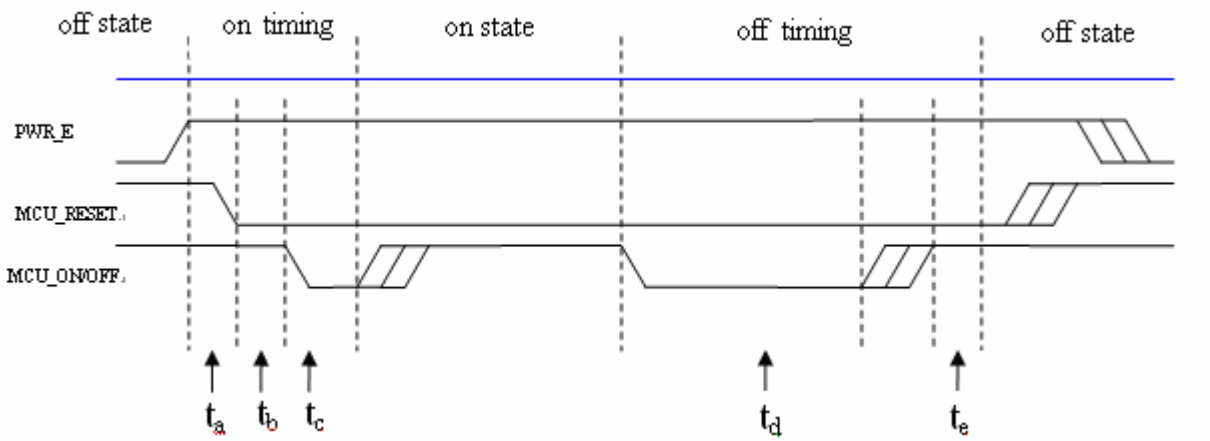


Table 4-2 ON/OFF timing features

t_a	t_b	t_c	t_d	t_e
20mS	10mS	2S	2S	6S

- **V_MSM**

There is a voltage output pin with current adjuster, which can be used to supply external power to the board. The voltage of this pin and the voltage of baseband processor/memory come from the same voltage adjuster. The voltage output is available only when the module is on. The normal output voltage is 2.85V, and the user should absorb the current from this pin as little as possible (less than 10mA). Generally, it is recommended to use this pin to match the level. When the module is off, the output voltage for this pin remains unchanged, but the impedance is rather high. Therefore, it's not recommended to use this pin for other purposes.

- **Other Advice**

In order to make sure the data is saved safely, please don't cut off the power when the module is on. It's strongly recommended to add battery or soft switch like the power key on the mobile phone.

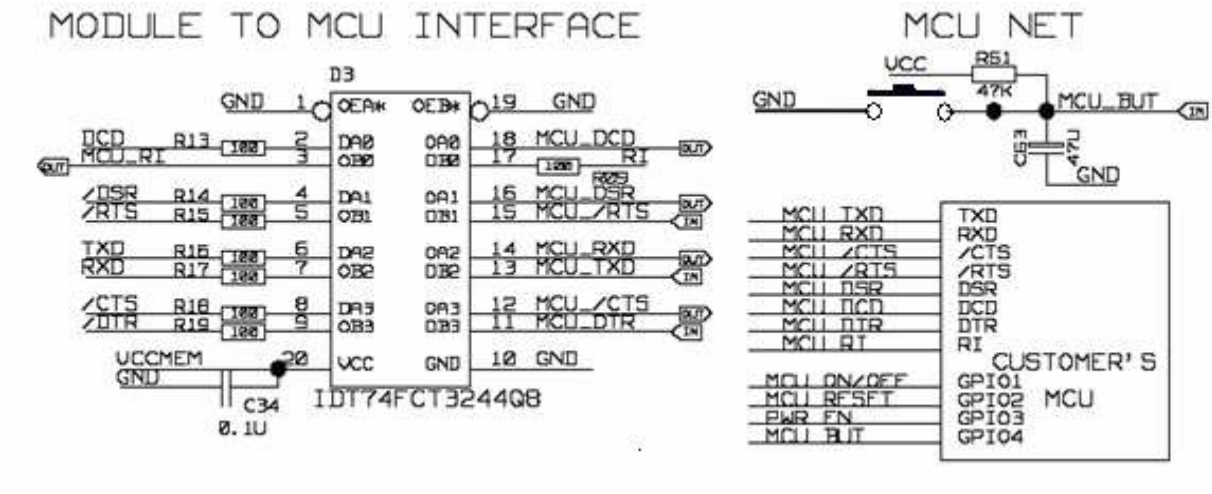
4.3 Serial Port

The module provides 2 UART transceivers and its logic functions conform to RS-232 interface standard. These

two UART could be used as serial port data interfaces to transmit data, provide test and debug channel, and download the software for upgrade.

Refer to Fig 4-3 when UART 1 is used as MCU:

Figure 4-3 UART to MCU interface

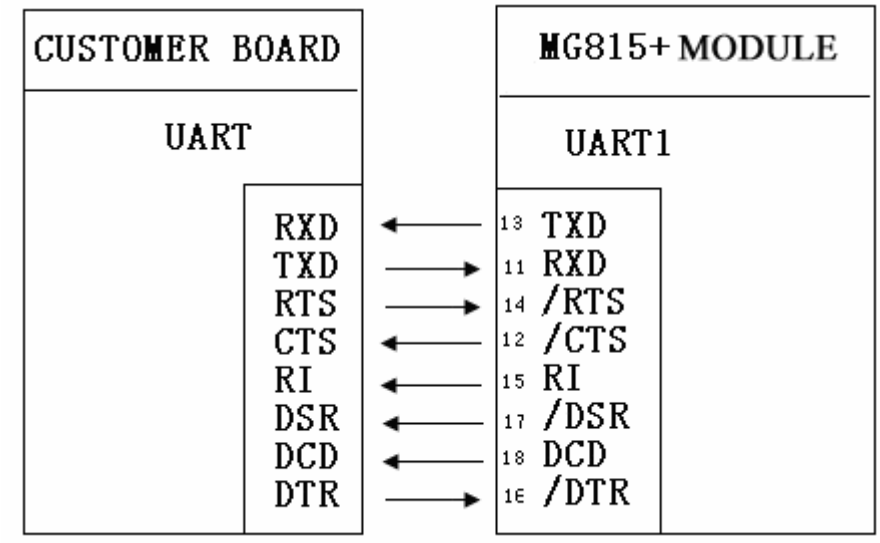


It is noted that the interface level of UART provided by the module shall conform to CMOS level, while not meet the requirements specified by RS-232 interface standard. If it is required to connect with the devices through standard RS-232 interface during the applications, second development designers must add transfer chip into their own designing, and use UART pins according to CMOS interface designing requirements. It's recommended to use 3V for UART level. MCU_BUT is the reset button.

It's specially noted that users need to extend UART 1 or UART 2 to update software, if they'd like to connect module to DTE in the design phase.

Refer to Fig 4-4 for UART 1 signal diagram:

Figure 4-4 UART 1 Signal Diagram



The corresponding PINS of UART 2 are for both UART and USB. GSM modules support UADT, but not USB; while CDMA modules support USB and UART both. Please refer to table 4-3 for details.

Table 4-3 USB and UART-2 Pin SN and Name

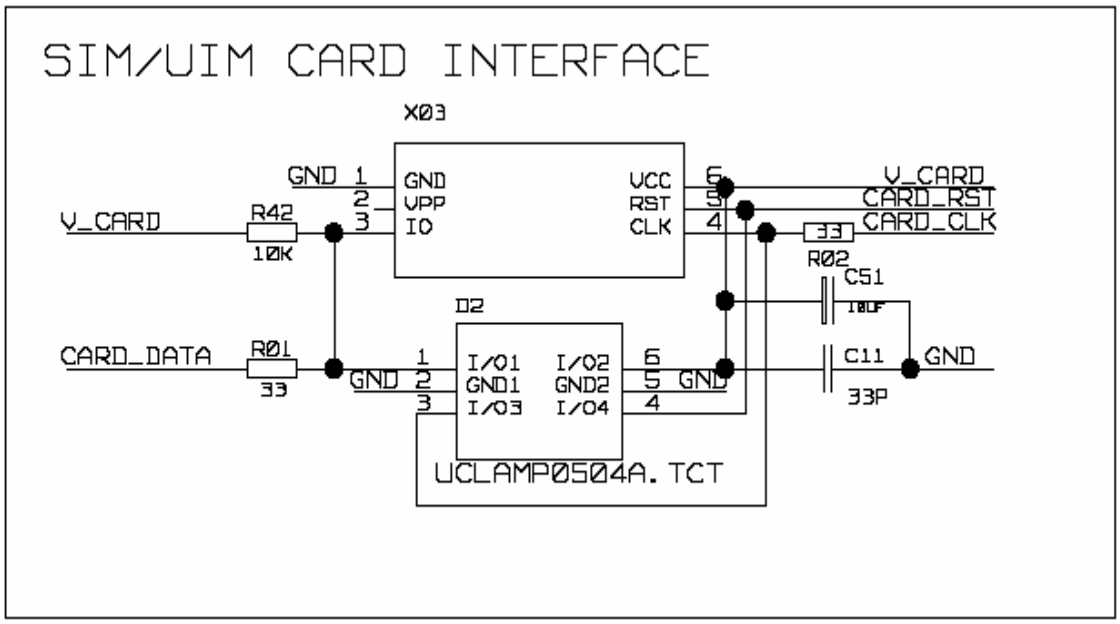
Signal name	UART	USB	pin
USB_ OE/TXD2	TXD2	USB_ OE	1

USB_DATA/RXD2	RXD2	USB_DATA	3
USB_VMO/ RTS2	RTS2	USB_VMO	5
USB_VPO/ CTS2	CTS2	USB_VPO	7
USB_SUS		USB_SUS	9

4.4 SIM/UIM Card Interface

Modules support 3V SIM/UIM card, SIM/UIM terminal includes 4 pins. V_CARD is used to supply SIM/UIM card. It's strongly recommended to add ESD to protect SIM/UIM card in hostile environments. D2 in the following layout is for ESD:

Figure 4-5 SIM/UIM card interface design reference

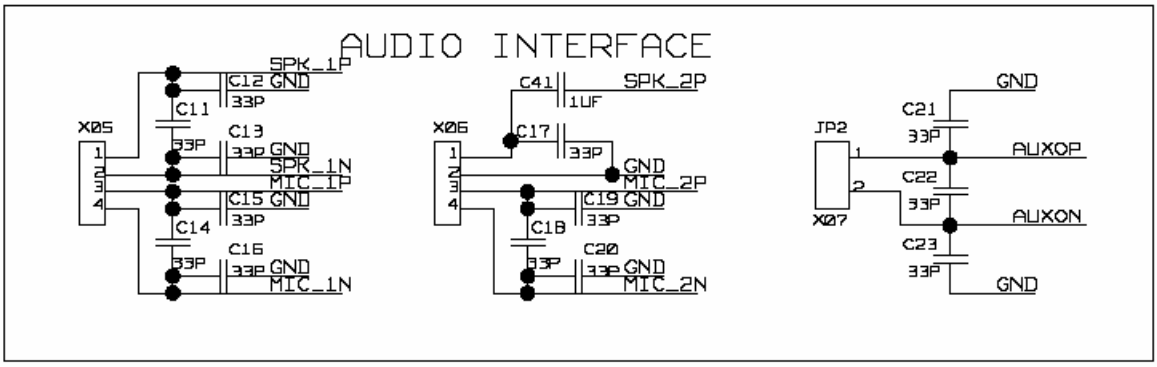


NOTE: *A 10k resistor is required for CARD_DATA pin to be draw up to V_CARD pin, because there are different SIM/UIM cards with quite different output currents. SIM/UIM card PCB circuit should be laid closely around the module as possible as you can, to avoid the interference of reading/writing from other sources.*

4.5 Audio Interface

The module provides audio input and output through MIC_2P. There are 2 speaker interfaces, 2 microphone interfaces and 1 line output. Only one pair I/O works at the same time.

Figure 4-6 audio interface circuit design reference



- **Microphone**

The system connector provides two microphone interfaces MIC_1 and MIC_2, which are both differential interface. They could be also used as single ended input (for example: earphone). It's recommended to use differential mode to reduce the noises. These two input are coupled in AC domain and added a 1.8V offset voltage inside, and they should directly connect with the receiver.

- **Speaker**

The system connector provides two speakers, SPK_1 & SPK_2. The former is differential interface, and the latter is single-ended interface, usually used for earphone. They both have 32 ohm impedance.

- **Line output**

The MIC_2P connector provides a differential line output via AUXOP and AOXON. The impedance is 8 ohm.

CDMA module audio interface is designed as below:

- Design of audio interface on the handset

Select the microphone with the sensitivity lower than -52dB since the output power for SPK_1 is 35mW and the max. gain in MIC_1 reaches 52dB. The level of MIC_1P PIN is about 1.8V.

Note: *if other kind of audio input method is adopted, the input signal should be within 2V. If the signal voltage is lower than 2V, then the pre-amplifier should be added. If the signal voltage is higher than 2V, then network attenuation should be added.*

- Design of audio interface on the receiver

Select the microphone with the sensitivity lower than -52dB since the output power for SPK_2 is 8.8mW and the max. gain in MIC_2 reaches 52dB. The level of MIC_2P PIN is about 1.8V. The receiver's design is just the same as the handset's.

GSM/GPRS module audio interface is designed as below:

- Design of audio interface on the receiver

Select the microphone with the sensitivity lower than -51.5dB since the output impedance for SPK_1 is 32 ohm and the max. gain in MIC_1 reaches 51.5dB. The level of MIC_1P PIN is about 2.5V.

Note: *if other kind of audio input method is adopted, the input signal should be within 0.5V. If the signal voltage is lower than 0.5V, then the pre-amplifier should be added. If the signal voltage is higher than 0.5V,*

then network attenuation should be added.

- Design of audio interface on the earphone

Select the microphone with the sensitivity lower than -51.5dB since the output impedance for SPK_2 is 32 ohm and the max. gain in MIC_2 reaches 51.5dB. The level of MIC_2P PIN is about 2.5V. The receiver's design is just the same as the handset's.

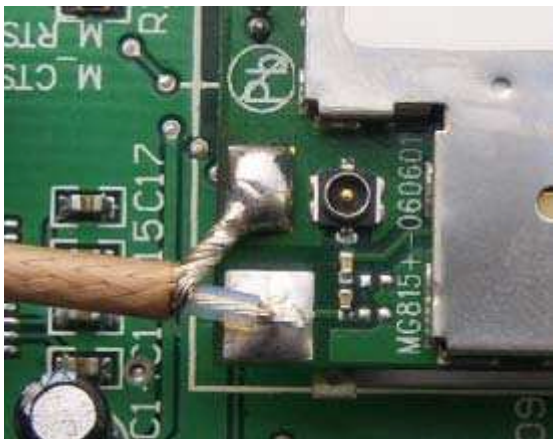
4.6 Antenna Interface

The module provides two types of RF connector:

- Extended jointing connector
- RF testing socket

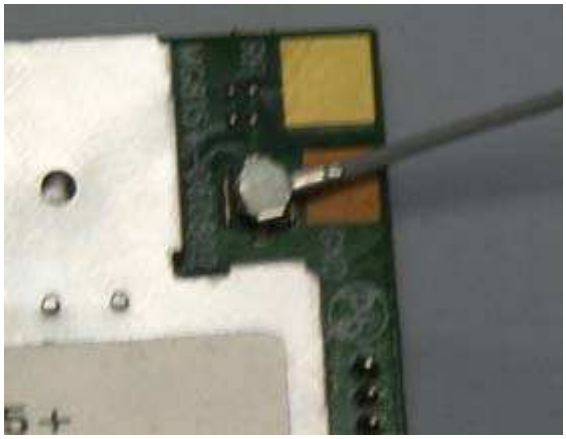
PCB jointing connector is used to connect module with antenna by 50 ohm RF shielding cable to cut down the cost. But it's not a complete way to shield EMI, and RF signal quality may be trivially affected. So if you decide to use this method, intense radiation must keep far away from PCB jointing connector. At the same time, you must ensure that core line of RF shielding cable has been jointed to PCB jointing connector, and the shielding metal wire netting on the RF cable has been jointed to GND of module. According to the figure below, the grounding part must be jointed firmly, otherwise, the core cable may be ruptured caused by shielding cable shaking.

Figure 4-7 Antenna Interface



Antenna test socket is used for calibration and testing. It connects module with antenna conveniently by appropriative 50 ohm socket to SMA connecting cable. The touch impedance of this socket is so tiny, and shielding characteristics are excellent. The impedance of antenna test socket is 50 ohm, its type is MM9329-2700B, please refer to socket manual provided by supplier to choose relative plugs. This is the antenna cable interface:

Figure 4-8 RF cable interface



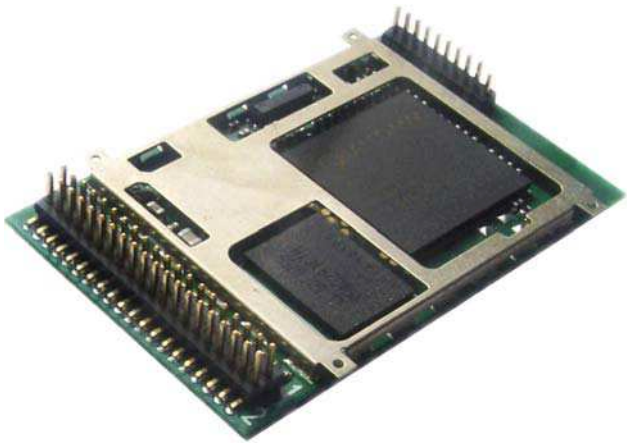
Proper measures should be taken to reduce the access loss of effective bands, and good shielding should be established between external antenna and RF connector. Besides, external RF cables should be kept far away from all interference sources such as high-speed digital signal or switch power supply.

According to mobile station standard, stationary wave ratio of antenna should be between1.1 to 1.5, and input impedance is 50 ohm. Different environments may have different requirements on the antenna's gain. Generally, the larger gain in the band and smaller outside the band, the better performance the antenna has. Isolation degree among ports must more than 30dB when multi-ports antenna is used. For example, between two different polarized ports on dual-polarized antenna, two different frequency ports on dual-frequency antenna, or among four ports on dual-polarized dual-frequency antenna, isolation degree should be more than 30dB.

5 Mechanical

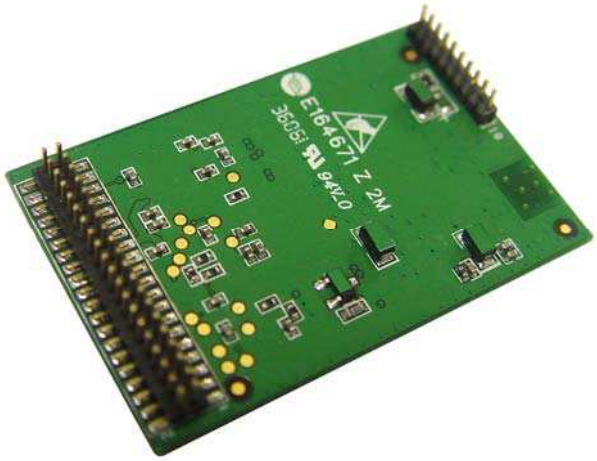
5.1 Appearance

Figure 5-1 module appearance of MG815+



- **Dimensions:** 44.0 mm（length）x 28.0mm（width）x 7.6mm（height）
- **Weight:** 8.5g

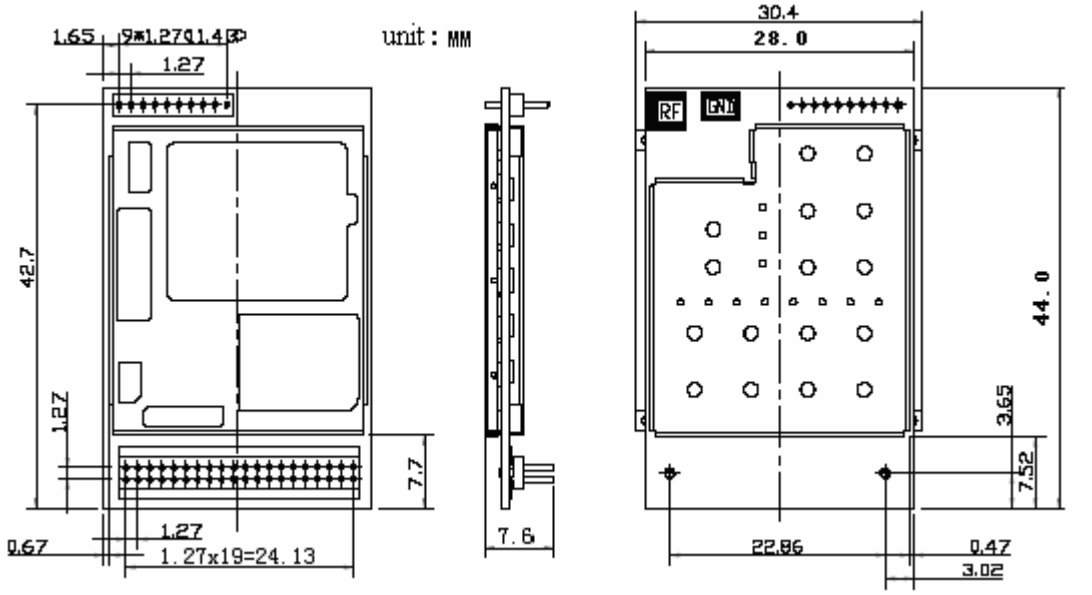
Figure 5-2 module appearance of ME3000



- **Dimensions:** 44.0 mm（length）x 28.0mm（width）x 7.6mm（height）
- **Weight:** 8g

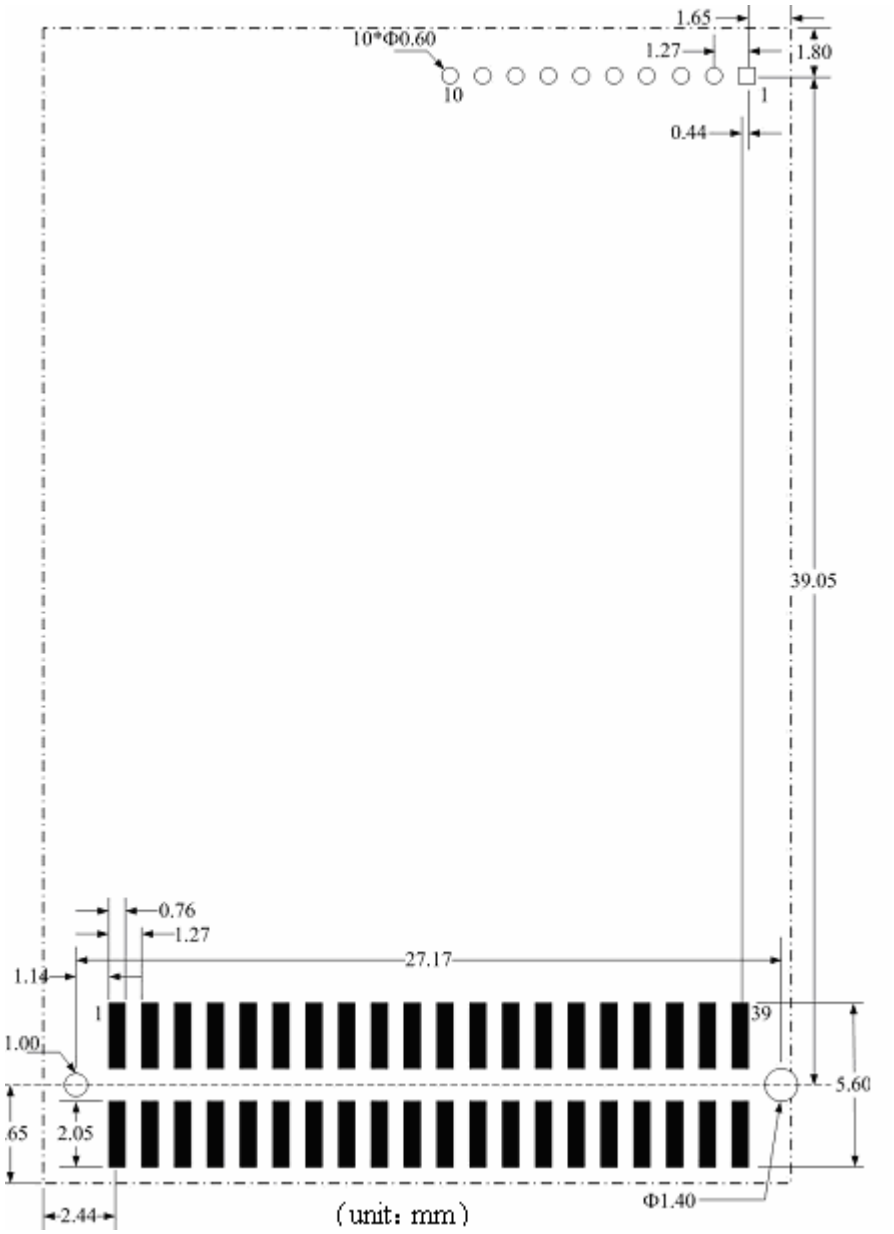
5.2 Module Assembly Line

Figure 5-3 Module assembly line（bottom view）



5.3 Main board PCB layout

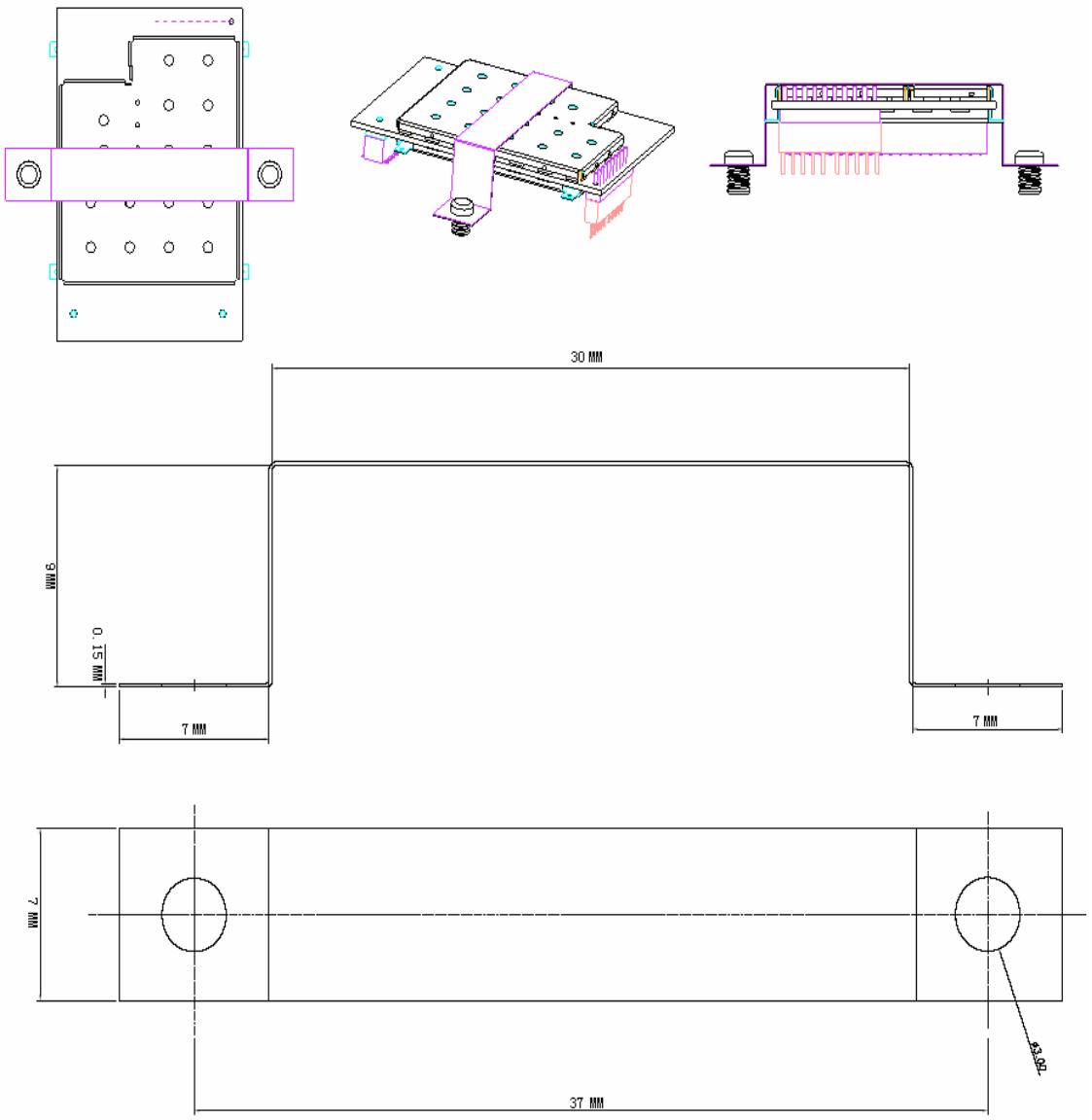
Figure 5-4 main board PCB layout（top view）



5.4 Fixing Method

The fixing metal sheet is made of stainless steel，and there are two fixing methods: jointing or inserting bolt. Refer to Fig 5-5 for product specification:

Figure 5-5 fixing method



6 Peripherals components

Table 6-1 Peripherals components

Models	SN	Supplier	Website
MIC29302WU	D1	MICREL	www.micrel.com
UCLAMP0504A.TCT// NZQA5V6XV5T1G	D2	SEMTECH// ON	www.semtech.com www.onsemi.com
IDT74FCT3244Q8// PI74FCT3244Q	D3	PERICOM// IDT	www.pericom.com www.idt.com
SQPOFZ-40-S1-VB-0	X01	stwxe	www.stwxe.com.cn
QPOFY-10S1-VB-024	X02	stwxe	www.stwxe.com.cn
M-C707 10M006 097 2	X03	AMPHENOL	www.amphenol.com