MX680
Hardware Design V2.00

Document Title	MX680 Hardware Design
Version	2.00
Date	2014-05-12
Status	Release
Document Control ID	

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Date	Version	Description of change	Author
2013-11-13	1.00	Origin	lihui
2014-05-12	1.10	HD update	lihui
2015-10-10	2.00	HD update	Zhaohaijun

1. Introduction

This document describes MX680 hardware interface in great detail.
This document can help user to quickly understand MX680 interface specifications, electrical and mechanical details. With the help of this document and other MX680 application notes, user guide, users can use MX680 to design various applications quickly.

2. MX680 Overview

MX680 is a Quad-band GSM/GPRS engine that works at frequencies of GSM850MHz, GSM900MHz,DCS1800MHz and PCS1900MHz. The MX680 features GPRS multi-slot class 12 and supports the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4. For more details about GPRS multi-slot classes and coding schemes, please refer to the Appendix B & C.

With a tiny profile of 19.9mm×23.6mm×2.65mm, the module can meet almost all the requirements for M2M applications, including Vehicles and Personal Tracking, Security System, Wireless POS, Industrial PDA, Smart Metering, and Remote Maintenance & Control, etc.

MX680 is an SMD type module with LCC package, which can be easily embedded into applications. It provides abundant hardware interfaces like Audio and UART Interface.Designed with power saving technique, the current consumption of MX680 is as low as 1.1 mA in SLEEP mode when DRX is 5.

MX680 is integrated with Internet service protocols, such as TCP/UDP, FTP and PPP. Extended AT commands have been developed for you to use these Internet service protocols easily.

The module fully complies with the RoHS directive of the European Union.

2.1. MX680 Key Features

Table 1: MX680 key features

Feature	Implementation
Power supply	Single supply voltage: 3.4V~4.4V Typical supply voltage: 4V
Power saving	Typical power consumption in SLEEP mode: 1.1 mA@ DRX=5 0.9 mA@ DRX=9
Frequency bands	● Quad-band: GSM850, GSM900, DCS1800, PCS1900 ● The module can search these frequency bands automatically ● The frequency bands can be set by AT command

	● Compliant to GSM Phase 2/2+
Transmitting power	● Class 4 (2W)：GSM850、EGSM900 ● Class 1 (1W)：DCS1800、PCS1900
GPRS connectivity	● GPRS multi-slot class 12（default） ● GPRS multi-slot class 1~12 (option) ● GPRS mobile station class B
Temperature range	● Normal operation：-35℃ ～ +80℃ ● Restricted operation: -40°C ~ -35°C and +80°C ~ +85°C 1) ● Storage temperature：-45 ℃ +90 ℃
Data GPRS	● GPRS data downlink transfer: max. 85.6 kbps ● GPRS data uplink transfer: max. 85.6 kbps ● Coding scheme: CS-1, CS-2, CS-3 and CS-4 ● PAP protocol for PPP connect ● Integrate the TCP/IP protocol. ● Support Packet Broadcast Control Channel (PBCCH)
USSD	● Unstructured Supplementary Services Data (USSD) support
SMS	● MT, MO, CB, Text and PDU mode ● SMS storage: SIM card
SIM interface	Support SIM card: 1.8V, 3V
External antenna	Antenna pad, Bluetooth antenna pad, FM antenna pad
Audio features	Speech codec modes: ● Half Rate (ETS 06.20) ● Full Rate (ETS 06.10) ● Enhanced Full Rate (ETS 06.50 / 06.60 / 06.80) ● Adaptive multi rate (AMR) ● Echo Cancellation ● Noise Suppression）
Serial port and debug port	● Full modem interface with status and control lines, unbalanced, asynchronous. ● 1200bps to 115200bps. ● Can be used for AT commands or data stream. ● Support RTS/CTS hardware handshake and software ON/OFF flow control. ● Multiplex ability according to GSM 07.10 Multiplexer Protocol. ● Autobauding supports baud rate from 1200 bps to 57600bps. ● upgrading firmware
USB	● USB_DM and USB_DP ● Can be used for debugging and upgrading firmware.
SIM application toolkit	GSM 11.14 Release 99
Real time clock	Support RTC
Timing functions	Use AT command set
Size	19.9*23.6*2.65mm
Weight	2.8g
Firmware upgrade	Main serial port or USB port.

Note: When the module works within this temperature range, the deviations from the GSM

specification may occur. For example, the frequency error or the phase error will be increased

Table 2: Coding schemes and maximum net data rates over air interface

Coding scheme	1 Timeslot	2 Timeslot	4 Timeslot
CS-1:	9.05kbps	18.1kbps	36.2kbps
CS-2:	13.4kbps	26.8kbps	53.6kbps
CS-3:	15.6kbps	31.2kbps	62.4kbps
CS-4:	21.4kbps	42.8kbps	85.6kbps

2.2. Operating Mode

The table below summarizes the various operating modes of MX680.

Table 3: Overview of operating modes

Mode	Function	
Normal operation	GSM/GPRS SLEEP	Module will automatically go into sleep mode if the conditions of sleep mode are enabling and there is no on air and no hardware interrupt (such as GPIO interrupt or data on serial port). In this case, the current consumption of module will reduce to the minimal level. In sleep mode, the module can still receive paging message and SMS.
	GSM IDLE	Software is active. Module is registered to the GSM network, and the module is ready to communicate.
	GSM TALK	Connection between two subscribers is in progress. In this case, the power consumption depends on network settings such as DTX off/on, FR/EFR/HR, hopping sequences, antenna.
	GPRS IDLE	The module is not registered to GPRS network. The module is not reachable through GPRS channel.
	GPRS STANDBY	Module is ready for GPRS data transfer, but no data is currently sent or received. In this case, power consumption depends on network settings and GPRS configuration.
	GPRS READY	The PDP context is active, but no data transfer is ongoing. The module is ready to receive or send GPRS data. The SGSN knows the cell where the module is located at.
	GPRS DATA	There is GPRS data transfer (PPP or TCP or UDP) in progress. In this case, power consumption is related with network settings (e.g. power control level); uplink/downlink data rates and GPRS configuration (e.g. Used multi-slot settings).

Power down	Normal power down by sending AT command “AT+QPOWD=1” or using the PWRKEY. The power management unit shuts down the power supply for the baseband part of the module, and only the power supply for the RTC is remained. Software is not active. The serial port is not accessible. Power supply (connected to VBAT) remains applied.
Minimum functionality mode	AT command “AT+CFUN” can be used to set the module to a minimum functionality mode without removing the power supply. In this mode, the RF part of the module will not work or the SIM card will not be accessible, or both RF part and SIM card will be closed, and the serial port is still accessible. The power consumption in this mode is lower than normal mode.

2.3. Functional Diagram

The following figure shows a functional diagram of MX680:

- GSM baseband
- GSM RF
- Power management
- Antenna interface
- Other interface
- FM，BT

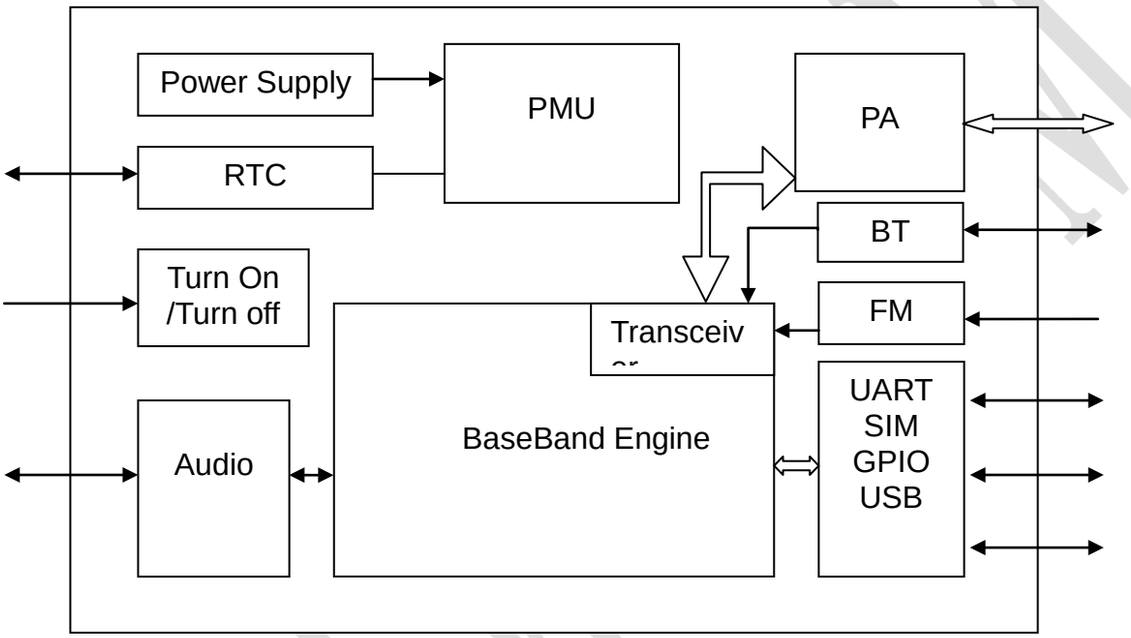

Figure 1: MX680 functional diagram

3. Package Information

3.1. Pin out Diagram

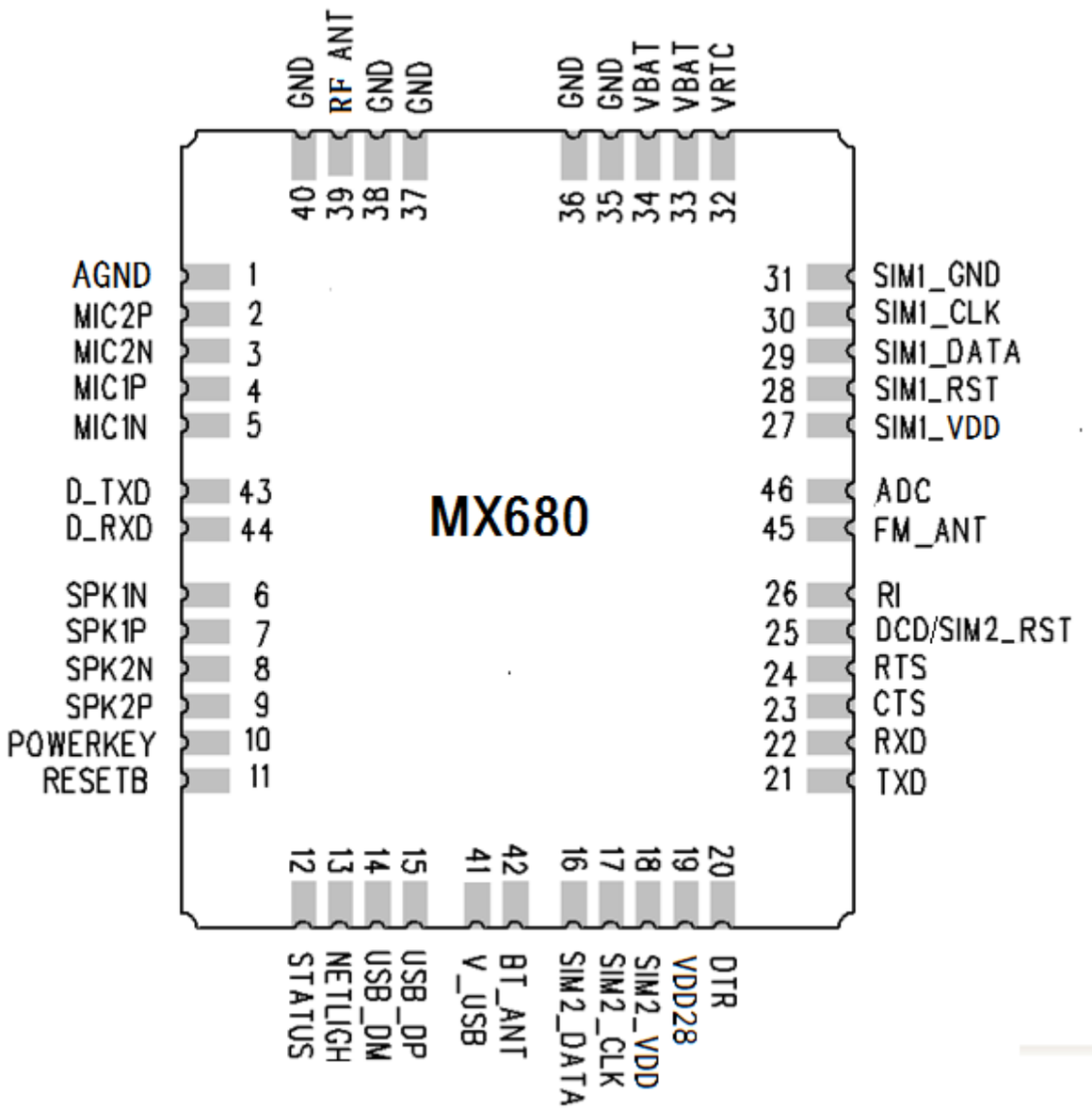

Figure 2: MX680 pin out diagram (Top view)

Table 4: MX680 pin assignment

Pin number	Pin name	I/O		Pin number	Pin name	I/O
1	AGND			2	MIC2P	I
3	MIC2N	I		4	MIC1P	I
5	MIC1N	I		6	SPK1N	O
7	SPK1P	O		8	SPK2N	O
9	SPK1N	O		10	PWRKEY	I
11	RESETB	I		12	STATUS	O
13	NETLIGHT	O		14	USB_DM	I
15	USB_DP	O		16	SIM2_DATA	A
17	SIM2_CLK	A		18	SIM2_VDD	A
19	VDD28	O		20	DTR	I
21	TXD	O		22	RXD	I
23	CTS	O		24	RTS	I
25	DCD/SIM2_RST	O		26	RT	O
27	SIM_VDD	O		28	SIM_RST	O
29	SIM_DATA	I/O		30	SIM_CLK	O
31	SIM_GND			32	VRTC	AI
33	VBAT	AI		34	VBAT	AI
35	GND			36	GND	
37	GND			38	GND	
39	RF_ANT	A		40	GND	
41	VBUS	I		42	NC	A
43	D_TXD	O		44	D_RXD	I
45	NC	A		46	ADC	

3.2. Pin Description

Table 5: Pin description

Power supply					
Pin name	Pin number	I/O	Description	DC characteristics	Comment
VBAT	33 34	AI	Power supply VBAT=3.4V～4.4V	Vmax=4.4V Vmin=3.4V Vnorm=4.0V	Make sure that supply sufficient current in a transmitting burst typically rises to 1.6A.
VRTC	32	AI	Power supply for RTC	VImax=VBAT VImin=2.6V	If these pins are unused,

				VInorm=2.8V VOmax=2.85V VOmin=2.6V VOnorm=2.8V Iout(max)=730uA Iin=2.6～5uA	keep open.
VDD28	19	O	2.8V power output	Vmax=2.9V Vmin=2.7V Vnorm=2.8V Imax=20mA	1.If these pins are unused, keep open. 2.Recommend to add a 2.2~4.7uF Bypass capacitor, when using this pin for power supply.
GND	35， 36，37， 38，40		Ground		
Power on/off					
Pin name	Pin number	I/O	Description	DC characteristics	Comment
PWRKEY	10	I	PWRKEY should be pulled low at least 1 second and then released to power on/down the module.	VILmax= 0.1*VBAT VIHmin= 0.6*VBAT VImax=VBAT	Internally pulled up to VBAT.
Reset					
Pin name	Pin number	I/O	Description	DC characteristics	Comment
RESETB	11	I/O	Reset inpu t(Active low)	VILmax=0.4V VIHmin=2.2V Vopenmax=2.8V	If these pins are unused, keep open.
Module Indicator					
Pin name	Pin number	I/O	Description	DC characteristics	Comment
STATUS	12	O	Indicate module's operating status. Output high level when module turns on, while output low level when module turns off.	VOHmin= 0.85*VDD_EXT VOLmax= 0.15*VDD_EXT	If these pins are unused,keep open.
Audio interfaces					
Pin name	Pin	I/O	Description	DC	Comment

	number			characteristics	
MIC1P MIC1N	4 5	I	Channel 1 positive and negative voice input		
MIC2P MIC2N	2 3	I	Channel 2 positive and negative voice input		
SPK1P SPK1N	7 6	O	Channel 1 positive and negative voice output		可单路输出
SPK2_P SPK2_N	9 8	O	Channel 2 positive and negative voice output		1. Integrate a Class-AB amplifier internally. 2. Support both Voice and ringtone output.
AGND	1		Analog ground , Separate ground connection for external audio circuits		If these pins are unused,keep open.
Network Status Indicator					
Pin name	Pin number	I/O	Description	DC characteristics	Comment
NETLIGHT	13	O	Network status indication	VOHmin= 0.85*VDD_EXT VOLmax= 0.15*VDD_EXT	If these pins are unused,keep open.
UART Port					
Pin name	Pin number	I/O	Description	DC characteristics	Comment
DTR	20	I	Data terminal ready	VILmin=-0.3V VILmax= 0.25*VDD_EXT VIHmin= 0.75*VDD_EXT VIHmax= VDD_EXT+0.3 VOHmin= 0.85*VDD_EXT VOLmax= 0.15*VDD_EXT	If only use TXD, RXD and GND to communicate, Recommended other pin open
TXD	21	O	Transmit data		
RXD	22	I	Receive data		
CTS	23	O	Clear to send		
RTS	24	I	Request to send		
DCD	25	O	Data carrier detect		
RI	26	O	Ring indicator		
D_TXD	43	O	Debug Transmit data		
D_RXD	44	I	Debug Receive data		
USB Port					
Pin name	Pin	I/O	Description	DC	Comment

	number			characteristics	
USB_DM	14		used for debugging and upgrading firmware.	VBUS_max=5.6V VBUS_min=4.4V VBUS_norm=5V	If these pins are unused,keep open.
USB_DP	15				
VBUS	41	I			
SIM card interface					
Pin name	Pin number	I/O	Description	DC characteristics	Comment
SIM1_VDD	27	O	Voltage supply for SIM1 card. Support 1.8V or 3V SIM card	3V_SIM: VOLmax=0.36 VOHmin= 0.9*SIM_VDD 1.8V_SIM: VOLmax= 0.2*SIM_VDD VOHmin= 0.9*SIM_VDD	All signals of SIM interface should be protected against ESD with a TVS diode array.
SIM1_RST	28	O	SIM1 reset		
SIM1_DATA	29	I/O	SIM1 data input/output		
SIM1_CLK	30	O	SIM1 clock		
SIM1_GND	31		SIM1 ground		
SIM2_DATA	16	I/O	SIM2 data		If these pins are unused,keep open.
SIM2_CLK	17	O	SIM2 clock		
SIM2_VDD	18	O	Voltage supply for SIM2 card		
SIM2_RST	25	O	SIM2 reset		
Antenna interface					
Pin name	Pin number	I/O	Description	DC characteristics	Comment
RF_ANT	39		Connect GSM antenna		

3.3. Package Dimensions

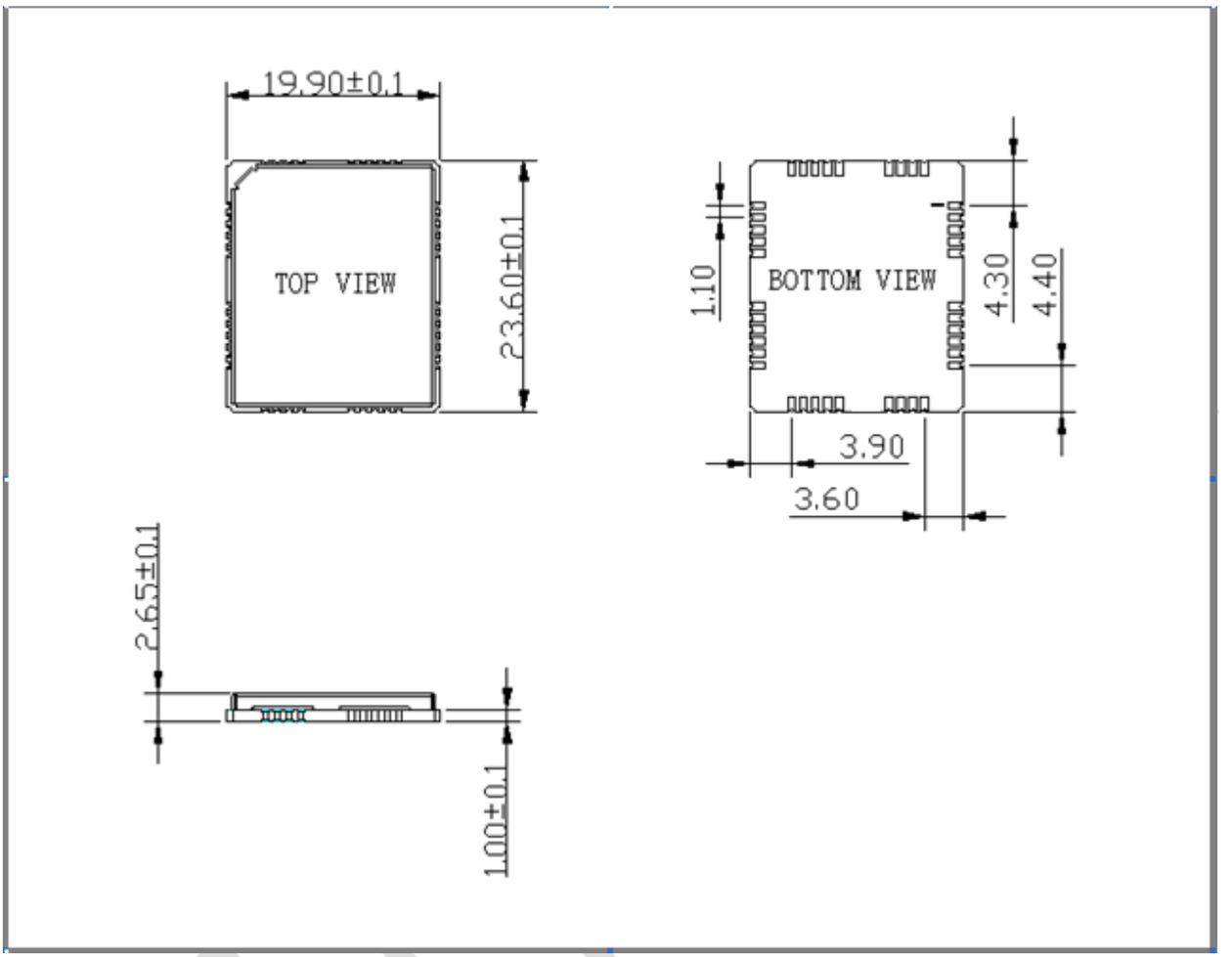

Figure 3: Dimensions of MX680 (Unit: mm)

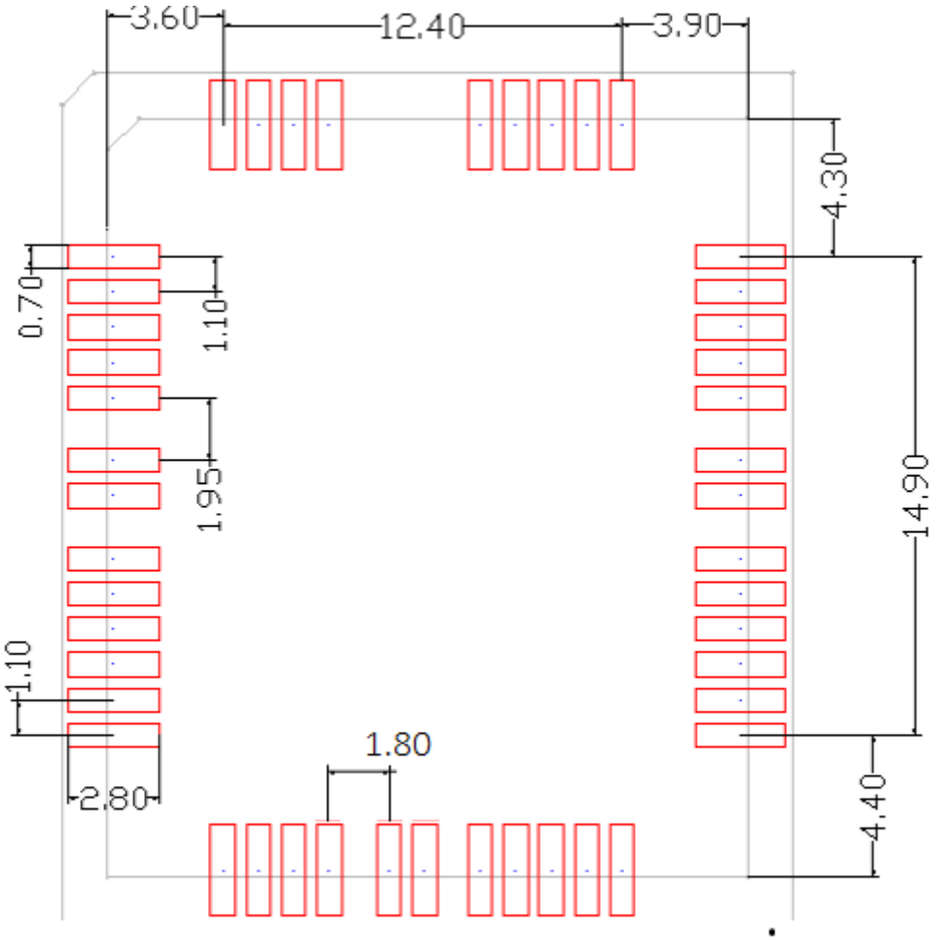

Figure 4: Recommended PCB footprint outline (Unit: mm)

4. Application Interface

4.1. Power Supply

The power supply range of MX680 is from 3.4V to 4.4V.Recommended voltage is 4.0V.The transmitting burst will cause voltage drop and the power supply must be able to provide sufficient current up to 2A. For the VBAT input, a bypass capacitor (low ESR) such as a 100 μF is strongly recommended.

Increase the 33PF and 10PF capacitors can effectively eliminate the high frequency interference. A 5.1V/500mW Zener diode is strongly recommended, the diode can prevent chip from damaging by the voltage surge. These capacitors and Zener diode should be placed as close as possible to MX680 VBAT pins.

The following figure is the reference design of +5V input power supply. The designed output for the power supply is 4.0V, thus a linear regulator can be used.

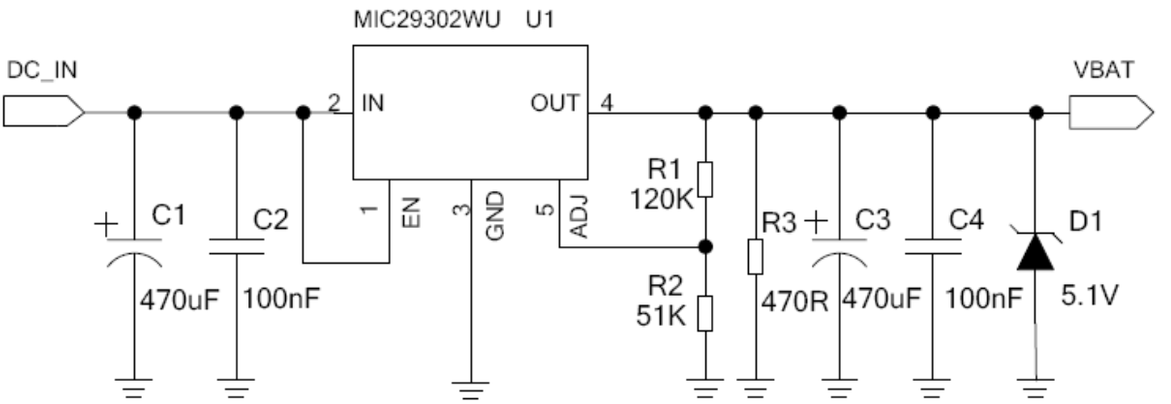

Figure 5: Reference circuit of the LDO power supply

If there is a high drop-out between the input and the desired output (VBAT), a DC-DC power supply will be preferable because of its better efficiency especially with the 2A peak current in burst mode of the module. The following figure is the reference circuit.

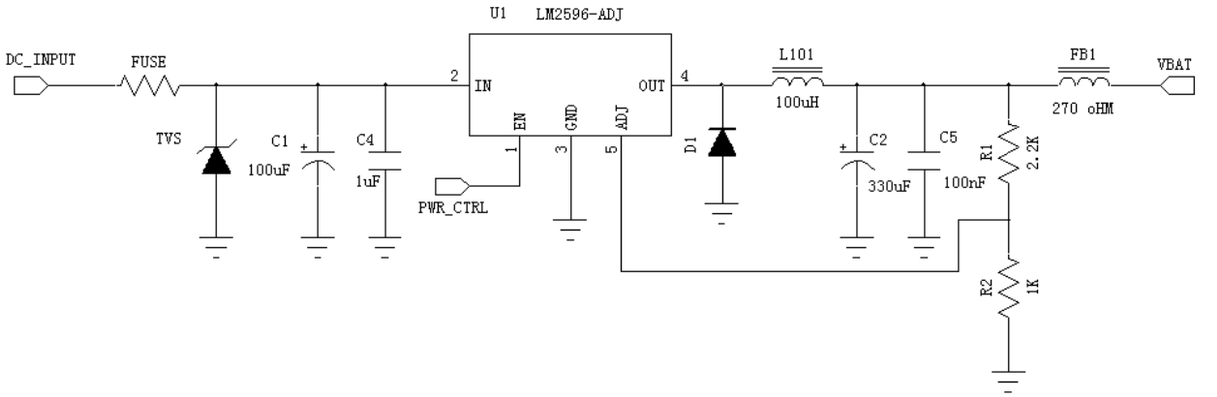

Figure 6: Reference circuit of the DC-DC power supply

The single 3.7V Li-ion cell battery can be connected to MX680 VBAT pins directly. But the Ni-Cd or Ni-MH battery must be used carefully, since their maximum voltage can rise over the absolute maximum voltage of the module and damage it

When battery is used, the total impedance between battery and VBAT pins should be less than 150mΩ. The following figure shows the VBAT voltage drop at the maximum power transmit phase, and the test condition is as following:

VBAT=4.0V,

A VBAT bypass capacitor CA=100μF tantalum capacitor (ESR=0.7Ω),

Another VBAT bypass capacitor CB=1μF.

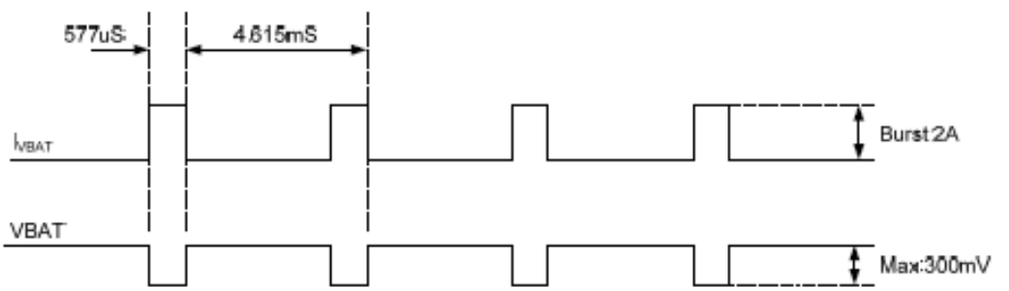

Figure 7: VBAT voltage drop during transmit burst

4.1.1. Power supply pin

Pin 33 and Pin 34 are VBAT input, Pins 36,37,38 are GND of power supply, VRTC pin is power supply of the RTC cicuit in the module.VDD28 output 2.8V when module is in normal operation mode.

When designing the power supply in user's application, pay special attention to power losses. Ensure that the input voltage never drops below 3.1V even when current consumption rises to 2A in the transmit burst. If the power voltage drops below 3.1V, the module may be shut down automatically. The PCB traces from the VBAT pins to the power supply must be wide enough (at least 60mil) to decrease voltage drops in the transmit burst. The power IC and the bypass capacitor should be placed to the module as close as possible.

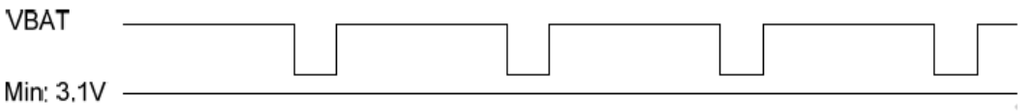

Figure 8: The minimal VBAT voltage requirement at VBAT drop

4.1.2. Monitoring Power Supply

AT command "AT+CBC" can be used to monitor the VBAT voltage. For detail, please refer to document [1].

4.2. Power on/down Scenarios

4.2.1. Power on MX680

User can power on MX680 by pulling down the PWRKEY pin for at least 1 second and release. This pin is already pulled up to VBAT in the module internal, so external pull up is not necessary. Reference circuit is shown as below.

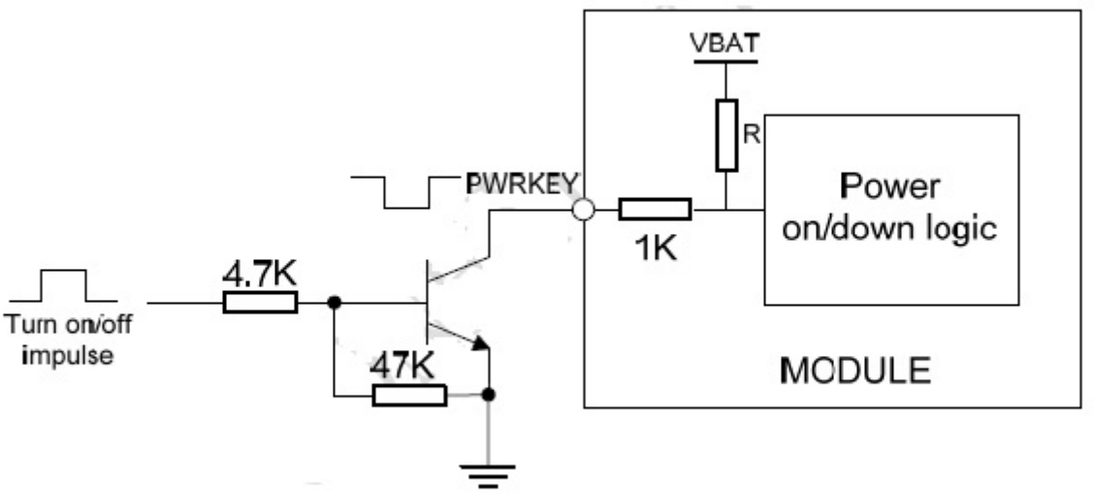

Figure 9: Powered on/down module using transistor

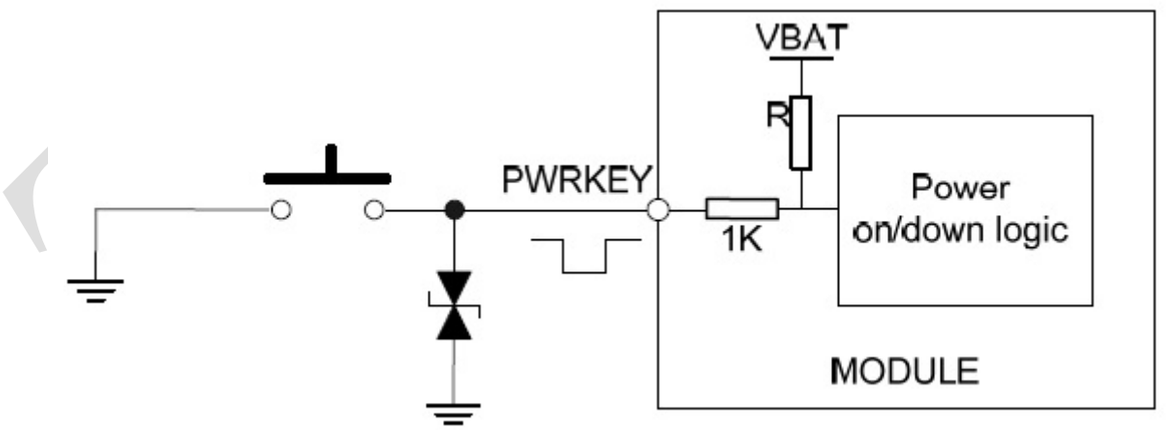

Figure 10: Powered on/down module using button

The power on timing is illustrated as in the following figure.

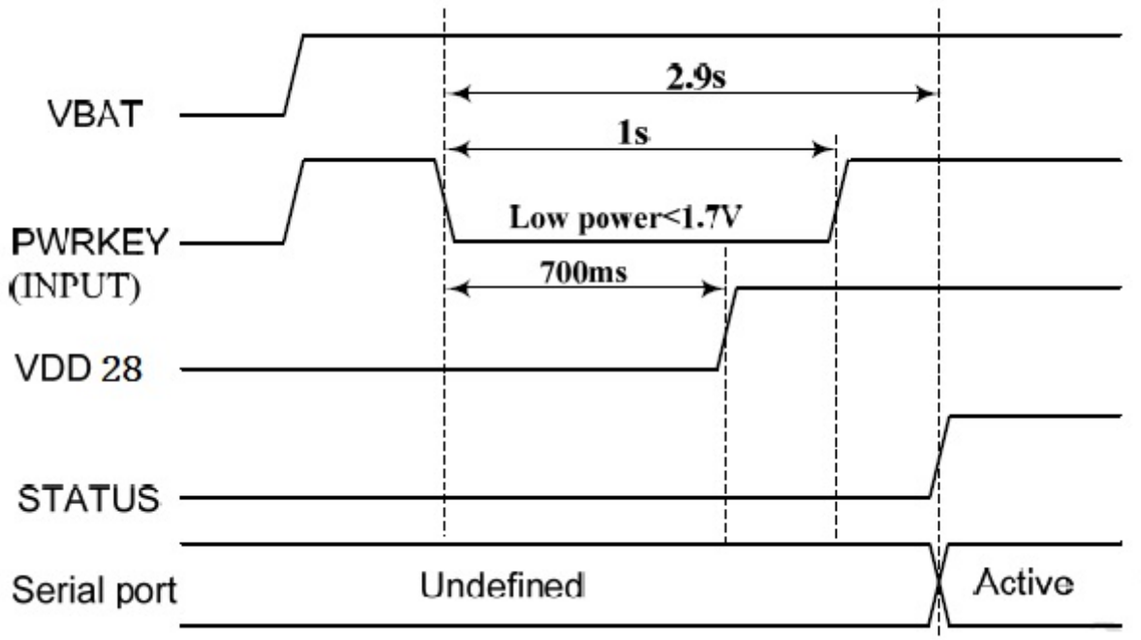

Figure 11: Timing of power on module

When power on procedure is completed, MX680 will send following URC to indicate that the module is ready to operate at fixed baud rate.

RDY

This URC does not appear when autobauding function is active.

Note: User can use AT command “AT+IPR=x” to set a fixed baud rate and save the configuration to non-volatile flash memory. After the configuration is saved as fixed baud rate, the Code “RDY” should be received from the serial port every time when MX680 is powered on. For details, please refer to the chapter “AT+IPR” in document [1].

4.2.2. Power down MX680

MX680 will be powered down in the following situations：

- Normal power down procedure: power down MX680 by the PWRKEY pin.。
- Normal power down procedure: power down MX680 by AT command “AT+QPOWD=1”.
- Abnormal power down: over-voltage or under-voltage automatic power down.
- Abnormal power down: over-temperature or under-temperature automatic power down.

4.2.2.1. Power down MX680 by the PWRKEY Pin

User can power down MX680 by pulling down the PWRKEY pin for at least 1 second and release. Please refer to the power on circuit. The power down timing is illustrated in the following figure.

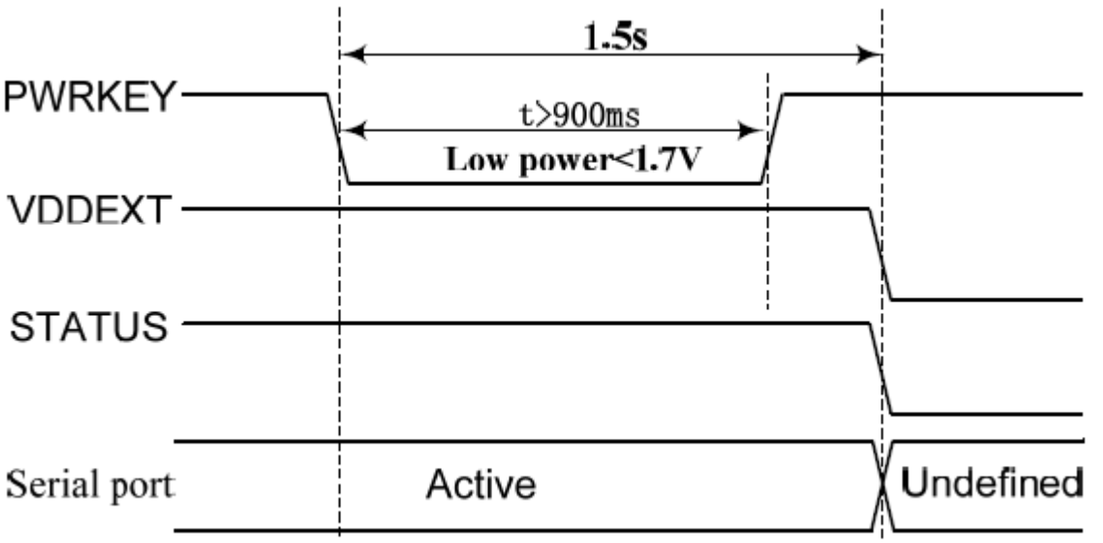

Figure 12: Timing of power down MX680 by PWRKEY

This procedure makes the module log off from the network and allows the software to enter into a secure state to save data before completely shut down.

Before the completion of the power down procedure, the module will send URC:

NORMAL POWER DOWN

At this moment, AT commands can not be executed any more, and only the RTC is still active. Power down mode can also be indicated by STATUS pin, which is at low level at this time.

4.2.2.2. Power down MX680 by AT Command

MX680 can be powered down by AT command “AT+QPOWD=1”. This procedure makes the module log off from the network and allows the software to enter into a secure state to save data before completely shut down.

Before the completion of the power down procedure, the module will send URC:

NORMAL POWER DOWN

At this moment, AT commands can not be executed any more, and only the RTC is still

active. Power down mode can also be indicated by STATUS pin, which is at low level at this time.

For detail about AT command “AT+QPOWD”, please refer to document [1].

4.2.2.3. Over-voltage or Under-voltage Power down

The module software monitors the VBAT voltage constantly.
If the voltage ≤ 3.5V, the following URC will be reported:

UNDER-VOLTAGE WARNNING

If the voltage ≥ 4.5V, the following URC will be reported:

OVER-VOLTAGE WARNNING

If the voltage < 3.3V, the following URC will be reported, and the module will be automatically powered down.

UNDER-VOLTAGE POWER DOWN

If the voltage > 4.6V, the following URC will be reported, and the module will be automatically powered down.

OVER-VOLTAGE POWER DOWN

At this moment, AT commands can not be executed any more, and only the RTC is still active.
Power down mode can also be indicated by STATUS pin, which is at low level at this time.

4.2.2.4. Over-temperature or Under-temperature Power down

The module will constantly monitor the temperature of the module,
If the temperature > +80 ℃, the following URC will be reported:

+CMTE: 1

If the temperature < -30 ℃, the following URC will be reported:

+CMTE:-1

If the temperature > +85 ℃, the followi
automatically powered down.

+CMTE: 2

If the temperature < -40 ℃, the followi
automatically powered down.

+CMTE:-2

At this moment, AT commands can not be executed any more, and only the RTC is still active. Power down mode can also be indicated by STATUS pin, which is at low level at this time.

Note： The default temperature detect is disable, AT command “AT+CMTE” could be used to read the temperature when the module is running.For details please refer to document [1].

4.3. Power Saving Mode

MX680 has two power saving modes: Minimum functionality mode and sleep mode. AT command“AT+QSCLK=1”can be used to set MX680 into sleep mode. AT command “AT+CFUN=<fun>“ can be used to set MX680 into minimum functionality. When MX680 is in sleep mode and minimum functionality mode, the current of module is lowest.

4.3.1. Minimum Functionality Mode

There are three functionality modes, which could be set by AT command “AT+CFUN=<fun>“. The command provides the choice of the functionality levels <fun>=0,1,4.

- AT+CFUN=0: Minimum functionality
- AT+CFUN=1: Full functionality (default).
- AT+CFUN=4: Flight mode (disable RF function). Minimum functionality mode

minimizes the current consumption to the lowest level. If MX680 is set to minimum functionality by “AT+CFUN=0”, the RF function and SIM card function will be disabled. In this case, the serial port is still accessible, but all AT commands correlative to RF function and SIM card function will not be accessible.

For detailed information about AT command “AT+CFUN=<fun>“, please refer to document [1].

4.3.2. Sleep Mode (AT+QSCLK=1)

User can control MX680 module to enter or exit the sleep mode (AT+QSCLK=1) by DTR signal. When DTR is in high level and without interrupt (on air and hardware such as GPIO interrupt or data in serial port), MX680 will enter sleep mode automatically. In this mode, MX680 can still receive paging or SMS from network but the serial port is not accessible.

Note: Autobauding is default. It cannot enter sleep mode in the absence of synchronous serial port baud rate after module power on.

4.3.3. Wake Up MX680 from Sleep Mode (AT+QSCLK=1)

When MX680 is in sleep mode (AT+QSCLK=1), the following methods can wake up the module:

- Pull down DTR pin.
  The serial port will be active after DTR pin is pulled to low level for about 50ms.
- Receive a voice or data call from network.
- Receive a SMS from network.
- Receive external interrupt

4.4. Serial Port and USB Interface

MX680 provides one unbalanced asynchronous serial ports. The module is designed as a DCE (Data Communication Equipment). The following figure shows the connection between module and client (DTE).

Table 6: Serial port and USB pin definition

	Pin name	Pin number	Function
Serial port	DTR	20	Data terminal ready
	RI	26	Ring indicator
	DCD	25	Data carrier detect
	CTS	23	Request to send
	RTS	24	Clear to send
	TXD	21	Transmit data
	RXD	22	Receive data
Debug port	D_TXD	43	Transmit data
	D_RXD	44	Receive data

Note: Hardware flow control is disable by default. AT command “AT+IFC=2,2”can enable hardware flow control. AT command “AT+IFC=0,0”can disable hardware flow control. For more details please refer to document [1]

Table 7: Serial port characteristics

Symbol	Min	Max	Unit
V_{IL}	-0.3	0.7	V
V_{IH}	2.1	3.1	V
V_{OL}	0	0.4	V
V_{OH}	2.4	-	V

4.4.1. Function of Serial Port

Serial port:

- Full mode device.
- Contains data lines TXD and RXD, hardware flow control lines RTS and CTS, status lines DTR, DCD and RI.
- Serial port can be used for CSD FAX, GPRS service and AT communication. It can also be used for multiplexing function. For details about multiplexing function, please refer to table 11.
- Serial port supports the following baud rates:
  1200, 2400, 4800, 9600, 19200, 38400, 57600 and 115200bps
- Autobauding only supports the following baud rates:
  1200, 2400, 4800, 9600, 19200, 38400 and 57600bps
- The default setting is autobauding.

Autobauding allows MX680 to automatically detect the baud rate of the host device. Pay more attention to the following requirements:

Synchronization between DTE and DCE:
When DCE powers on with autobauding enabled, it is recommended to send "AT" or "at" or "aT" or "At" to synchronize the baud rate, until DTE receives the "OK" response, which means DTE and DCE are correctly synchronized. For more information please refer to AT command "AT+IPR".

Restrictions of autobauding operation:
The DTE serial port must be set at 8 data bits, no parity and 1 stop bit.
The URC such as "RDY", "+CFUN: 1" and "+CPIN: READY" will not be reported.

Note: User can use AT command "AT+IPR=x" to set a fixed baud rate and the setting will be saved to non-volatile flash memory automatically. After the configuration is set as fixed baud rate, the URC such as "RDY", "+CFUN: 1" and "+CPIN: READY" will be reported when MX680 is powered on.

4.4.2. Serial Interfaces

The following figure shows the connection between module and client (DTE).

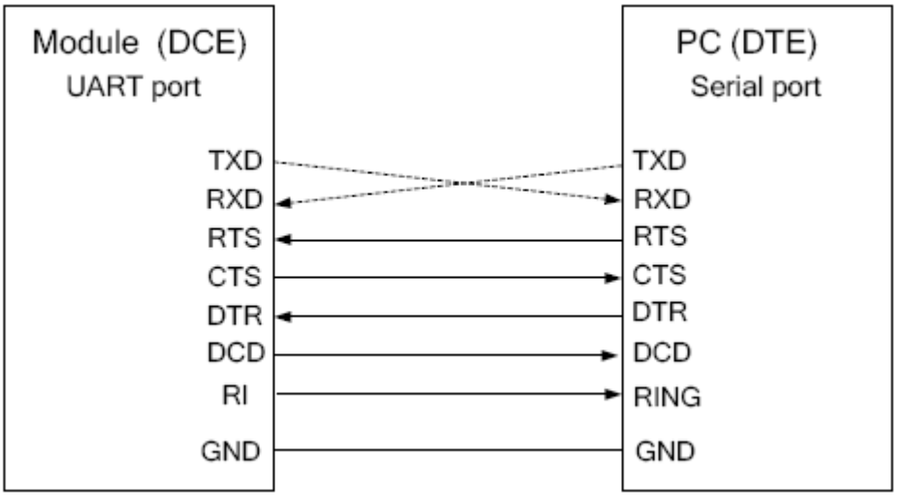

Figure 13: Connection of the serial interfaces

Three-line connection is shown as below.

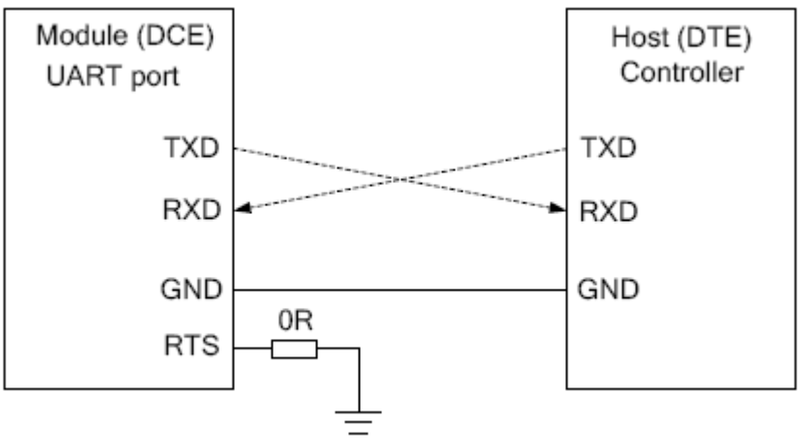

Figure 14: Reference Design for UART Port

UART Port with hardware flow control is shown as below. This connection will enhance the reliability of the mass data communication.

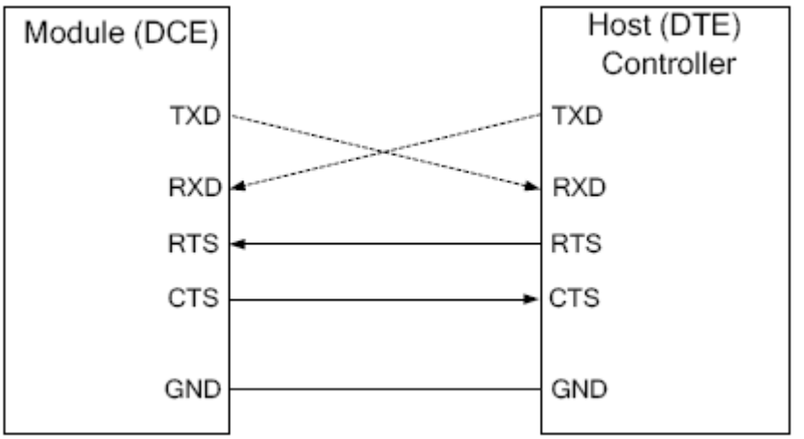

Figure 15: Reference Design for UART Port with Hardware Flow Control

4.4.3. Debug Interface

MX680 could achieve software debug function through USB interface. When powering on the module, connect VBUS,USB_DP,USB_DM, and GND to PC, then install the driver following the prompts, a UART port could be recognized by PC, customer could achieve the software Debug with this UART port.

ZhiwuCom recommendeds the following connected diagram:

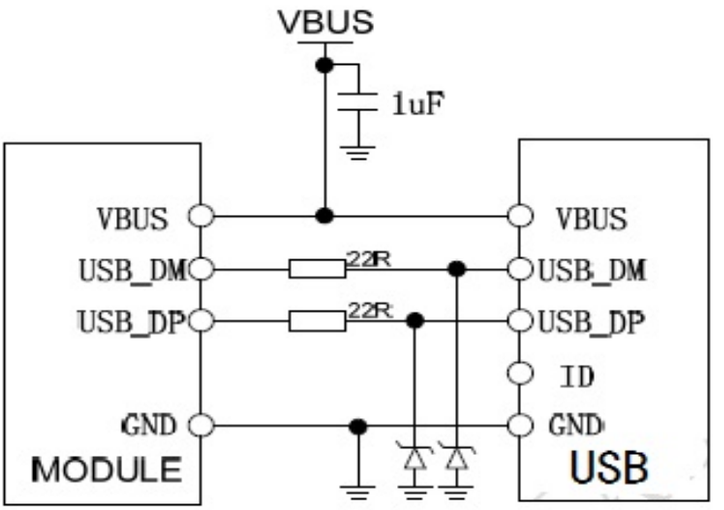

Figure 16: USB reference circuit

The TVS on USB data line should be less than 5pf, and traced by differential forms.

Note: please reserve the USB interface or test point for the further debugging

Table 8: VBUS operation voltage

Pin	Min	Typ	Max	Unit
VBUS	4.3	5	7	V

4.4.4. Software Upgrade and Debug

Customer could upgrade module's firmware through USB or UART interface.

If upgrading through USB port, it is necessary to power on MX680 first, then connect VBUS, USB_DP, USB_DM, and GND to PC. There is no need to operate PWRKEY pin in the whole procedure, when MX680 detects VBUS and could communicate normally with USB_DP and USB_DM, it will enter USB download mode automatically.

Note: When only USB_DP and USB_DM are connected, no VBUS, customer need to pull down COL0(pin20) before power on the module, then press the PWRKEY button, the module will enter download mode;

If customer upgrades the software through UART port, it is strongly recommended to lead the D_TXD, D_RXD, GND and PWRKEY pin to IO connector for the upgrading, and PWRKEY pin should connect to GND while upgrading. Refer to the following figure for debugging and upgrading software.

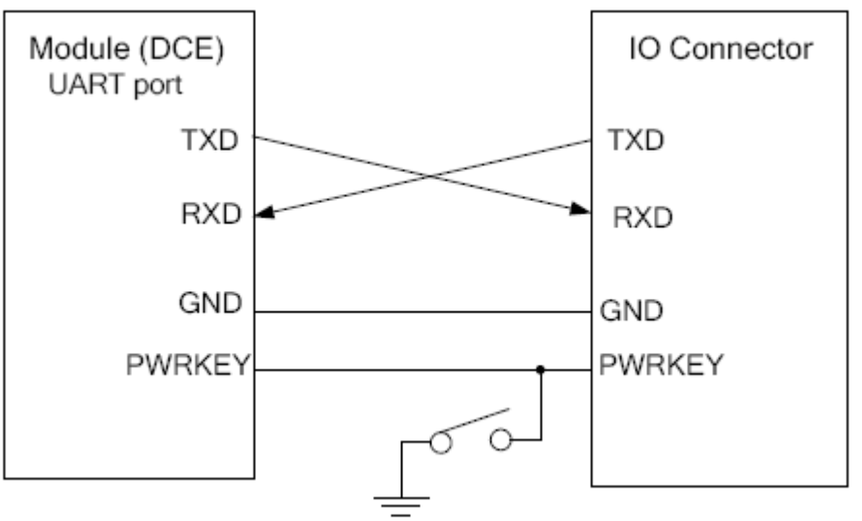

Figure 17: Connection for software upgrading and debugging

The serial port and the debug port support the CMOS level. If user connects the module to the computer, the level shifter should be added between the DCE and DTE.

4.4.4. UART Application

The reference design of 3.3V level match is shown as below. If the host is a 3V system, please change the 5.6K resistor to 10K.

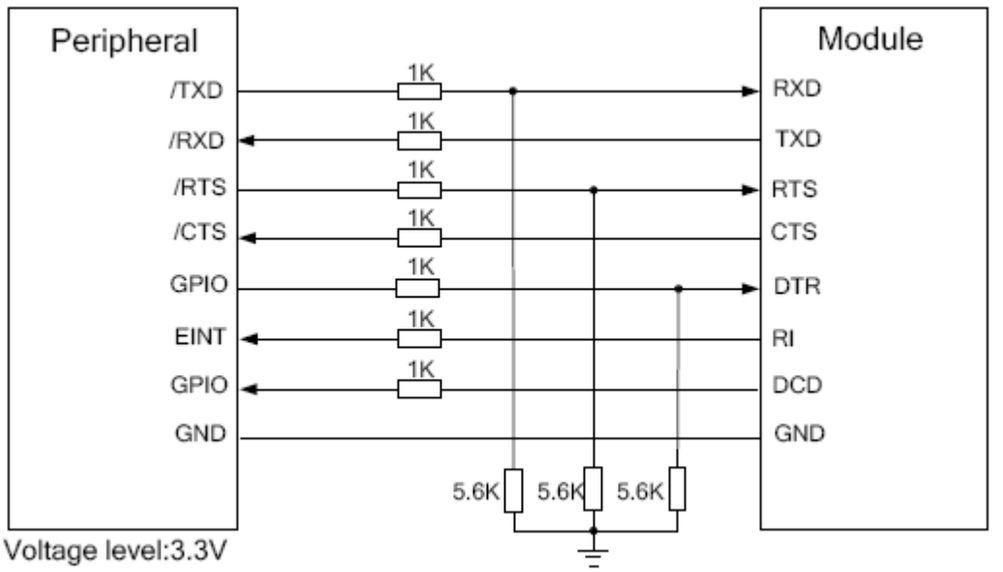

Figure 18: Level Match Design for 3.3V System

The reference design for 5V level match is shown as below. The connection of dotted line can be referred to the connection of solid line. Please pay attention to the direction of signal. Input dotted line of module should be referred to input solid line of the module. Output dotted line of module should be referred to output solid line of the module.

As to the circuit below, VDD_EXT supplies power for the I/O of module, while VCC_MCU supplies power for the I/O of the peripheral.

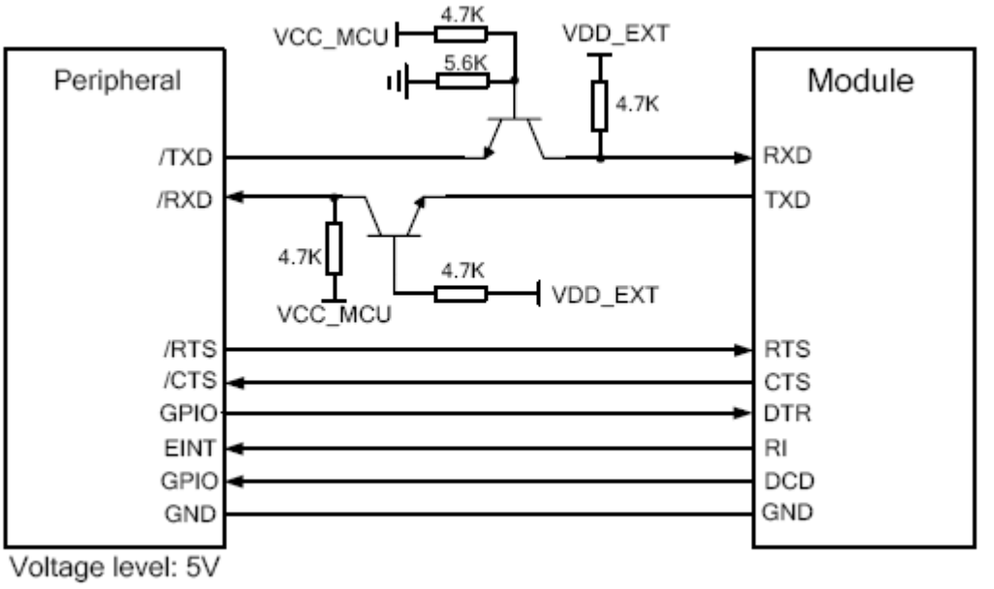

Figure 19: Level Match Design for 5V System

The following circuit shows a reference design for the communication between module and PC. Since the electrical level of module is 2.8V, so a RS-232 level shifter must be used.

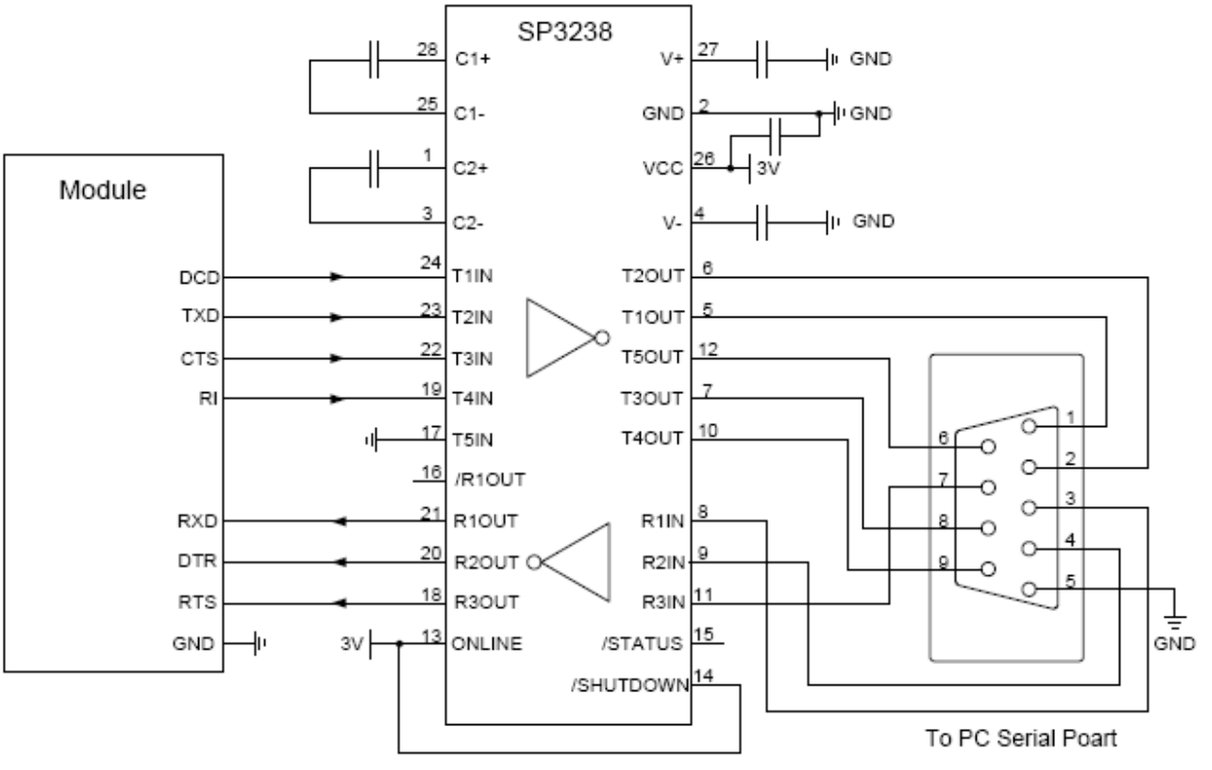

Figure 20: Level Match Design for RS-232

4.5. SIM Card Interface

The SIM interface complies with the GSM Phase 1 specification and the new GSM Phase 2+ specification for FAST 64 kbps SIM card. Both 1.8V and 3.0V SIM card are supported. The SIM interface is powered from an internal regulator in the module.

4.5.1. SIM Card Application

Table 9: SIM pin definition

Pin name	Pin number	功能
SIM1_VDD	27	Voltage supply for SIM1 card. Support 1.8V or 3V SIM card
SIM1_RST	28	SIM1 reset
SIM1_ DATA	29	SIM1 data input/output
SIM1_CLK	30	SIM1clock
SIM2_ DATA	17	SIM2 data input/output
SIM2_CLK	18	SIM2 clock
SIM2_VDD	19	Voltage supply for SIM2 card. Support 1.8V or 3V SIM card
SIM2_RST	25	SIM2 reset

The reference circuit for a 6-pin SIM card socket is illustrated as the following figure.

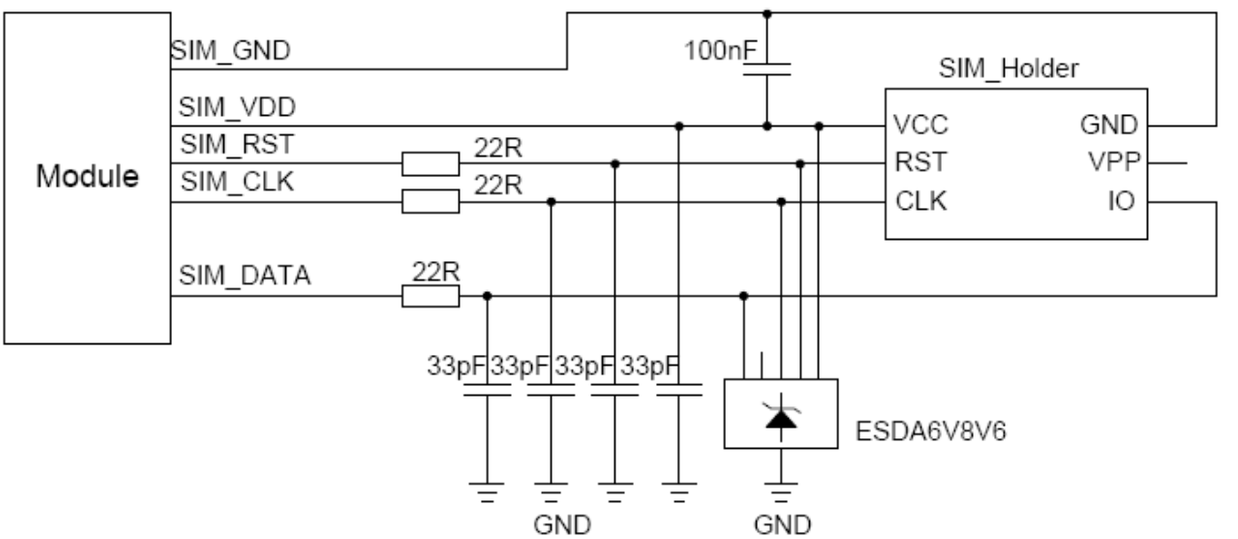

Figure 21: Reference Circuit for 6-pin SIM Card Holder

In order to enhance the reliability and availability of the SIM card in application. Please follow the below criterion in the SIM circuit design.

- Keep layout of SIM card as close as possible to the module. Assure the possibility of the length of the trace is less than 200mm.
- Keep SIM card signal away from RF and VBAT alignment.
- Assure the ground between module and SIM cassette short and wide. Keep the width of ground no less than 0.5mm to maintain the same electric potential. The decouple capacitor of SIM_VDD is less than 1uF and must be near to SIM cassette.
- To avoid cross talk between SIM_DATA and SIM_CLK. Keep them away with each other and shield them with surrounded ground
- In order to offer good ESD protection, it is recommended to add TVS such as WILL (http://www.willsemi.com/) ESDA6V8AV6. The 22Ω resistors should be connected in series between the module and the SIM card so as to suppress the EMI spurious transmission and enhance the ESD protection. Please to be noted that the SIM peripheral circuit should be close to the SIM card socket.
- Place the RF bypass capacitors (33pF) close to the SIM card on all signals line for improving EMI.

4.5.2.6 Pin SIM Cassette

As to the 6-pin SIM card holder, it is recommended to use Amphenol C707 10M006 512 2. Please visit http://www.amphenol.com for more information.

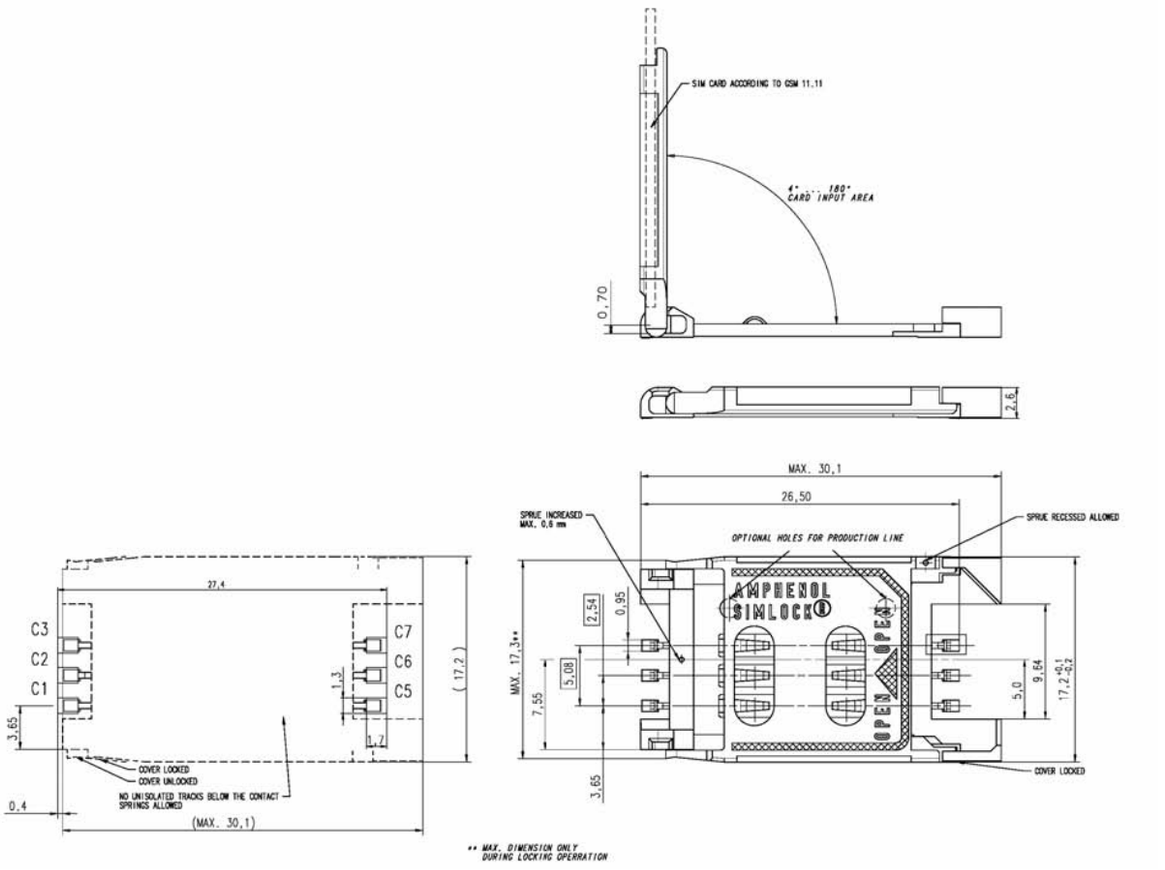

Figure 22: Amphenol C707 10M006 512 2 SIM Card Holder

Table 10: Pin Description of Amphenol SIM Card Holder

Pin	name	Description
C1	SIM_VDD	SIM card power supply
C2	SIM_RST	SIM card reset
C3	SIM_CLK	SIM card clock
C5	GND	Ground
C6	VPP	Not connected
C7	SIM_DATA	SIM card data I/O

4.6. RI Behaviors

Table 11: RI behaviors

State	RI response
Standby	High
Voice call	The pin is changed to low. When any of the following events occur, the pin will be changed to high: （1）Establish the call （2）Hang up the call
Data call	The pin is changed to low. When any of the following events occur, the pin will be changed to high: （1）Establish the call （2）Hang up the call
SMS	The pin is changed to low, and kept low for 120ms when a SMS is received. Then it is changed to high.
URC	The pin is changed to low, and kept low for 120ms when some URCs are reported. Then it is changed to high. For more details, please refer to document [10].

NOTE: If URC of SMS is disabled, the RI will not change.

If the module is used as a caller, the RI would maintain high except the URC or SMS is received. On the other hand, when it is used as a receiver, the timing of the RI is shown below.

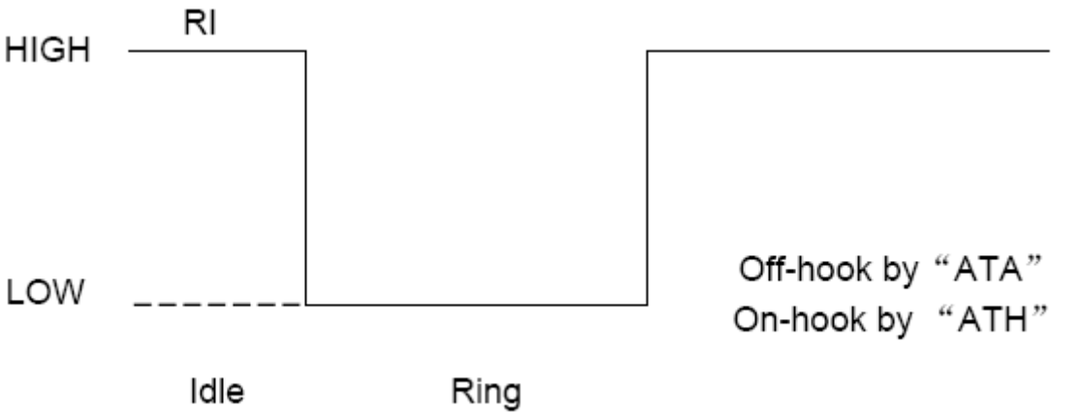

Figure 23: RI Behavior of Voice Calling as a Receiver

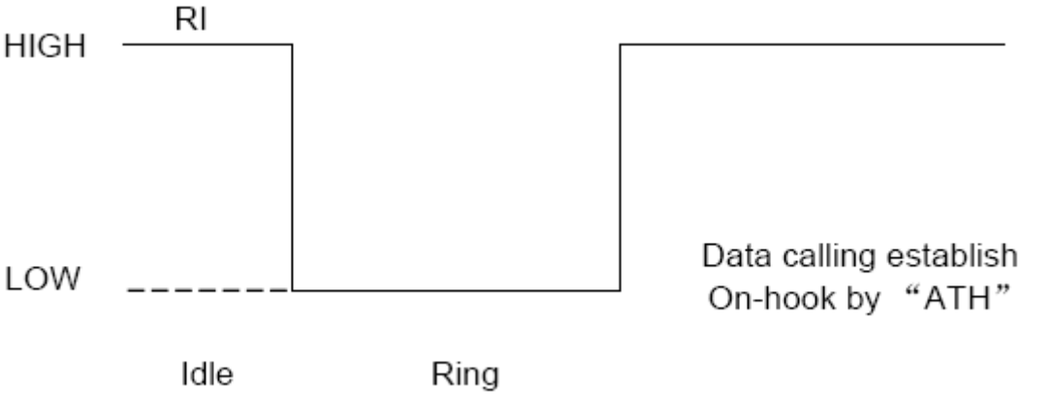

Figure 24: RI Behavior of Data Calling as a Receiver

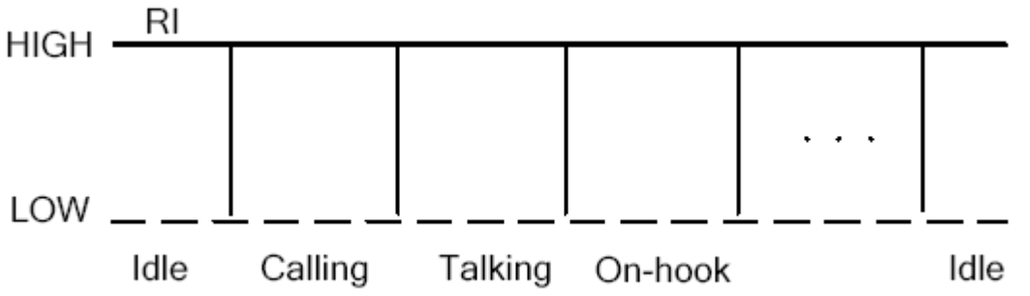

Figure 25: RI Behavior as a Caller

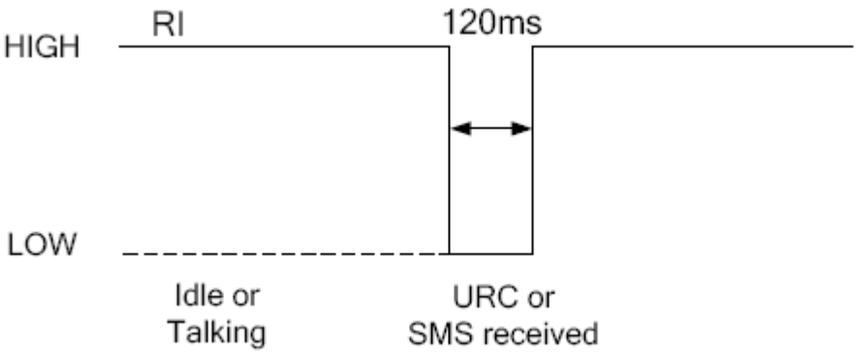

Figure 26: RI Behavior of URC or SMS Received

4.7. Network Status Indication

The NETLIGHT pin can be used to drive a network status indication LED. The status of this pin is listed in following table:

Table 12: Working State of the NETLIGHT

State	Module function
Off	The module is not running.
64ms On/ 800ms Off	The module is not synchronized with network.
64ms On/ 3000ms Off	The module is synchronized with network.
64ms On/ 300ms Off	The GPRS data transmission after dialing the PPP connection.

A reference circuit is shown as below

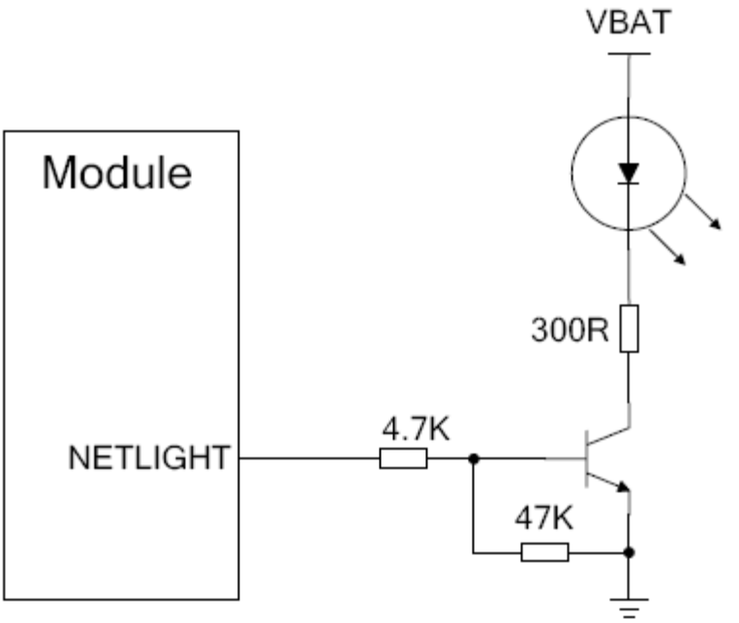

Figure 27: Reference Design for NETLIGHT

4.8. Operating Status Indication

The STATUS pin is set as an output pin and can be used to judge whether or not module is power-on. In the design, this pin can be connected to a GPIO of DTE or be used to drive an LED in order to judge the module's operation status. A reference circuit is shown in below.

Table 13: Pin Definition of the STATUS

Name	Pin	Description
STATUS	12	Indicate module operating status

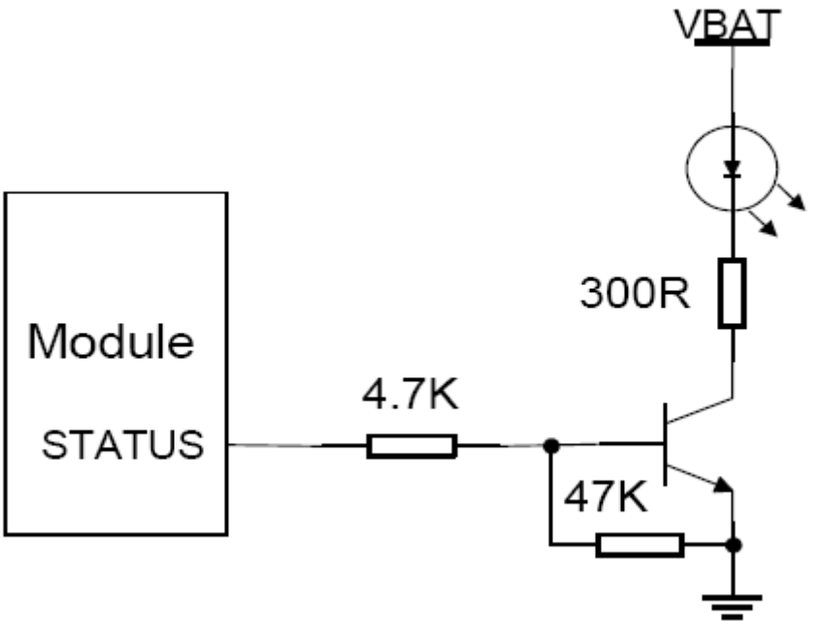

Figure 28: Reference Design for STATUS

4.8. Antenna Interface

There are three antenna ports for MX680, GSM antenna port named RF_ANT, Bluetooth antenna port named BT_ANT and FM antenna port named FM_ANT_P/ FM_ANT_N, The RF interface of the three antenna ports has an impedance of 50Ω.

- The input impendence of the antenna should be 50Ω, and the VSWR should be less than 2.
- It is recommended that the GSM antenna and the BT antenna should be placed as far as possible.
- The isolations of the three antenna should be bigger than 30db

4.8.1. Antenna Interface

There is a GSM antenna pad named RF_ANT for MX680, the connection of the antenna must be decoupled from DC voltage. This is necessary because the antenna connector is DC coupled to ground via an inductor for ESD protection.

The external antenna must be matched properly to achieve best performance, so the matching circuit is necessary, the connection is recommended as following:

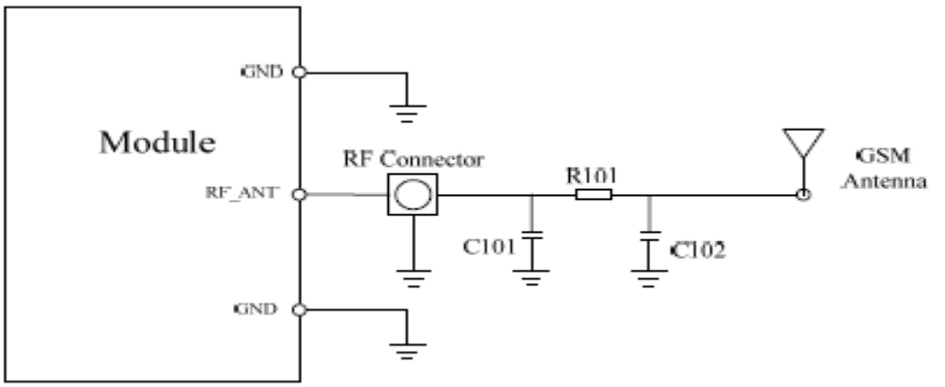

Figure 29: GSM antenna matching circuit

R101 , C101 , C102 are the matching circuit, the value should be defined by the antenna design. Normally R101 is 0Ω, C101 and C102 are not mounted. The RF connector is used for conduction test. If the space between RF pin and antenna is not enough, the matching circuit should be designed as in the following figure:

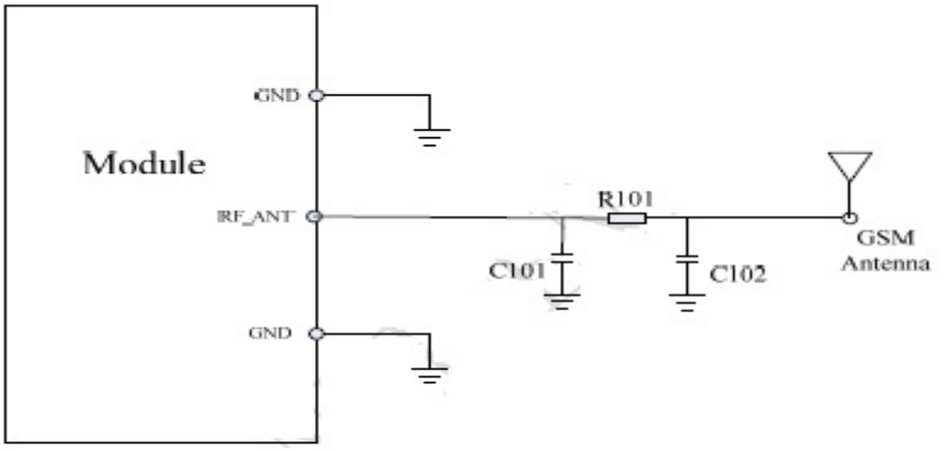

Figure 30: GSM simple antenna matching circuit

Normally R101 is 0Ω, C101 and C102 are not mounted.

4.9. Audio Interfaces

Table 14: Audio interface definition

Pin number	Pin Name	I/O	Description
4 5	MIC1P MIC1N	I	Channel 1 Microphone input
2 3	MIC2P MIC2N	I	Channel 2 Microphone input
7 6	SPK1P SPK1N	O	Channel 1 Audio output
1	AGND	AGND	Form a pseudo-differential pair with SPK2P
8 9	SPK2P SPK2N	O	Channel 2 Audio output
43 44	ER_L ER_R	I	Earphone output

SPK1N/P is used for output of the receiver.which can be used as a single-ended channel.
SPK2N/P is used for loudspeaker output as it embedded an amplifier of class AB
ER_L/P can be used for output of earphone, which can be used as a single-ended channel.

Audio interfaces are all differential input channels.

In order to improve audio performance, the following reference circuits are recommended. The audio signals have to be layout according to differential signal layout rules as shown in following figures.

4.9.1 Microphone Interfaces Configuration

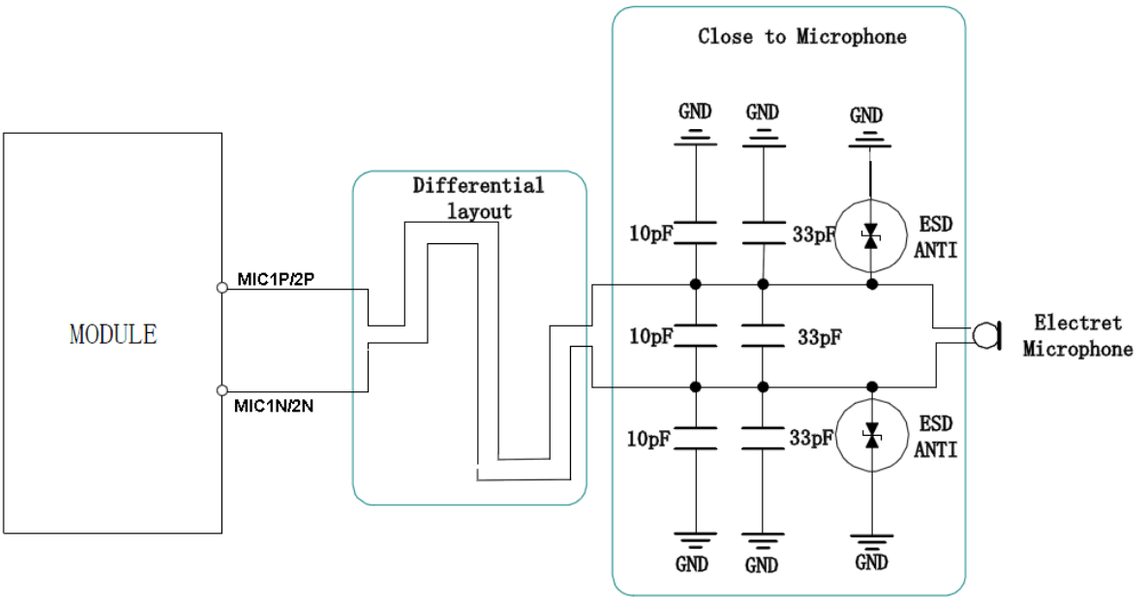

Figure 31: Speaker with amplifier reference circuit

4.9.2 Speaker Interfaces Configuration

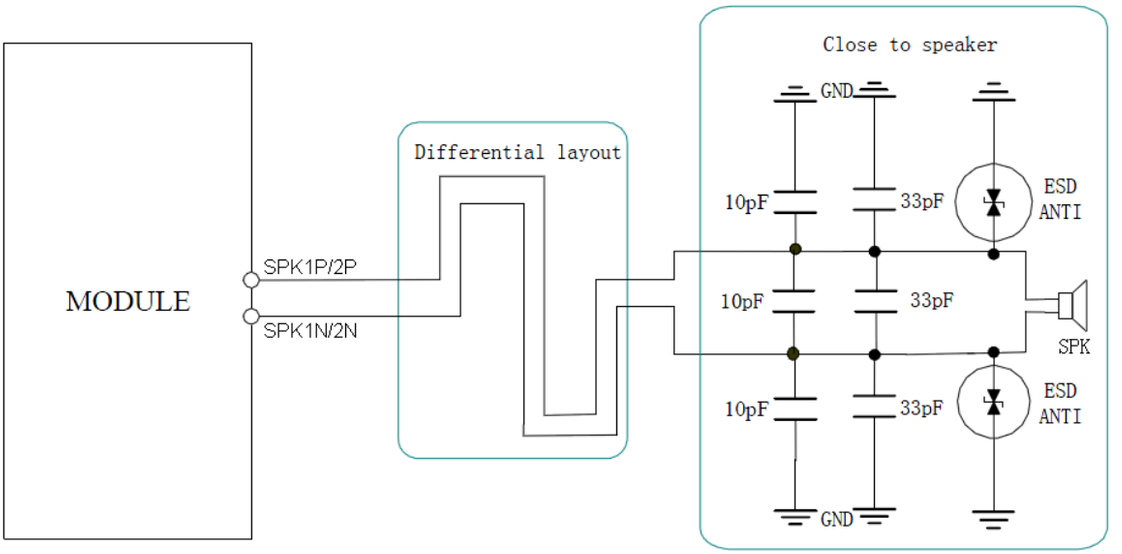

Figure 32: Speaker reference circuit

4.9.3 Earphone Interfaces Configuration

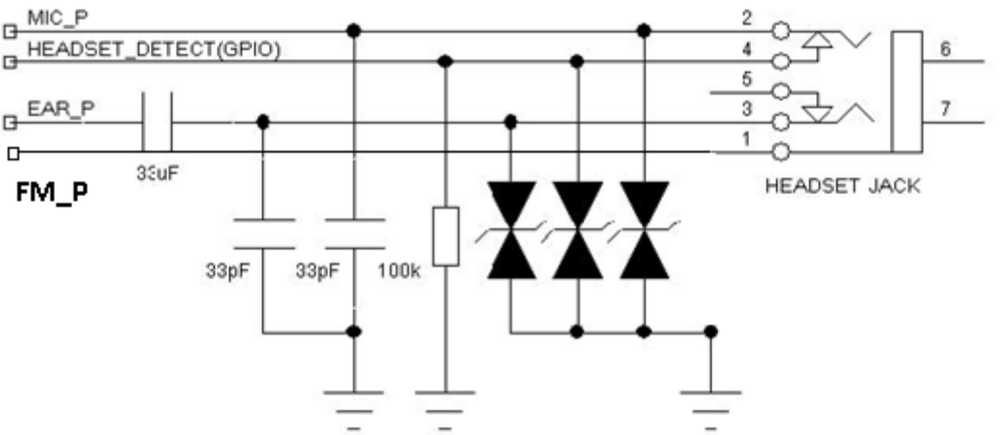

Figure 33: Earphone reference circuit

4.9.4 Audio Electronic Characteristic

Table 15: Microphone input characteristics

Parameter		Min	Typ	Max	Unit
Working voltage		1.2	1.5	2.0	V
Working current		200	-	500	uA
Input impedance(differential)		1.2	2.2		KΩ
Microphone biasing voltage			1.9	2.2	V
SINAD	THD <1% at F=1KHz; pre-amp gain = 20 dB; PGA gain = 14 dB		15.9		mVrms
	THD<5%at F=1KHz; pre-amp gain = 0 dB; PGA gain = 0 dB		740		mVrms

Table 16: Audio output characteristics

Parameter	Conditions	Min	Max	Max	Unit
Normal output(SPK)	RL=32Ω THD=0.1%	-	91	-	mW
	RL=8Ω		500	850	mW

	THD=1%				
	Output swing voltage			4.2	Vpp

4.9.5 TDD

GSM signal could interfere audio by coupling or conducting. Coupling noise could be filtered by adding 33pF and 10pF capacitor over audio lines. 33pF capacitor could eliminate noise from GSM850/EGSM900MHz, while 10pF capacitor could eliminate noise from DCS1800/PCS1900Mhz frequency. Coupling noise should have something to do with PCB layout. Under some scenarios, TDD noise from GSM850/EGSM900MHz frequency affects heavily, but some different story is from DCS1800/PCS1900Mhz frequency, so customer should develop this filter solution according to field test result.

GSM antenna is the key coupling interfering source of TDD noise. Thereat, pay attention to the layout of audio lines which should be far away from RF cable and antenna and VBAT pin. The bypass capacitor for filtering should be placed near module and another group need to be placed near to connector.

Conducting noise is mainly caused by the VBAT drop. If audio PA was powered by VBAT directly, then there will be some cheep noise from speaker output easily. So it is better to put big capacitor and ferrite bead near audio PA input.

TDD noise has something to do with GND signal surely. If GND signal issued is not good, lots of high-frequency noises will interfere microphone and speaker over bypass capacitor. So care of good GND during PCB layout need to be taken.

5. Electrical, Reliability and Radio Characteristics

5.1 Absolute Maximum Ratings

The absolute maximum ratings stated in following table are stress ratings under non-operating conditions. Stresses beyond any of these limits will cause permanent damage to MX680.

Table 17: Absolute maximum ratings

Symbol	Min	Typ	Max	Unit
VBAT	-	-	4.5	V
Current	0	-	2.0	A
VBUS			30	V
II*	-	-	8	mA
IO*	-	-	8	mA

*These parameters are for digital interface pins, such as keypad, GPIO, I2C, UART, LCD and PCM.

5.2 Operating Temperature

The operating temperature is listed in the following table:

Table 18: Operating Temperature

Symbol	Min	Typ	Max	Unit
Normal operation	-35	+25	+80	℃
Restricted operation:	-40 ~ -35		+80 ~ +85	℃
Storage temperature	-45		+90	℃

NOTE: When the module works within this temperature range, the deviation from the GSM specification may occur. For example, the frequency error or the phase error will be increased.

5.3 Digital Interface Characteristics

Table 19: Digital interface characteristics

Symbol	Parameter	Min	Typ	Max	Unit
V_{IH}	High-level input current	2.1	-	3.1	V
V_{IL}	Low-level input current	-0.3	-	0.7	V
V_{OH}	High-level output voltage	2.4	-	-	V
V_{OL}	Low-level output voltage	-	-	0.4	V

*These parameters are for digital interface pins, such as keypad, GPIO, I2C, UART, LCD and PCM.

5.4 SIM Card Interface

Table 20: 3V SIM

Symbol	Parameter	Min	Typ	Max	Unit
I_{IH}	High-level input current	-1	-	1	mA
I_{OL}	Low-level input current	-1	-	1	mA
V_{IH}	High-level input voltage	2.4	-	-	V
V_{IL}	Low-level input voltage	-	-	0.4	V
V_{OH}	High-level output voltage	2.7	-	-	V
V_{OL}	Low-level output voltage	-	-	0.4	V

Table 21: 1.8V SIM

Symbol	Parameter	Min	Typ	Max	Unit
I_{IM}	High-level input current	-1	-	1	mA
I_{OM}	Low-level input current	-1	-	1	mA
V_{IH}	High-level input voltage	1.4	-	-	V
V_{IL}	Low-level input voltage	-	-	0.27	V
V_{OH}	High-level output voltage	1.62	-	-	V
V_{OL}	Low-level output voltage	-	-	0.36	V

5.5 SIM_VDD Characteristics

Table 22: SIM_VDD characteristics

Symbol	Parameter	Min	Typ	Max	Unit
VO	Output voltage	-	3.0	-	V
		-	1.8	-	
IO	Output voltage	-	-	10	mA

5.6 VDD_EXT Characteristics

Table 23: VDD_EXT Characteristics

Symbol	Parameter	Min	Typ	Max	Unit
VO	Output voltage	2.7	2.8	2.9	V
IO	Output current	-	-	50	mA

5.7 Current Consumption(VBAT=4.0V)

Table 24: Current consumption

Symbol	Parameter	Conditions			measured value	Unit
I_{VBAT}	Average currnet	Power down mode			133	uA
		Sleep mode	BS-PA-MFRMS=9		1.6	mA
			BS-PA-MFRMS=5		1.7	
			BS-PA-MFRMS=2		2.6	
		Idle mode	GSM850		21	mA
			EGSM 900			
			DCS 1800			
			PCS1900			
		Voice call	GSM850	PCL=5	235	mA
				PCL=12	105	
				PCL=19	75	
			GSM900	PCL=5	275	mA
				PCL=12	110	
				PCL=19	75	
			DCS180	PCL=0	162	mA

			0	PCL=7	88	
				PCL=15	70	
			PCS1900	PCL=0	145	mA
				PCL=7	80	
				PCL=15	68	
		Data mode GPRS(1RX,4TX)	GSM850	PCL=5	506	mA
				PCL=12	221	
				PCL=19	115	
			EGSM900	PCL=5	605	mA
				PCL=12	255	
				PCL=19	115	
			DCS1800	PCL=0	328	mA
				PCL=7	162	
				PCL=15	98	
			PCS1900	PCL=0	306	mA
				PCL=7	155	
				PCL=15	99	
		Data mode GPRS(4RX,1TX)	GSM850	PCL=5	215	mA
				PCL=12	95	
				PCL=19	65	
			EGSM900	PCL=5	256	mA
				PCL=12	108	
				PCL=19	68	
			DCS1800	PCL=0	155	mA
				PCL=7	80	
				PCL=15	65	
			PCS1900	PCL=0	145	mA
				PCL=7	80	
				PCL=15	66	
		Data mode GPRS(3RX,2TX)	GSM850	PCL=5	362	mA
				PCL=12	145	

				PCL=19	92	
			EGSM900	PCL=5	428	mA
				PCL=12	159	
				PCL=19	95	
			DCS1800	PCL=0	245	mA
				PCL=7	115	
				PCL=15	83	
			PCS1900	PCL=0	225	mA
				PCL=7	113	
				PCL=15	98	
$I_{VBAT-peak}$	Peak current	During Tx burst			2	A

5.8 Electro-Static Discharge

MX680 is an ESD sensitive component, so attention should be paid to the procedure of handling and packaging. The ESD test results are shown in the following table.

Table 25: The ESD characteristics (Temperature: 25 ℃, Humidity: 45 %)

Pin name	Contact discharge	Air discharge
VBAT	±5KV	±10KV
GND	±5KV	±10KV
RXD, TXD	±3KV	±6KV
Antenna port	±5KV	±10KV
PWRKEY	±4KV	±8KV

5.9 Radio Characteristics

5.9.1. Module RF Output Power

The following table shows the module conducted output power, it is followed by the 3GPP TS 05.05 technical specification requirement.

Table 26: GSM850 and EGSM900 conducted RF output power

GSM850/EGSM 900			
PCL	Nominal output ower (dBm)	Tolerance (dB) for conditions	
		Normal	Extreme
5	33	±2	±2.5
6	31	±3	±4
7	29	±3	±4
8	27	±3	±4
9	25	±3	±4
10	23	±3	±4
11	21	±3	±4
12	19	±3	±4
13	17	±3	±4
14	15	±3	±4
15	13	±3	±4
16	11	±5	±6
17	9	±5	±6
18	7	±5	±6
19-31	5	±5	±6

Table 27: DCS1800 and PCS1900 conducted RF output power

DCS 1800/PCS1900			
PCL	Nominal output ower (dBm)	Tolerance (dB) for conditions	
		Normal	Extreme
0	30	±2	±2.5
1	28	±3	±4
2	26	±3	±4
3	24	±3	±4
4	22	±3	±4
5	20	±3	±4
6	18	±3	±4

7	16	±3	±4
8	14	±3	±4
9	12	±4	±5
10	10	±4	±5
11	8	±4	±5
12	6	±4	±5
13	4	±4	±5
14	2	±5	±6
15-28	0	±5	±6

5.9.2. Module RF Receive Sensitivity

The following table shows the module's conducted receiving sensitivity, it is tested under static condition.

Table 28: Conducted RF receive sensitivity

Frequency	Receive sensitivity (Typical)	Receive sensitivity(Max)
GSM850/EGSM900	＜-109dBm	＜-107dBm
DCS1800/PCS1900	＜-109dBm	＜-107dBm

5.9.3. Module Operating Frequencies

The following table shows the module's operating frequency range; it is followed by the 3GPP TS 05.05 technical specification requirement.

Table 29: Operating frequencies

Frequency	Receive	Transmit
GSM850	869 ～ 894MHz	824 ～ 849MHz
EGSM900	925 ～ 960MHz	880 ～ 915MHz
DCS1800	1805 ～ 1880MHz	1710 ～ 1785MHz
PCS1900	1930 ～ 1990MHz	1850 ～ 1910MHz

6. Manufacturing

6.1. Top and Bottom View of MX680

Figure 34: Top and bottom view of MX680

6.2. Typical Solder Reflow Profile

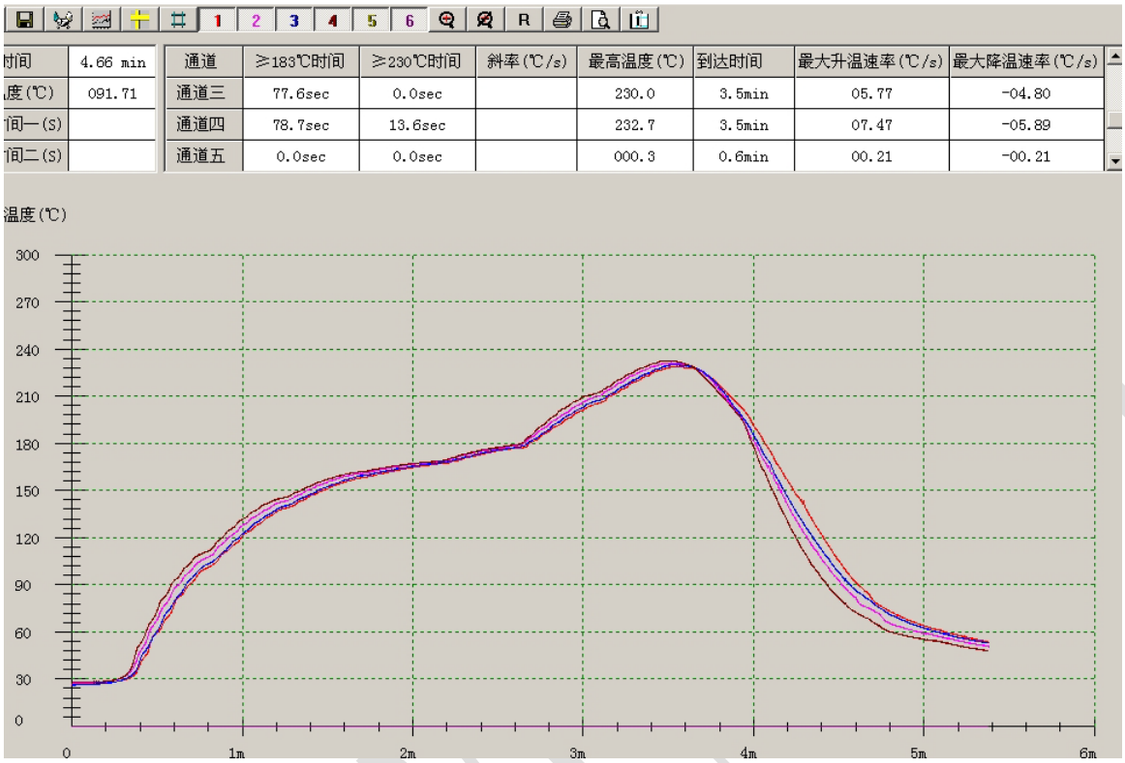

Figure 35: Ramp-Soak-Spike Reflow Profile

6.3. The Moisture Sensitivity Level(MSL)

The moisture sensitivity level of MX680 module is 3. The modules should be mounted within 168 hours after unpacking in the environmental conditions of temperature <30 ℃ and relative humidity of <60% (RH). It is

7. Appendix

7.1. Terms and Abbreviations

Table 30: Terms and abbreviations

Abbreviation	Description
ADC	Analog-to-Digital Converter
AMR	Adaptive Multi-Rate

CS	Coding Scheme
CSD	Circuit Switched Data
CTS	Clear to Send
DTE	Data Terminal Equipment (typically computer, terminal, printer)
DTR	Data Terminal Ready
DTX	Discontinuous Transmission
EFR	Enhanced Full Rate
EGSM	Enhanced GSM
ESD	Electrostatic Discharge
ETS	European Telecommunication Standard
FR	Full Rate
GPRS	General Packet Radio Service
GSM	Global Standard for Mobile Communications
IMEI	International Mobile Equipment Identity
HR	Half Rate
MO	Mobile Originated
MS	Mobile Station (GSM engine), also referred to as TE
MT	Mobile Terminated
Li-ion	Lithium-Ion
PAP	Password Authentication Protocol
PBCCH	Packet Broadcast Control Channel
PCL	Power Control Level
PCB	Printed Circuit Board
PCS	Personal Communication System, also referred to as GSM 1900
PDU	Protocol Data Unit
PPP	Point-to-point protocol
RF	Radio Frequency
RMS	Root Mean Square (value)
RTC	Real Time Clock
RX	Receive Direction
SIM	Subscriber Identification Module
SMS	Short Message Service

TE	Terminal Equipment, also referred to as DTE
TX	Transmit Direction
UART	Universal Asynchronous Receiver & Transmitter
URC	Unsolicited Result Code
USSD	Unstructured Supplementary Service Data
Phonebook abbreviations	
FD	SIM fix dialing phonebook
LD	SIM last dialing phonebook (list of numbers most recently dialed)
MC	Mobile Equipment list of unanswered MT calls (missed calls)
ON	SIM (or ME) own numbers (MSISDNs) list
RC	Mobile Equipment list of received calls
SM	SIM phonebook
NC	Not connect

7.2. Safety Caution

Table 31: Safety caution

Marks	Requirements
	When in a hospital or other health care facility, observe the restrictions about the use of mobiles. Switch the cellular terminal or mobile off, medical equipment may be sensitive to not operate normally for RF energy interference.
	Switch off the cellular terminal or mobile before boarding an aircraft. Make sure it is switched off. The operation of wireless appliances in an aircraft is forbidden to prevent interference with communication systems. Forget to think much of these instructions may lead to the flight safety or offend against local legal action, or both.
	Do not operate the cellular terminal or mobile in the presence of flammable gases or fumes. Switch off the cellular terminal when you are near petrol stations, fuel depots, chemical plants or where blasting operations are in progress. Operation of any electrical equipment in potentially explosive atmospheres can constitute a safety hazard.
	Your cellular terminal or mobile receives and transmits radio frequency energy while switched on. RF interference can occur if it is used close to TV sets, radios, computers or other electric equipment.
	Road safety comes first! Do not use a hand-held cellular terminal or mobile when driving a vehicle, unless it is securely mounted in a holder for hands free operation. Before making a call with a hand-held terminal or mobile, park the vehicle.
	GSM cellular terminals or mobiles operate over radio frequency signals and cellular networks and cannot be guaranteed to connect in all conditions, for example no mobile fee or a invalid SIM card. While you are in this condition and need emergent help, please remember using emergency calls. In order to make or receive calls, the cellular terminal or mobile must be switched on and in a service area with adequate cellular signal strength. Some networks do not allow for emergency call if certain network services or phone features are in use (e.g. lock functions, fixed dialing etc.). You may have to deactivate those features before you can make an emergency call. Also, some networks require that a valid SIM card be properly inserted in the cellular terminal or mobile.

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FCC Notice

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.

NOTE 1: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
-Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
-Consult the dealer or an experienced radio/TV technician for help.

NOTE 2: Any changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Radiation Exposure Statement:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. End users must follow the specific operating instructions for satisfying RF exposure compliance.

Note 1: This module certified that complies with RF exposure requirement under mobile or fixed condition, this module is to be installed only in mobile or fixed applications.

A mobile device is defined as a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons. Transmitting devices designed to be used by consumers or workers that can be easily re-located, such as wireless devices associated with a personal computer, are considered to be mobile devices if they meet the 20 centimeter separation requirement.

A fixed device is defined as a device is physically secured at one location and is not able to be easily moved to another location.

Note 2: Any modifications made to the module will void the Grant of Certification, this module is limited to OEM installation only and must not be sold to end-users, end-user has no manual instructions to remove or install the device, only software or operating procedure shall be placed in the end-user operating manual of final products.

Note 3: Additional testing and certification may be necessary when multiple modules are used.

Note 4: To ensure compliance with all non-transmitter functions the host manufacturer is responsible for ensuring compliance with the module(s) installed and fully operational. For example, if a host was previously authorized as an unintentional radiator under the Declaration of Conformity procedure without a transmitter certified module and a module is added, the host manufacturer is responsible for ensuring that the after the module is installed and operational the host continues to be compliant with the Part 15B unintentional radiator requirements. Since this may depend on the details of how the module is integrated with the host, LM Technologies Ltd. shall provide guidance to the host manufacturer for compliance with the Part 15B requirements.

Note 5: FCC ID label on the final system must be labeled with “Contains FCC ID: 2AKL7MX680”.