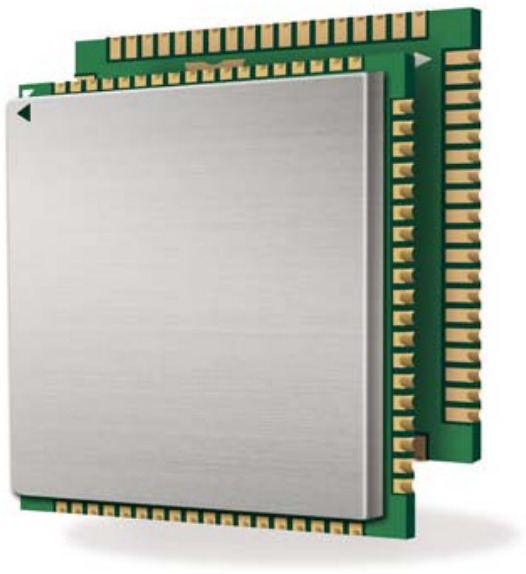
M50

Quectel Cellular Engine



Hardware Design

M50_HD_V2.0

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0. Revision history

Revision	Date	Author	Description of change
1.0	2011-12-20	Ray XU	Initial
1.1	2012-02-03	Ray XU	1. Updated PCM interface 2. Updated SD interface 3. Updated charging interface 4. Updated timing of turning on the module
1.2	2012-07-20	Baly BAO	1. Deleted the USB interface 2. Deleted the camera interface
1.3	2012-10-22	Mountain ZHOU	1. Updated functional diagram 2. Updated reference design circuit 3. Updated audio characteristics 4. Updated VRTC DC characteristics 5. Updated SLEEP current consumption 6. Updated internet service protocols 7. Updated SIM pins' name 8. Modified PCM function 9. Deleted FAX function
2.0	2012-06-16	Ray XU	1. Update the module size 2. Update the pin layout

1. Introduction

This document defines the M50 module and describes the hardware interface of M50 which are connected with the customer application and the air interface.

This document can help customers quickly understand module interface specifications, electrical and mechanical details. Associated with application notes and user guide, customers can use M50module to design and set up mobile applications easily.

1.1. Related documents

Table 1: Related documents

SN	Document name	Remark
[1]	M50_ATC	AT commands set
[2]	ITU-T Draft new recommendation V.25ter	Serial asynchronous automatic dialing and control
[3]	GSM 07.07	Digital cellular telecommunications (Phase 2+); AT command set for GSM Mobile Equipment (ME)
[4]	GSM 07.10	Support GSM 07.10 multiplexing protocol
[5]	GSM 07.05	Digital cellular telecommunications (Phase 2+); Use of Data Terminal Equipment – Data Circuit terminating Equipment (DTE – DCE) interface for Short Message Service (SMS) and Cell Broadcast Service (CBS)
[6]	GSM 11.14	Digital cellular telecommunications (Phase 2+); Specification of the SIM Application Toolkit for the Subscriber Identity module – Mobile Equipment (SIM – ME) interface
[7]	GSM 11.11	Digital cellular telecommunications (Phase 2+); Specification of the Subscriber Identity module – Mobile Equipment (SIM – ME) interface
[8]	GSM 03.38	Digital cellular telecommunications (Phase 2+); Alphabets and language-specific information
[9]	GSM 11.10	Digital cellular telecommunications (Phase 2); Mobile Station (MS) conformance specification; Part 1: Conformance specification
[10]	GSM_UART_AN	UART port application note
[11]	GSM_FW_Upgrade_AN01	GSM Firmware upgrade application note
[12]	M10_EVB_UGD	M10 EVB user guide

1.2. Terms and abbreviations

Table 2: Terms and abbreviations

Abbreviation	Description
ADC	Analog-to-Digital Converter
AMR	Adaptive Multi-Rate
ARP	Antenna Reference Point
ASIC	Application Specific Integrated Circuit
BER	Bit Error Rate
BOM	Bill Of Material
BTS	Base Transceiver Station
CHAP	Challenge Handshake Authentication Protocol
CS	Coding Scheme
CSD	Circuit Switched Data
CTS	Clear To Send
DAC	Digital-to-Analog Converter
DRX	Discontinuous Reception
DSP	Digital Signal Processor
DCE	Data Communications Equipment (typically module)
DTE	Data Terminal Equipment (typically computer, external controller)
DTR	Data Terminal Ready
DTX	Discontinuous Transmission
EFR	Enhanced Full Rate
EGSM	Enhanced GSM
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
ETS	European Telecommunication Standard
FCC	Federal Communications Commission (U.S.)
FDMA	Frequency Division Multiple Access
FR	Full Rate
GMSK	Gaussian Minimum Shift Keying
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
HR	Half Rate
I/O	Input/Output
IC	Integrated Circuit
IMEI	International Mobile Equipment Identity
Imax	Maximum Load Current
Inorm	Normal Current
kbps	Kilo Bits Per Second
LED	Light Emitting Diode

Li-Ion	Lithium-Ion
MO	Mobile Originated
MS	Mobile Station (GSM engine)
MT	Mobile Terminated
PAP	Password Authentication Protocol
PBCCH	Packet Switched Broadcast Control Channel
PCB	Printed Circuit Board
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
TDMA	Time Division Multiple Access
TE	Terminal Equipment
TX	Transmitting Direction
UART	Universal Asynchronous Receiver & Transmitter
URC	Unsolicited Result Code
USSD	Unstructured Supplementary Service Data
VSWR	Voltage Standing Wave Ratio
Vmax	Maximum Voltage Value
Vnorm	Normal Voltage Value
Vmin	Minimum Voltage Value
VIHmax	Maximum Input High Level Voltage Value
VIHmin	Minimum Input High Level Voltage Value
VILmax	Maximum Input Low Level Voltage Value
VILmin	Minimum Input Low Level Voltage Value
VImax	Absolute Maximum Input Voltage Value
VImin	Absolute Minimum Input Voltage Value
VOHmax	Maximum Output High Level Voltage Value
VOHmin	Minimum Output High Level Voltage Value
VOLmax	Maximum Output Low Level Voltage Value
VOLmin	Minimum Output Low Level Voltage Value
Phonebook abbreviations	
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

1.3. Safety cautions

The following safety precautions must be observed during all phases of the operation, such as usage, service or repair of any cellular terminal or mobile incorporating M50module. Manufacturers of the cellular terminal should send the following safety information to users and operating personnel and to incorporate these guidelines into all manuals supplied with the product. If not so, Quectel does not take on any liability for customer failure to comply with these precautions.

When in a hospital or other health care facility, observe the restrictions about the use of mobile. 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 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 gas or fume. Switch off the cellular terminal when you are near petrol station, fuel depot, chemical plant or where blasting operations are in progress. Operation of any electrical equipment in potentially explosive atmosphere 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 set, radio, computer or other electric equipment.

Road safety comes first! Do not use a hand-held cellular terminal or mobile while 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 signal and cellular network and cannot be guaranteed to connect in all conditions, for example no mobile fee or an invalid SIM card. While you are in this condition and need emergent help, Please Remember using emergency call. In order to make or receive call, 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 cellular terminal or mobile.

CE2200 According to the R&TTE Directive 1999/95/CE, all wireless equipment and telecommunications terminals sold in EU must meet all the stipulated health, safety RF, EMC requirements that provide for CE mark. Quectel Module M50 is fully in accordance with all the directives of EU.

1.4. Directives and standards

The M50 module is designed to comply with the FCC statements. FCC ID: XMR201211M50.
The Host system using M50, should have label indicated contains FCC ID: XMR201211M50.

1.4.1. FCC Statement

1. This device complies with Part 15 of the FCC rules. Operation is subject to the following conditions:
   a) This device may not cause harmful interference.
   b) This device must accept any interference received, including interference that may cause undesired operation.
2. Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

1.4.2. FCC 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 and your body as well as kept minimum 20cm from radio antenna depending on the Mobile status of this module usage.

The manual of the host system, which uses M50, must include RF exposure warning statement to advice user should keep minimum 20cm from the radio antenna of M50 module depending on the Mobile status.

The following list of antenna is indicating the maximum permissible antenna gain.

Type		Maximum Gain (850Hz/900Hz)	Maximum Gain (1800Hz/1900Hz)	Impedance
External Antenna	Monopole	0.5dBi	2dBi	50Ω
	Vehicular antenna	0.5dBi	2dBi	50Ω
Internal Antenna	Monopole	0.5dBi	2dBi	50Ω
	PIFA	0.5dBi	2dBi	50Ω
	FPC	0.5dBi	2dBi	50Ω
	PCB	0.5dBi	2dBi	50Ω

This radio module must not be installed to co-locate and operate simu ltaneously with other radios in host system;
additional testing and equipment authorization may be required to op erating simultaneously with other radios.

2. Product concept

M50 is a Quad-band GSM/GPRS engine that works at frequencies of GSM850MHz, GSM900MHz, DCS1800MHz and PCS1900MHz. The M50 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 A and Appendix B***.

With a tiny profile of 24.5mm×25.3mm×2.6mm, 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.

M50 is an SMD type module with LCC package, which can be embedded in customer's applications. It provides abundant hardware interfaces between the module and customer's host board.

Designed with power saving technique, the current consumption of M50 is as low as 1.3 mA in SLEEP mode when DRX is 5.

M50 is integrated with Internet service protocols, such as TCP, UDP, FTP and PPP. Extended AT commands have been developed for customer to use these Internet service protocols easily.

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

2.1. Key features

Table 3: Module key features

Feature	Description
Power supply	Single supply voltage 3.3V~ 4.6V Typical supply voltage 4.0V
Power saving	Typical power consumption in SLEEP mode: 1.3 mA@ DRX=5 1.2 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 with GSM Phase 2/2+
GSM class	Small MS
Transmitting power	● Class 4 (2W) at GSM850 and GSM900 ● Class 1 (1W) at DCS1800 and PCS1900
GPRS connectivity	● GPRS multi-slot class 12 (default) ● GPRS multi-slot class 1~12 (configurable) ● GPRS mobile station class B

Temperature range	● Normal operation: -35°C ~ +80°C ● Restricted operation: -40°C ~ -35°C and +80°C ~ +85°C [1)] ● Storage temperature: -45°C ~ +90°C
DATA GPRS: CSD:	● 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 ● Support the protocols PAP (Password Authentication Protocol) usually used for PPP connections ● Internet service protocols TCP/UDP/FTP/PPP/HTTP/NTP/PING ● Support Packet Broadcast Control Channel (PBCCH) ● CSD transmission rates: 2.4, 4.8, 9.6, 14.4 kbps non-transparent ● Support Unstructured Supplementary Service Data (USSD)
SMS	● Text and PDU mode ● SMS storage: SIM card
SIM interface	Support SIM card: 1.8V, 3V
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 Suppression ● Echo Cancellation ● Noise Reduction ● Embedded one amplifier of class AB with maximum driving power up to 800mW
UART interfaces	UART Port: ● Seven lines on UART port interface ● Used for AT command, GPRS data and CSD data ● Multiplexing function ● Support autobauding from 4800 bps to 115200 bps Debug Port: ● Two lines on debug port interface DBG_TXD and DBG_RXD ● Debug Port only used for firmware debugging Auxiliary Port: ● Used for AT command
Phonebook management	Support phonebook types: SM, ME, ON, MC, RC, DC, LD, LA
SIM Application Toolkit	Support SAT class 3, GSM 11.14 Release 99
Real time clock	Supported
Physical characteristics	Size: 24.5 (±0.15) × 25.3 (±0.15) × 2.6 (±0.2) mm Weight: 3.3g
Firmware upgrade	Firmware upgrade via UART Port

Antenna interface	Connected to antenna pad with 50 Ohm impedance control

1）When the module works in this temperature range, the deviations from the GSM specification may occur. For example, the frequency error or the phase error will be increased.

Table 4: 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. Functional diagram

The following figure shows a block diagram of the M50 module and illustrates the major functional parts:

- Power management
- Baseband
- Serial Flash
- The radio frequency part
- The peripheral interface
  —Charge interface
  —PCM interface
  —SD interface
  —SIM interface
  —Audio interface
  —Serial interface
  —Power supply
  —RF interface
  —ADC
  —Turn on/off interface (PWRKEY & EMERG_OFF)

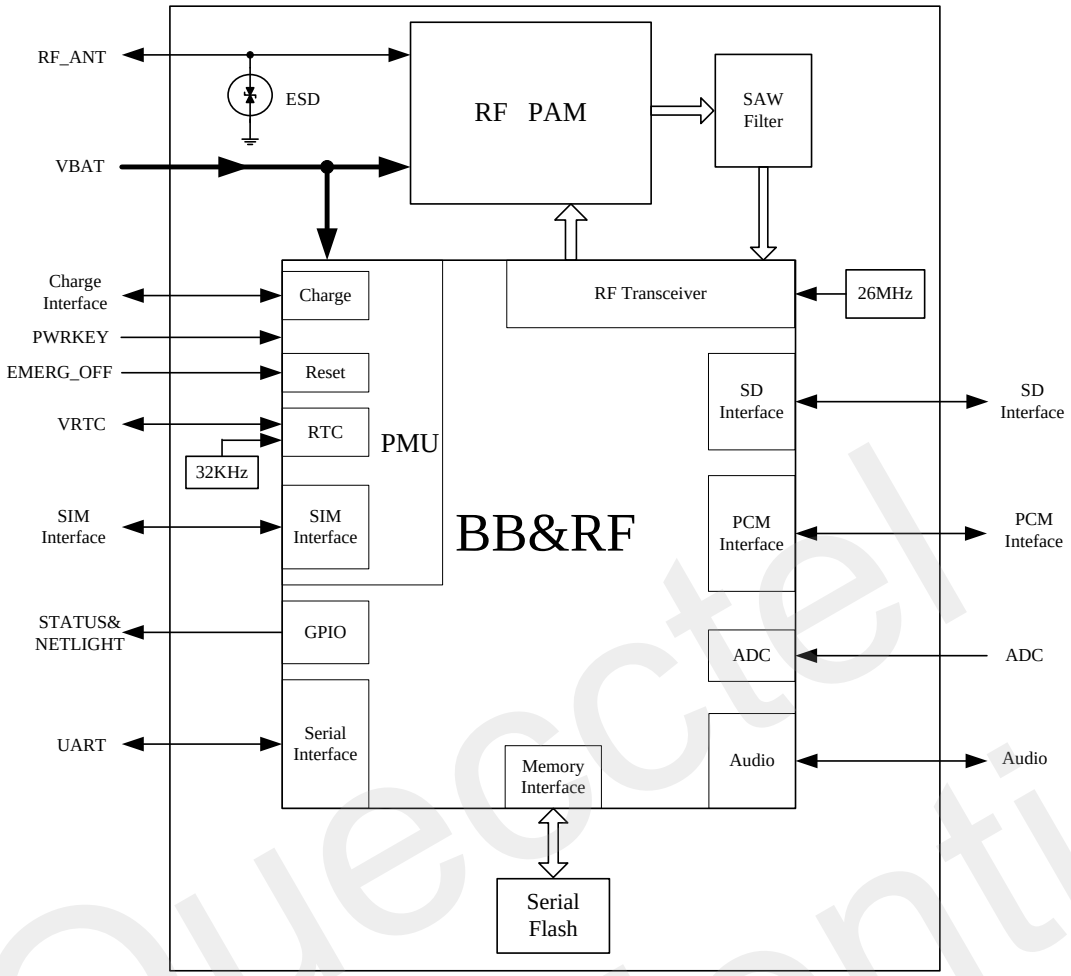

Figure 1: Module functional diagram

2.3. Evaluation board

In order to help customer to develop applications with M50 , Quectel supplies an evaluation board (EVB), RS-232 to USB cable, power adapter, earphone, antenna and other peripherals to control or test the module. For details, please refer to the ***document [12]***.

3. Application interface

The module is equipped with 83-pin SMT pads and it adopts LCC package. Detailed descriptions on Sub-interfaces included in these pads are given in the following chapters:

- Power supply
- Power on/down
- Charge interface
- RTC
- Serial interfaces
- Audio interfaces
- SIM interface
- SD interface
- PCM interface
- ADC

3.1. Pin of module

3.1.1. Pin assignment

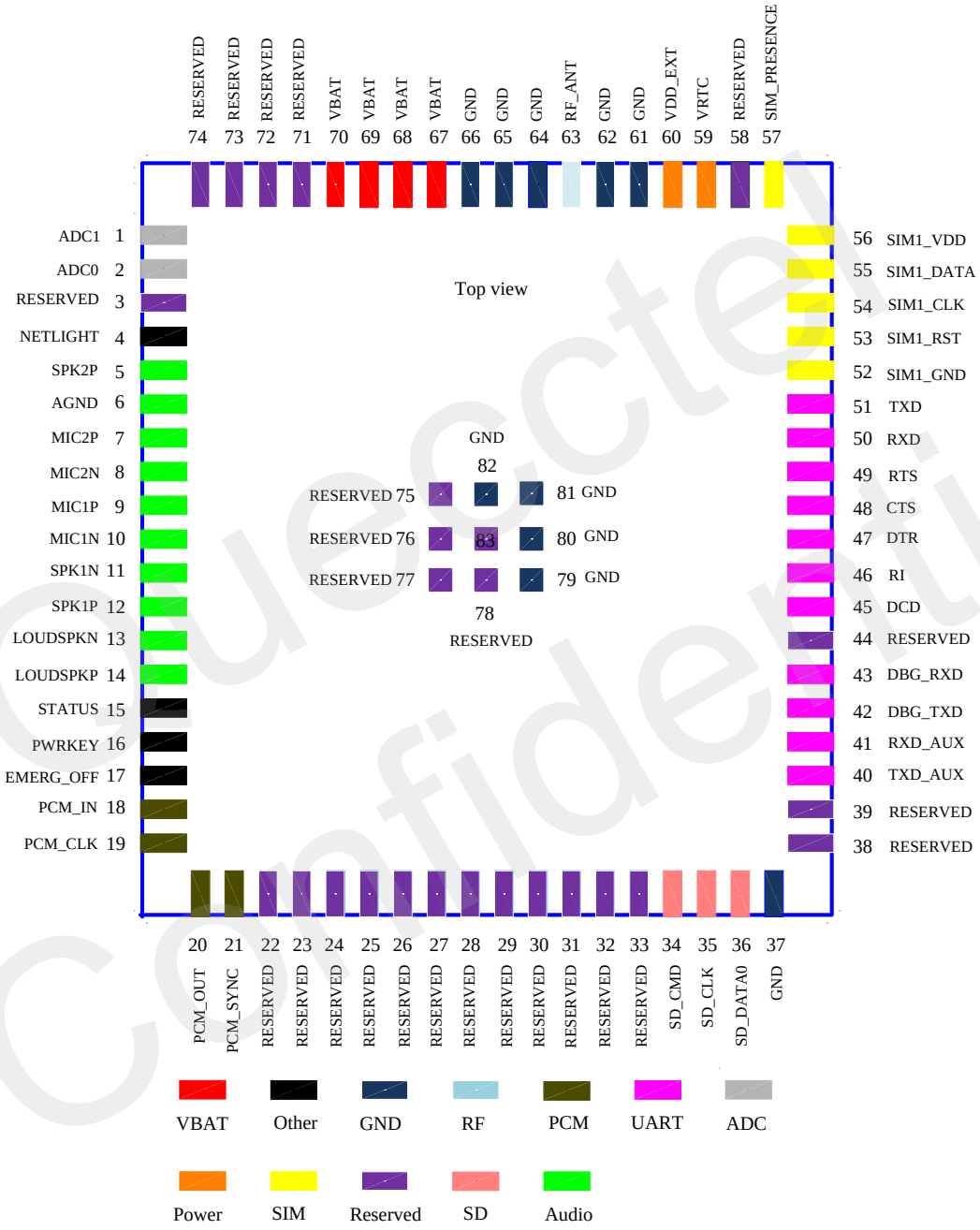

Figure 2: Pin assignment

Table 5: M50 pin assignment

管脚号	管脚名	输入/输出	管脚号	管脚名	输入/输出
1	ADC1	I	2	ADC0	I
3	RESERVED		4	NETLIGHT	O
5	SPK2P	O	6	AGND	
7	MIC2P	I	8	MIC2N	I
9	MIC1P	I	10	MIC1N	I
11	SPK1N	O	12	SPK1P	O
13	LOUDSPKN	O	14	LOUDSPKP	O
15	STATUS	O	16	PWRKEY	I
17	EMERG_OFF	I	18	PCM_IN	I
19	PCM_CLK	O	20	PCM_OUT	O
21	PCM_SYNC	O	22	RESERVED	
23	RESERVED		24	RESERVED	
25	RESERVED		26	RESERVED	
27	RESERVED		28	RESERVED	
29	RESERVED		30	RESERVED	
31	RESERVED		32	RESERVED	
33	RESERVED		34	SD_CMD	O
35	SD_CLK	O	36	SD_DATA0	I/O
37	GND		38	RESERVED	
39	RESERVED		40	TXD_AUX	O
41	RXD_AUX	I	42	DBG_TXD	O
43	DBG_RXD	I	44	RESERVED	
45	DCD	O	46	RI	O
47	DTR	I	48	CTS	O
49	RTS	I	50	RXD	I
51	TXD	O	52	SIM_GND	
53	SIM_RST	O	54	SIM_CLK	O
55	SIM_DATA	I/O	56	SIM_VDD	O
57	SIM_PRESENCE	I	58	RESERVED	
59	VRTC	I/O	60	VDD_EXT	O
61	GND		62	GND	
63	RF_ANT	I/O	64	GND	
65	GND		66	GND	
67	VBAT	I	68	VBAT	I
69	VBAT	I	70	VBAT	I
71	RESERVED		72	RESERVED	

73	RESERVED			74	RESERVED	
75	RESERVED			76	RESERVED	
77	RESERVED			78	RESERVED	
79	GND			80	GND	
81	GND			82	GND	
83	GND					

Note: Keep all reserved pins open.

3.1.2. Pin description

Table 6: Pin description

Power supply					
PIN NAME	PIN NO.	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
VBAT	67, 68, 69, 70	I	Main power supply of module: VBAT=3.3V~4.6V	Vmax= 4.6V Vmin=3.3V Vnorm=4.0V	Make sure that supply sufficient current in a transmitting burst which typically rises to 1.6A.
VRTC	59	I/O	Power supply for RTC when VBAT is not supplied for the system. Charging for backup battery or golden capacitor when the VBAT is supplied.	VImax=3.3V VImin=1.5V VInorm=2.8V VOmax=2.85V VOmin=2.6V VOnorm=2.8V Iout(max)= 1mA Iin=2.6~5 uA	If unused, keep this pin open.
VDD_EXT	60	O	Supply 2.8V voltage for external circuit.	Vmax=2.9V Vmin=2.7V Vnorm=2.8V Imax=20mA	1. If unused, keep this pin open. 2. Recommended to add a 2.2~4.7uF bypass capacitor when supplying power for external circuit.
GND	37, 61,		Ground		

	62, 64, 65, 66,				
Turn on/off					
PIN NAME	PIN NO.	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
PWRKEY	15	I	Turn on/off control. PWRKEY should be pulled down for a moment to turn on or off the system.	VILmax= 0.1×VBAT VIHmin= 0.6×VBAT VImax=VBAT	Pulled up to VBAT internally.
Emergency shutdown					
PIN NAME	PIN NO.	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
EMERG_OFF	17	I	Emergency off. Pulled down for at least 20ms, which will turn off the module in case of emergency. Use it only when normal shutdown through PWRKEY or AT command cannot perform well.	VILmax=0.4V VIHmin=2.2V V_{open}max=2.8V	Open drain/collector driver required in cellular device application. If unused, keep this pin open.
Module indicator					
PIN NAME	PIN NO.	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
STATUS	16	O	Indicate module operating status. High level indicates module is power-on and low level indicates power-down.	VOHmin= 0.85×VDD_EXT VOLmax= 0.15×VDD_EXT	If unused, keep this pin open.
Audio interface					
PIN NAME	PIN NO.	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
MIC1P MIC1N	9, 10	I	Channel one for positive and negative voice-band input		If unused, keep these pins open.

MIC2P MIC2N	7, 8	I	Channel two for positive and negative voice-band input		
SPK1P SPK1N	12, 11	O	Channel one for positive and negative voice-band output		1. If unused, keep these pins open. 2. Support both voice and ringtone output.
SPK2P	5	O	Channel two for voice-band output		
AGND	6		Analog ground. Constitute a pseudo differential channel with SPK2P.		
LOUDSPKN LOUDSPKP	13, 14	O	Channel three of positive and negative voice-band output		1. If unused, keep these pins open. 2. Embedded amplifier of class AB internally. 3. Support both voice and ringtone output.
Net status indicator					
PIN NAME	PIN NO.	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
NETLIGHT	4	O	Network status indication	VOHmin= 0.85×VDD_EXT VOLmax= 0.15×VDD_EXT	If unused, keep this pin open.
UART Port					
PIN NAME	PIN NO.	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
DTR	47	I	Data terminal ready	VILmin=0V VILmax= 0.25×VDD_EXT VIHmin= 0.75×VDD_EXT VIHmax= VDD_EXT+0.3 VOHmin= 0.85×VDD_EXT VOLmax=	If only use TXD, RXD and GND to communicate, recommend pulling down RTS and keeping other pins open.
RXD	50	I	Receive data		
TXD	49	O	Transmit data		
RTS	51	I	Request to send		
CTS	48	O	Clear to send		
RI	46	O	Ring indicator		
DCD	45	O	Data carrier detection		

				0.15×VDD_EXT	
Debug Port					
PIN NAME	PIN NO.	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
DBG_TXD	42	O	UART interface for debugging only.	VILmin=0V 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 unused, keep these pins open.
DBG_RXD	43	I			
Auxiliary UART Port					
PIN NAME	PIN NO.	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
TXD_AUX	40	O	Transmit data	VILmin=0V 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 unused, keep these pins open.
RXD_AUX	41	I	Receive data		
SIM interface					
PIN NAME	PIN NO.	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
SIM_VDD	56	O	Power supply for SIM card	The voltage can be selected by firmware automatically. Either 1.8V or 3V.	All signals of SIM interface should be protected against ESD with a TVS diode array. Maximum cable length is 200mm from the module pad to SIM card
SIM_DATA	54	I/O	SIM data	3V： VOLmax=0.4 VOHmin= SIM_VDD-0.4 1.8V: VOLmax=	

				0.15×SIM_VDD VOHmin= SIM_VDD-0.4	holder.
SIM_CLK	55	O	SIM clock	3V： VOLmax=0.4 VOHmin= 0.9×SIM_VDD 1.8V: VOLmax= 0.12×SIM_VDD VOHmin= 0.9×SIM_VDD	
SIM_RST	53	O	SIM reset	3V： VOLmax=0.36 VOHmin= 0.9×SIM_VDD 1.8V: VOLmax= 0.2×SIM_VDD VOHmin= 0.9×SIM_VDD	
SIM_GND	52		SIM ground		
SIM_PRESENCE	57	I	SIM card detection	VILmin=0V VILmax= 0.25×VDD_EXT VIHmin= 0.75×VDD_EXT VIHmax= VDD_EXT+0.3	If unused, keep this pin open.
ADC					
PIN NAME	PIN NO.	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
ADC0	2	I	General purpose analog to digital converter.	Voltage range: 0V to 2.8V	Please give priority to the use of ADC0. If unused, keep these pins open.
ADC1	1	I	General purpose analog to digital converter.	Voltage range: 0V to 2.8V	
PCM					
PIN NAME	PIN NO.	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
PCM_CLK	19	O	PCM clock	VILmin=0V VILmax=	
PCM_IN	18	I	PCM data input		

PCM_OUT	20	O	PCM data output	0.25×VDD_EXT VIHmin= 0.75×VDD_EXT VIHmax= VDD_EXT+0.3 VOHmin= 0.85×VDD_EXT VOLmax= 0.15×VDD_EXT	
PCM_SYNC	21	O	PCM frame synchronization		
SD card					
PIN NAME	PIN NO.	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
SD_CMD	34	O	SD command	VILmin=0V 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	
SD_CLK	35	O	SD clock		
SD_DATA0	36	I/O	SD data		
RF interface					
PIN NAME	PIN NO.	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
RF_ANT	63	I/O	RF antenna pad	Impedance of 50Ω	
Other interface					
PIN NAME	PIN NO.	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
DOWNLOAD	3	I		VILmin=0V VILmax= 0.25×VDD_EXT VIHmin= 0.75×VDD_EXT VIHmax= VDD_EXT+0.3	Keep this pin open.
RESERVED	22~33, 38~39, 44, 58,				Keep these pins open.

	71~ 75				

3.2. Operating modes

The table below briefly summarizes the various operating modes in the following chapters.

Table 7: Overview of operating modes

Mode	Function	
Normal operation	GSM/GPRS SLEEP	The module will automatically go into SLEEP mode if DTR is set to high level and there is no interrupt (such as GPIO interrupt or data on UART port). In this case, the current consumption of module will reduce to the minimal level. During SLEEP mode, the module can still receive paging message and SMS from the system normally.
	GSM IDLE	Firmware is active. The module has registered to the GSM network, and the module is ready to send and receive GSM data.
	GSM TALK	GSM connection is ongoing. In this mode, the power consumption is decided by the configuration of Power Control Level (PCL), dynamic DTX control and the working RF band.
	GPRS IDLE	The module is not registered to GPRS network. The module is not reachable through GPRS channel.
	GPRS STANDBY	The module is registered to GPRS network, but no GPRS PDP context is active. The SGSN knows the Routing Area where the module is located at.
	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 in transfer. In this mode, power consumption is decided by the PCL, working RF band and GPRS multi-slot configuration.
Power down	Normal shutdown by sending the "AT+QPOWD=1" command, using the PWRKEY or the EMERG_OFF[1)] pin. The power management ASIC disconnects the power supply from the base band part of the module, and only the power supply for the RTC is remained. Software is not active. The UART interfaces are not accessible. Operating voltage (connected to VBAT) remains applied.	
Minimum functionality mode (without removing power supply)	"AT+CFUN" command can set the module to a minimum functionality mode without removing the power supply. In this case, 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 disabled, but the UART port is still accessible. The power consumption in this case is very low.	

1) Use the EMERG_OFF pin only while failing to turn off the module by the command "AT+QPOWD=1" and the PWRKEY pin. Please refer to the Section 3.4.2.4.

3.3. Power supply

3.3.1. Power features of module

The power supply is one of the key issues in the designing GSM terminals. Due to the 577us radio burst emission in GSM every 4.615ms, power supply must be able to deliver high current peaks in a burst period. During these peaks, drops on the supply voltage must not exceed minimum working voltage of module.

For the M50 module, the max current consumption could reach to 1.6A during a transmit burst. It will cause a large voltage drops on the VBAT. In order to ensure stable operation of the module, it is recommended that the max voltage drop during the transmit burst does not exceed 400mV.

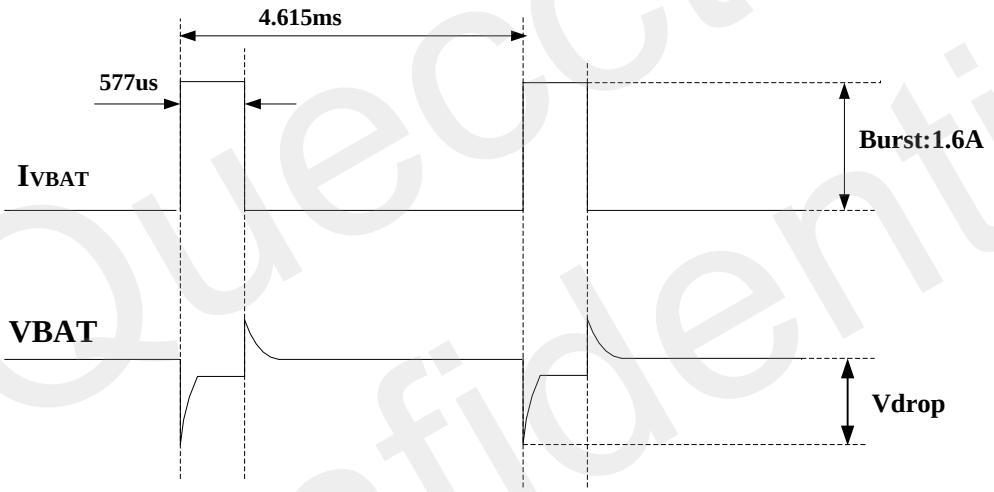

Figure 3: Voltage ripple during transmitting

3.3.2. Decrease supply voltage drop

The power supply rang of the module is 3.3V to 4.6V. Make sure that the input voltage will never drop below 3.3V even in a transmitting burst. If the power voltage drops below 3.3V, the module could turn off automatically. For better power performance, it is recommended to place a 100uF tantalum capacitor with low ESR (ESR=0.7Ω) and ceramic capacitor 100nF, 33pF and 10pF near the VBAT pin. The reference circuit is illustrated in Figure 4.

The VBAT route should be wide enough to ensure that there is not too much voltage drop occurring during transmit burst. The width of trace should be no less than 2mm and the principle of the VBAT route is the longer route, the wider trace.

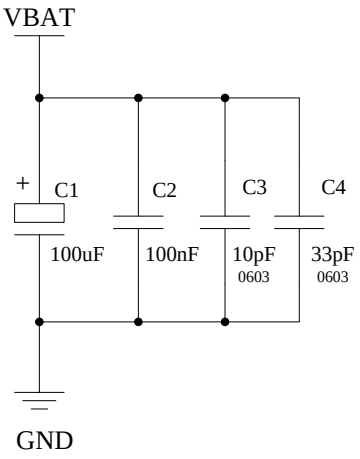

Figure 4: Reference circuit for the VBAT input

3.3.3. Reference design for power supply

The power design for the module is very important, since the performance of power supply for the module largely depends on the power source. The power supply is capable of providing the sufficient current up to 2A at least. If the voltage drop between the input and output is not too high, it is suggested to use a LDO as module's power supply. If there is a big voltage difference between the input source and the desired output (VBAT), a switcher power converter is prefer to use as a power supply.

Figure 5 shows a reference design for +5V input power source. The designed output for the power supply is 4.16V and the maximum load current is 3A. In addition, in order to get a stable output voltage, a zener diode is placed close to the pins of VBAT. As to the zener diode, it is suggested to use a zener diode which reverse zener voltage is 5.1V and dissipation power is more than 1 Watt.

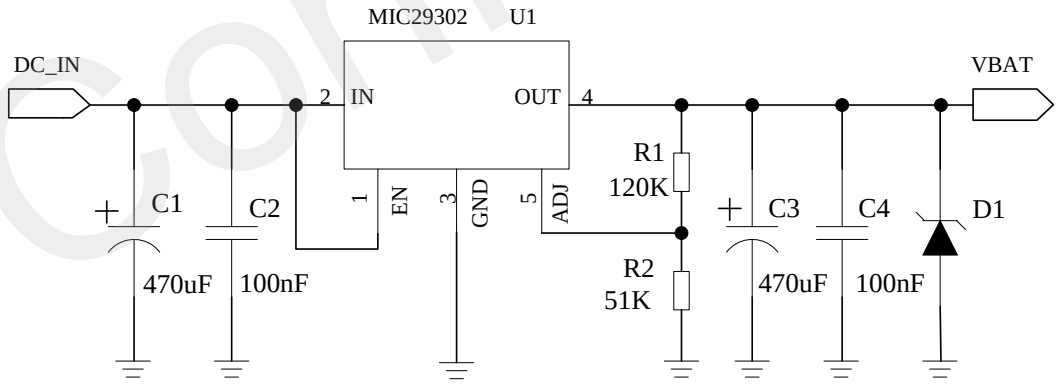

Figure 5: Reference circuit for power supply

3.3.4. Monitor power supply

To monitor the supply voltage, customer can use the "AT+CBC" command which includes three parameters: charging status, remaining battery capacity and voltage value (in mV). It returns the 0~100 percent of battery capacity and actual value measured between VBAT and GND. The voltage is automatically measured in period of 5s. The displayed voltage (in mV) is averaged over the last measuring period before the "AT+CBC" command is executed.

For details, please refer to the ***document [1].***

3.4. Power on and down scenarios

3.4.1. Power on

Customer's application can turn on the module by driving the pin PWRKEY to a low level voltage, and after STATUS pin outputs a high level, PWRKEY pin can be released. Customer may monitor the level of the STATUS pin to judge whether the module is power-on or not. An open collector driver circuit is suggested to control the PWRKEY. A simple reference circuit is illustrated as below.

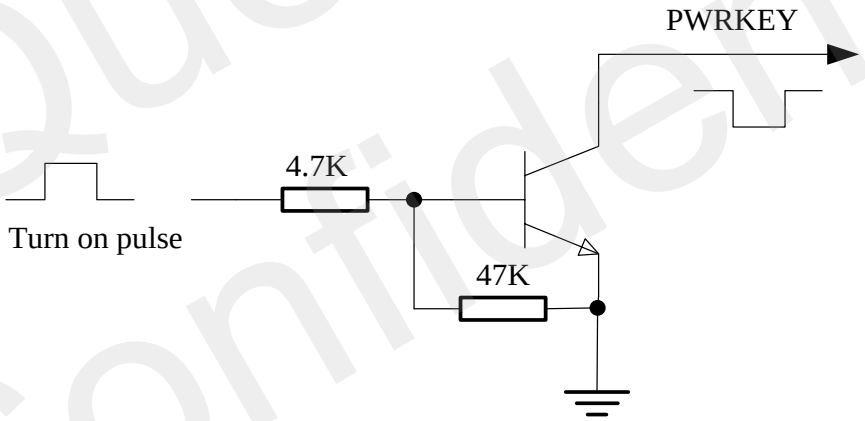

Figure 6: Turn on the module using driving circuit

Note: The module is set to autobauding mode (AT+IPR=0) in default configuration. In the autobauding mode, the URC "RDY" after powering on is not sent to host controller. When the module receives AT command, it will be powered on after a delay of 2 or 3 seconds. Host controller should firstly send an "AT" or "at" string in order that the module can detect baud rate of host controller, and it should send the second or the third "AT" or "at" string until receiving "OK" string from the module. Then an "AT+IPR=x;&W" should be sent to set a fixed baud rate for the module and save the configuration to flash memory of the module. After these configurations, the URC "RDY" would be received from the UART Port of the module every time when the module is powered on. Refer to the section "AT+IPR" in document [1].

The other way to control the PWRKEY is using a button directly. A TVS component is indispensable to be placed nearby the button for ESD protection. When pressing the key, electrostatic strike may generate from finger. A reference circuit is shown in the following figure.

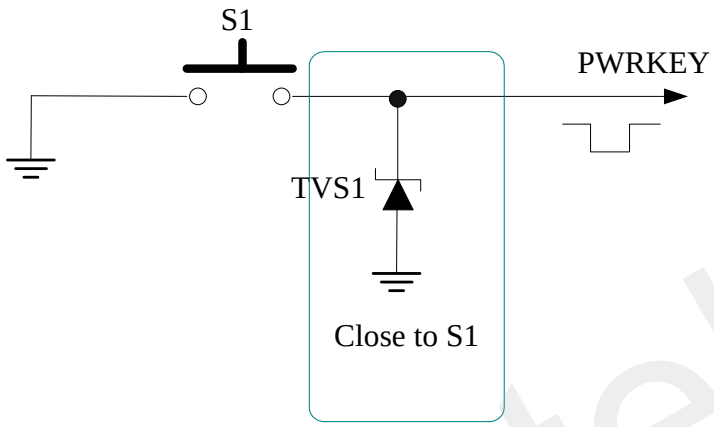

Figure 7: Turn on the module using keystroke

The power-on scenarios is illustrated as the following figure.

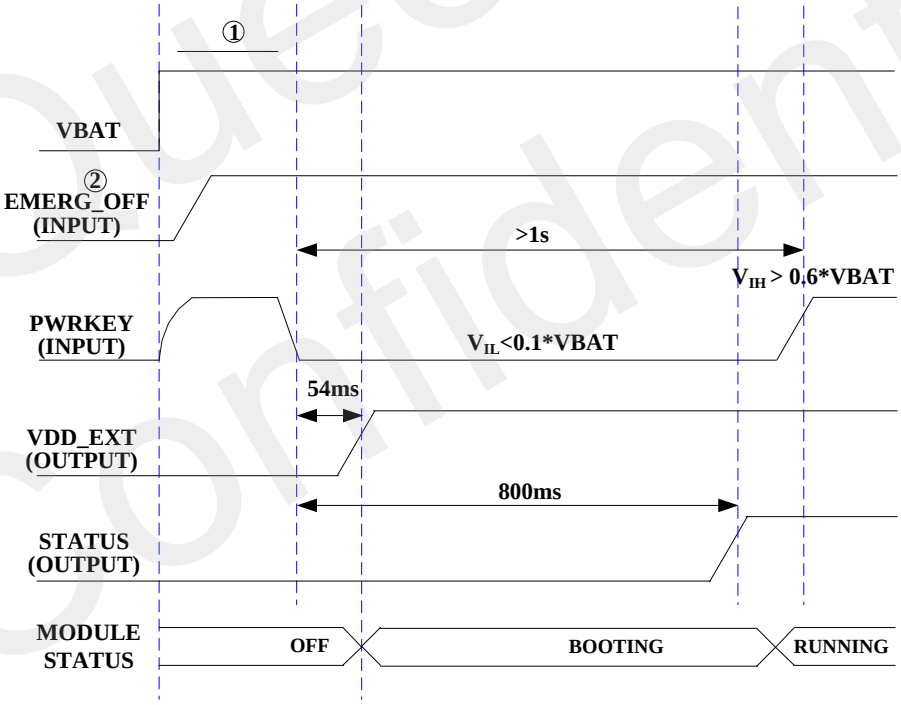

Figure 8: Timing of turning on system

① ***Make sure that VBAT is stable before pulling down PWRKEY pin. The time between them is recommended 30ms.***

② ***EMERG_OFF should be floated when it is unused***

3.4.2. Power down

The following procedures can be used to turn off the module:

- Normal power down procedure: Turn off module using the PWRKEY pin
- Normal power down procedure: Turn off module using command "AT+QPOWD"
- Over-voltage or under-voltage automatic shutdown: Take effect when over-voltage or under-voltage is detected
- Emergent power down procedure: Turn off module using the EMERG_OFF pin

3.4.2.1. Power down module using the PWRKEY pin

Customer's application can turn off the module by driving the PWRKEY to a low level voltage for a certain time. The power down scenario is illustrated in Figure 9.

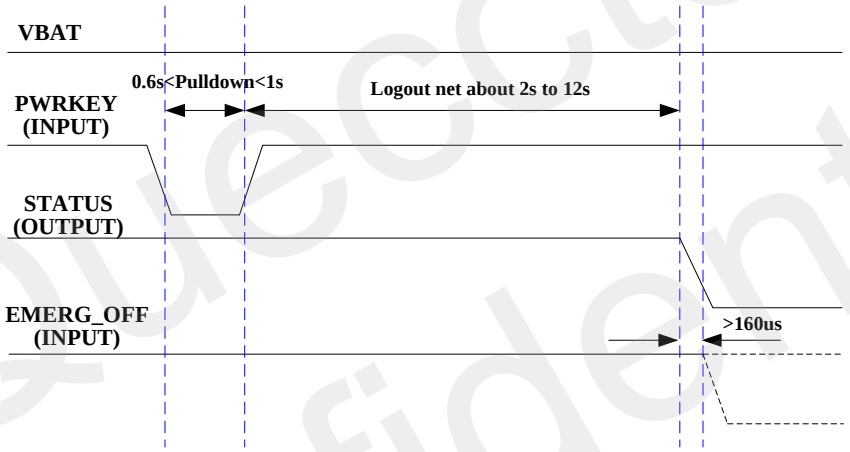

Figure 9: Timing of turning off the module

The power down procedure causes the module to log off from the network and allows the firmware to save important data before completely disconnecting the power supply, thus it is a safe way.

Before the completion of the power down procedure, the module sends out the result code shown below:

NORMAL POWER DOWN

Note: This result code does not appear when autobauding is active and DTE and DCE are not correctly synchronized after start-up. The module is recommended to set a fixed baud rate.

After that moment, no further AT commands can be executed. Then the module enters the power down mode, only the RTC is still active. The power down mode can also be indicated by the

STATUS pin, which is a low level voltage in this mode.

3.4.2.2. Power down module using AT command

Customer's application can turn off the module via AT command "AT+QPOWD=1". This command will let the module to log off from the network and allow the firmware to save important data before completely disconnecting the power supply, thus it is a safe way.

Before the completion of the power down procedure the module sends out the result code shown below:

NORMAL POWER DOWN

After that moment, no further AT commands can be executed. And then the module enters the power down mode, only the RTC is still active. The power down mode can also be indicated by STATUS pin, which is a low level voltage in this mode.

Please refer to the ***document [1]*** for details about the AT command "AT+QPOWD".

3.4.2.3. Over-voltage or under-voltage automatic shutdown

The module will constantly monitor the voltage applied on the VBAT, if the voltage is ≤ 3.5V, the following URC will be presented:

UNDER_VOLTAGE WARNING

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

OVER_VOLTAGE WARNING

The normal input voltage range is from 3.3V to 4.6V. If the voltage is > 4.6V or < 3.3V, the module would automatically shutdown itself.

If the voltage is < 3.3V, the following URC will be presented:

UNDER_VOLTAGE POWER DOWN

If the voltage is > 4.6V, the following URC will be presented:

OVER_VOLTAGE POWER DOWN

Note: These result codes do not appear when autobauding is active and DTE and DCE are not

correctly synchronized after start-up. The module is recommended to set to a fixed baud rate.

After that moment, no further AT commands can be executed. The module logs off from network and enters power down mode, and only RTC is still active. The power down mode can also be indicated by the pin STATUS, which is a low level voltage in this mode.

3.4.2.4. Emergency shutdown using EMERG_OFF pin

The module can be shut down by driving the pin EMERG_OFF to a low level voltage over 20ms and then releasing it. The EMERG_OFF line can be driven by an open-drain/collector driver or a button. The circuit is illustrated as the following figures.

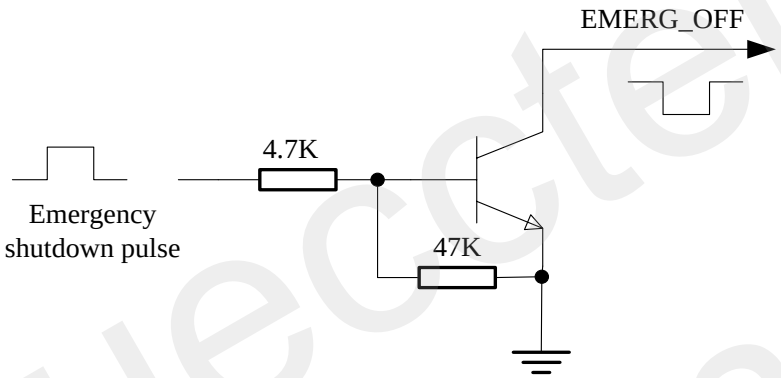

Figure 10: Reference circuit for EMERG_OFF by using driving circuit

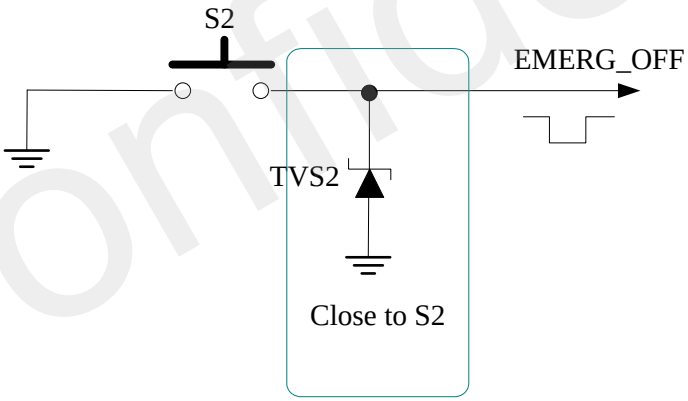

Figure 11: Reference circuit for EMERG_OFF by using button

3.4.3. Restart

Customer's application can restart the module by driving the PWRKEY to a low level voltage for a certain time, which is similar to the way of turning on module. Before restarting the module, at

least 500ms should be delayed after detecting the low level of STATUS. The restart timing is illustrated as the following figure.

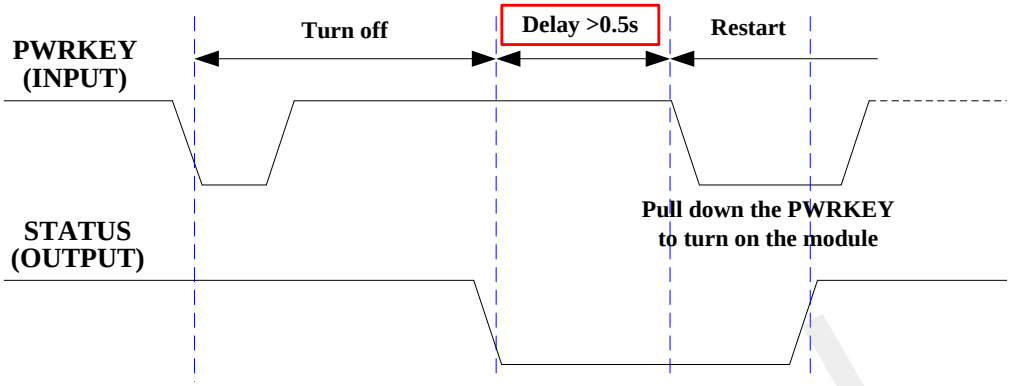

Figure 12: Timing of restarting system

The module can also be restarted by the PWRKEY after emergency shutdown.

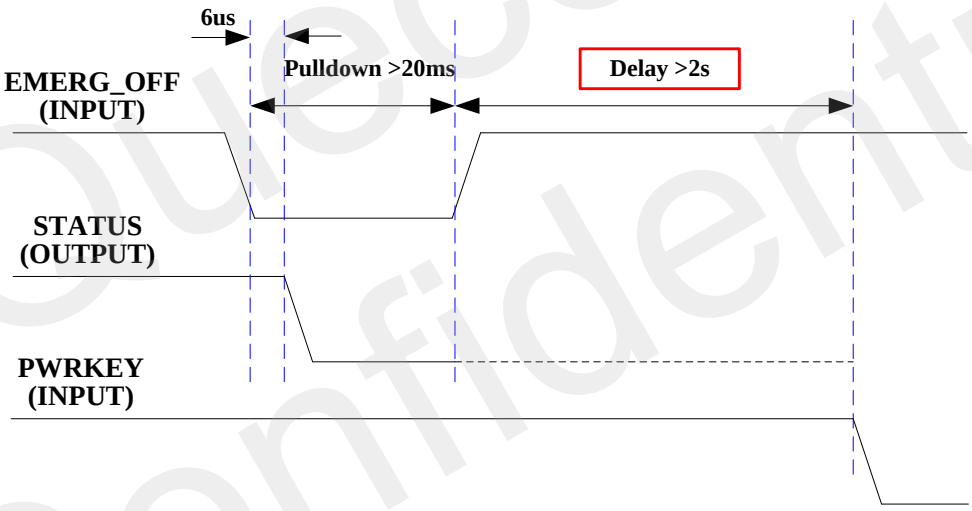

Figure 13: Timing of restarting system after emergency shutdown

3.5. Charge interface

M50 provides charging function for rechargeable Li-Ion or Lithium Polymer battery. It is introduced simply in this document. If customer wants to get more information about charging, please refer to the ***document [13].***

Table 8: Pin definition of the charging

Name	Pin	I/O	Description.
GATDRV	74	O	Charge driving
CHGLDO	73	I	Charger power supply source
CHGDET	72	I	Charger detection
ISENSE	71	I	Current sense
BATSNS	70	I	VBAT voltage sense

3.6. Power saving

Upon system requirement, there are several actions to drive the module to enter low current consumption status. For example, "AT+CFUN" can be used to set module into minimum functionality mode and DTR hardware interface signal can be used to lead system to SLEEP mode.

3.6.1. Minimum functionality mode

Minimum functionality mode reduces the functionality of the module to a minimum level, thus minimize the current consumption when the slow clocking mode is activated at the same time. This mode is set with the "AT+CFUN" command which provides the choice of the functionality levels <fun>=0, 1, 4.

- 0: minimum functionality
- 1: full functionality (default)
- 4: disable both transmitting and receiving of RF part

If the module is set to minimum functionality by "AT+CFUN=0", the RF function and SIM card function would be disabled. In this case, the UART port is still accessible, but all AT commands correlative with RF function or SIM card function will be not accessible.

If the module has been set by "AT+CFUN=4", the RF function will be disabled, the UART port is still active. In this case, all AT commands correlative with RF function will be not accessible.

After the module is set by "AT+CFUN=0" or "AT+CFUN=4", it can return to full functionality by

"AT+CFUN=1".

For detailed information about "AT+CFUN", please refer to the ***document [1]***.

3.6.2. SLEEP mode

The SLEEP mode is disabled in default firmware configuration. Customer's application can enable this mode by "AT+QSCLK=1". On the other hand, the default setting is "AT+QSCLK=0" and in this mode, the module cannot enter SLEEP mode.

When "AT+QSCLK=1" is sent to the module, customer's application can control the module to enter or exit from the SLEEP mode through pin DTR. When DTR is set to high level, and there is no on-air or hardware interrupt such as GPIO interrupt or data on UART port, the module will enter SLEEP mode automatically. In this mode, the module can still receive voice, SMS or GPRS paging from network but the UART port is not accessible.

3.6.3. Wake up module from SLEEP mode

When the module is in the SLEEP mode, the following methods can wake up the module.

- If the DTR Pin is set low, it would wake up the module from the SLEEP mode. The UART port will be active within 20ms after DTR is changed to low level.
- Receive a voice or data call from network wakes up module.
- Receive an SMS from network wakes up module.

Note: DTR pin should be held at low level during communication between the module and DTE.

3.7. Summary of state transition

Table 9: Summary of state transition

Current mode	Next mode		
	Power down	Normal mode	SLEEP mode
Power down		Use PWRKEY	
Normal mode	AT+QPOWD, use PWRKEY pin, or use EMERG_OFF pin		Use AT command "AT+QSCLK=1" and pull DTR up
SLEEP mode	Use PWRKEY pin, or use EMERG_OFF pin	Pull DTR down or incoming call or SMS or GPRS	

3.8. RTC backup

The RTC (Real Time Clock) can be supplied by an external capacitor or battery (rechargeable or non-chargeable) through the pin VRTC. A 1.5K resistor has been integrated in the module for current limiting. A coin-cell battery or a super-cap can be used to backup power supply for RTC.

The following figures show various sample circuits for RTC backup.

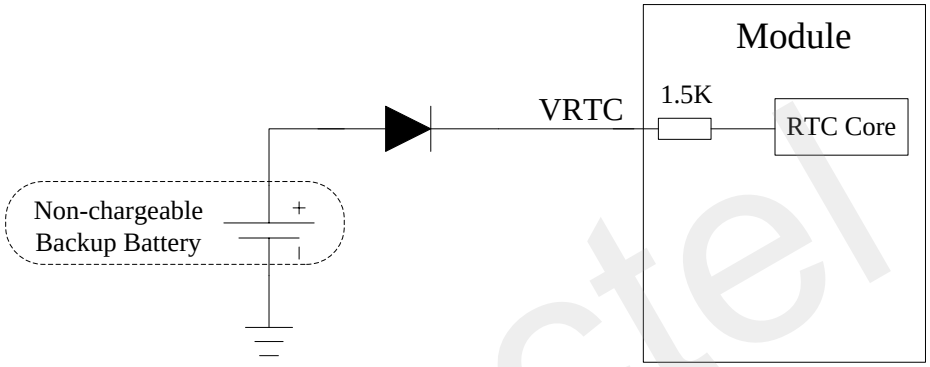

Figure 14: RTC supply from non-chargeable battery

Figure 15: RTC supply from rechargeable battery

Figure 16: RTC supply from capacitor

Coin-type rechargeable capacitor such as XH414H-IV01E from Seiko can be used.

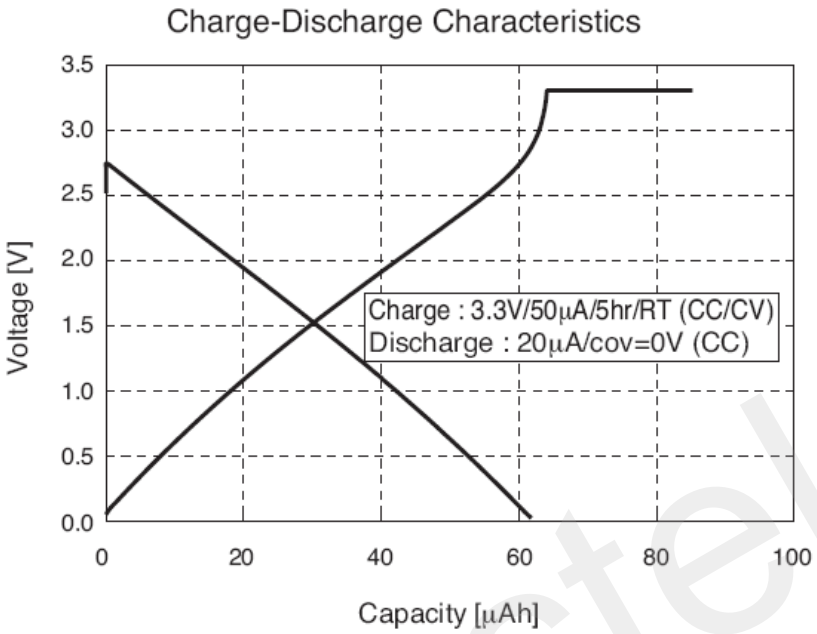

Figure 17: Seiko XH414H-IV01E Charge Characteristics

3.9. Serial interfaces

The module provides three serial ports: UART Port, Debug Port and Auxiliary UART Port. The module is designed as a DCE (Data Communication Equipment), following the traditional DCE-DTE (Data Terminal Equipment) connection. Autobauding function supports baud rate from 4800bps to 115200bps.

The UART Port:

- TXD: Send data to RXD of DTE.
- RXD: Receive data from TXD of DTE.
- RTS: Request to send.
- CTS: Clear to send.
- DTR: DTE is ready and inform DCE (this pin can wake the module up).
- RI: Ring indicator (when the call, SMS, data of the module are coming, the module will output signal to inform DTE).
- DCD: Data carrier detection (the validity of this pin demonstrates the communication link is set up).

Note: The module disables hardware flow control by default. When hardware flow control is required, RTS and CTS should be connected to the host. AT command "AT+IFC=2,2" is used to enable hardware flow control. AT command "AT+IFC=0,0" is used to disable the hardware flow control. For more details, please refer to the document [1].

The Debug Port

- DBG_TXD: Send data to the COM port of computer.
- DBG_RXD: Receive data from the COM port of computer.

The Auxiliary UART Port

- TXD_AUX: Send data to the RXD of DTE.
- RXD_AUX: Receive data from the TXD of DTE.

The logic levels are described in the following table.

Table 10: Logic levels of the UART interfaces

Parameter	Min	Max	Unit
V_{IL}	0	0.25×VDD_EXT	V
V_{IH}	0.75×VDD_EXT	VDD_EXT +0.3	V
V_{OL}		0.15×VDD_EXT	V
V_{OH}	0.85×VDD_EXT		V

Table 11: Pin definition of the UART interfaces

Interface	Name	Pin	Description
Debug Port	DBG_RXD	43	Receive data of the debug port
	DBG_TXD	42	Transmit data of the debug port
UART Port	RI	46	Ring indicator
	RTS	51	Request to send
	CTS	48	Clear to send
	RXD	50	Receive data of the UART port
	TXD	49	Transmit data of the UART port
	DTR	47	Data terminal ready
	DCD	45	Data carrier detection
Auxiliary UART Port	RXD_AUX	41	Receive data of the Auxiliary UART
	TXD_AUX	40	Transmit data of the Auxiliary UART

3.9.1. UART Port

3.9.1.1. The features of UART Port.

- Seven lines on UART interface
- Contain data lines TXD and RXD, hardware flow control lines RTS and CTS, other control lines DTR, DCD and RI.

- Used for AT command, GPRS data, etc. Multiplexing function is supported on the UART Port. So far only the basic mode of multiplexing is available.
- Support the communication baud rates as the following:
  300, 600, 1200, 2400, 4800, 9600, 14400, 19200, 28800, 38400, 57600, 115200.
- The default setting is autobauding mode. Support the following baud rates for Autobauding function:
  4800, 9600, 19200, 38400, 57600, 115200.
- The module disables hardware flow control by default. AT command "AT+IFC=2,2" is used to enable hardware flow control.

After setting a fixed baud rate or autobauding, please send "AT" string at that rate. The UART port is ready when it responds "OK".

Autobauding allows the module to detect the baud rate by receiving the string "AT" or "at" from the host or PC automatically, which gives module flexibility without considering which baud rate is used by the host controller. Autobauding is enabled by default. To take advantage of the autobauding mode, special attention should be paid according to the following requirements:

Synchronization between DTE and DCE:

When DCE (the module) powers on with the autobauding enabled, it is recommended to wait 2 to 3 seconds before sending the first AT character. After receiving the "OK" response, DTE and DCE are correctly synchronized.

If the host controller needs URC in the mode of autobauding, it must be synchronized firstly. Otherwise the URC will be discarded.

Restrictions on autobauding operation:

- The UART port has to be operated at 8 data bits, no parity and 1 stop bit (factory setting).
- The "At" and "aT" commands cannot be used.
- Only the strings "AT" or "at" can be detected (neither "At" nor "aT").
- The Unsolicited Result Codes like "RDY", "+CFUN: 1" and "+CPIN: READY" will not be indicated when the module is turned on with autobauding enabled and not be synchronized.
- Any other Unsolicited Result Codes will be sent at the previous baud rate before the module detects the new baud rate by receiving the first "AT" or "at" string. The DTE may receive unknown characters after switching to new baud rate.
- It is not recommended to switch to autobauding from a fixed baud rate.
- If autobauding is active it is not recommended to switch to multiplex mode.

Note: To assure reliable communication and avoid any problems caused by undetermined baud rate between DCE and DTE, it is strongly recommended to configure a fixed baud rate and save it instead of using autobauding after start-up. For more details, please refer to the Section "AT+IPR" in document [1].

3.9.1.2. The connection of UART

The connection between module and host using UART Port is very flexible. Three connection styles are illustrated as below.

Reference design for Full-Function UART connection is shown as below when it is applied in modulation-demodulation.

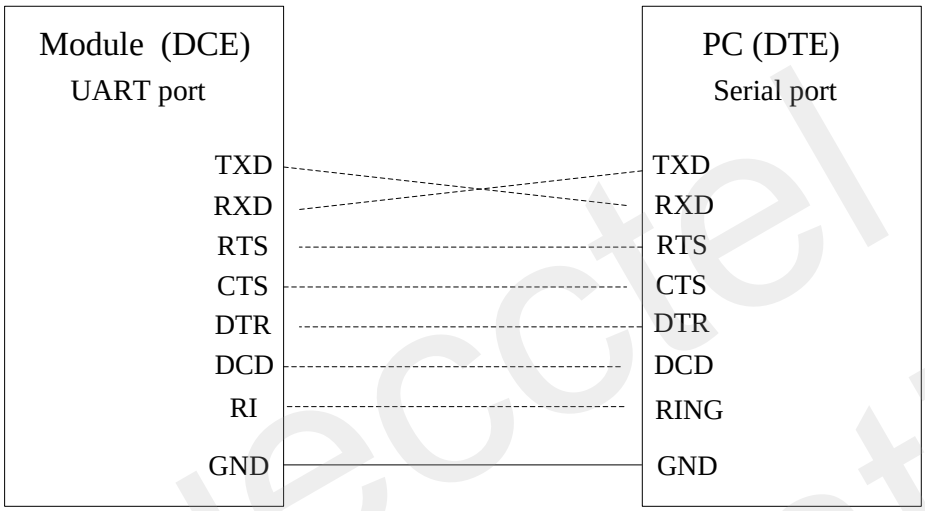

Figure 18: Reference design for Full-Function UART

Three-line connection is shown as below.

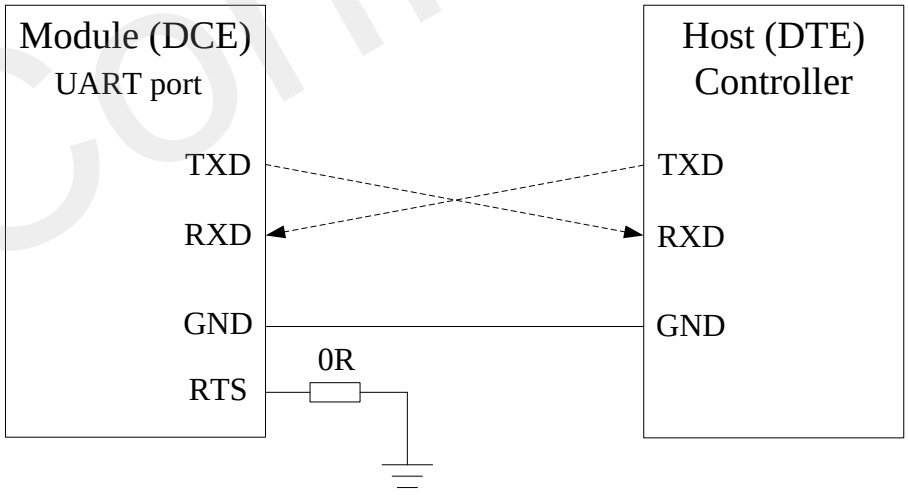

Figure 19: Reference design for UART Port

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

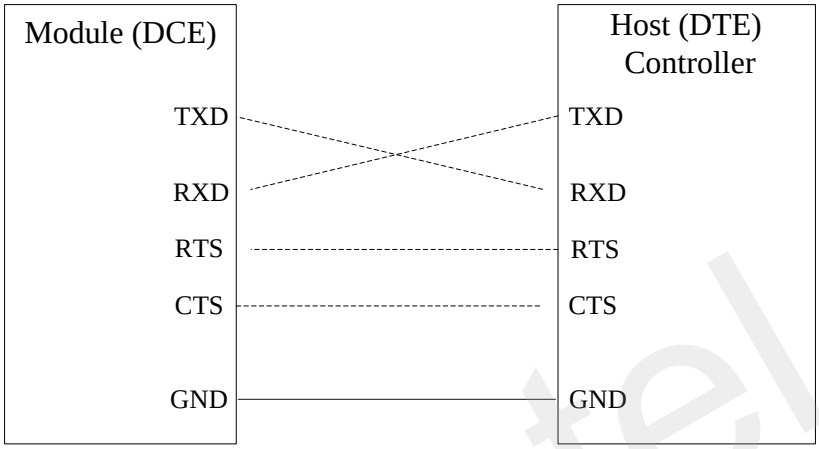

Figure 20: Reference design for UART Port with hardware flow control

3.9.1.3. Firmware upgrade

The TXD, RXD can be used to upgrade firmware. The PWRKEY pin must be pulled down before the firmware upgrade. Please refer to the following figure for Firmware upgrade.

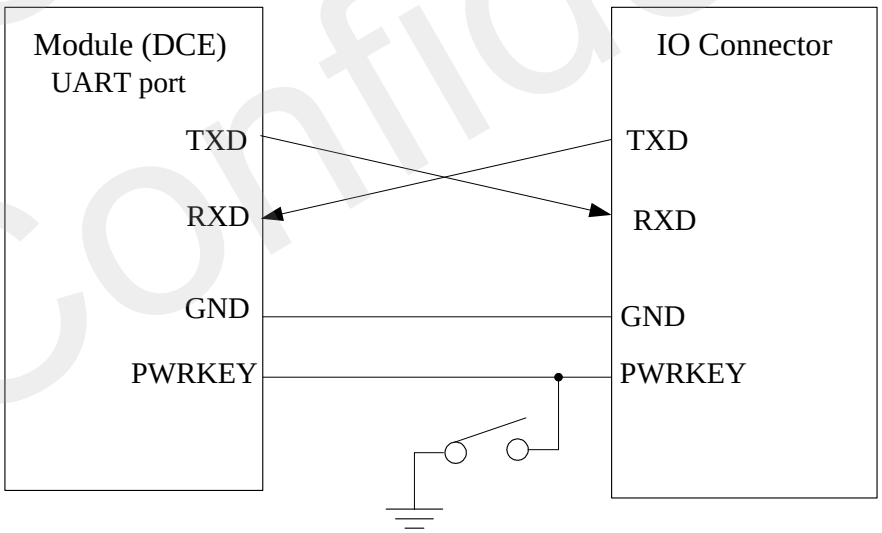

Figure 21: Reference design for Firmware upgrade

Note: The firmware of module might need to be upgraded due to certain reasons, it is recommended to reserve these pins in the host board for firmware upgrade. For detailed design, please refer to the document [11].

3.9.2. Debug Port

Debug Port

- Two lines: DBG_TXD and DBG_RXD
- It outputs log information automatically.
- Debug Port is only used for firmware debugging and its baud rate must be configured as 460800bps.

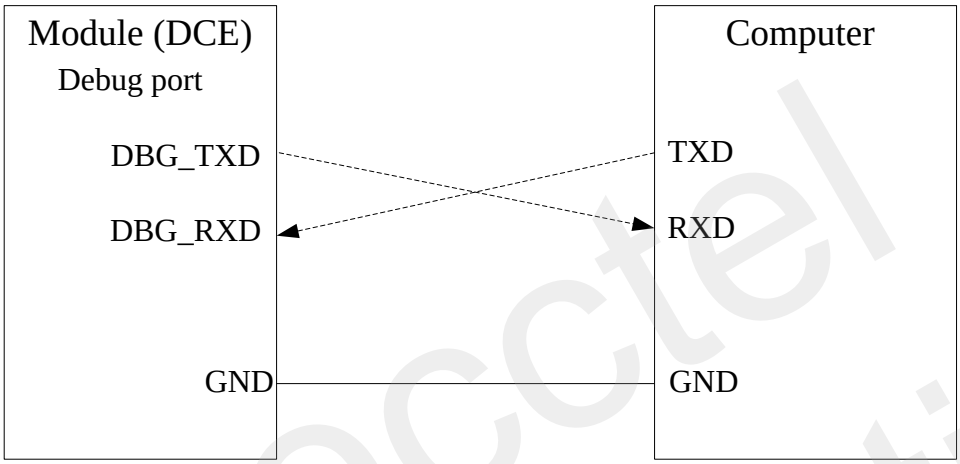

Figure 22: Reference design for Debug Port

3.9.3. Auxiliary UART Port

Auxiliary UART Port

- Two data lines: TXD_AUX and RXD_AUX
- Auxiliary UART port is used for AT command only and does not support GPRS data, CSD FAX, Multiplexing function etc.
- Auxiliary UART port supports the communication baud rates as the following:
  4800, 9600, 14400, 19200, 28800, 38400, 57600, 115200.
- The default baud rate setting is 115200bps, and does not support autobauding. The baud rate can be modified by AT+QSEDCB command. For more details, please refer to the ***document [1]***.

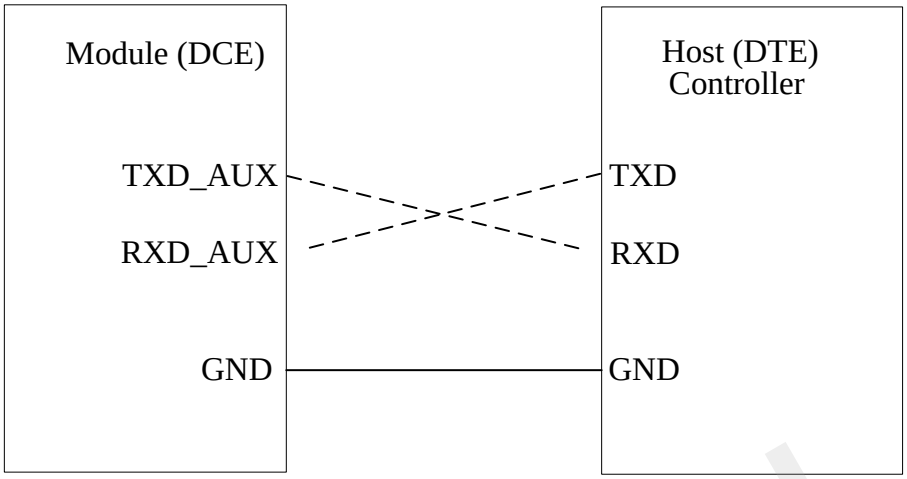

Figure 23: Reference design for Auxiliary UART port

3.9.4. 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 15K.

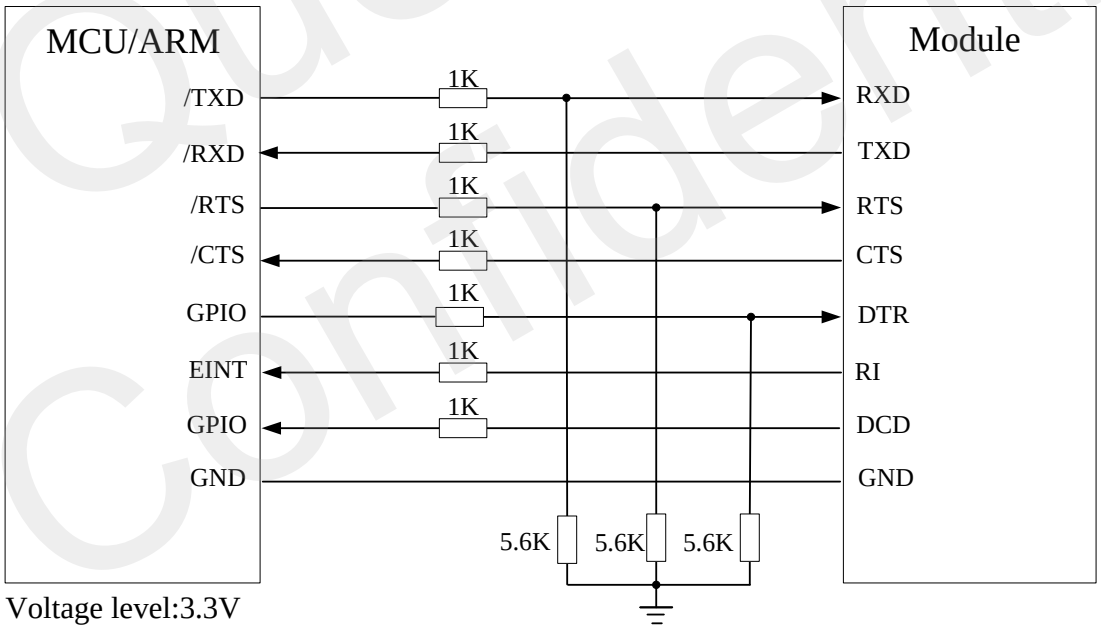

Figure 24: Level match design for 3.3V system

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 MCU/ARM.

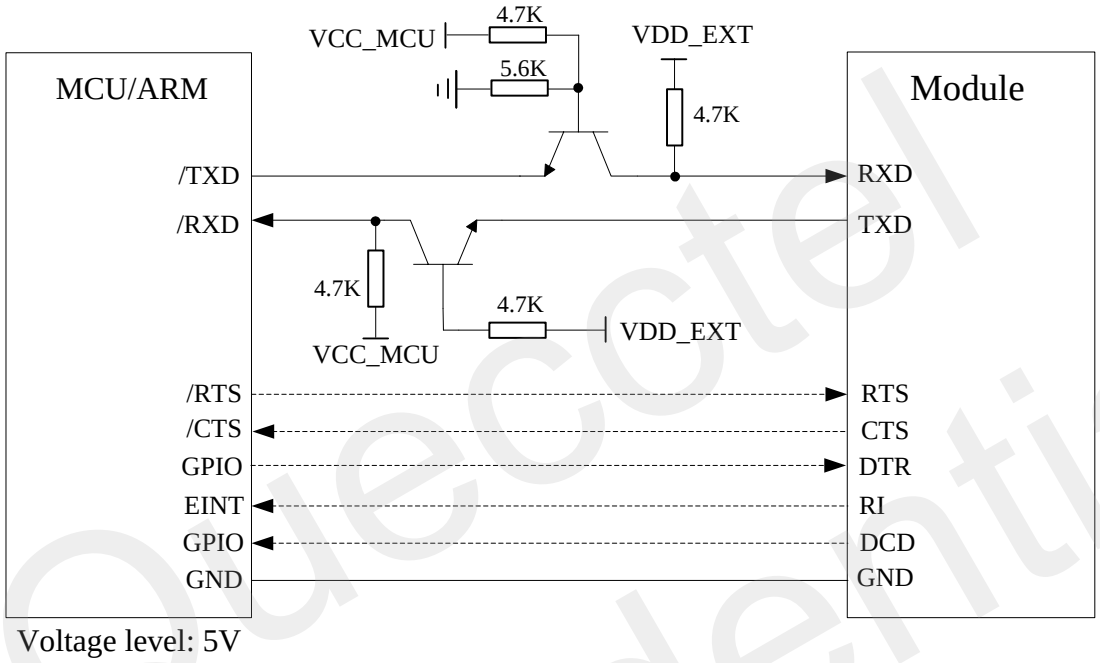

Figure 25: Level match design for 5V system

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.

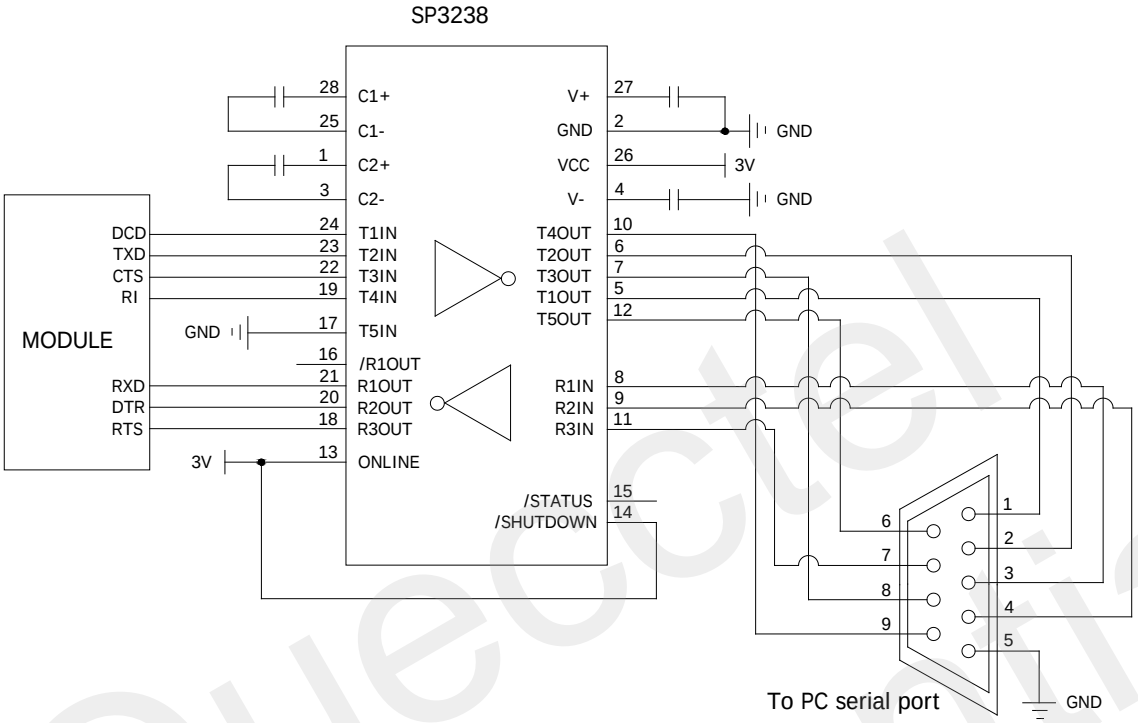

Figure 26: Level match design for RS-232

3.10. Audio interfaces

The module provides two analogy input channels and three analogy output channels.

Table 12: Pin definition of Audio interfaces

Interface	Name	Pin	Description
AIN1/AOUT1	MIC1P	9	Channel one for Microphone positive input
	MIC1N	10	Channel one for Microphone negative input
	SPK1P	12	Channel one for Audio positive output
	SPK1N	11	Channel one for Audio negative output
AIN2/AOUT2	MIC2P	7	Channel two for Microphone positive input
	MIC2N	8	Channel two for Microphone negative input
	SPK2P	5	Channel two for Audio positive output
	AGND	6	Analog ground.
AOUT3	LOUDSPKP	14	Channel three for Audio positive output
	LOUDSPKN	13	Channel three for Audio negative output

AIN1 and AIN2 can be used for input of microphone and line. An electret microphone is usually used. AIN1 and AIN2 are both differential input channels.

AOUT1 is used for output of the receiver. This channel is typically used for a receiver built into a handset. AOUT1 channel is a differential channel.

AOUT2 is typically used with earphone. It is a single-ended and mono channel. SPK2P and AGND can establish a pseudo differential mode.

AOUT3 is used for loud speaker output as it embedded an amplifier of class AB whose maximum drive power is 800mW.

All of these three audio channels support voice and ringtone output, and so on, and can be swapped by “AT+QAUDCH” command. For more details, please refer to the ***document [1]*.**

Use AT command “AT+QAUDCH” to select audio channel:

- 0--AIN1/AOUT1, the default value is 0.
- 1--AIN2/AOUT2
- 2--AIN2/AOUT3

For each channel, customer can use AT+QMIC to adjust the input gain level of microphone. Customer can also use “AT+CLVL” to adjust the output gain level of receiver and speaker. “AT+QSIDET” is used to set the side-tone gain level. For more details, please refer to the ***document [1]*.**

Table 13: AOUT3 output characteristics

Parameter	Condition	Min	Typ	Max	Unit
RMS power	8ohm load VBAT=4.3V THD+N=1%		800		mW
	8ohm load VBAT=3.7V THD+N=1%		700		mW
Gain adjustment range		0		18	dB
Gain adjustment steps			3		dB

3.10.1. Decrease TDD noise and other noise

The 33pF capacitor is applied for filtering out 900MHz RF interference when the module is transmitting at GSM900MHz. Without placing this capacitor, TDD noise could be heard. Moreover, the 10pF capacitor here is for filtering out 1800MHz RF interference. However, the resonant frequency point of a capacitor largely depends on the material and production technique. Therefore, customer would have to discuss with its capacitor vendor to choose the most suitable capacitor for filtering out GSM850MHz, GSM900MHz, DCS1800MHz and PCS1900MHz separately.

The severity degree of the RF interference in the voice channel during GSM transmitting period largely depends on the application design. In some cases, GSM900 TDD noise is more severe; while in other cases, DCS1800 TDD noise is more obvious. Therefore, customer can have a choice based on test results. Sometimes, even no RF filtering capacitor is required.

The capacitor which is used for filtering out RF noise should be close to RJ11 or other audio interfaces. Audio alignment should be as short as possible.

In order to decrease radio or other signal interference, the position of RF antenna should be kept away from audio interface and audio alignment. Power alignment and audio alignment should not be parallel, and power alignment should be far away from audio alignment.

The differential audio traces have to be placed according to the differential signal layout rule.

3.10.2. Microphone interfaces design

AIN1 and AIN2 channels come with internal bias supply for external electret microphone. A reference circuit is shown in the following figure.

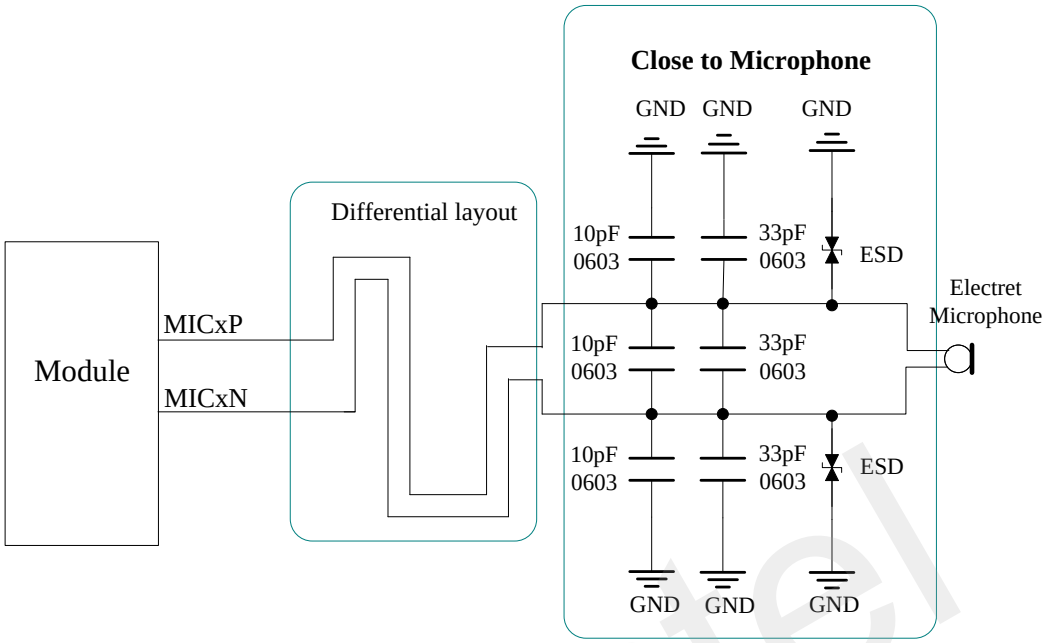

Figure 27: Reference design for AIN1&AIN2

3.10.3. Receiver and speaker interface design

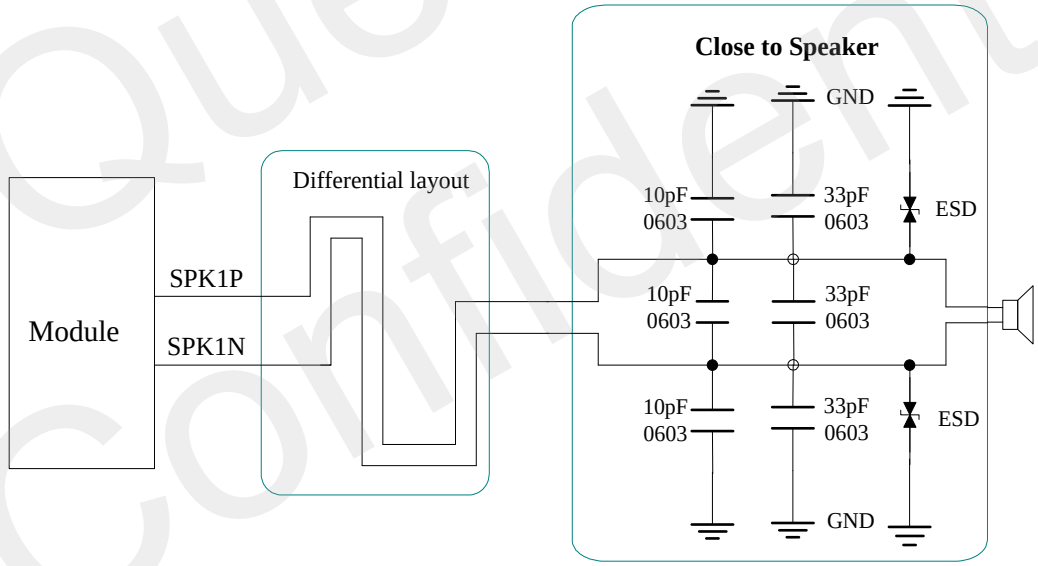

Figure 28: Reference design for AOUT1

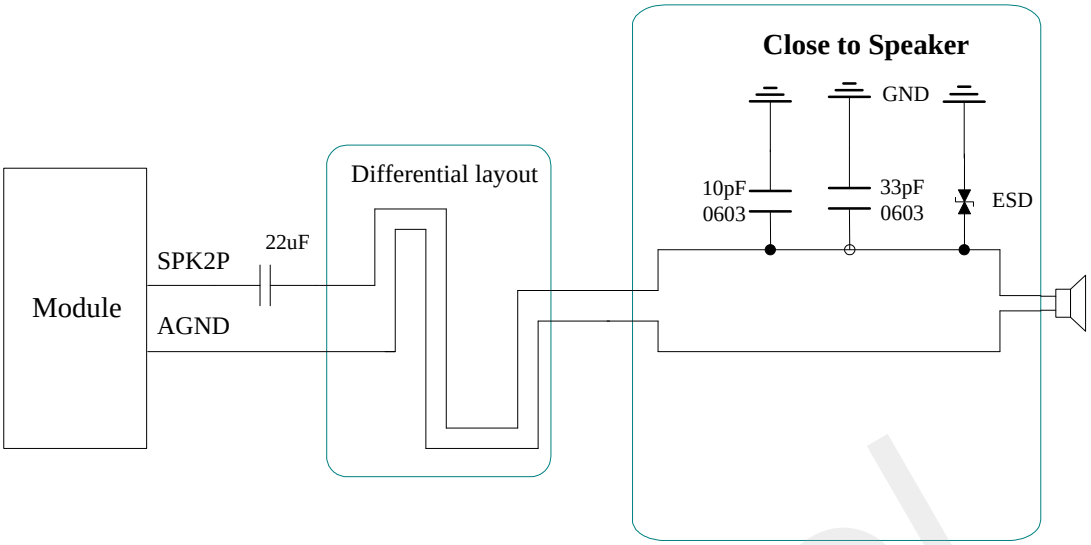

Figure 29: Handset interface design for AOUT2

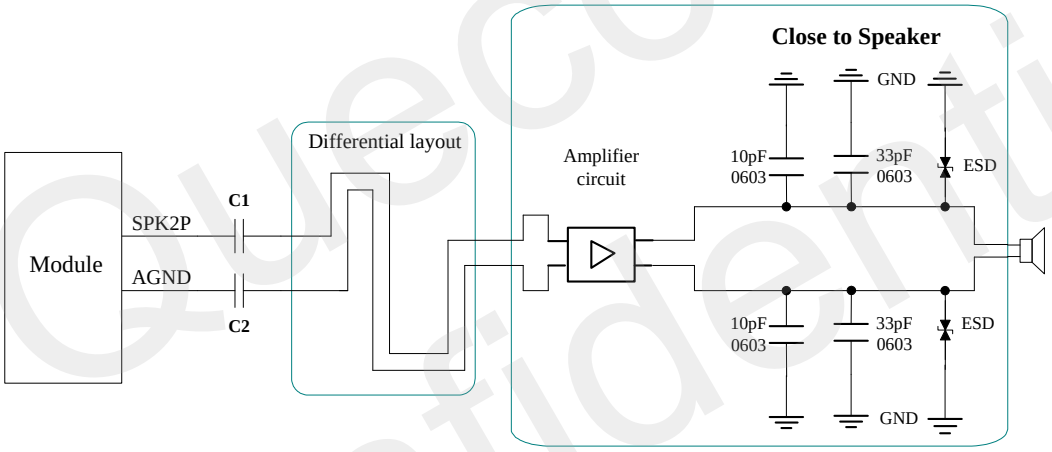

Figure 30: Speaker interface design with an amplifier for AOUT2

Texas Instrument's TPA6205A1is recommended for a suitable differential audio amplifier. There are plenty of excellent audio amplifiers in the market.

Note: The value of C1 and C2 here depends on the input impedance of audio amplifier.

3.10.4. Earphone interface design

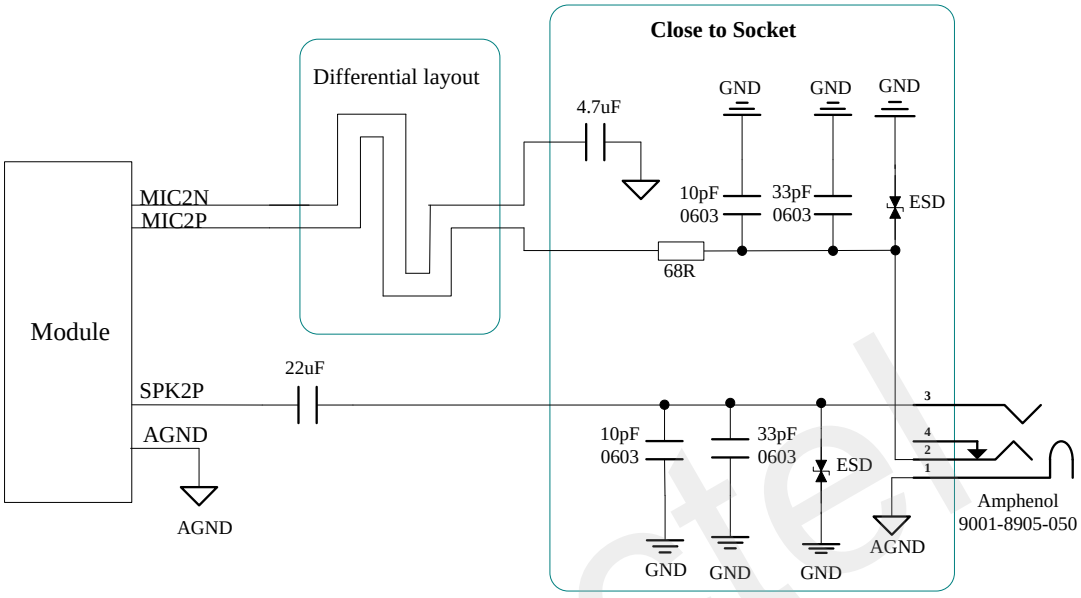

Figure 31: Earphone interface design

3.10.5. Loud speaker interface design

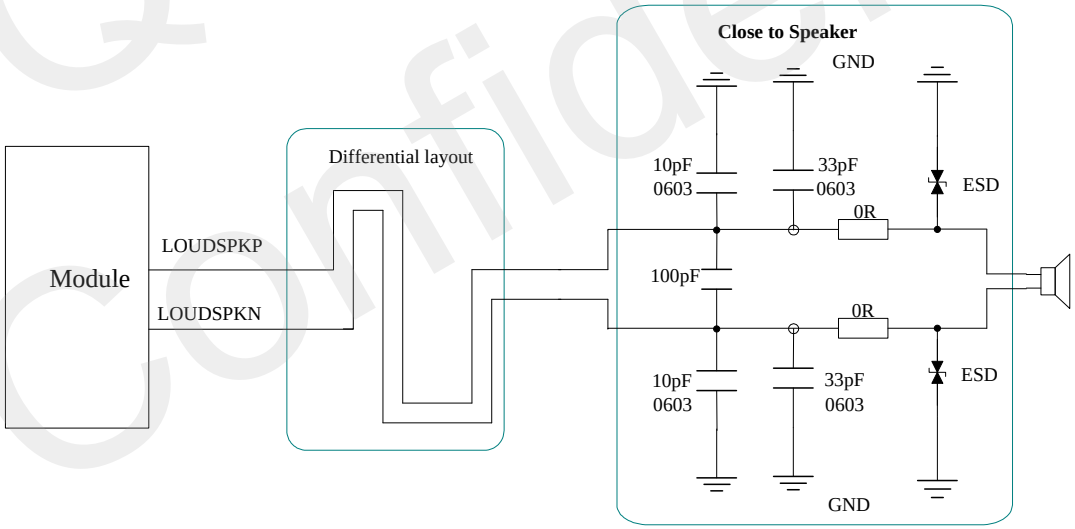

Figure 32: Loud speaker interface design

3.10.6. Audio characteristics

Table 14: Typical electret microphone characteristics

Parameter	Min	Typ	Max	Unit
Working Voltage	1.2	1.5	2.0	V
Working Current	200		500	uA
External Microphone Load Resistance		2.2		kOhm

Table 15: Typical speaker characteristics

Parameter			Min	Typ	Max	Unit
Normal Output (AOUT1)	Single Ended	Load Resistance	28	32		Ohm
		Ref level	0		2.4	Vpp
	Differential	Load Resistance	28	32		Ohm
		Ref level	0		4.8	Vpp
Auxiliary Output (AOUT2)	Single Ended	Load Resistance	16	32		Load Resistance
		Ref level	0		2.4	Vpp
Output (AOUT3)	Differential	Load Resistance		8		Load Resistance
		Ref level	0		2×VBAT	Vpp

3.11. SIM card interface

3.11.1. SIM card application

The SIM interface supports the functionality of the GSM Phase 1 specification and also supports the functionality of the new GSM Phase 2+ specification for FAST 64 kbps SIM card, which is intended for use with a SIM application Tool-kit.

The SIM interface is powered from an internal regulator in the module. Both 1.8V and 3.0V SIM Cards are supported.

Table 16: Pin definition of the SIM interface

Name	Pin	Description
SIM_VDD	56	Supply power for SIM Card. Automatic detection of SIM card voltage. 3.0V±10% and 1.8V±10%. Maximum supply current is around 10mA.
SIM_DATA	54	SIM data
SIM_CLK	55	SIM clock
SIM_RST	53	SIM reset
SIM_PRESENCE	57	SIM card detection
SIM_GND	52	SIM ground

In Figure 33, the pin SIM_PRESENCE is used to detect whether the tray of the Molex SIM socket, which is used for holding SIM card, is present in the card socket. When the tray is inserted in the socket, SIM_PRESENCE is at low level. Regardless of whether the SIM card is in the tray or not, the change of SIM_PRESENCE level from high to low level inspires the module to reinitialize SIM card. In default configuration, SIM card detection function is disabled. Customer's application can use "AT+QSIMDET=1,0 " to switch on and "AT+QSIMDET=0,0 " to switch off the SIM card detection function. For detail of this AT command, please refer to the ***document [1]***. When "AT+QSIMDET=1,0" is set and the tray with SIM card is removed from SIM socket, the following URC will be presented.

+CPIN: NOT READY

When the tray with SIM card is inserted into SIM socket again and the module finishes re-initialization SIM card, the following URC will be presented.

Call Ready

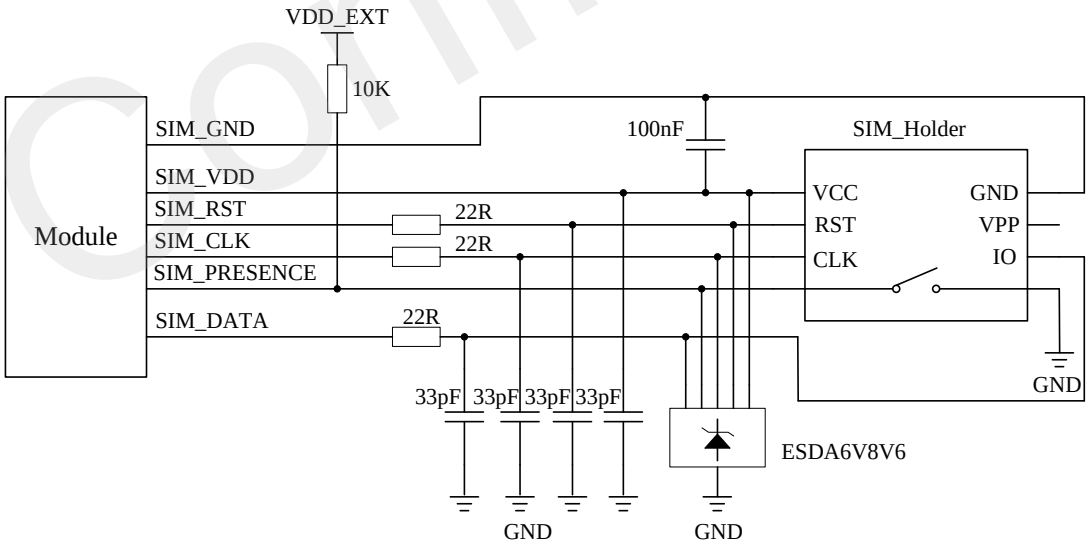

Figure 33: Reference circuit of the 8 pins SIM card

Note: Please do not use "AT+QSIMDET=1,1" which causes to initialize SIM card when Figure 33 circuit is adopted.

If customer does not need the SIM card detection function, keep SIM_PRESENCE open. The reference circuit using a 6-pin SIM card socket is illustrated as the following figure.

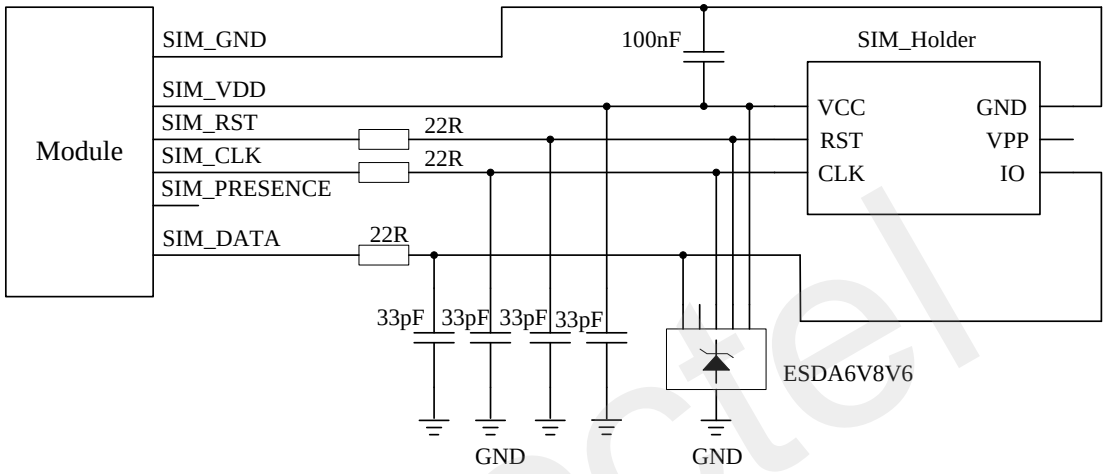

Figure 34: Reference circuit of the 6 pins SIM card

In order to enhance the reliability and availability of the SIM card in the customer's 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 20cm.
- 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 added 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.

3.11.2. 6 Pin SIM cassette

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

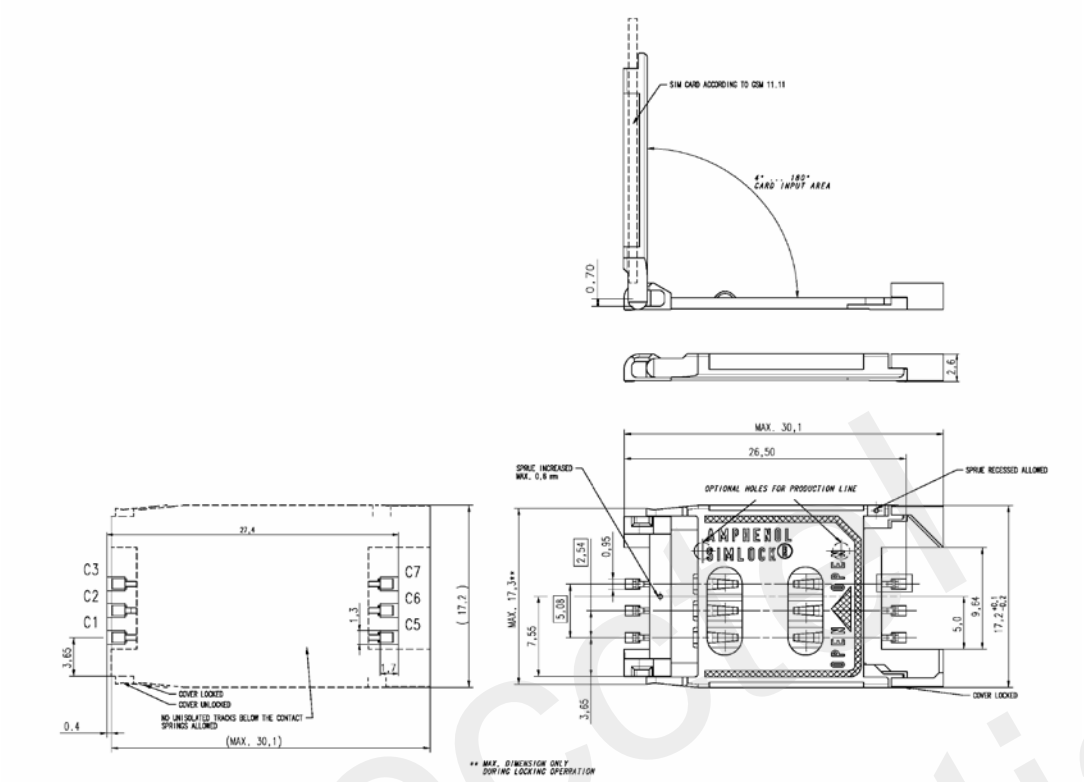

Figure 35: Amphenol C707 10M006 512 2 SIM card holder

Table 17: Pin description of Amphenol SIM card holder

Name	Pin	Description
SIM_VDD	C1	SIM Card Power Supply
SIM_RST	C2	SIM Card Reset
SIM_CLK	C3	SIM Card Clock
GND	C5	Ground
VPP	C6	Not Connect
SIM_DATA	C7	SIM Card data I/O

3.11.3. 8 Pin SIM cassette

For 8-pin SIM card holder, it is recommended to use Molex 91228. Please visit http://www.molex.com for more information.

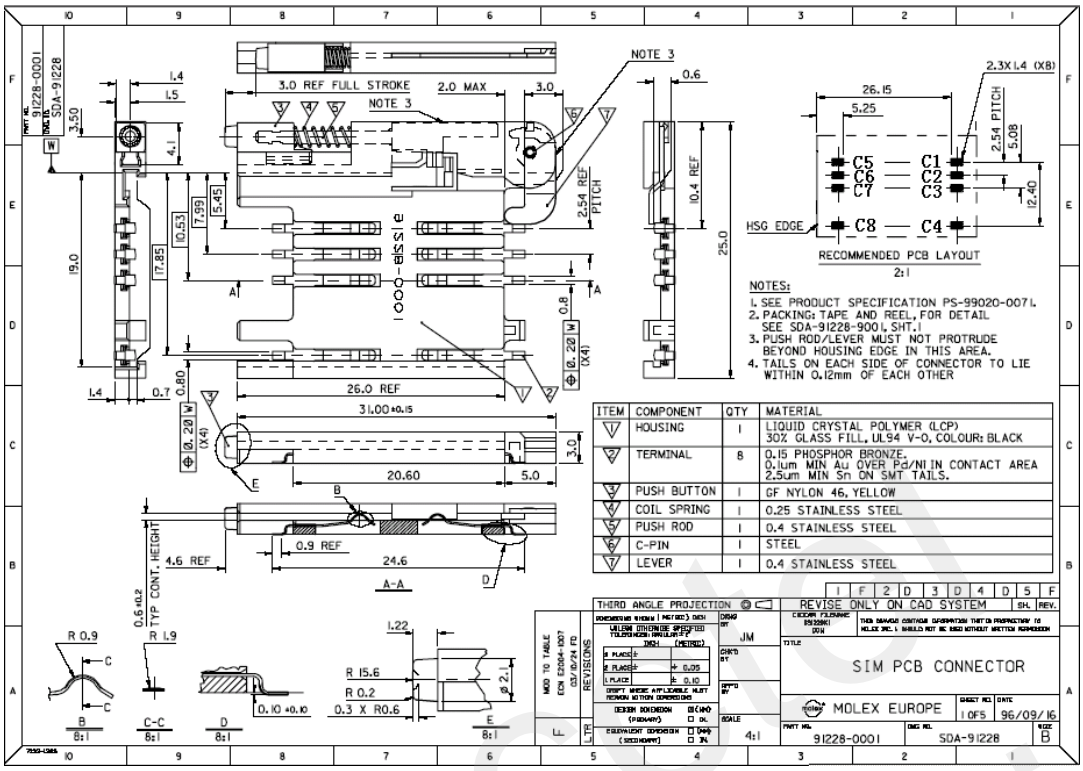

Figure 36: Molex 91228 SIM card holder

Table 18: Pin description of Molex SIM card holder

Name	Pin	Description
SIM_VDD	C1	SIM Card Power supply
SIM_RST	C2	SIM Card Reset
SIM_CLK	C3	SIM Card Clock
SIM_PRESENCE	C4	SIM Card Presence Detection
GND	C5	Ground
VPP	C6	Not Connect
SIM_DATA	C7	SIM Card Data I/O
SIM_DETECT	C8	Pulled down GND with external circuit. When the tray is present, C4 is connected to C8.

3.12. SD card interface

The module provides SD card interface that support many types of memory, such as Memory Stick, SD/MCC card and T-Flash or Micro SD card. The following are the main features of SD card interface.

- Only supports 1bit serial mode.
- Does not support the SPI mode SD/MMC memory card.
- Does not support hot plug.
- Up to 26MHz data rate in serial mode.
- Up to 32GB maximum memory card capacity.

With interface features and reference circuit of SD card shown in Figure 37, the users can easily design the SD card application circuit to enhance the memory capacity of the module. The module can record and store the audio files to the SD card, and play the audio files from SD card as well.

Table 19: Pin definition of the SD card interface

Name	Pin	Description
SD_DATA0	36	SD data
SD_CLK	35	SD clock
SD_CMD	34	SD command

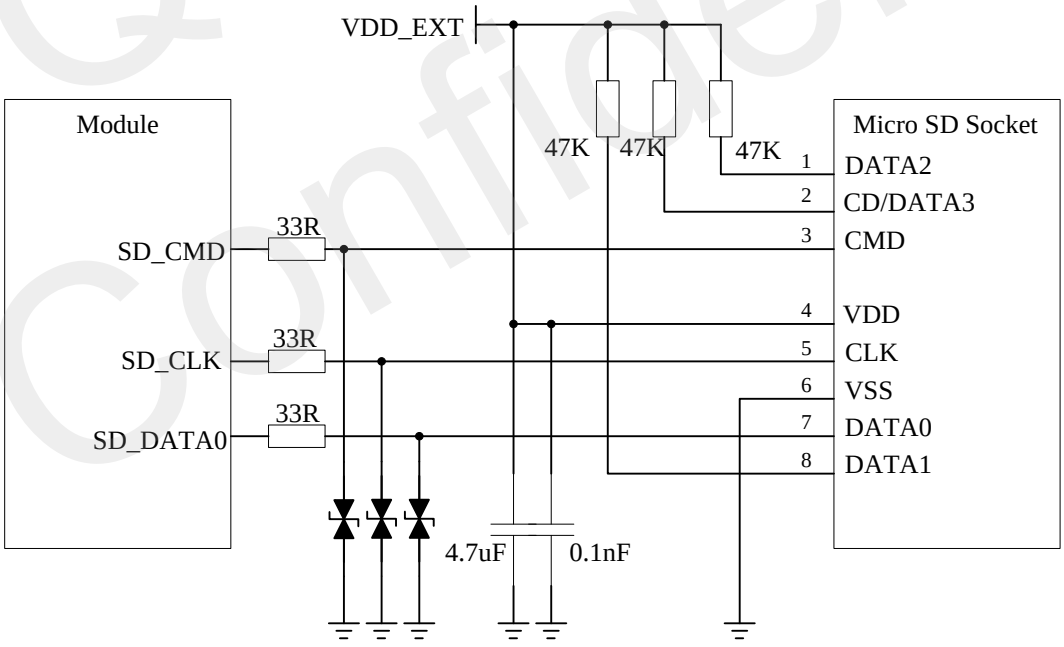

Figure 37: Reference circuit of SD card

Table 20: Pin name of the SD card and Micro SD card

Pin NO.	Pin name of SD card	Pin name of T-Flash(Micro SD) card
1	CD/DATA3	DATA2
2	CMD	CD/DATA3
3	VSS1	CMD
4	VDD	VDD
5	CLK	CLK
6	VSS2	VSS
7	DATA0	DATA0
8	DATA1	DATA1
9	DATA2	

In SD card interface designing, in order to ensure good communication performance with SD card, the following design principles should be complied with.

- Route SD card trace as short as possible. Keep total trace length < 100mm, and trace difference of DATA0, CMD, and CLK to be < 10mm. The SD_CLK and SD_DATA0 line must be shielded by GND in order to avoid interference.
- In order to offer good ESD protection, it is recommended to add TVS on signals with the capacitance is less than 15pF.
- Reserve external pull-up resistor for other data lines except the DATA0.

3.13. PCM interface

M50 supports PCM interface. It is used for digital audio transmission between the module and the customer's device. This interface is composed of PCM_CLK, PCM_SYNC, PCM_IN and PCM_OUT signal lines.

Pulse-code modulation (PCM) is a converter that changes the consecutive analog audio signal to discrete digital signal. The whole procedure of Pulse-code modulation contains sampling, quantizing and encoding.

Table 21: Pin definition of PCM interface

Name	Pin	I/O	Description
PCM_CLK	19	O	PCM clock
PCM_IN	18	I	PCM data input
PCM_OUT	20	O	PCM data output
PCM_SYNC	21	O	PCM frame synchronization

3.13.1. Configuration

M50 supports 16 bits line code PCM format. The sample rate is 8 KHz, the clock source is 256 KHz, and the module can only act as master mode. The PCM interfaces support long and short synchronization simultaneously. It only supports MSB first. For more detailed information, please see the table below.

Table 22: Configuration

PCM	
Line interface format	Linear
Data length	Linear: 16 bits
Sampling rate	8KHz
PCM clock/synchronization source	PCM master mode: clock and synchronization is generated by module
PCM synchronization rate	8KHz
PCM clock rate	PCM master mode:256 KHz
PCM synchronization format	Long/short synchronization
PCM data ordering	MSB first
Zero padding	Yes
Sign extension	Yes

3.13.2. Timing

The sample rate of the PCM interface is 8 KHz and the clock source is 256 KHz, so every frame contains 32 bits data, since M50 supports 16 bits line code PCM format, the left 16 bits are invalid. The following diagram shows the timing of different combinations. The synchronization length in long synchronization format can be programmed by firmware from one bit to eight bits. In the Sign extension mode, the high three bits of 16 bits are sign extension, and in the Zero padding mode, the low three bits of 16 bits are zero padding.

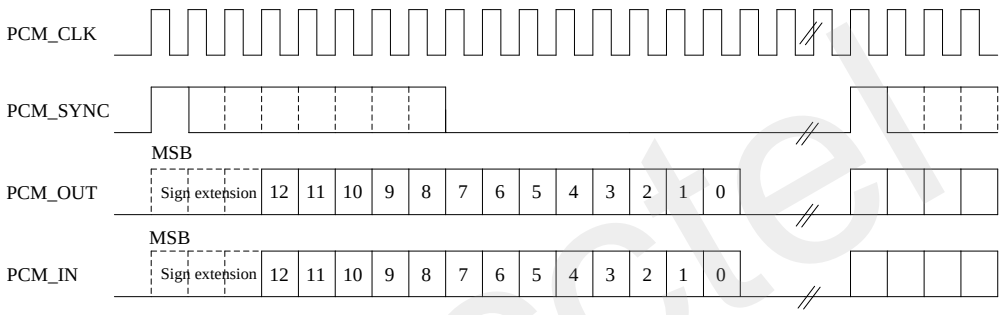

Figure 38: Long synchronization & Sign extension diagram

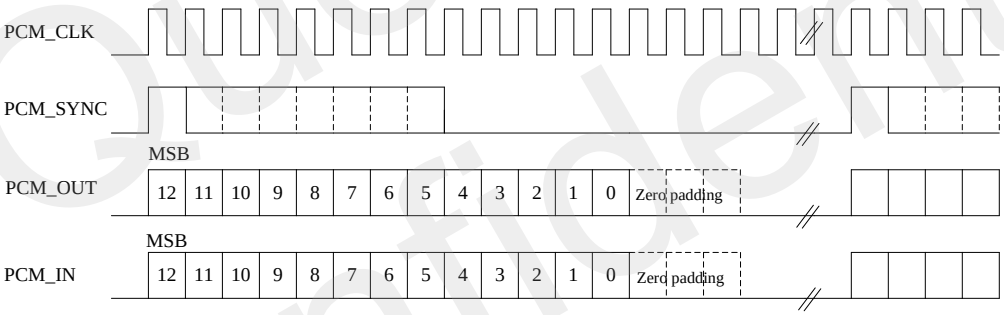

Figure 39: Long synchronization & Zero padding diagram

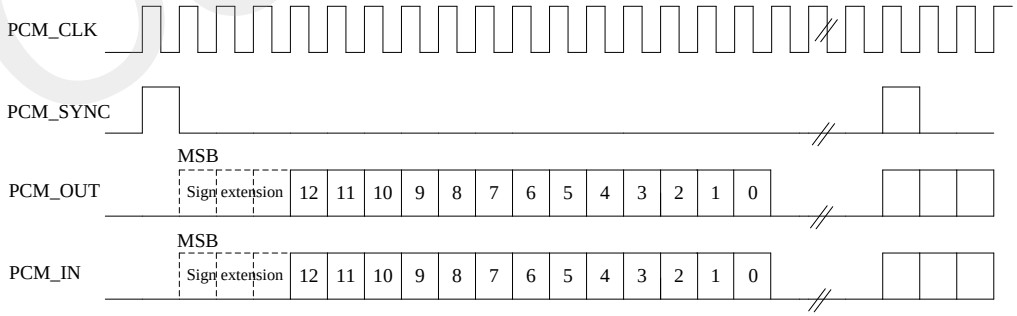

Figure 40: Short synchronization & Sign extension diagram

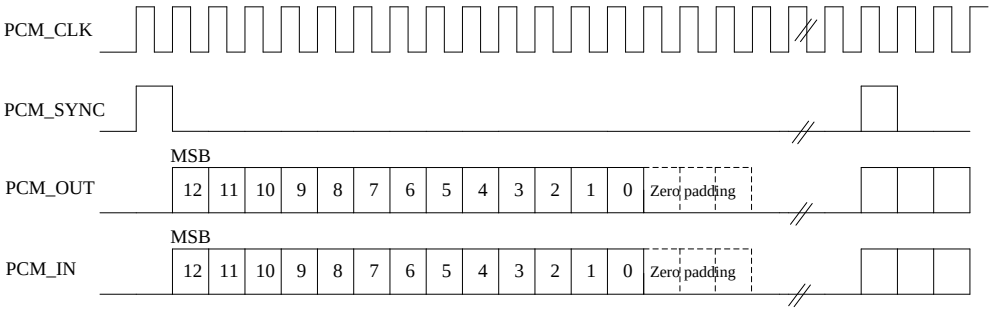

Figure 41: Short synchronization & Zero padding diagram

3.13.3. Reference design

As M50 only acts as a master, the module provides synchronization and clock source. The reference design is shown as below.

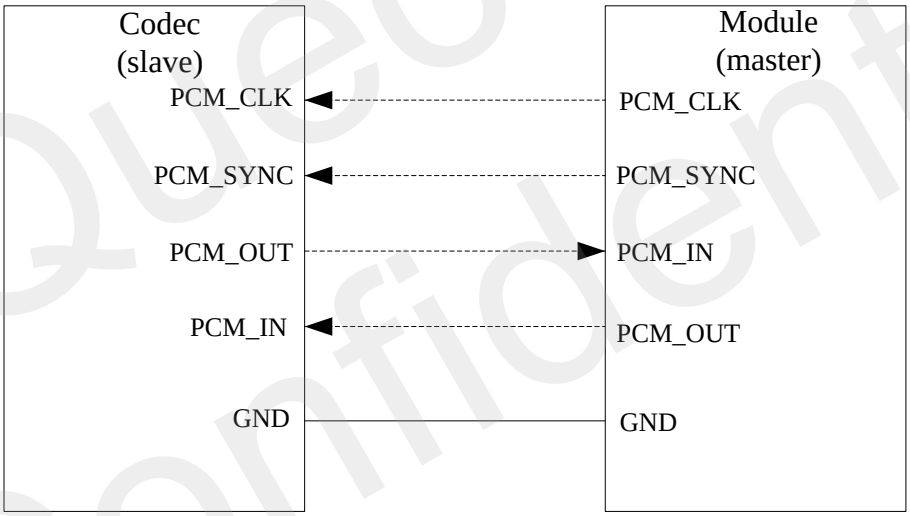

Figure 42: Reference design for PCM

3.13.4. AT command

There are two AT commands about the configuration of PCM are listed as below.

“AT+QPCMON” can configure operating mode of PCM.
AT+QPCMON= mode,Sync_Type,Sync_Length,SignExtension,MSBFirst

Table 23: QPCMON command description

Parameter	scope	Description
Mode	0~2	0: Close PCM 1: Open PCM 2: Open PCM when audio talk is set up
Sync_Type	0~1	0: Short synchronization 1: Long synchronization
Sync_Length	1~8	Programmed from one bit to eight bit
SignExtension	0~1	0: Zero padding 1: Sign extension
MSBFirst	0~1	0: MSB first 1: Not supported

"AT+QPCMVOL" can configure volume of input and output.
AT+QPCMVOL=vol_pcm_in,vol_pcm_out

Table 24: QPCMVOL command description

Parameter	scope	Description
vol_pcm_in	0~32767	Set the input volume
vol_pcm_out	0~32767	Set the output volume The voice may be distorted when this value exceeds 16384.

3.14. ADC

The module provides two ADC channel to measure the value of voltage. Please give priority to the use of ADC0 channel. The command "AT+QADC" can read the voltage value applied on ADC0 pin, while AT command "AT+QEADC" can read the voltage value applied on ADC1 pin. For details of this AT command, please refer to the ***document [1]***. In order to improve the accuracy of ADC, the layout of ADC should be surrounded by ground.

Table 25: Pin definition of the ADC

Name	Pin	Description
ADC0	2	General purpose analog to digital converter
ADC1	1	General purpose analog to digital converter

Table 26: Characteristics of the ADC

Parameter	Min	Typ	Max	Unit
Voltage Range	0		2.8	V
ADC Resolution		10		bit
ADC Accuracy		2.7		mV

3.15. Behaviors of the RI

Table 27: Behaviors of the RI

State	RI response
Standby	HIGH
Voice calling	Change to LOW, then: 1. Change to HIGH when call is established. 2. Use ATH to hang up the call, RI changes to HIGH. 3. Calling part hangs up, RI changes to HIGH first, and changes to LOW for 120ms indicating "NO CARRIER" as an URC, then changes to HIGH again. 4. Change to HIGH when SMS is received.
Data calling	Change to LOW, then: 1. Change to HIGH when data connection is established. 2. Use ATH to hang up the data calling, RI changes to HIGH. 3. Calling part hangs up, RI changes to HIGH first, and changes to LOW for 120ms indicating "NO CARRIER" as an URC, then changes to HIGH again.

	4. Change to HIGH when SMS is received.
SMS	When a new SMS comes, the RI changes to LOW and holds low level for about 120 ms, then changes to HIGH.
URC	Certain URCs can trigger 120ms low level on RI. For more details, please refer to the ***document [1]***

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.

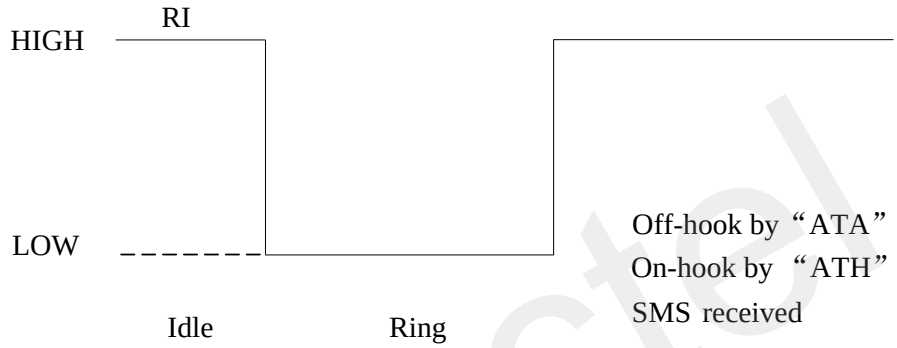

Figure 43: RI behavior of voice calling as a receiver

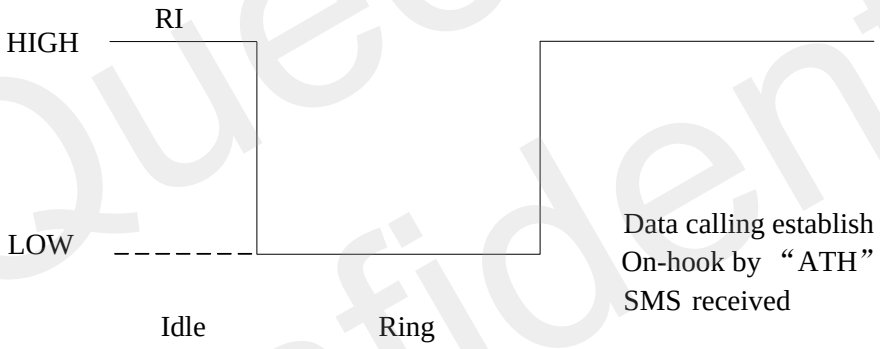

Figure 44: RI behavior of data calling as a receiver

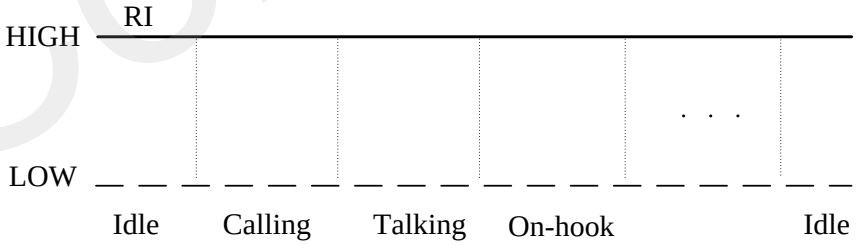

Figure 45: RI behavior as a caller

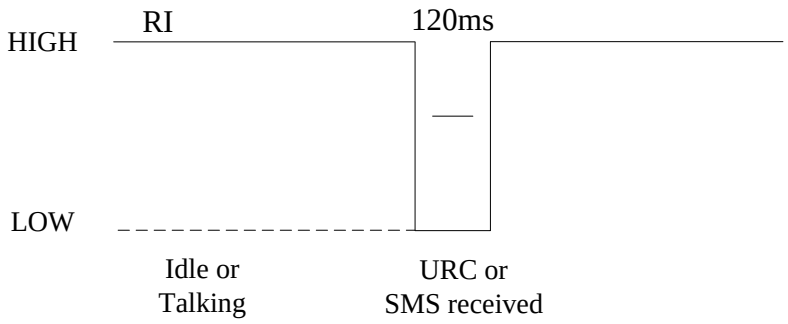

Figure 46: RI behavior of URC or SMS received

3.16. Network status indication

The NETLIGHT signal can be used to drive a network status indicator LED. The working state of this pin is listed in the following table.

Table 28: 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/ 2000ms Off	The module is synchronized with network.
64ms On/ 600ms Off	GPRS data transfer is ongoing.

A reference circuit is shown as below.

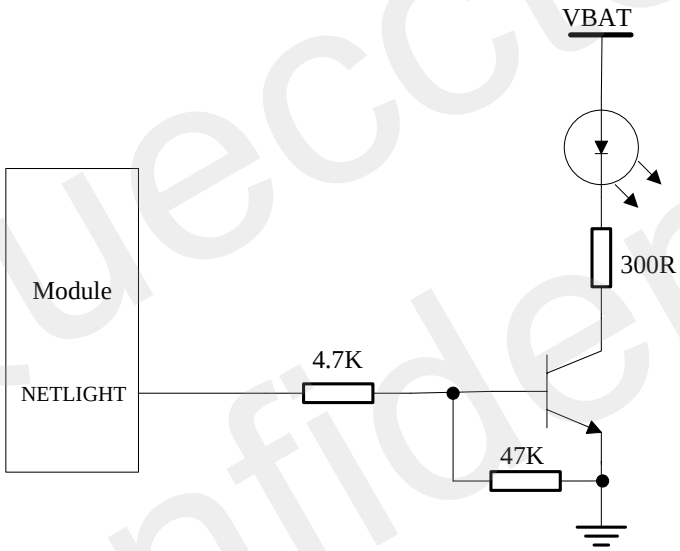

Figure 47: Reference design for NETLIGHT

3.17. Operating status indication

The STATUS pin is set as an output pin and can be used to judge whether module is power-on. In customer's 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 Figure 48.

Table 29: Pin definition of the STATUS

Name	Pin	Description
STATUS	16	Indicate module operating status

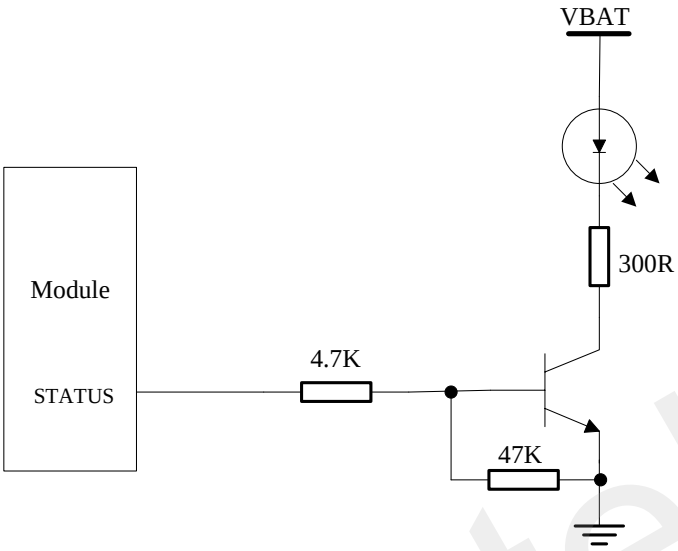

Figure 48: Reference design for STATUS

4. Antenna interface

The Pin 63 is the RF antenna pad. The RF interface has an impedance of 50Ω.

Table 30: Pin definition of the RF_ANT

Name	Pin	Description
GND	61	Ground
GND	62	Ground
RF_ANT	63	RF antenna pad
GND	64	Ground
GND	65	Ground
GND	66	Ground

4.1. RF reference design

The reference design for RF is shown as below.

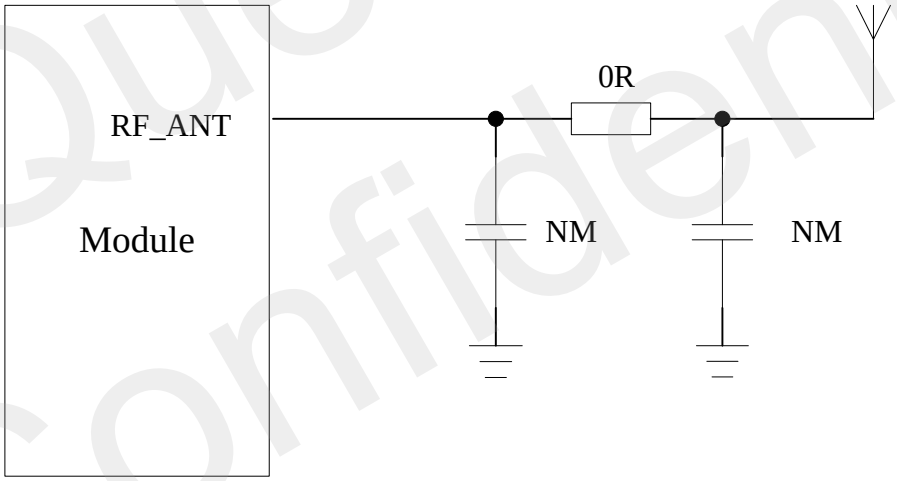

Figure 49: Reference design for RF

M50 provides an RF antenna pad for customer's antenna connection. The RF trace in host PCB connected to the module RF antenna pad should be micro-strip line or other types of RF trace, whose characteristic impedance should be close to 50Ω. M50 comes with grounding pads which are next to the antenna pad in order to give a better grounding. Besides, a ∏ type match circuit is suggested to be used to adjust the RF performance.

To minimize the loss on the RF trace and RF cable, take design into account carefully. It is recommended that the insertion loss should meet the following requirements:

- GSM850/EGSM900 is <1dB.
- DCS1800/PCS1900 is <1.5dB.

4.2. RF output power

Table 31: The module conducted RF output power

Frequency	Max	Min
GSM850	32.5dBm ±1dB	5dBm±5dB
EGSM900	32.5dBm ±1dB	5dBm±5dB
DCS1800	29.5dBm ±1dB	0dBm±5dB
PCS1900	29.5dBm ±1dB	0dBm±5dB

Note: In GSM850&EGSM900 GPRS 4 slots TX mode, the max output power is reduced by 2.5dB. This design conforms to the GSM specification as described in section 13.16 of 3GPP TS 51.010-1.

4.3. RF receiving sensitivity

Table 32: The module conducted RF receiving sensitivity

Frequency	Receive sensitivity
GSM850	< -108.5dBm
EGSM900	< -108.5dBm
DCS1800	< -108.5dBm
PCS1900	< -108.5dBm

4.4. Operating frequencies

Table 33: The module operating frequencies

Frequency	Receive	Transmit	ARFCH
GSM850	869~894MHz	824~849MHz	128~251
EGSM900	925~960MHz	880~915MHz	0~124, 975~1023
DCS1800	1805~1880MHz	1710~1785MHz	512~885
PCS1900	1930~1990MHz	1850~1910MHz	512~810

4.5. RF cable soldering

Soldering the RF cable to RF pad of module correctly will reduce the loss on the path of RF, please refer to the following example of RF soldering.

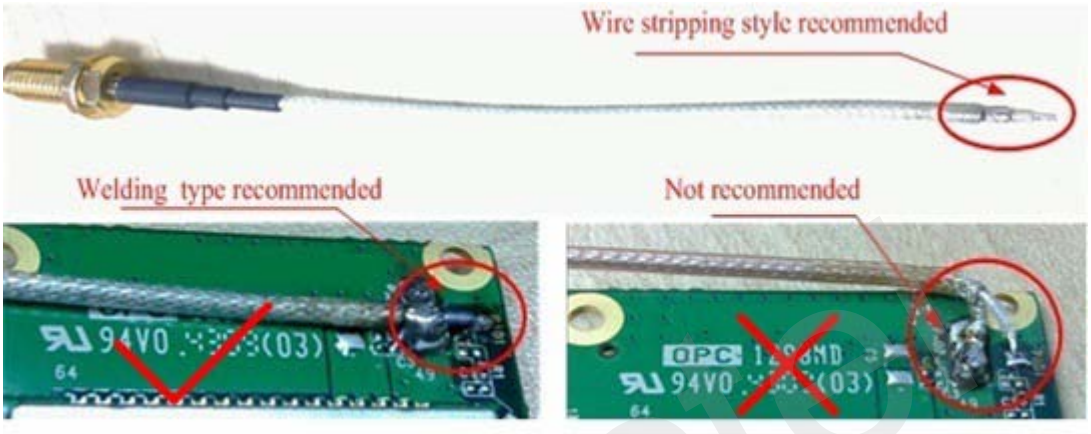

Figure 50: RF soldering sample

5. Electrical, reliability and radio characteristics

5.1. Absolute maximum ratings

Absolute maximum ratings for power supply and voltage on digital and analog pins of module are listed in the following table:

Table 34: Absolute maximum ratings

Parameter	Min	Max	Unit
VBAT	-0.3	+4.73	V
Peak current of power supply	0	2	A
RMS current of power supply (during one TDMA- frame)	0	0.7	A
Voltage at digital pins	-0.3	3.3	V
Voltage at analog pins	-0.3	3.0	V
Voltage at digital/analog pins in power down mode	-0.25	0.25	V

5.2. Operating temperature

The operating temperature is listed in the following table:

Table 35: Operating temperature

Parameter	Min	Typ	Max	Unit
Normal Temperature	-35	+25	+80	℃
Restricted Operation[1)]	-40 ~ -35		+80 ~ +85	℃
Storage Temperature	-45		+90	℃

1）When the module works in 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. Power supply ratings

Table 36: The module power supply ratings

Parameter	Description	Conditions	Min	Typ	Max	Unit
VBAT	Supply voltage	Voltage must stay within the min/max values, including voltage drop, ripple, and spikes.	3.3	4.0	4.6	V
	Vdrop during transmitting burst	Maximum power control level on GSM850 and GSM900.			400	mV
	Voltage ripple	Maximum power control level on GSM850 and GSM900 @ f<200kHz @ f>200kHz			 50 2	 mV mV
I_{VBAT}	Average supply current	Power down mode SLEEP mode @ DRX=5		30 1.3		uA mA
		Minimum functionality mode AT+CFUN=0 IDLE mode SLEEP mode AT+CFUN=4 IDLE mode SLEEP mode		 13 0.98 13 1.0		 mA mA mA mA
		IDLE mode GSM850/EGSM 900 DCS1800/PCS1900		 13 13		 mA mA
		TALK mode GSM850/EGSM 900[1)] DCS1800/PCS1900[2)]		 209/208 191/202		 mA mA
		DATA mode, GPRS (3 Rx,2Tx) GSM850/EGSM 900[1)] DCS1800/PCS1900[2)]		 435/400 313/337		 mA mA
		DATA mode, GPRS(2 Rx,3Tx) GSM850/EGSM 900[1)] DCS1800/PCS1900[2)]		 605/558 399/460		 mA mA
		DATA mode, GPRS (4 Rx,1Tx) GSM850/EGSM 900[1)] DCS1800/PCS1900[2)]		 265/240 200/212		 mA mA
		DATA mode, GPRS (1Rx,4Tx) GSM850/EGSM 900[1)]		 615/560		 mA

		DCS1800/PCS1900[2)]		420/470		mA
	Peak supply current (during transmission slot)	Maximum power control level on GSM850 and GSM900.		1.6	1.8	A

[1)] ***Power control level PCL 5***

[2)] ***Power control level PCL 0***

5.4. Current consumption

The values of current consumption are shown as below.

Table 37: The module current consumption

Condition	Current Consumption
Voice Call	
GSM850	@power level #5 <300mA,Typical 209mA @power level #12,Typical 96mA @power level #19,Typical 73mA
GSM900	@power level #5 <300mA,Typical 208mA @power level #12,Typical 96mA @power level #19,Typical 73mA
DCS1800	@power level #0 <250mA,Typical 191mA @power level #7,Typical 93mA @power level #15,Typical 70mA
PCS1900	@power level #0 <250mA,Typical 202mA @power level #7,Typical 95mA @power level #15,Typical 71mA
GPRS Data	
DATA mode, GPRS (1 Rx,1 Tx) CLASS 12	
GSM850	@power level #5 <350mA,Typical 199mA @power level #12,Typical 87mA @power level #19,Typical 63mA
EGSM 900	@power level #5 <350mA,Typical 200mA @power level #12,Typical 96mA @power level #19,Typical 70mA
DCS 1800	@power level #0 <300mA,Typical 184mA @power level #7,Typical 82mA @power level #15,Typical 66mA
PCS 1900	@power level #0 <300mA,Typical 192mA @power level #7,Typical 82mA @power level #15,Typical 66mA

DATA mode, GPRS (3 Rx, 2 Tx) CLASS 12	
GSM850	@power level #5 <550mA,Typical 435mA @power level #12,Typical 158mA @power level #19,Typical 99mA
EGSM 900	@power level #5 <550mA,Typical 400mA @power level #12,Typical 150mA @power level #19,Typical 97mA
DCS 1800	@power level #0 <450mA,Typical 313mA @power level #7,Typical 130mA @power level #15,Typical 92mA
PCS 1900	@power level #0 <450mA,Typical 337mA @power level #7,Typical 140mA @power level #15,Typical 94mA
DATA mode, GPRS (2 Rx, 3 Tx) CLASS 12	
GSM850	@power level #5 <640mA,Typical 605mA @power level #12,Typical 195mA @power level #19,Typical 107mA
EGSM 900	@power level #5 <600mA,Typical 558mA @power level #12,Typical 185mA @power level #19,Typical 106mA
DCS 1800	@power level #0 <490mA,Typical 399mA @power level #7,Typical 150mA @power level #15,Typical 94mA
PCS 1900	@power level #0 <480mA,Typical 460mA @power level #7,Typical 166mA @power level #15,Typical 98mA
DATA mode, GPRS (4 Rx,1 Tx) CLASS 12	
GSM850	@power level #5 <350mA,Typical 265mA @power level #12,Typical 122mA @power level #19,Typical 93mA
EGSM 900	@power level #5 <350mA,Typical 240mA @power level #12,Typical 115mA @power level #19,Typical 90mA
DCS 1800	@power level #0 <300mA,Typical 200mA @power level #7,Typical 107mA @power level #15,Typical 89mA
PCS 1900	@power level #0 <300mA,Typical 212mA @power level #7,Typical 118mA @power level #15,Typical 90mA
DATA mode, GPRS (1 Rx, 4 Tx) CLASS 12	
GSM850	@power level #5 <660mA,Typical 615mA @power level #12,Typical 232mA @power level #19,Typical 118mA

EGSM 900	@power level #5 <660mA,Typical 560mA @power level #12,Typical 215mA @power level #19,Typical 114mA
DCS 1800	@power level #0 <530mA,Typical 420mA @power level #7,Typical 173mA @power level #15,Typical 97mA
PCS 1900	@power level #0 <530mA,Typical 470mA @power level #7,Typical 192mA @power level #15,Typical 101mA

Note: GPRS Class 12 is the default setting. The module can be configured from GPRS Class 1 to Class 12 by "AT+QGPCLASS". Setting to lower GPRS class would make it easier to design the power supply for the module.

5.5. Electro-static discharge

Although the GSM engine is generally protected against Electrostatic Discharge (ESD), ESD protection precautions should still be emphasized. Proper ESD handling and packaging procedures must be applied throughout the processing, handling and operation of any applications using the module.

The measured ESD values of module are shown in the following table.

Table 38: The ESD endurance (Temperature:25℃,Humidity:45 %)

Tested point	Contact discharge	Air discharge
VBAT,GND	±5KV	±10KV
RF_ANT	±5KV	±10KV
PWRKEY STATUS	±2KV	±4KV
SIM_VDD, SIM_DATA SIM_CLK, SIM_RST	±2KV	±4KV
TXD, RXD RTS, CTS, DTR	±2KV	±4KV
Others	±0.5KV	±1KV

6. Mechanical dimensions

This chapter describes the mechanical dimensions of the module.

6.1. Mechanical dimensions of module

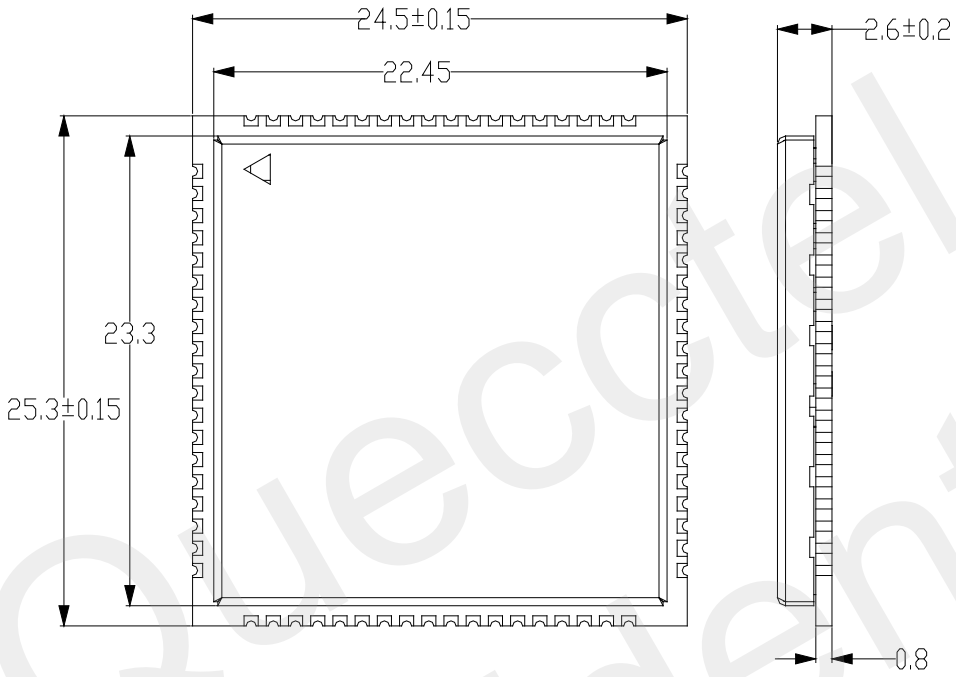

Figure 51: M50 top and side dimensions

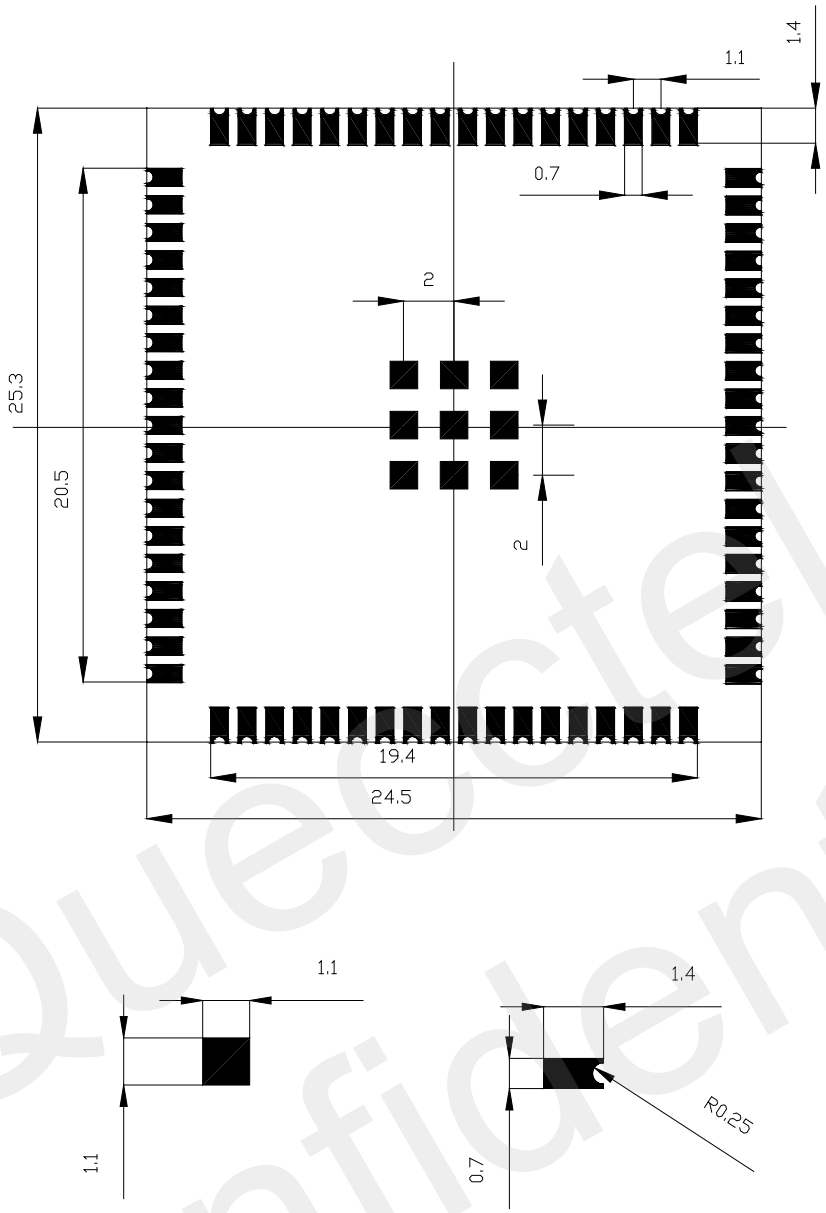

Figure 52: M50 bottom dimensions

6.2. Recommended footprint without bottom centre pads

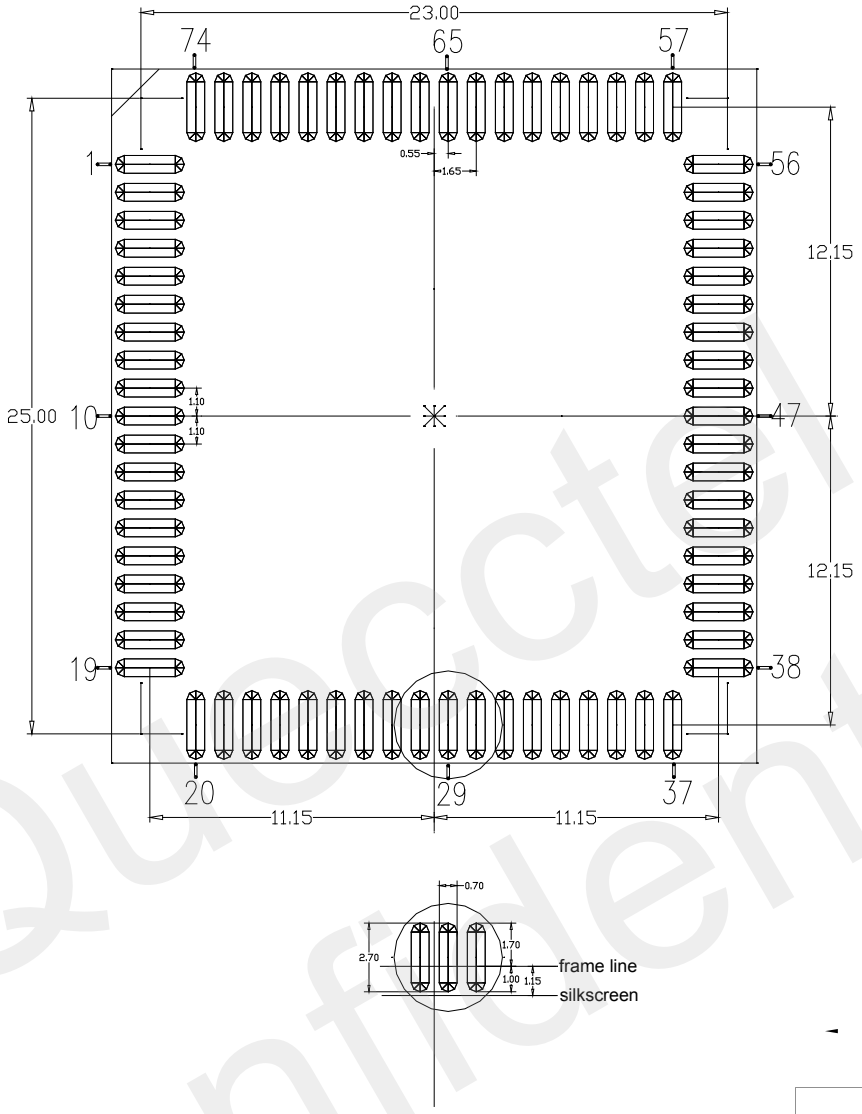

Figure 53: Recommended footprint without bottom centre pads

6.4. Top view of the module

Figure 54: Top view of the module

6.5. Bottom view of the module

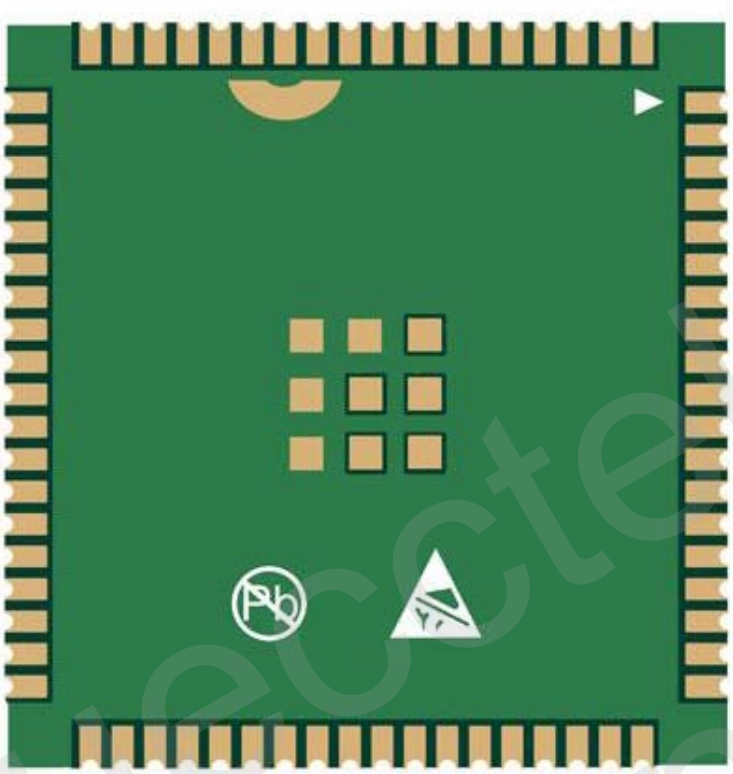

Figure 55: Bottom view of the module

7. Storage and manufacturing

7.1. Storage

M50 is distributed in vacuum-sealed bag. The restriction of storage condition is shown as below.

Shelf life in sealed bag: 12 months at <40℃/90% RH

After this bag is opened, devices that will be subjected to reflow solder or other high temperature process must be:

- Mounted within 72 hours at factory conditions of ≤30℃/60% RH
- Stored at <10% RH

Devices require bake before mounting, if:

- Humidity indicator card is >10% when read at 23℃±5℃
- Mounted exceed 72 hours at factory conditions of ≤30 ℃/60% RH

If baking is required, devices may be baked for 48 hours at 125℃±5℃

Note: As plastic container cannot be subjected to high temperature, devices must be removed prior to high temperature (125 ℃) bake. If shorter bake times are desired, refer to the IPC/JEDECJ-STD-033 for bake procedure.

7.2. Soldering

The squeegee should push the paste on the surface of the stencil that makes the paste fill the stencil openings and penetrate to the PCB. The force on the squeegee should be adjusted so as to produce a clean stencil surface on a single pass. To ensure the module soldering quality, the thickness of stencil at the hole of the module pads should be 0.2mm for M50 .

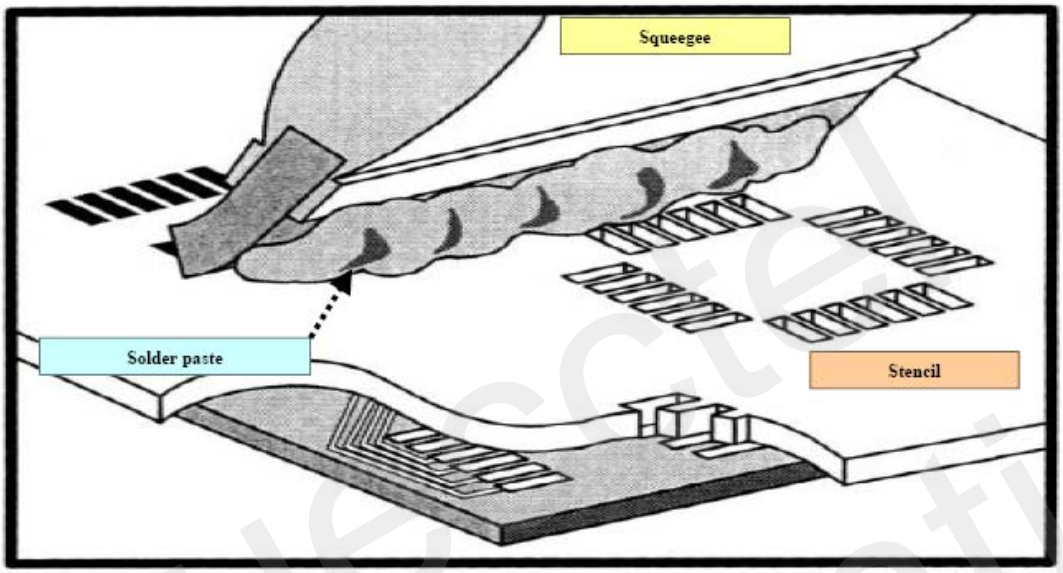

Figure 56: Paste application

Suggest peak reflow temperature is from 235℃ to 245℃ (for SnAg3.0Cu0.5 alloy). Absolute max reflow temperature is 260℃. To avoid damage to the module when it was repeatedly heated, it is suggested that the module should be mounted after the first panel has been reflowed. The following picture is the actual diagram which we have operated.

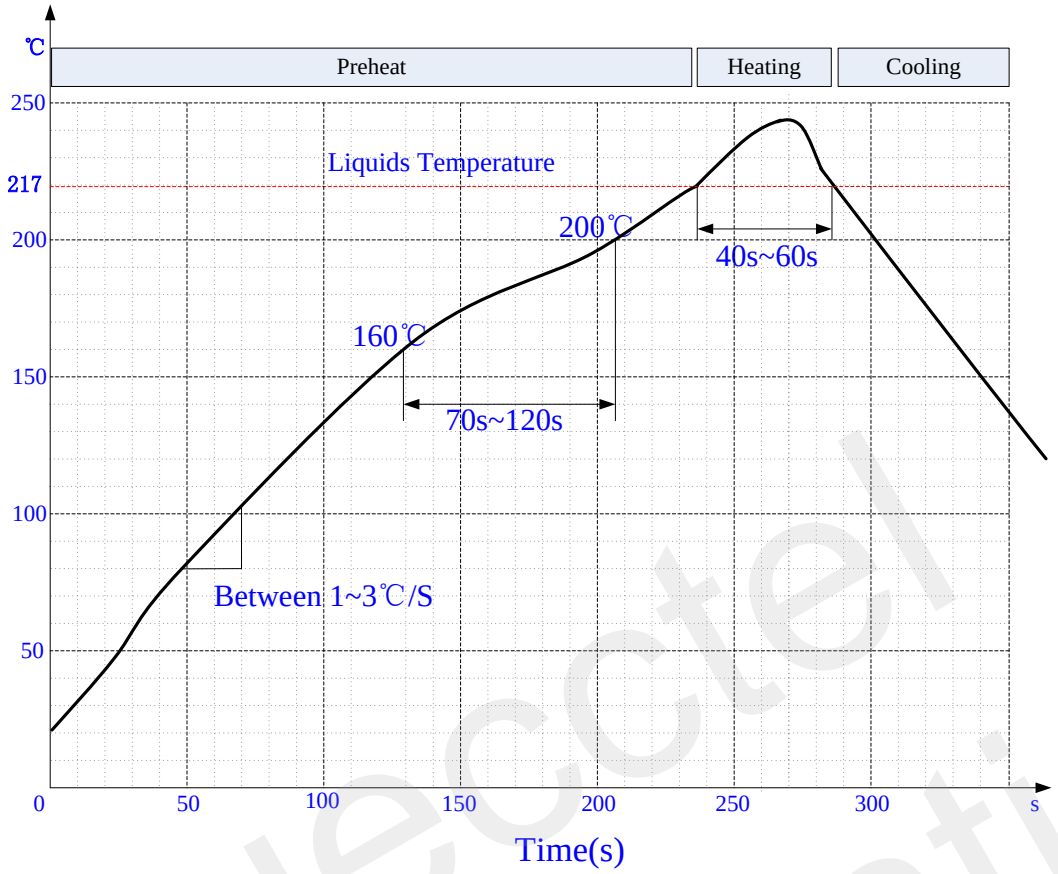

Figure 57: Ramp-Soak-Spike reflow profile

7.3. Packaging

M50 modules are distributed in trays of 20 pieces each. This is especially suitable for the M50 according to SMT processes requirements.

The trays are stored inside a vacuum-sealed bag which is ESD protected. It should not be opened until the devices are ready to be soldered onto the application.

Figure 58: Module tray

Appendix A: GPRS coding schemes

Four coding schemes are used in GPRS protocol. The differences between them are shown in Table 39.

Table 39: Description of different coding schemes

Scheme	Code rate	USF	Pre-coded USF	Radio Block excl.USF and BCS	BCS	Tail	Coded bits	Punctured bits	Data rate Kb/s
CS-1	1/2	3	3	181	40	4	456	0	9.05
CS-2	2/3	3	6	268	16	4	588	132	13.4
CS-3	3/4	3	6	312	16	4	676	220	15.6
CS-4	1	3	12	428	16	-	456	-	21.4

Radio block structure of CS-1, CS-2 and CS-3 is shown as Figure 60:

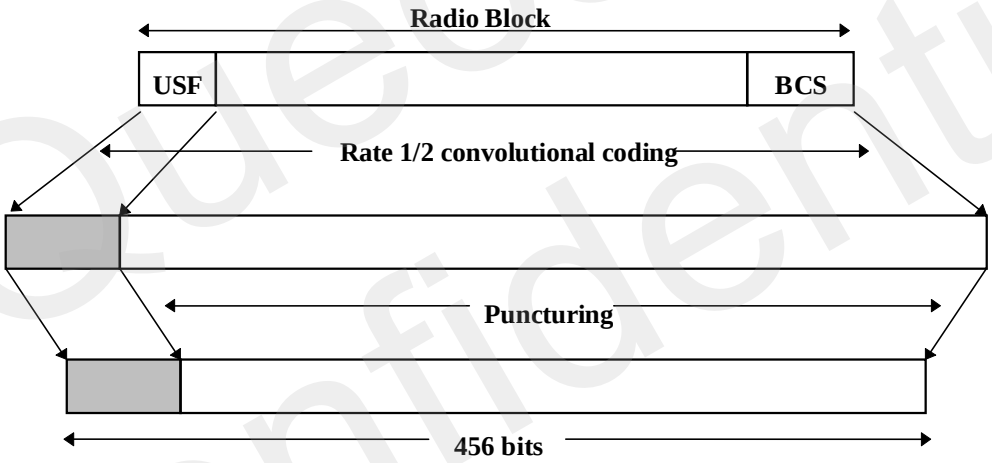

Figure 59: Radio block structure of CS-1, CS-2 and CS-3

Radio block structure of CS-4 is shown as Figure 61:

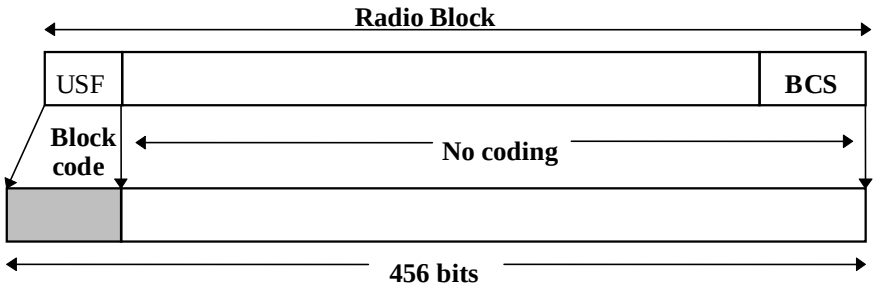

Figure 60: Radio block structure of CS-4

Appendix B: GPRS multi-slot classes

Twenty-nine classes of GPRS multi-slot modes are defined for MS in GPRS specification. Multi-slot classes are product dependant, and determine the maximum achievable data rates in both the uplink and downlink directions. Written as 3+1 or 2+2, the first number indicates the amount of downlink timeslots, while the second number indicates the amount of uplink timeslots. The active slots determine the total number of slots the GPRS device can use simultaneously for both uplink and downlink communications. The description of different multi-slot classes is shown in Table 40.

Table 40: GPRS multi-slot classes

Multislot class	Downlink slots	Uplink slots	Active slots
1	1	1	2
2	2	1	3
3	2	2	3
4	3	1	4
5	2	2	4
6	3	2	4
7	3	3	4
8	4	1	5
9	3	2	5
10	4	2	5
11	4	3	5
12	4	4	5

Shanghai Quectel Wireless Solutions Co., Ltd.

Room 501, Building 13, No.99 Tianzhou Road, Shanghai, China 200233

Tel: +86 21 5108 6236

Mail: info@quectel.com