M08-R Hardware Design

GSM/GPRS Module Series

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About the Document

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Contents

About the Document **1**
Contents **2**
Table Index **4**
Figure Index **5**

1 Introduction 7
1.1. Safety Information 8

2 Product Concept 9
2.1. General Description 9
2.2. Key Features 9
2.3. Functional Diagram 12
2.4. Evaluation Board 13

3 Application Interfaces 14
3.1. General Description 14
3.2. Pin Assignment 15
3.3. Pin Description 16
3.4. Operating Modes 20
3.5. Power Supply 21
3.5.1. Power Features 21
3.5.2. Decrease Supply Voltage Drop 22
3.5.3. Reference Design for Power Supply 22
3.5.4. Monitor Power Supply 23
3.6. Power-on/off Scenarios 24
3.6.1. Power-on 24
3.6.2. Power-off 26
3.6.2.1. Turn off Module Using PWRKEY Pin 26
3.6.2.2. Turn off Module Using AT Command 27
3.6.2.3. Low-voltage Automatic Shutdown 27
3.6.3. Restart 28
3.7. Power Saving 28
3.7.1. Minimum Functionality Mode 28
3.7.2. Sleep Mode 29
3.7.3. Wake up Module from Sleep Mode 29
3.8. Mode Switch 30
3.9. RTC 30
3.10. UART Interfaces 32
3.10.1. Main UART Port 34
3.10.1.1. Features of Main UART Port 34
3.10.1.2. Connection for Main UART Port 36
3.10.2. Debug UART Port 37
3.10.3. Auxiliary UART Port 38

3.10.4. UART Application 39
3.11. Audio Interfaces 41
3.11.1. Decrease TDD Noise and Other Noises 41
3.11.2. Microphone Interface Design 42
3.11.3. Receiver Interface Design 43
3.11.4. Speaker Interface Design 43
3.11.5. Audio Characteristics 44
3.12. (U)SIM Interface 45
3.13. ADC Interface 47
3.14. RI Signal Interface 47
3.15. Network Status Indication 49
3.16. Work Status Indication 50
3.17. RF Transmitting Signal Indication 51

4 Antenna Interface 53
4.1. GSM Antenna Interface 53
4.1.1. RF Reference Design 53
4.1.2. RF Output Power 55
4.1.3. RF Receiving Sensitivity 55
4.1.4. Operating Frequencies 55
4.1.5. RF Cable Soldering 56

5 Electrical, Reliability and Radio Characteristics 57
5.1. Absolute Maximum Ratings 57
5.2. Operation and Storage Temperatures 58
5.3. Power Supply Ratings 58
5.4. Current Consumption 60
5.5. Electrostatic Discharge 61

6 Mechanical Dimensions 63
6.1. Mechanical Dimensions of the Module 63
6.2. Recommended Footprint 65
6.3. Top and Bottom Views of the Module 66

7 Storage and Manufacturing 67
7.1. Storage 67
7.2. Manufacturing and Soldering 67
7.3. Packaging 69

8 Appendix A References 71
9 Appendix B GPRS Coding Schemes 75
10 Appendix C GPRS Multi-slot Classes 77

Table Index

Table 1: M08-R Key Features 9
Table 2: Coding Schemes and Maximum Net Data Rates over Air Interface 11
Table 3: IO Parameters Definition 16
Table 4: Pin Description 16
Table 5: Overview of Operating Modes 20
Table 6: Summary of Mode Switch 30
Table 7: Logic Levels of UART Interfaces 33
Table 8: Pin Definition of UART Interfaces 34
Table 9: Pin Definition of Audio Interfaces 41
Table 10: Typical Characteristics of Electret Microphone 44
Table 11: Typical Characteristics of Speaker 44
Table 12: Pin Definition of (U)SIM Interface 45
Table 13: Pin Definition of ADC 47
Table 14: Characteristics of ADC 47
Table 15: RI Behaviors 47
Table 16: Working State of NETLIGHT 49
Table 17: Pin Definition of Work Status Indication 50
Table 18: Pin Definition of RFTXMON 51
Table 19: Pin Definition of GSM Antenna Interface 53
Table 20: Antenna Cable Requirements 54
Table 21: Antenna Requirements 54
Table 22: RF Output Power 55
Table 23: RF Receiving Sensitivity 55
Table 24: Operating Frequencies 55
Table 25: Absolute Maximum Ratings 57
Table 26: Operating and Storage Temperatures 58
Table 27: The Module Power Supply Ratings 58
Table 28: The Module Current Consumption 60
Table 29: Electrostatic Discharge Characteristics (25ºC, 45% Relative Humidity) 61
Table 30: Recommended Thermal Profile Parameters 68
Table 31: Reel Packaging 70
Table 32: Reference Documents 71
Table 33: Terms and Abbreviations 72
Table 34: Description of Different Coding Schemes 75
Table 35: GPRS Multi-slot Classes 77

Figure Index

Figure 1: Module Functional Diagram 12
Figure 2: Pin Assignment 15
Figure 3: Voltage Ripple during Transmitting 21
Figure 4: Reference Circuit for VBAT Input 22
Figure 5: Reference Circuit for Power Supply 23
Figure 6: Turn on Module through an Open Collector Driver 24
Figure 7: Turn on the Module through a Button 25
Figure 8: Timing of Turning on the Module 25
Figure 9: Timing of Turning off the Module 26
Figure 10: Timing of Restarting the Module 28
Figure 11: VRTC Supplied by a Non-chargeable Battery 31
Figure 12: VRTC Supplied by a Rechargeable Battery 31
Figure 13: VRTC Supplied by a Capacitor 32
Figure 14: Reference Design for Full-Function UART Port 36
Figure 15: Reference Design for Three-wire UART Port 36
Figure 16: Reference Design for the Main UART Port with Hardware Flow Control 37
Figure 17: Reference Design for Firmware Upgrade 37
Figure 18: Reference Design for the Auxiliary UART Port 38
Figure 19: Level Match Design for 3.3V System 39
Figure 20: RS-232 Interface Level Shifter Circuit 40
Figure 21: Reference Design for Microphone Interface 42
Figure 22: Reference Design for Receiver Interface 43
Figure 23: Reference Design for Speaker with an Amplifier 43
Figure 24: Reference Circuit for (U)SIM Interface with the 8-pin (U)SIM Card Connector 45
Figure 25: Reference Circuit for (U)SIM Interface with the 6-pin (U)SIM Card Connector 46
Figure 26: RI Behavior as a Caller 48
Figure 27: RI Behavior as a Receiver of Voice Calling 48
Figure 28: RI Behavior of URC or SMS Received 48
Figure 29: Reference Design for NETLIGHT 49
Figure 30：Reference Design of STATUS 50
Figure 31: RFTXMON Signal During Burst Transmission 51
Figure 32: RFTXMON Signal During Call 52
Figure 33: Reference Design for GSM Antenna 53
Figure 34: RF Soldering Sample 56
Figure 35: M08-R Module Top and Side Dimensions 63
Figure 36: M08-R Module Bottom Dimensions 64
Figure 37: Recommended Footprint (Top View) 65
Figure 38: Top View of the Module 66
Figure 39: Bottom View of the Module 66
Figure 40: Recommended Reflow Soldering Thermal Profile 68
Figure 41: Tape Dimensions (in mm) 69

Figure 42: Reel Dimensions (in mm) 70
Figure 43: Radio Block Structure of CS-1, CS-2, and CS-3 75
Figure 44: Radio Block Structure of CS-4 76

1 Introduction

This document defines the M08-R module and describes its air interface and hardware interfaces which are related to customers' applications.

This document helps customers quickly understand M08-R module interface specifications, electrical and mechanical details, as well as other related information of the module. Applied in conjunction with the related application notes and user guides, customers can use M08-R to design and set up mobile applications easily.

1.1. Safety Information

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 M08-R module. Manufacturers of the cellular terminal should send the following safety information to users and operating personnel, and incorporate these guidelines into all manuals supplied with the product. If not so, Quectel assumes no liability for customers' failure to comply with these precautions.

	Full attention must always be given to driving in order to reduce the risk of an accident. Using a mobile while driving (even with a handsfree kit) causes distraction and can lead to an accident. Please comply with laws and regulations restricting the use of wireless devices while driving.
	Switch off the cellular terminal or mobile before boarding an aircraft. The operation of wireless appliances in an aircraft is forbidden to prevent interference with communication systems. If the device offers an Airplane Mode, then it should be enabled prior to boarding an aircraft. Please consult the airline staff for more restrictions on the use of wireless devices on boarding the aircraft.
	Wireless devices may cause interference on sensitive medical equipment, so please be aware of the restrictions on the use of wireless devices when in hospitals, clinics or other healthcare facilities.
	The cellular terminal or mobile contains a transmitter and receiver. When it is ON, it receives and transmits radio frequency signals. RF interference can occur if it is used close to a TV set, radio, computer or other electric equipment.
	In locations with potentially explosive atmospheres, obey all posted signs to turn off wireless devices such as your phone or other cellular terminals. Areas with potentially explosive atmospheres include fuelling areas, below decks on boats, fuel or chemical transfer or storage facilities, areas where the air contains chemicals or particles such as grain, dust or metal powders, etc.

2 Product Concept

2.1. General Description

M08-R is an industrial-grade quad-band GSM/GPRS module that works at frequencies of GSM850, EGSM900, DCS1800 and PCS1900. Its general features are listed below:

- Support GPRS data transmission and GSM SMS service;
- Support GPRS multi-slot class 1~12 (Class 12 by default) and GPRS coding schemes CS-1, CS-2, CS-3, and CS-4;
- Designed with power-saving technology, the current consumption is as low as 1.3mA in sleep mode when DRX is 5;
- Integrate various Internet service protocols, such as TCP, UDP, PPP, HTTP, NTP, PING, and IPv6;
- Support extended AT commands.

M08-R is an SMD type module that can be easily embedded into applications of data transmission products via its 42 LCC pins.

With the ultra-small size of 17.6mm ×15.7mm × 2.4mm, M08-R can meet almost all the requirements for M2M applications, including vehicles, personal tracking, security system, wireless POS, industrial PDA, smart metering, remote maintenance, and control, etc.

2.2. Key Features

The following table describes the features of the M08-R module.

Table 1: M08-R Key Features

Features	Details
Power Supply	Single supply voltage: 3.45V~4.25V Typical supply voltage: 4.0V
Power Saving	Typical power consumption in sleep mode: ● 1.3mA @DRX=5 ● 1.2mA @DRX=9

Frequency Bands	Quad-band: GSM850/EGSM900/DCS1800/PCS1900 The module can search these frequency bands automatically The frequency bands can be set by AT commands Compliant to GSM Phase 2/2+
GSM Power Class	Class 4 (2W) at GSM850/EGSM900 Class 1 (1W) at DCS1800/PCS1900
GPRS Connectivity	GPRS multi-slot class 12 (by default) GPRS multi-slot class 1~12 (configurable) GPRS mobile station class B
GPRS Data Features	GPRS data downlink transfer: max. 85.6kbps GPRS data uplink transfer: max. 85.6kbps Coding scheme: CS-1, CS-2, CS-3 and CS-4 Support PAP (Password Authentication Protocol) and CHAP (Challenge Handshake Authentication Protocol) protocols which are usually used for PPP connection Support Internet service protocols: TCP/UDP/PPP/HTTP/NTP/PING/IPv6/FTP/SSL Support Unstructured Supplementary Service Data (USSD)
Temperature Ranges	● Operation temperature range: -35°C ~ +75°C [1)] ● Extended temperature range: -40°C ~ +85°C [2)] ● Storage temperature range: -40°C ~ +90°C
SMS	Text and PDU mode SMS storage: (U)SIM card
(U)SIM Interface	Support (U)SIM card: 1.8V/3.0V
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 ● Noise reduction
UART Interfaces	**Main UART port:** ● Full-function UART port ● Used for AT command communication and GPRS data transmission ● Support adaptive baud rates from 4800bps to 115200bps **Debug UART port:** ● Used for firmware upgrading, debugging and log output ● Fixed baud rates: 921600bps **Auxiliary UART port:** ● Used for AT command communication only
Phonebook Management	Support phonebook types: SM, ME, ON, MC, RC, DC, LD, LA

(U)SIM Application Toolkit	Support SAT class 3, GSM 11.14 Release 99
Real Time Clock (RTC)	Supported
Physical Characteristics	Size: (17.6±0.15)mm × (15.7±0.15)mm × (2.4±0.2)mm Package: LCC Weight: Approx. 1.18g
Firmware Upgrade	Firmware upgrade via debug UART port or DFOTA
Antenna Interface	GSM antenna interface 50Ω impedance
RoHS	All hardware components are fully compliant with EU RoHS directive.

NOTES

1. [1] Within the operation temperature range, the module is 3GPP compliant.
2. [2] Within the extended temperature range, the module remains the ability to establish and maintain a voice, SMS, data transmission, etc. There is no unrecoverable malfunction. There are also no effects on the radio spectrum and no harm to the radio network. Only one or more parameters like P_{out} might reduce in their value and exceed the specified tolerances. When the temperature returns to normal operation temperature levels, the module will meet 3GPP specifications again.

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

2.3. Functional Diagram

The following figure shows a block diagram of M08-R and illustrates the major functional parts.

- Power Management
- Memory
- Radio Frequency
- Peripheral Interfaces
  - — PWRKEY
  - — UART Interfaces
  - — Audio Interfaces
  - — (U)SIM Interface
  - — RI signal Interface
  - — ADC Interface
  - — Status Indication interface
  - — Antenna interface
  - — GPIO Interface

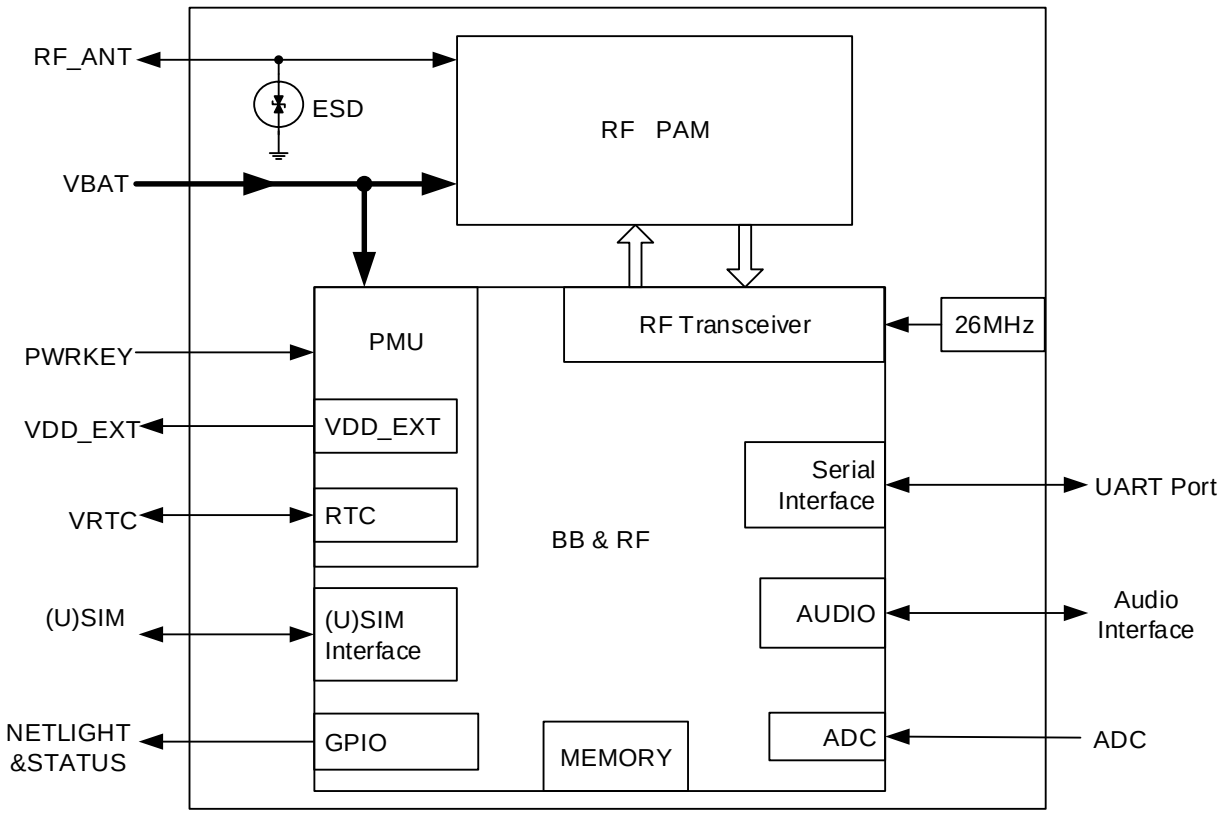

Figure 1: Module Functional Diagram

2.4. Evaluation Board

Quectel provides a complete set of development tools to help the use and testing of the M08-R module. The development tools include a GSM-EVB (evaluation board), USB to RS-232 cable, micro USB cable, power adapter, antenna, RF components, etc. For details, please refer to ***document [3]***.

3 Application Interfaces

3.1. General Description

M08-R has 42 LCC pins. The following chapters provide detailed descriptions of the interfaces/functions listed below:

- Power supply
- Power-on/off
- Power saving
- RTC
- UART interfaces
- Audio interfaces
- (U)SIM interface
- RI Signal Interface
- Status indication interface
- ADC interface
- RF transmitting signal indication

3.2. Pin Assignment

The following figure shows the pin assignment of M08-R.

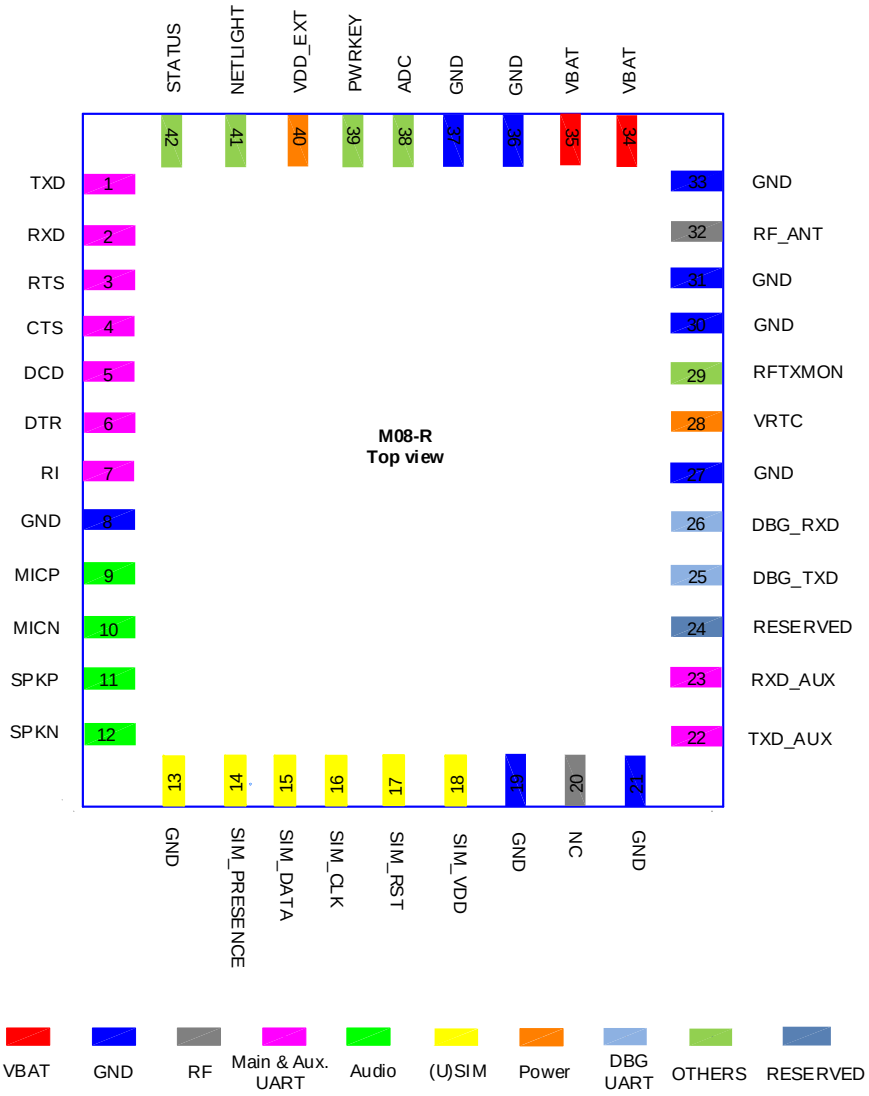

Figure 2: Pin Assignment

NOTE

All reserved pins should be kept open.

3.3. Pin Description

Table 3: IO Parameters Definition

Type	Description
AI	Analog input
AO	Analog output
DI	Digital input
DO	Digital output
IO	Bidirectional
PI	Power input
PO	Power output

Table 4: Pin Description

Power Supply					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
VBAT	34, 35	PI	Main power supply of module	$V_I$max=4.25V $V_I$min=3.45V $V_I$norm=4.0V	It must be provided with sufficient current up to 2.0A.
VRTC	28	IO	Input: Supply power to RTC when VBAT is removed. Output: Charge for backup battery or ultra-capacitor when VBAT is applied.	$V_I$max=3.5V $V_I$min=3.0V $V_I$norm=3.3V $V_O$max=3.39V $V_O$min=2.99V $V_O$norm=3.1V $I_O$max=1.9mA Iin≈21μA	If unused, keep this pin open.
VDD_EXT	40	PO	Supply 2.8V voltage for external circuit.	$V_O$max=2.9V $V_O$min=2.7V $V_O$norm=2.8V $I_O$max=20mA	If unused, keep this pin open. It is recommended to add a 2.2μF ~4.7μF bypass capacitor when using this pin to supply power to

					external circuits.
GND	8,13 19,21, 27,30, 31,33, 36,37		Ground		
PWRKEY					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
PWRKEY	39	DI	Turn-on/-off key. PWRKEY should be pulled down for a moment to turn on/off the system.	V_{IL}max= 0.1×VBAT V_{IH}min= 0.6×VBAT V_{IH}max=3.1V	It is recommended to use an open drain/collector driver to control the PWRKEY.
Audio Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
MICP	9	AI	Audio differential input channel		If unused, keep these pins open.
MICN	10				
SPKP	11	AO	Audio differential output channel		
SPKN	12				
Network Status Indicator					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
NETLIGHT	41	DO	Network status indication	V_{OH}min= 0.85×VDD_EXT V_{OL}max= 0.15×VDD_EXT	If unused, keep these pins open.
STATUS	42	DO	Indicate module's operating status		
Main UART Port					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
TXD	1	DO	Transmit data	V_{IL}min=0V V_{IL}max= 0.25×VDD_EXT V_{IH}min= 0.75×VDD_EXT V_{IH}max=	If only TXD, RXD and GND are used for communication, it is recommended to keep the rest pins of main UART
RXD	2	DI	Receive data		
DTR	6	DI	Data terminal ready		
RI	7	DO	Ring indication		

DCD	5	DO	Data carrier detection	VDD_EXT+0.2 V_{OH}min= 0.85×VDD_EXT V_{OL}max= 0.15×VDD_EXT	port open.
CTS	4	DO	Clear to send		
RTS	3	DI	Request to send		
Debug UART Port					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
DBG_TXD	25	DO	Transmit data	V_{IL}min=0V V_{IL}max= 0.25×VDD_EXT V_{IH}min= 0.75×VDD_EXT V_{IH}max= VDD_EXT+0.2 V_{OH}min= 0.85×VDD_EXT V_{OL}max= 0.15×VDD_EXT	If unused, keep this pin open.
DBG_RXD	26	DI	Receive data		If unused, keep this pin open.
Auxiliary UART Port					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
TXD_AUX	22	DO	Transmit data	V_{IL}min=0V V_{IL}max= 0.25×VDD_EXT V_{IH}min= 0.75×VDD_EXT V_{IH}max= VDD_EXT+0.2 V_{OH}min= 0.85×VDD_EXT V_{OL}max= 0.15×VDD_EXT	If unused, keep this pin open.
RXD_AUX	23	DI	Receive data		If unused, keep this pin open.
(U)SIM Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
SIM_VDD	18	PO	Power supply for (U)SIM card	Either 1.8V or 3.0V, selected by the software automatically.	All signals of (U)SIM interface should be protected against ESD with a TVS diode array. The maximum trace
SIM_CLK	16	DO	Clock signal of (U)SIM card	V_{OL}max= 0.15×SIM_VDD	

				V_{OH}min= 0.85×SIM_VDD	length from the module pad to (U)SIM card connector should be 200mm.
SIM_DATA	15	IO	Data signal of (U)SIM card	V_{IL}max= 0.25×SIM_VDD V_{IH}min= 0.75×SIM_VDD V_{OL}max= 0.15×SIM_VDD V_{OH}min= 0.85×SIM_VDD	
SIM_RST	17	DO	Reset signal of (U)SIM card	V_{OL}max= 0.15×SIM_VDD V_{OH}min= 0.85×SIM_VDD	
SIM_ PRESENCE	14	DI	(U)SIM card insertion detection	V IL min=0V V IL max= 0.25×VDD_EXT V IH min= 0.75×VDD_EXT V IH max= VDD_EXT+0.2	
ADC					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
ADC	38	AI	General-purpose analog to digital converter	Voltage range: 0V to 1.8V	If unused, keep this pin open.
Antenna Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RF_ANT	32	IO	GSM antenna interface		50Ω impedance
Transmitting Signal Indication					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RFTXMON	29	DO	RF Transmitting signal indication	V_{OH}min= 0.85×VDD_EXT V_{OL}max= 0.15×VDD_EXT	If unused, keep this pin open.
Other Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**

NC	20				Keep this pin open.
Reserved Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RESERVED	24				Keep this pin open.

3.4. Operating Modes

The following table briefly describes the various working modes of M08-R module.

Table 5: Overview of Operating Modes

Mode	Function	
Normal operation	GSM/GPRS SLEEP	After enabling sleep mode by **AT+QSCLK=1**, the module will automatically enter sleep mode if DTR is set to a high level and there is no interrupt (such as GPIO interrupt or data on UART port). In this case, the current consumption of the module will reduce to a minimal level. During sleep mode, the module can still receive paging messages and SMS from the system normally.
	GSM IDLE	The software is active. The module has registered to the GSM network and is ready to send and receive GSM data.
	GSM TALK	GSM connection is ongoing. In this mode, the power consumption of the module 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 the GPRS network nor reachable through the GPRS channel.
	GPRS STANDBY	The module is registered to a 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	GPRS data transfer. In this mode, the power consumption of the module is decided by the PCL, working RF band and GPRS multi-slot configuration.

Power down	The normal shutdown can be conducted by sending **AT+QPOWD=1** or using PWRKEY. In this case, operating voltage (connected to VBAT) remains applied; the power management ASIC disconnects the power supply from the baseband part of the module while the only power supply for RTC remains. Software is not active and the UART port is not accessible.
Minimum functionality mode (without removing power supply)	**AT+CFUN** can be used to set the module to minimum functionality mode without removing the power supply. In this case, either the module's RF part or (U)SIM card does not work, or both of them are disabled; but the UART port is still accessible. The power consumption, in this case, is very low.

3.5. Power Supply

3.5.1. Power Features

Power supply design is an important part of the M08-R application design. Due to the 577 μs burst in the GSM part every 4.615ms, in a burst period, the power supply must be able to deliver high peak current and the supply voltage should not drop below the minimum working voltage of the module.

The maximum current consumption of the module could reach 2.0A during a burst transmission, which will cause a large voltage drop on VBAT. In order to ensure the stability of the module's operation, it is recommended that the maximum voltage drop during the burst transmission should not exceed 400mV.

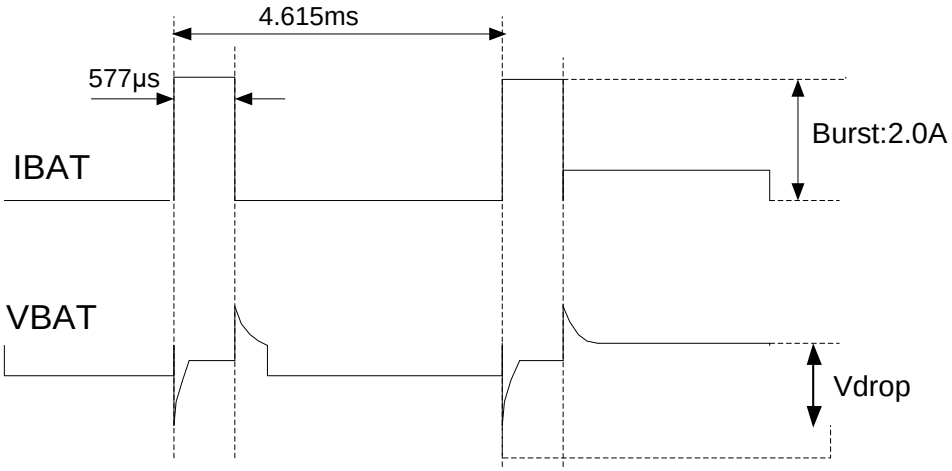

Figure 3: Voltage Ripple during Transmitting

3.5.2. Decrease Supply Voltage Drop

The power supply range of the module is 3.45V to 4.25V. Make sure that the input voltage will never drop below 3.45V even in a burst transmission. If the power voltage drops below 3.45V, the module could be turned off automatically. For better power performance, it is recommended to place a 100μF tantalum capacitor with low ESR (ESR=0.7Ω), ceramic capacitors of 100nF, 33pF and 10pF, and TVS near the VBAT pin. The reference circuit is illustrated in the following figure.

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

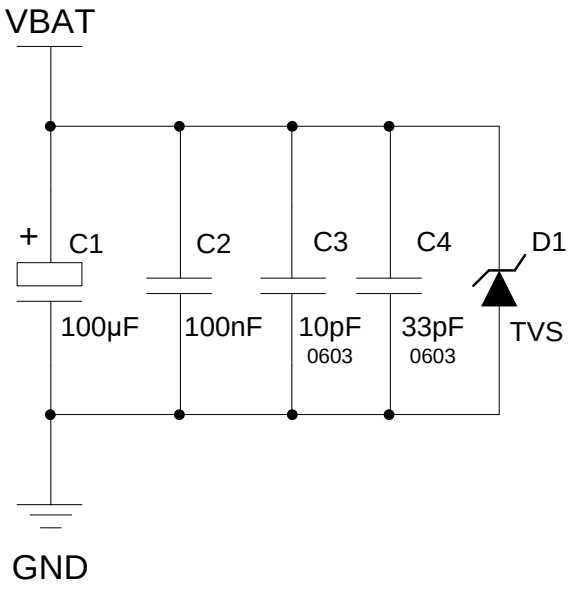

Figure 4: Reference Circuit for VBAT Input

3.5.3. Reference Design for Power Supply

Power design for the module is very important, as the performance of the module largely depends on the power source. The power supply should be provided with sufficient current up to 2.0A at least. If the voltage difference between the input and the output voltage is not too big, it is suggested to use an LDO to supply power for the module; if there is a big voltage difference between the input and the output voltage, a switcher power converter is preferred to be used.

The following figure shows a reference design for a +5V input power supply. The designed output voltage for the power supply is 4.0V and the maximum load current is 3.0A. In order to ensure the stability of the

output voltage, a zener diode is suggested to be placed close to the VBAT pin.

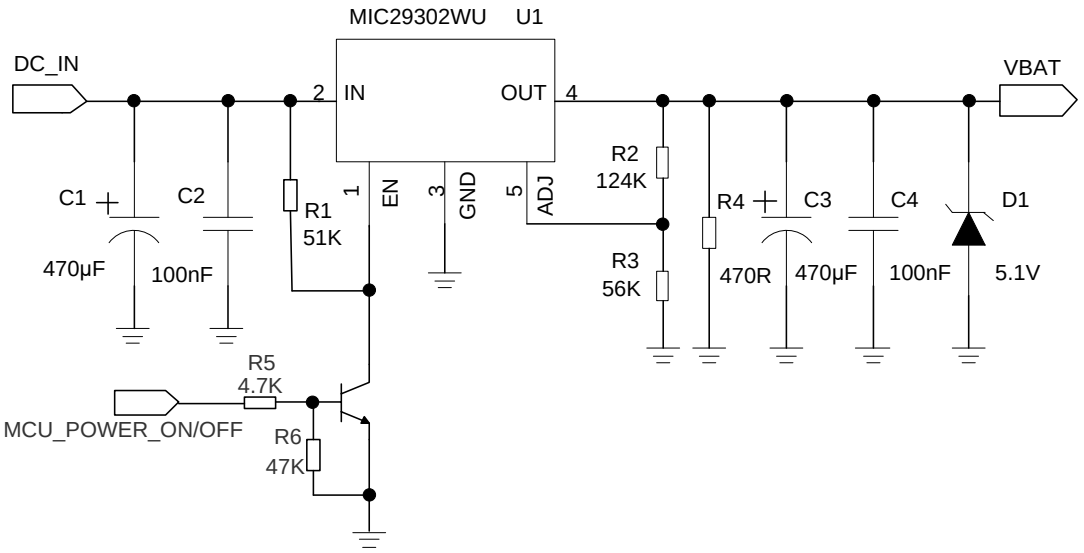

Figure 5: Reference Circuit for Power Supply

NOTE

It is recommended to control the module's main power supply (VBAT) via an LDO enabled pin to restart the module when the module becomes abnormal. A power switch circuit like the P-channel MOSFET switch circuit can also be used to control VBAT.

3.5.4. Monitor Power Supply

The command **AT+CBC** can be used to monitor the supply voltage of the module. The unit of the displayed voltage is in mV. For details, please refer to the ***document [1]***.

3.6. Power-on/off Scenarios

3.6.1. Power-on

M08-R module can be turned on by driving PWRKEY to a low level at least 1.2s. It is recommended to use an open drain/collector driver to control the PWRKEY. A simple reference circuit is illustrated as below.

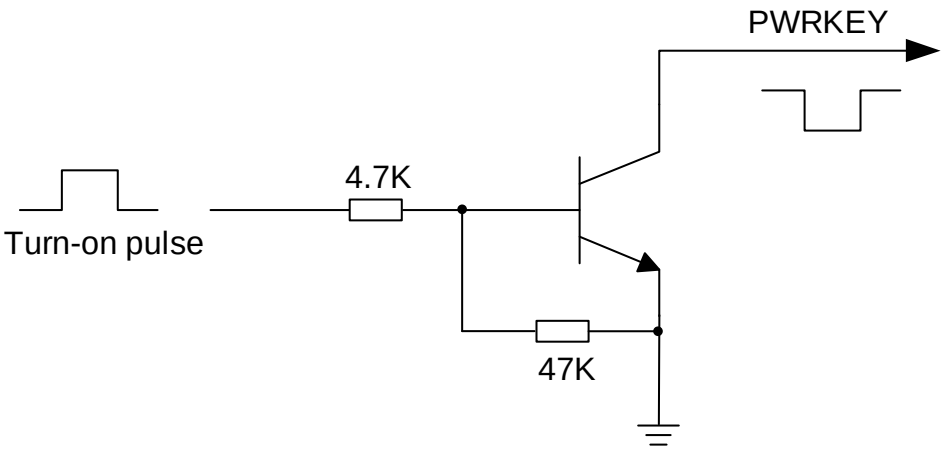

Figure 6: Turn on Module through an Open Collector Driver

NOTES

1. M08-R is set to autobauding mode (**AT+IPR=0**) by default; in this mode, after the module is powered on, URC "RDY" is not reported to the host controller. AT commands can be received by the module 4s~5s after it is powered on. The host controller should first send an "**AT**" string to the module so that the module can detect the host controller's baud rate, and then continue to send the next "**AT**" string until "**OK**" returned from the module is received. Then **AT+IPR=x;&W** should be sent to set a fixed baud rate for the module and save the configuration to its flash memory. After the configuration is completed, URC "RDY" would be received from the main UART port every time the module is powered on. For more details, refer to the related content of **AT+IPR** in ***document [1]***.
2. An AT command can be sent 4 or 5 seconds after the module is powered on. If the AT command is responded, it indicates the module is turned on successfully; otherwise it indicates the module fails to be turned on.

The other way to control the PWRKEY is through a button directly. While pressing the button, an electrostatic strike may generate from the finger, and thus, a TVS component is indispensable to be placed nearby the button for ESD protection and for the best performance. A reference circuit is shown in the following figure.

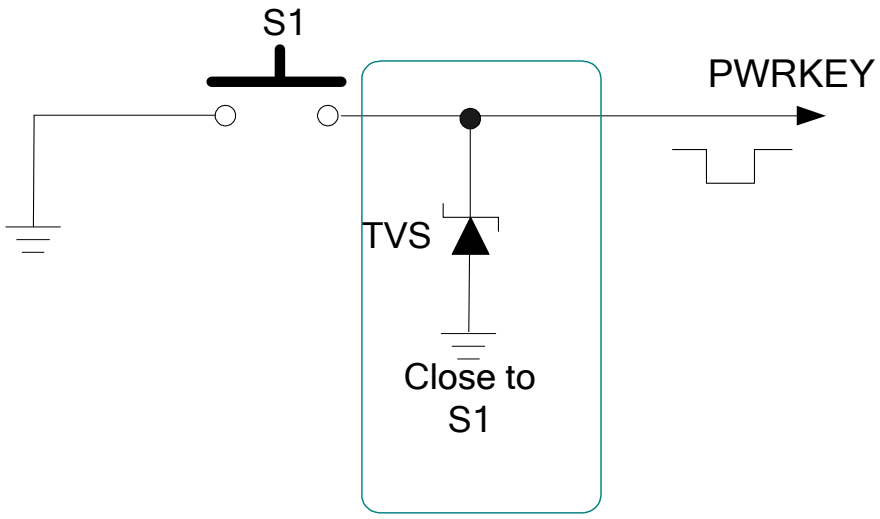

Figure 7: Turn on the Module through a Button

The timing of turning on the module is illustrated as the following figure.

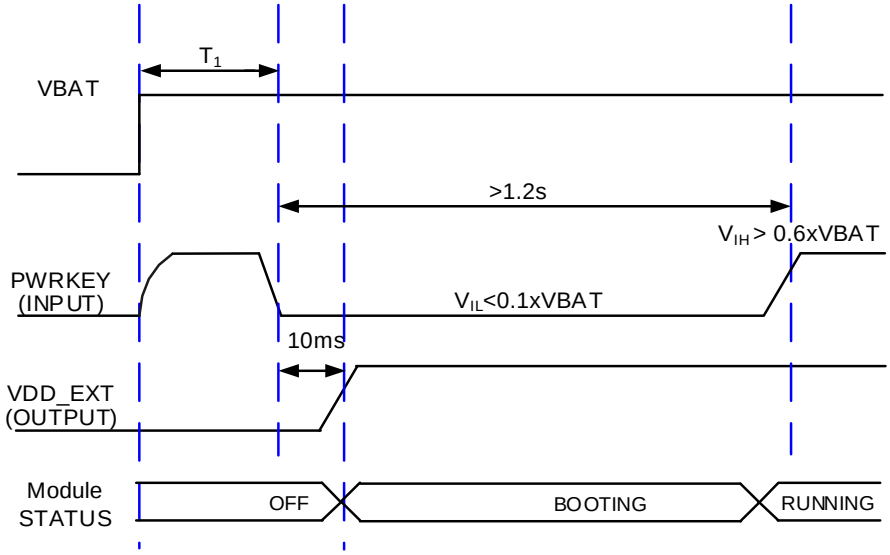

Figure 8: Timing of Turning on the Module

NOTE

Make sure that the VBAT voltage is stable before pulling down the PWRKEY pin. T1 (the time between power-on of VBAT and pull-off of PWRKEY pin) is recommended to be 100ms.

3.6.2. Power-off

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

- Normal power-off procedure: Turn off the module using PWRKEY.
- Normal power-off procedure: Turn off the module using **AT+QPOWD=1**.
- Low-voltage automatic shutdown: Take effect when low voltage is detected.

After being turned off, the module will enter power-off mode and no further AT commands can be executed.

3.6.2.1. Turn off Module Using PWRKEY Pin

It is a safe way to turn off the module by driving PWRKEY to a low level for about 1s~1.2s. The timing of turning off the module is illustrated below.

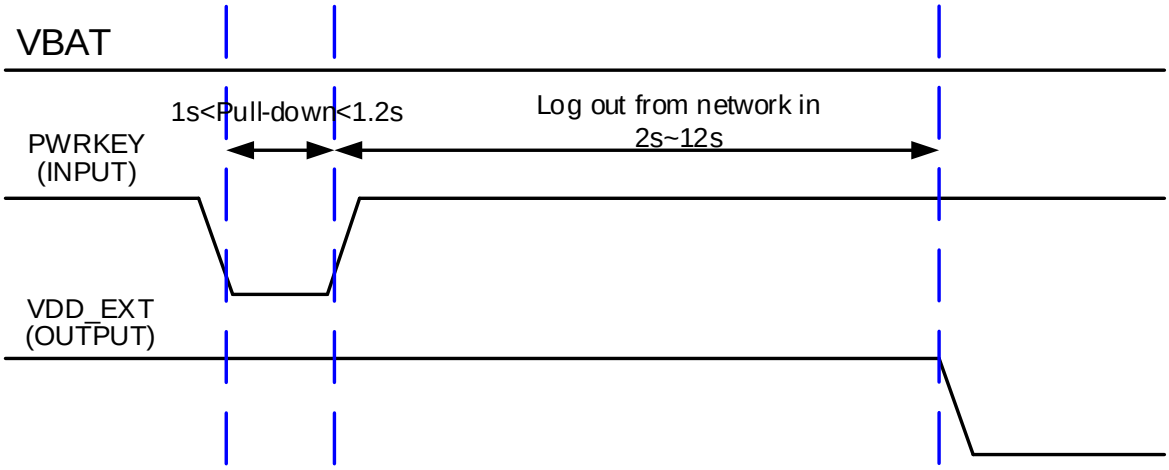

Figure 9: Timing of Turning off the Module

The power-off procedure causes the module to log off from the network and allows the firmware to save important data before completely disconnecting the power supply.

Before the completion of the power-off procedure, the module sends out the URC shown below:

NORMAL POWER DOWN

Since then, no further AT commands can be executed. Then the module enters power-down mode, while RTC is still active.

NOTES

1. This URC does not appear when autobauding is applied and DTE and DCE are not correctly synchronized after start-up. It is recommended to set the module to a fixed baud rate.
2. As the time of network logout is related to the local mobile network, it is recommended to delay for about 12s before disconnecting the power supply or restarting the module.

3.6.2.2. Turn off Module Using AT Command

It is also a safe way to turn off the module via command **AT+QPOWD=1**. This command causes the module to log off from the network and allows the firmware to save important data before completely disconnecting the power supply.

Before the completion of the power-off procedure the module sends out the URC shown below:

NORMAL POWER DOWN

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

3.6.2.3. Low-voltage Automatic Shutdown

The module will constantly monitor the voltage applied to VBAT. If the voltage is ≤3.55V, the following URC will be presented:

UNDER_VOLTAGE WARNING

The normal input voltage ranges from 3.45V to 4.25V. If the voltage is <3.45V, the module will automatically shut down.

If the voltage is <3.45V, the following URC will be presented:

UNDER_VOLTAGE POWER DOWN

Since then, no further AT commands can be executed. The module logs off from the network and enters power-down mode, while only RTC is still active.

NOTE

These URCs do not appear when autobauding is applied and DTE and DCE are not correctly synchronized after start-up. It is recommended to set the module to a fixed baud rate.

3.6.3. Restart

The module can be restarted by driving PWRKEY to a low level for a certain time, which is similar to the way to turn on the module. In order to make the internal LDOs discharge completely after turning off the module, it is recommended to delay for about 500ms before restarting the module. The restart timing is illustrated as the following figure.

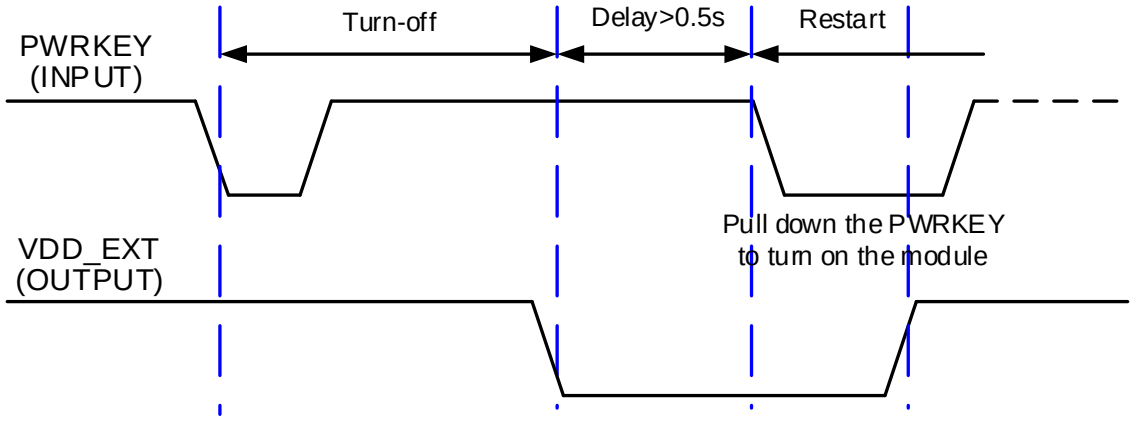

Figure 10: Timing of Restarting the Module

3.7. Power Saving

Based on system requirements, there are two ways to get the M08-R module into low current consumption status.

- Executing **AT+CFUN** to make the module enter the minimum functionality mode.
- Executing **AT+QSCLK=1** to make the module enter sleep mode.

3.7.1. Minimum Functionality Mode

Minimum functionality mode reduces the functionality of the M08-R module to a minimum level, and the current consumption can also be minimized when slow clocking mode is activated at the same time. Minimum functionality mode is set by executing **AT+CFUN**, which provides the choice of the functionality levels <fun>=0, 1, 4.

- 0: minimum functionality (with RF and (U)SIM disabled)
- 1: full functionality (by default)
- 4: disable both transmitting and receiving functions of the RF part

If the M08-R module is set to minimum functionality by **AT+CFUN=0**, RF and (U)SIM card functions would be disabled. In this case, the UART port is still accessible, but all AT commands related to RF or (U)SIM card functions will not be available.

If the M08-R module is set by **AT+CFUN=4**, the RF function will be disabled, but the UART port is still active. In this case, all AT commands related to RF function will not be available.

For module already set by **AT+CFUN=0** or **AT+CFUN=4**, **AT+CFUN=1** can be used to set it back to full functionality.

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

3.7.2. Sleep Mode

The sleep mode is disabled by default. It can be enabled by **AT+QSCLK=1**.

If the module is set by **AT+QSCLK=1**, customers can control the module to enter or exit from sleep mode through the DTR pin. When DTR is set to a high level, and there is no 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 the network, but the UART port does not work.

If the module is set by **AT+QSCLK=0**, the module will completely exit from sleep mode. In this case, whether DTR is active or not, the module will not enter the sleep mode.

3.7.3. Wake up Module from Sleep Mode

Module in sleep mode can be woken up in the following ways.

- Pull down DTR pin for about 800ms.
- Receive a voice or data call from the network.
- Receive an SMS from the network.

NOTE

DTR pin should be kept at a low level during communication between the module and DTE.

3.8. Mode Switch

Table 6: Summary of Mode Switch

Current Mode	Next Mode		
	Power Down	**Normal Mode**	**Sleep Mode**
Power Down		Use PWRKEY	
Normal Mode	Use **AT+QPOWD** or PWRKEY		Use **AT+QSCLK=1** and pull DTR up
Sleep Mode	Use PWRKEY	Pull DTR down or incoming call/SMS/GPRS	

3.9. RTC

For the M08-R module, the RTC function is supported, and it is designed to work with an internal power supply.

There are three types of designs for RTC backup power:

- Use VBAT as the power source of RTC.

When the module is turned off while the main power supply (VBAT) is remained, RTC is still active as it is powered by VBAT. In this case, the VRTC pin can be kept open.

- Use VRTC as the power source of RTC.

If the main power supply (VBAT) is removed after the module is turned off, a backup supply such as a coin-cell battery or an ultra-capacitor can be used to supply power to the VRTC pin to keep RTC active.

- Use VBAT and VRTC as RTC's power source.

If only the VRTC pin is powered to keep the RTC active, an error of 1.5 minutes a day will be caused. Therefore, it is recommended to power both VBAT and VRTC pins at the same time when the RTC function is needed. The recommended power supply circuits for RTC core are shown below.

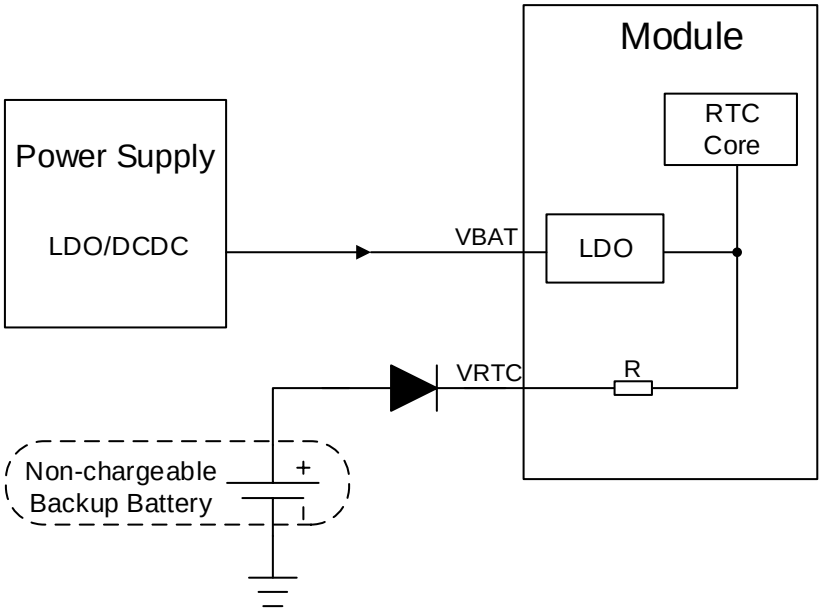

Figure 11: VRTC Supplied by a Non-chargeable Battery

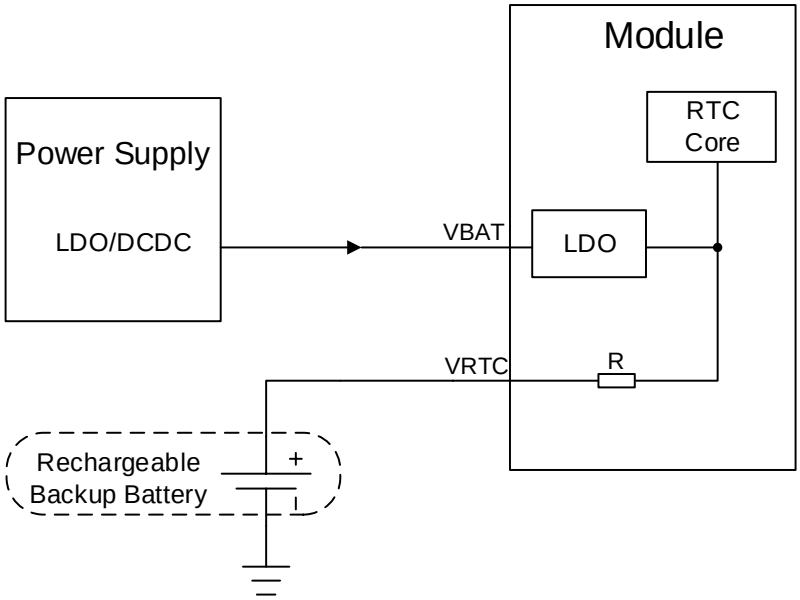

Figure 12: VRTC Supplied by a Rechargeable Battery

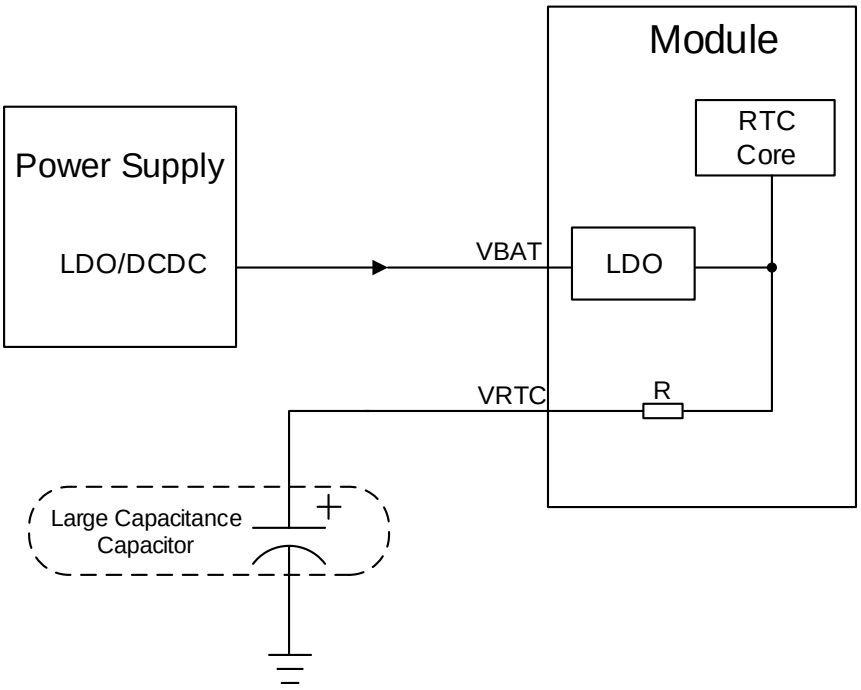

Figure 13: VRTC Supplied by a Capacitor

A rechargeable or non-chargeable coin-cell battery can also be used here, for more information, please visit http://www.sii.co.jp/en.

NOTE

Please keep the main power supply (VBAT) applied to ensure the accuracy of real-time.

3.10. UART Interfaces

M08-R provides three UART interfaces: main UART port, debug UART port and auxiliary UART port. The module is designed as a DCE (Data Communication Equipment), following the traditional DCE-DTE (Data Terminal Equipment) connection. The supported autobauding ranges from 4800bps to 115200bps.

Main 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 informs DCE (this pin can wake the module up).
- RI: Ring indicator (when there is a call, SMS or URC output, the module will inform DTE through RI

pin).
- DCD: Data carrier detection (the validity of this pin demonstrates the successful set-up of the communication link).

The two pins, RTS and CTS, are used as hardware flow control, which is disabled by default. When hardware flow control is required, RTS and CTS should be connected to the host. **AT+IFC=2,2** is used to enable hardware flow control while **AT+IFC=0,0** is used to disable it. For more details, please refer to the ***document [1]***.

When the module is used as a Modem, both DCD and RI should be employed. In addition, when there are incoming calls and URC information output, RI will output the related signal to remind the host controller. Please refer to ***Chapter 3.13*** for more details.

Debug UART port:

- DBG_TXD: Send data to DTE port.
- DBG_RXD: Receive data from the DTE port.

Auxiliary UART port:

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

Logic levels of UART interfaces are described in the following table.

Table 7: Logic Levels of UART Interfaces

Parameter	Min.	Max.	Unit
V_{IL}	0	0.25×VDD_EXT	V
V_{IH}	0.75×VDD_EXT	VDD_EXT +0.2	V
V_{OL}	0	0.15×VDD_EXT	V
V_{OH}	0.85×VDD_EXT	VDD_EXT	V

The pin definition of UART interfaces is listed below:

Table 8: Pin Definition of UART Interfaces

Interface	Pin Name	Pin No.	Description	Note
Main UART Port	TXD	1	Transmit data	If only TXD, RXD and GND are used for communication, please keep the rest pins of UART interfaces open.
	RXD	2	Receive data	
	DTR	6	Data terminal ready	
	RI	7	Ring indication	
	DCD	5	Data carrier detection	
	CTS	4	Clear to send	
	RTS	3	Request to send	
Debug UART Port	DBG_RXD	26	Receive data	If unused, keep these pins open.
	DBG_TXD	25	Transmit data	
Auxiliary UART Port	RXD_AUX	23	Receive data	If unused, keep these pins open.
	TXD_AUX	22	Transmit data	

3.10.1. Main UART Port

3.10.1.1. Features of Main UART Port

The features of the main UART port are listed below:

- It includes data lines TXD and RXD, hardware flow control lines RTS and CTS, as well as other control lines DTR, DCD and RI.
- It has 8 data bits, 1 stop bit and has no parity check.
- The hardware flow control is disabled by default and the software flow control is not supported.
- It is used for AT command sending, GPRS data transmission and it supports software multiplexing.
- It supports the following baud rates: 2400bps, 4800bps, 9600bps, 14400bps, 19200bps, 28800bps, 38400bps, 57600bps and 115200bps.

- The module is set by default with autobauding applied in a range of 4800bps, 9600bps, 19200bps, 38400bps, 57600bps, and 115200bps.
- The module disables hardware flow control by default. **AT+IFC=2,2** is used to enable hardware flow control.

After fixed baud rates or autobauding is set, please send "**AT**" string at that rate. If the UART port is ready, "**OK**" will be returned.

Autobauding is enabled by default. It allows the module to detect the baud rate automatically upon receiving an "**AT**" string from the host or PC, which offers module flexibility without needs to consider which baud rate is used by the host controller. Autobauding function allows the host controller to communicate with the module even when the current baud rate is not known.

To make full use of the autobauding function, special attention should be paid to the following requirements.

- **Synchronization between DTE and DCE:**

When DCE (the module) is powered on with the autobauding function enabled, it is recommended to wait for 4s~5s before sending the first "**AT**" string. If "**OK**" is received, it suggests that DTE and DCE are correctly synchronized.

In the autobauding mode, if the host controller needs URC, synchronization should be conducted first, otherwise, the URC will be discarded.

- **The settings of Autobauding;**

1) The UART port has 8 data bits, 1 stop bit and has no parity check (factory setting).
2) Only the string "**AT**" can be detected ("**At**", "**at**", or "**aT**" cannot be detected).
3) URC like "**RDY**", "**+CFUN: 1**" and "**+CPIN: READY**" will not be reported if the module is turned on with autobauding function enabled while without synchronization conducted in the first place.
4) The module detects the new baud rate upon receiving the first "**AT**" string, before this, some other URC will be sent using the previous baud rate. Therefore, DTE may receive unknown strings after switching to a new baud rate.
5) It is not recommended to switch to autobauding mode when the module is in the fixed baud rate mode.
6) If autobauding is active, it is not recommended to switch to multiplexing mode.

NOTE

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

3.10.1.2. Connection for Main UART Port

The connection between the module and the host is very flexible. The following are three typical connection types.

The reference design for the full-function UART port connection is shown below. This connection type is mainly used in modulation demodulation mode (PPP dial-up).

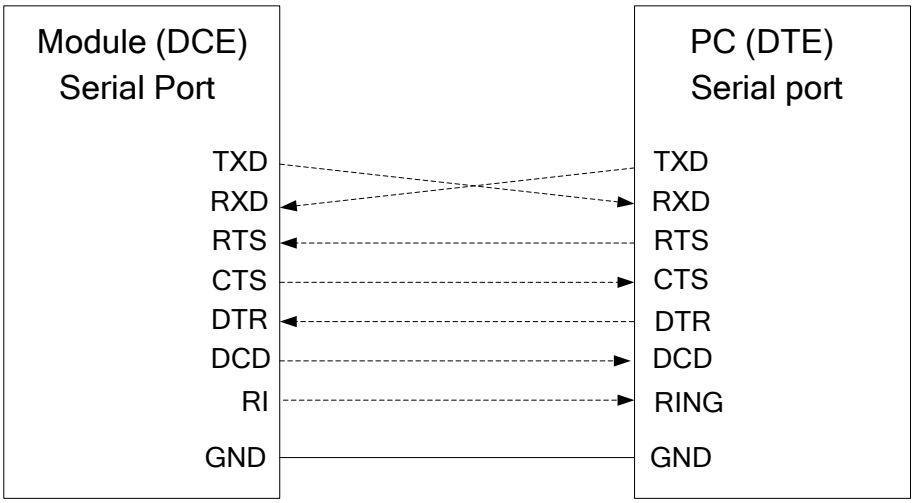

Figure 14: Reference Design for Full-Function UART Port

Three-wire UART port connection is shown below.

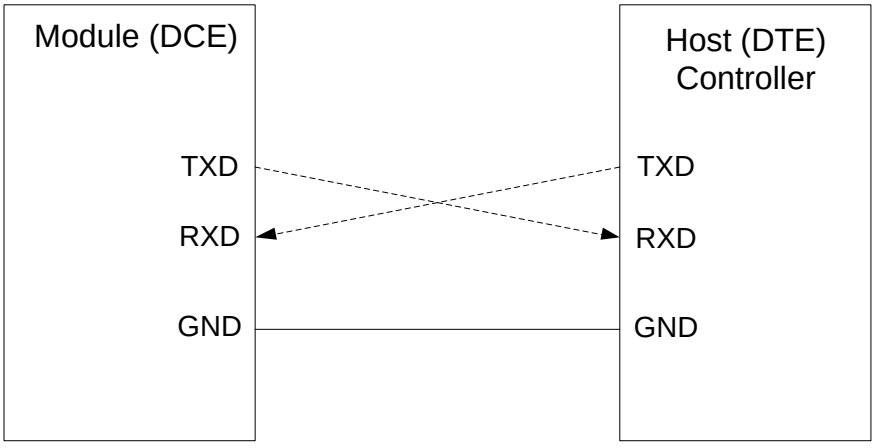

Figure 15: Reference Design for Three-wire UART Port

The connection for the main UART port with hardware flow control is shown below. This connection will enhance the reliability of mass data communication and prevent data loss.

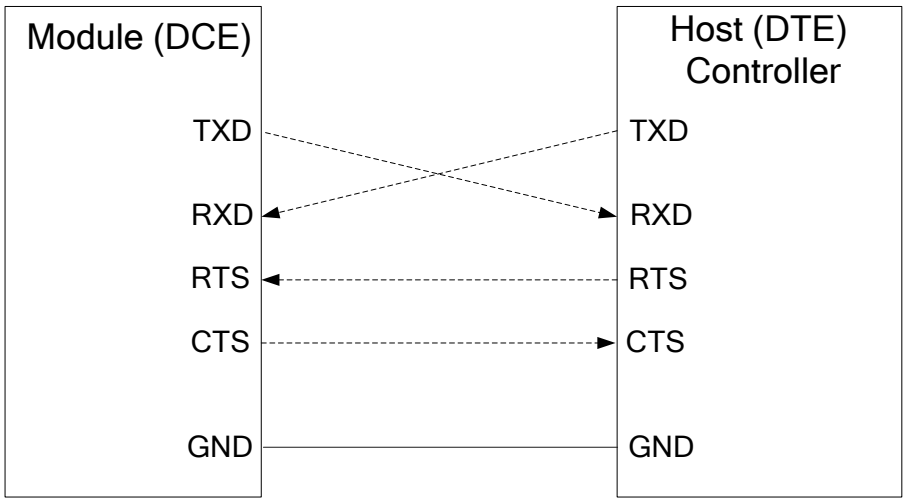

Figure 16: Reference Design for the Main UART Port with Hardware Flow Control

3.10.2. Debug UART Port

- Data lines: DBG_TXD and DBG_RXD.
- It is used for firmware debugging and upgrading with a fixed baud rate of 921600bps.
- It outputs log information automatically.

During the firmware upgrade process, the PWRKEY pin must be pulled down. The following is a reference design for firmware upgrade.

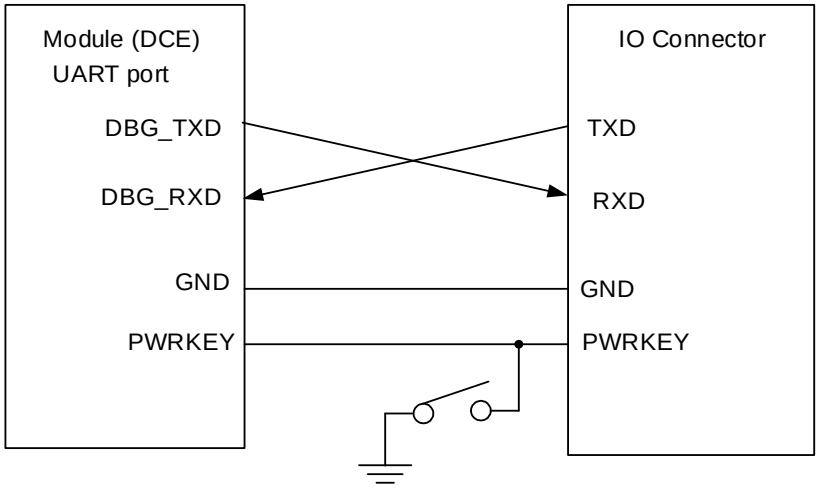

Figure 17: Reference Design for Firmware Upgrade

3.10.3. 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, multiplexing function, etc.
- Auxiliary UART port supports the following baud rates: 2400bps, 4800bps, 9600bps, 14400bps, 19200bps, 28800bps, 38400bps, 57600bps, 115200bps, 230400bps, 460800bps and 921600bps.
- Auxiliary UART port could be used after sending **AT+QEAUART=1** on the main UART port.
- The baud rate is set to 115200bps by default, and autobauding is not supported. The baud rates can be modified by executing **AT+QSEDCB**. For more details, please refer to the ***document [1]***.

The reference design of the auxiliary UART port is shown below.

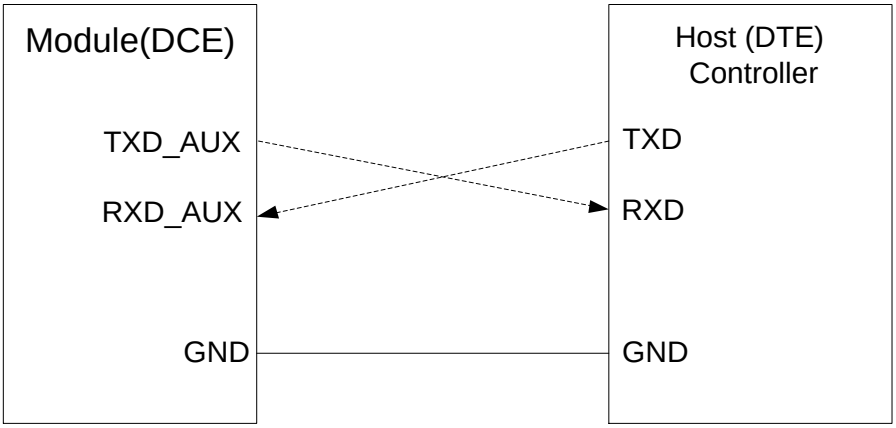

Figure 18: Reference Design for the Auxiliary UART Port

3.10.4. UART Application

The reference design of a 3.3V level match is shown below. If the host is a 3.0V system, according to the principle of voltage distribution, please use a 10KΩ resistor instead of the 5.6KΩ one.

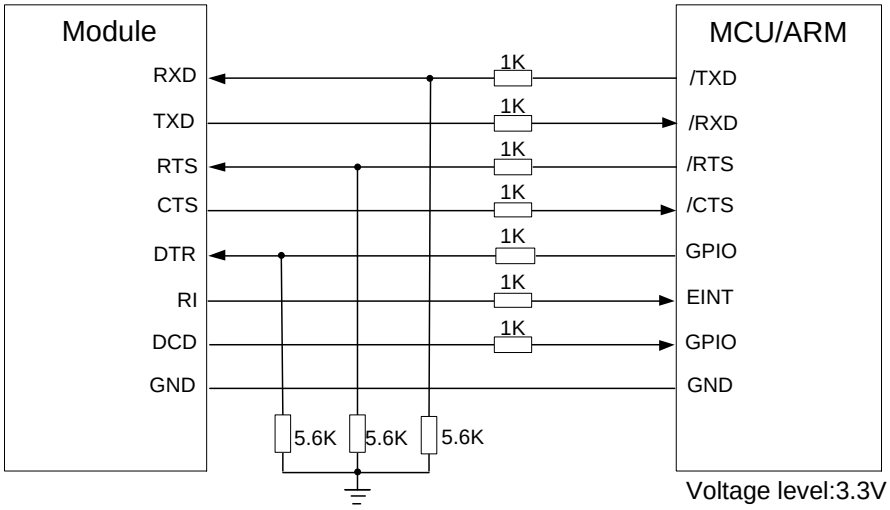

Figure 19: Level Match Design for 3.3V System

NOTE

If the level of the host is 3.0V or 3.3V, it is highly recommended to add a resistor divider circuit to the UART signal lines. For a higher voltage level system, the level shifter IC could be added between the host and the module. For more details about UART circuit design, please refer to ***document [6]***.

When the module communicates with a PC, as the level of the module is 2.8V CMOS, an RS-232 level shifter should be used. Please make sure that the I/O voltage of level shifter connected to the module is 2.8V. The connection of a standard RS232 interface and the module is shown below.

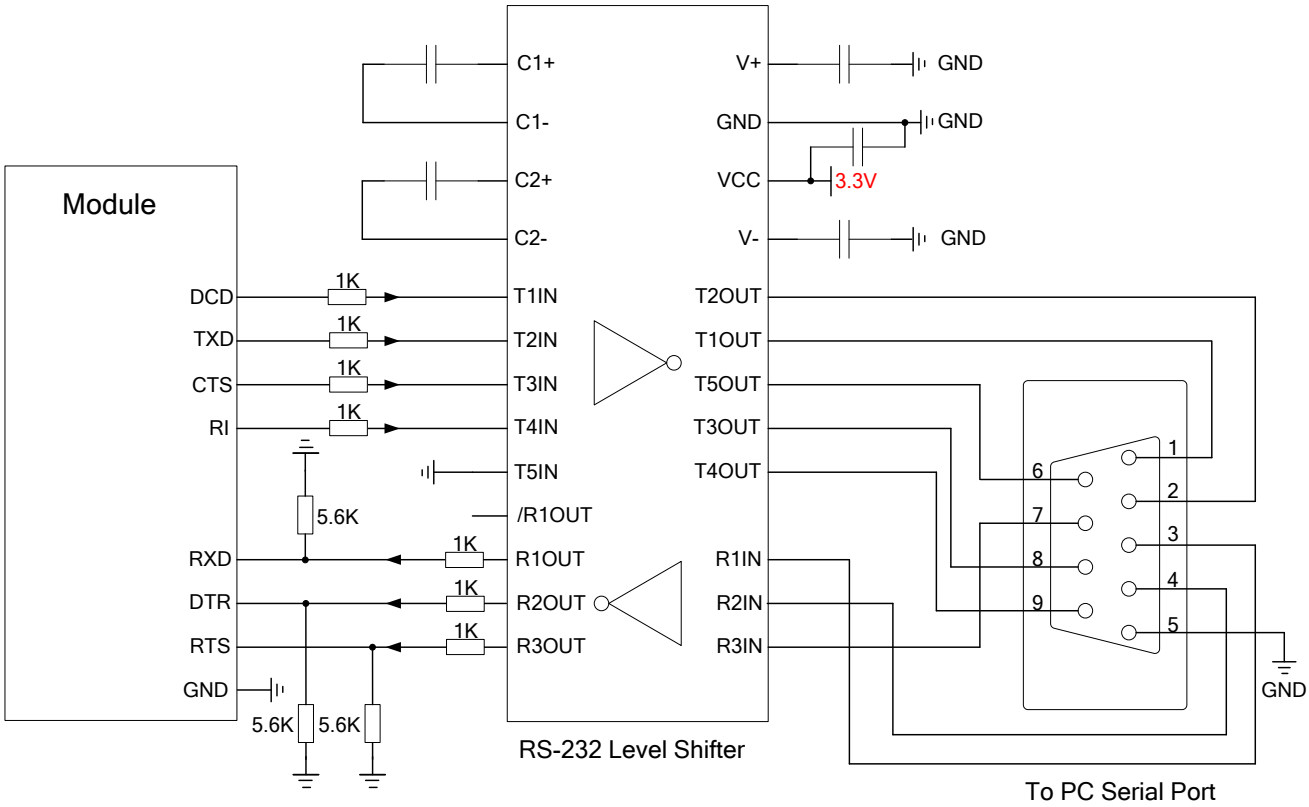

Figure 20: RS-232 Interface Level Shifter Circuit

Please visit vendors' website to select a suitable RS-232 level shifter IC, such as http://www.maximintegrated.com and http://www.exar.com.

3.11. Audio Interfaces

The module provides one analog input channel and one analog output channel.

Table 9: Pin Definition of Audio Interfaces

Audio channel	Pin Name	Pin No.	Description
AIN/AOUT	MICP	9	Microphone input (+)
	MICN	10	Microphone input (-)
	SPKP	11	Audio output Channel (+)
	SPKN	12	Audio output Channel (-)

AIN channels are differential input channels, which can be applied for the input of a microphone (usually an electret microphone is used).

AOUT channels are used for the output of the receiver and speaker. They are differential channels, which support audio output and ringing.

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

NOTE

"*" means under development.

3.11.1. Decrease TDD Noise and Other Noises

It is recommended to use the electret microphone with dual built-in capacitors (e.g. 10pF and 33pF) to filter out RF interference, thus reducing TDD noise. The 33pF capacitor is applied to filter out EGSM900 RF interference when the module is transmitting at EGSM900MHz, and without placing this capacitor, TDD noise could be heard; while the 10pF capacitor is used to filter out 1800MHz RF interference. Please note that the frequency resonant point of a capacitor largely depends on the material and production technique. Therefore, customers would have to discuss with their capacitor vendors to choose the most suitable capacitors for filtering out RF interference when the module is working at GSM850, EGSM900, DCS1800 and PCS1900 separately.

The severity degree of the RF interference in the audio channel during GSM transmitting largely depends on the application design. In some cases, EGSM900 TDD noise is more severe; while in other cases, DCS1800 TDD noise is more obvious. Therefore, customers can choose a suitable capacitor based on the test results. Sometimes, even no RF filtering capacitor is required.

The capacitor which is used for filtering out RF interference in the PCB board should be put close to the audio interface, and the audio trace should be as short as possible.

In order to decrease radio or other signal interference, the RF antenna should be placed away from the audio interface and trace. The power trace should not be placed in parallel with or near the audio trace.

The differential audio traces must be routed according to the differential signal layout rules.

3.11.2. Microphone Interface Design

AIN channels come with internal bias supply voltage for an external electret microphone. A reference circuit is shown in the following figure.

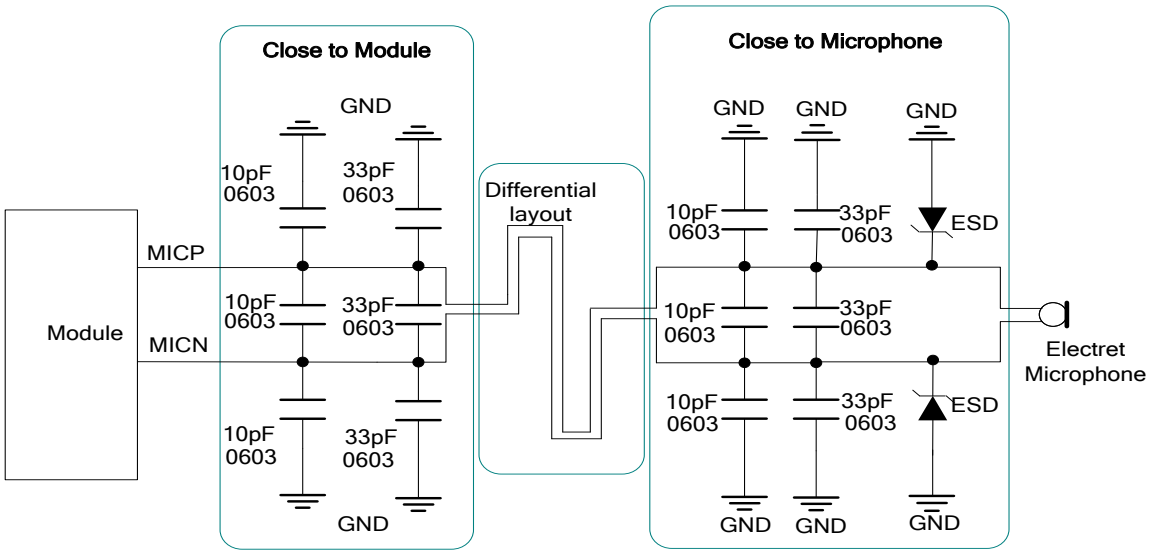

Figure 21: Reference Design for Microphone Interface

NOTE

MIC channel is sensitive to ESD, so it is not recommended to remove the ESD components used for protecting the MIC.

3.11.3. Receiver Interface Design

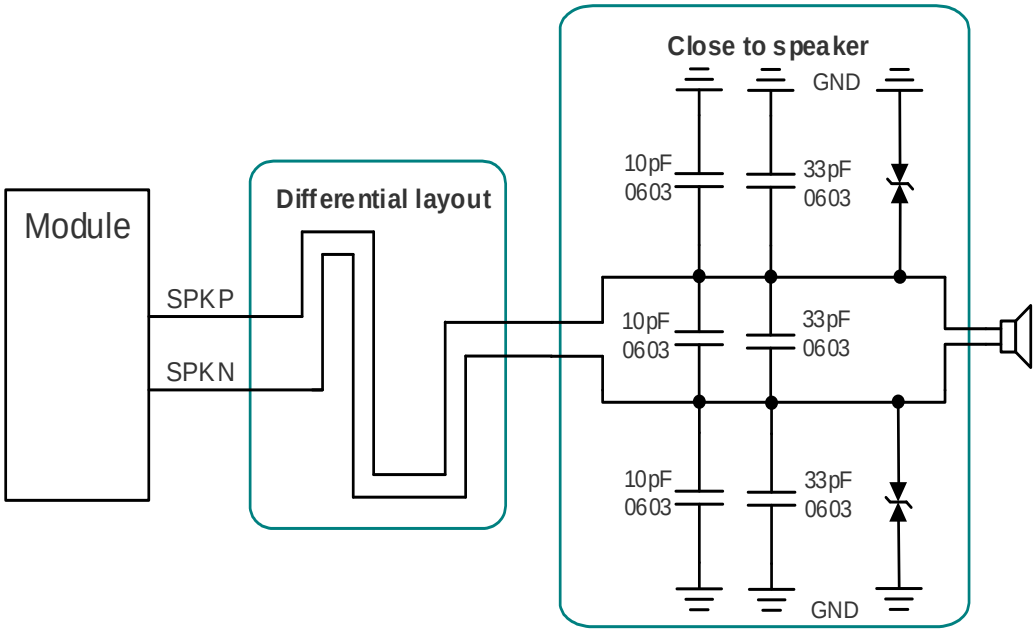

Figure 22: Reference Design for Receiver Interface

3.11.4. Speaker Interface Design

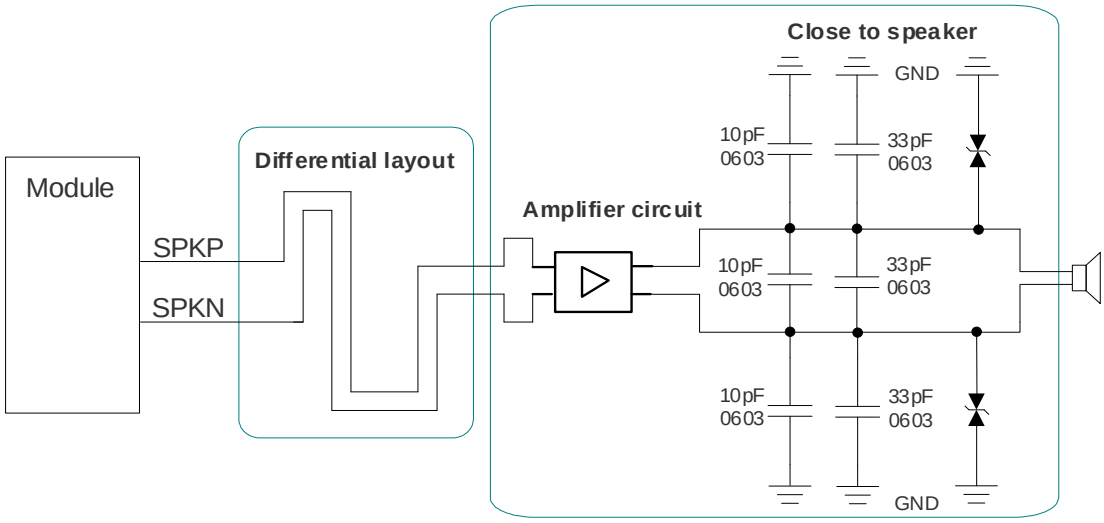

Figure 23: Reference Design for Speaker with an Amplifier

Customers can choose suitable differential audio amplifiers from *Texas Instrument*'s website (http://www.ti.com). There are also other excellent audio amplifier vendors available in the market.

3.11.5. Audio Characteristics

Table 10: Typical Characteristics of Electret Microphone

Parameter	Min.	Typ.	Max.	Unit
Working Voltage	1.8	2	2.4	V
Working Current			1000	μA
External Microphone Load Resistance	2			KΩ

Table 11: Typical Characteristics of Speaker

Parameter			Min.	Typ.	Max.	Unit
AOUT (SPK)	Differential output	Load resistance		32		Ω
		Reference level	0		3.7	Vpp

3.12. (U)SIM Interface

The (U)SIM interface is compliant with GSM Phase 1 and GSM Phase 2+ and supports FAST 64 kbps (U)SIM card (intended for use with (U)SIM application toolkit).

The (U)SIM interface is powered by an internal regulator in the module. Both 1.8V and 3.0V (U)SIM cards are supported.

Table 12: Pin Definition of (U)SIM Interface

Pin Name	Pin No.	Description
SIM_VDD	18	Supply power for (U)SIM card. Automatically detect (U)SIM card voltage. 3.0V±5% and 1.8V±5%. The maximum supply current is 10mA.
SIM_CLK	16	The clock signal of (U)SIM card
SIM_DATA	15	Data signal of (U)SIM card
SIM_RST	17	Reset signal of (U)SIM card
SIM_PRESENCE	14	(U)SIM card insertion detection

The following figure shows a reference design for (U)SIM interface with an 8-pin (U)SIM card connector.

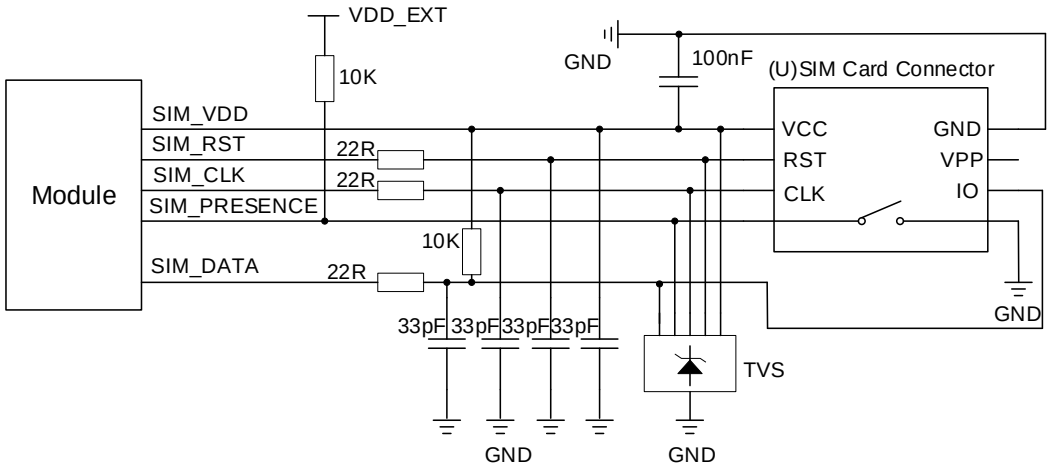

Figure 24: Reference Circuit for (U)SIM Interface with the 8-pin (U)SIM Card Connector

If (U)SIM card insertion detection function is not used, keep pin SIM_PRESENCE unconnected. A reference circuit for (U)SIM interface with a 6-pin (U)SIM card connector is illustrated in the following figure.

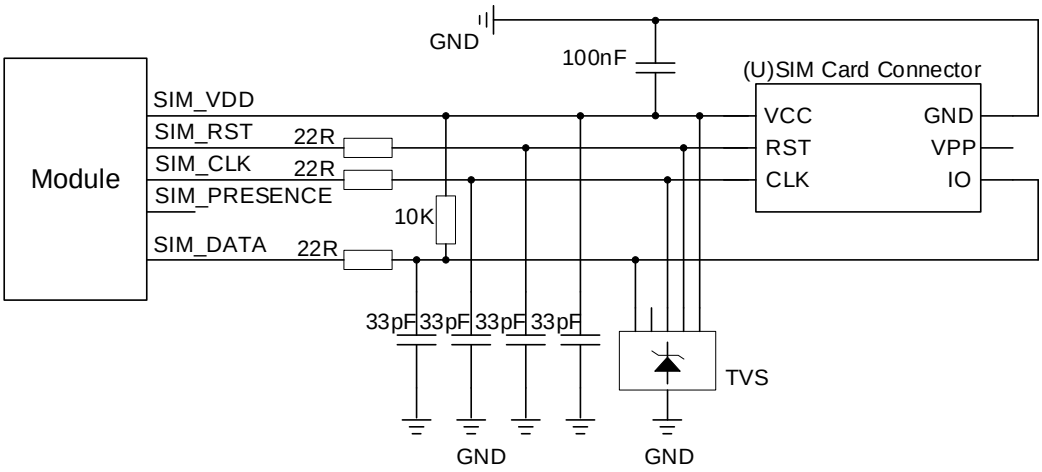

Figure 25: Reference Circuit for (U)SIM Interface with the 6-pin (U)SIM Card Connector

For details about (U)SIM card connector, please http://www.amphenol.com and http://www.molex.com.

In order to ensure good performance and avoid damage of (U)SIM cards, please follow the criteria below in (U)SIM circuit design:

- Keep placement of (U)SIM card connector as close to the module as possible. Keep the trace length of (U)SIM card signals as less than 200mm as possible.
- Keep (U)SIM card signals away from RF and VBAT traces.
- A filter capacitor shall be reserved for USIM_VDD, and its maximum capacitance should not exceed 1μF. The capacitor should be placed near to (U)SIM card.
- To avoid cross-talk between USIM_DATA and USIM_CLK, keep them away from each other and shield them from the ground. USIM_RST also needs ground protection.
- In order to offer good ESD protection, it is recommended to add a TVS diode array with parasitic capacitance not exceeding 50pF. The 22Ω resistors should be added in series between the module and (U)SIM card to suppress EMI spurious transmission and enhance ESD protection. Please note that the (U)SIM peripheral circuit should be close to the (U)SIM card connector. The 22pF capacitors should be added in parallel on USIM_DATA, USIM_VDD, USIM_CLK, and USIM_RST signal lines to filter RF interference, and they should be placed as close to the (U)SIM card connector as possible
- The pull-up resistor on the SIM_DATA line can help improve anti-jamming capability. When the trace of (U)SIM card is long or close to interference, it is recommended to place a pull-up resistor near the card connector.

3.13. ADC Interface

The module provides an ADC channel to measure the value of voltage. The value of the voltage applied on the ADC channel can be read by **AT+QADC**. In order to improve the accuracy of ADC, the layout of ADC should be surrounded by ground. For details of this AT command, please refer to the ***document [1].***

Table 13: Pin Definition of ADC

Pin Name	Pin No.	Description
ADC	38	Analog to digital converter.

Table 14: Characteristics of ADC

Item	Min.	Typ.	Max.	Units
Voltage Range	0		1.8	V
ADC Resolution		10		bits

3.14. RI Signal Interface

Table 15: RI Behaviors

State	RI Response
Standby	HIGH
Voice call	Change to LOW, then: 1. Change to HIGH when a call is established. 2. Use ATH to hang up the call; RI changes to HIGH. 3. Caller hangs up, RI changes to HIGH first, and changes to LOW for 120ms indicating URC “NO CARRIER”, then changes to HIGH again. 4. Change to HIGH when SMS is received.
SMS	When a new SMS comes, RI changes to LOW and holds for about 120ms, then changes to HIGH.
URC	Certain URCs can cause RI staying in LOW for 120ms.

If the module is used as a caller, RI would remain in HIGH except URC or SMS is received.

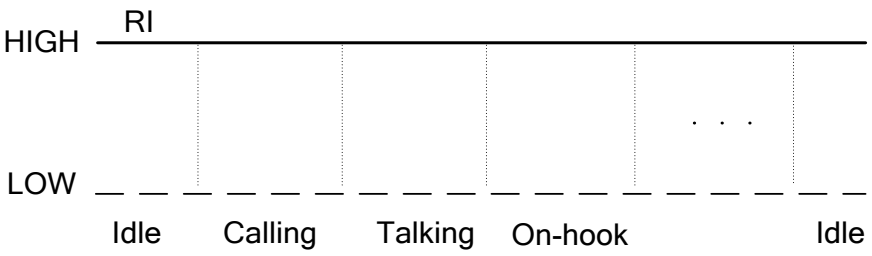

Figure 26: RI Behavior as a Caller

On the other hand, when it is used as a receiver, the timing of RI is shown below.

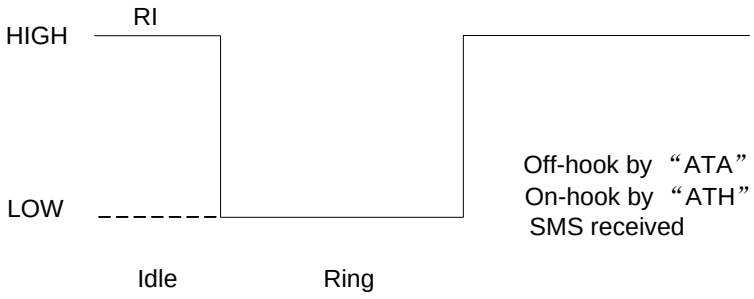

Figure 27: RI Behavior as a Receiver of Voice Calling

When URC or SMS is received, the timing of RI is shown below.

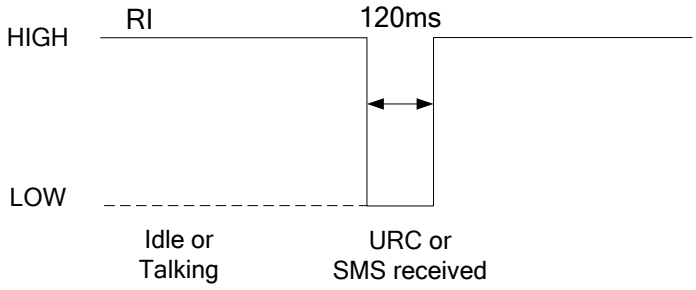

Figure 28: RI Behavior of URC or SMS Received

3.15. 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 16: Working State of NETLIGHT

State	Module Function
OFF	The module stops running.
64ms ON/800ms OFF	The module is not synchronized with the network.
64ms ON/2000ms OFF	The module is synchronized with the network.
64ms ON/600ms OFF	GPRS data transmission upon PPP dial-up connection.

A reference circuit is shown below.

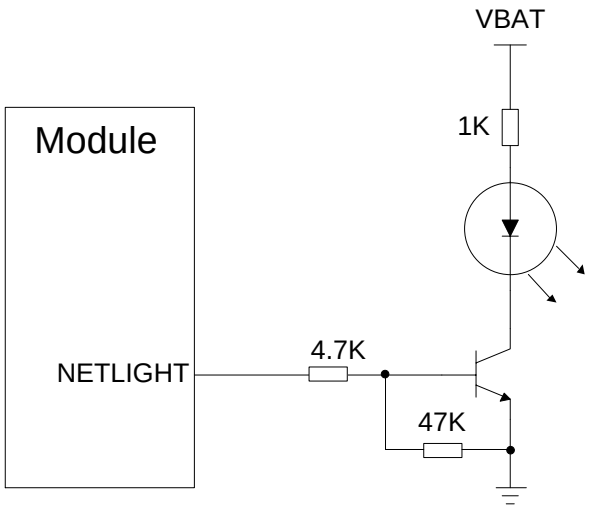

Figure 29: Reference Design for NETLIGHT

3.16. Work Status Indication

The STATUS pin is a digital output for the module's operation status indication. It can be connected to a transistor as an LED indication circuit as below.

Table 17: Pin Definition of Work Status Indication

Pin Name	Pin No.	Description
STATUS	42	Indicate module's operating status

The following figure shows circuit designs of STATUS:

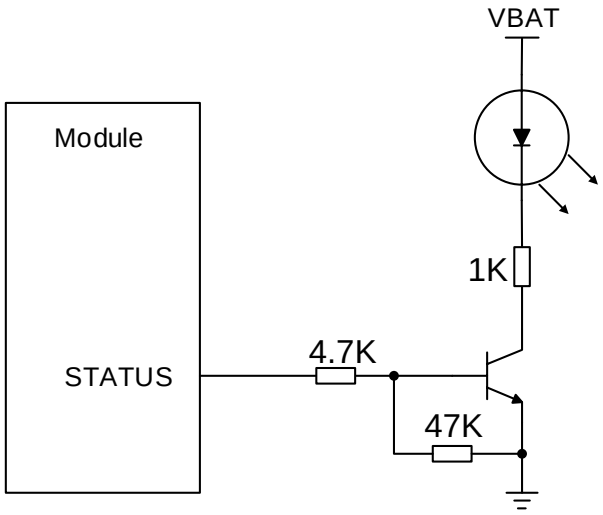

Figure 30：Reference Design of STATUS

3.17. RF Transmitting Signal Indication

The module provides an RFTXMON pin which will output a high level when the GSM transmitter is active and low level when transmitting activity is completed.

Table 18: Pin Definition of RFTXMON

Pin Name	Pin No.	Description
RFTXMON	29	RF transmission indication

There are two different modes for this function:

1) GSM transmits burst indication

RFTXMON is used to indicate the transmit burst. If it outputs a high level, there will be a transmit burst of 220 μs later. **AT+QCFG="RFTXburst",1** can be executed to enable the function. The timing of the RFTXMON signal is shown below.

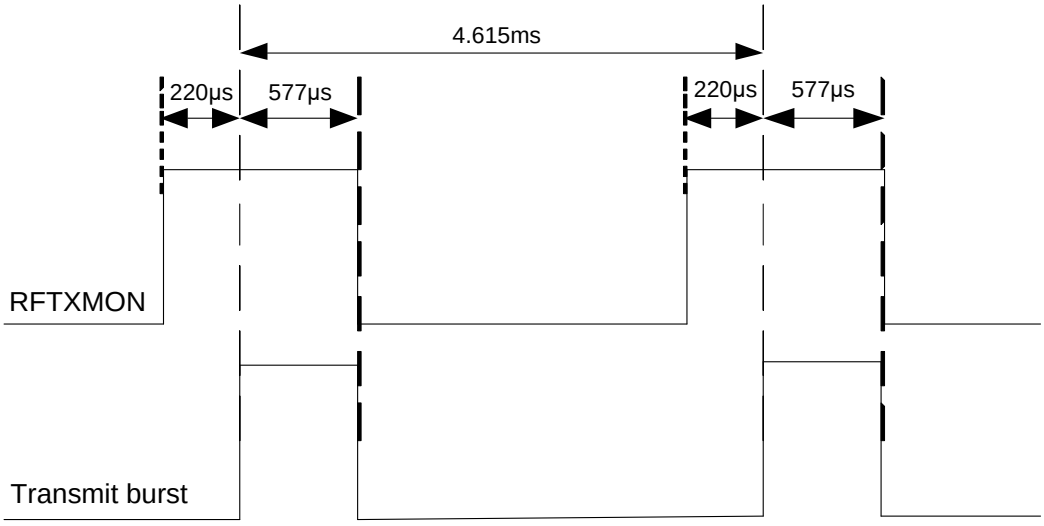

Figure 31: RFTXMON Signal During Burst Transmission

2) Active during the call

RFTXMON will output a high level during a call and the pin will output a low level after being hanged up.

AT+QCFG="RFTXburst",2 can be executed to enable the function.

The timing of the RFTXMON signal is shown below.

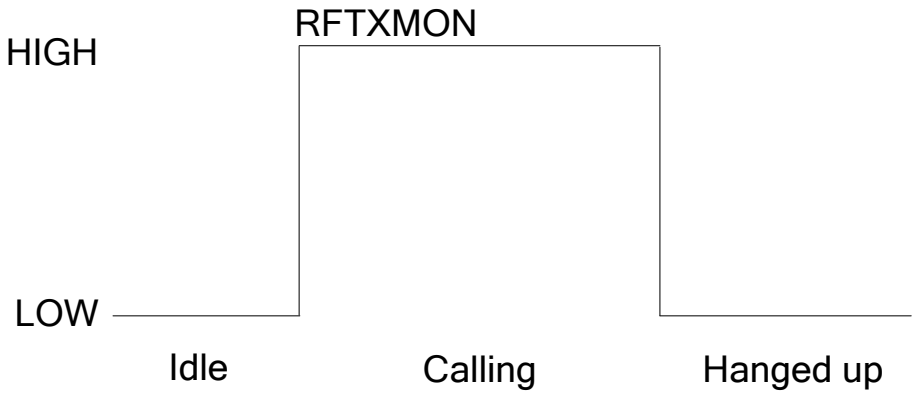

Figure 32: RFTXMON Signal During Call

4 Antenna Interface

M08-R has a GSM antenna interface with an impedance of 50Ω.

4.1. GSM Antenna Interface

The pin definition of the GSM antenna interface is shown below.

Table 19: Pin Definition of GSM Antenna Interface

Pin Name	Pin No.	Description
RF_ANT	32	GSM antenna pin
GND	30, 31, 33	Ground

4.1.1. RF Reference Design

The external antenna must be matched properly to achieve the best performance, so the matching circuit should be reserved. The reference design for the GSM antenna is shown below, among which C1 and C2 are should not be mounted and only the 0Ω R1 should be mounted.

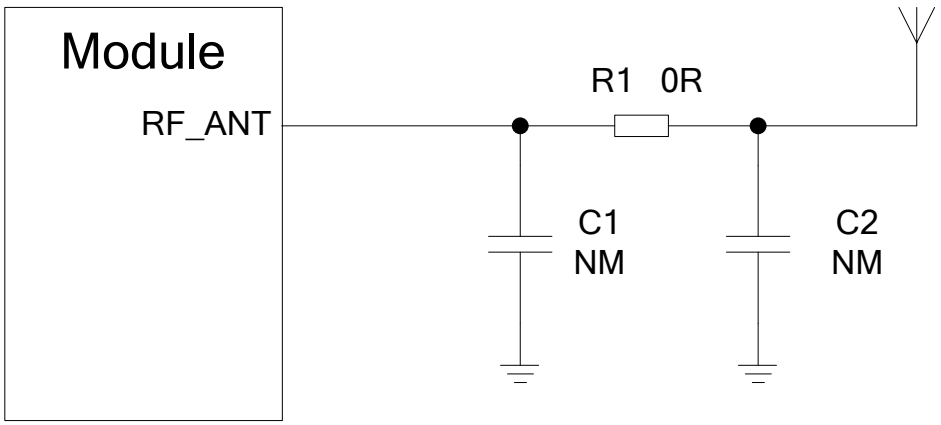

Figure 33: Reference Design for GSM Antenna

M08-R provides an RF antenna pad for the antenna connection. The RF trace in host PCB connected to the module RF antenna pad should be coplanar waveguide line or microstrip line, whose characteristic impedance should be close to 50Ω. M08-R comes with grounding pads that are next to the antenna pad in order to give a better grounding. In addition, a π type match circuit is recommenced to be used to adjust the RF performance.

To minimize the loss on RF trace and RF cable, please take design into account carefully. The following table shows the requirement on the GSM antenna.

Table 20: Antenna Cable Requirements

Frequency	Requirements
GSM850/EGSM900	Cable insertion loss <1dB
DCS1800/PCS1900	Cable insertion loss <1.5dB

Table 21: Antenna Requirements

Item	Requirements
Frequency Range	GSM850/EGSM900/DCS1800/PCS1900
VSWR	≤ 2
Efficiency	> 30%
Max Input Power (W)	50
Input Impedance (Ω)	50

4.1.2. RF Output Power

Table 22: RF Output Power

Frequency	Max.	Min.
GSM850	33dBm±2dB	5dBm±5dB
EGSM900	33dBm±2dB	5dBm±5dB
DCS1800	30dBm±2dB	0dBm±5dB
PCS1900	30dBm±2dB	0dBm±5dB

4.1.3. RF Receiving Sensitivity

Table 23: RF Receiving Sensitivity

Frequency	Receiving Sensitivity
GSM850	< -107.5dBm
EGSM900	< -107.5dBm
DCS1800	< -106.5dBm
PCS1900	< -106.5dBm

4.1.4. Operating Frequencies

Table 24: Operating Frequencies

Frequency	Receive	Transmit	ARFCN
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

4.1.5. RF Cable Soldering

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

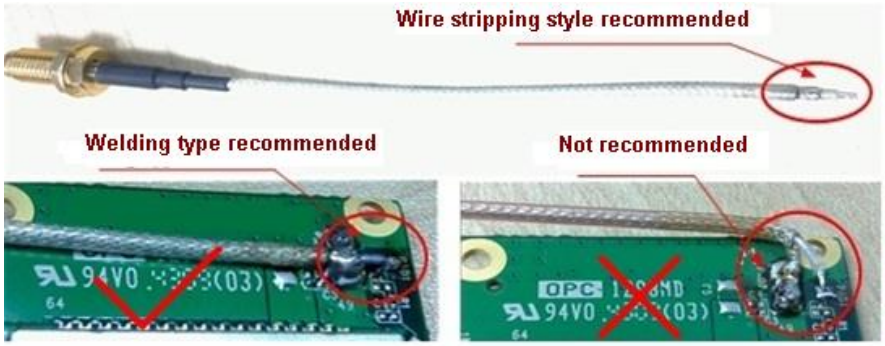

Figure 34: RF Soldering Sample

5 Electrical, Reliability and Radio Characteristics

5.1. Absolute Maximum Ratings

The absolute maximum ratings for power supply and voltage on digital and analog pins of the module are listed in the following table.

Table 25: Absolute Maximum Ratings

Parameter	Min.	Max.	Unit
VBAT	-0.3	4.5	V
Peak Current of Power Supply	0	2.0	A
RMS Current of Power Supply (during one TDMA-frame)	0	0.7	A
Voltage at Digital Pins	-0.3	3.08	V
Voltage at Analog Pins	-0.3	3.08	V

5.2. Operation and Storage Temperatures

The following table lists the operation and storage temperatures of the module.

Table 26: Operating and Storage Temperatures

Parameter	Min.	Typ.	Max.	Unit
Operation temperature range [1)]	-35	+25	+75	°C
Extended temperature range [2)]	-40		+85	°C
Storage Temperature Range	-40		+90	°C

NOTES

1. [1)] Within the operation temperature range, the module is 3GPP compliant.
2. [2)] Within the extended temperature range, the module remains the ability to establish and maintain a voice, SMS, data transmission, etc. There is no unrecoverable malfunction. There are also no effects on the radio spectrum and no harm to the radio network. Only one or more parameters like P_{out} might reduce in their value and exceed the specified tolerances. When the temperature returns to normal operation temperature levels, the module will meet 3GPP specifications again.

5.3. Power Supply Ratings

Table 27: The Module Power Supply Ratings

Parameter	Description	Conditions	Min.	Typ.	Max.	Unit
VBAT	Supply voltage	The actual input voltages must stay between the minimum and maximum values.	3.45	4.0	4.25	V
	Voltage drop during burst transmission	Maximum power control level on GSM850/EGSM900.			400	mV
I_{VBAT}	Average supply current	Power down mode		40		μA
		Sleep mode @DRX=5		1.3		mA
		Minimum functionality mode ● **AT+CFUN=0**				

		Idle mode	9.5		mA
		Sleep mode	0.8		mA
		● **AT+CFUN=4**			
		Idle mode	9.5		mA
		Sleep mode	0.8		mA
		Talk mode			
		GSM850/EGSM900 [1)]	250/238		mA
		DCS1800/PCS1900 [2)]	175/162		mA
		Data mode, GPRS (3 Rx, 2 Tx)			
		GSM850/EGSM900 [1)]	390/370		mA
		DCS1800/PCS1900 [2)]	270/248		mA
		Data mode, GPRS (2 Rx, 3 Tx)			
		GSM850/EGSM900 [1)]	475/443		mA
		DCS1800/PCS1900 [2)]	304/282		mA
		Data mode, GPRS (4 Rx, 1 Tx)			
		GSM850/EGSM900 [1)]	265/250		mA
		DCS1800/PCS1900 [2)]	188/174		mA
		Data mode, GPRS (1 Rx, 4 Tx)			
		GSM850/EGSM900 [1)]	480/456		mA
		DCS1800/PCS1900 [2)]	310/295		mA
	Peak supply current (during each transmission slot)	Maximum power control level on GSM850/EGSM900.	1.8	2	A

NOTES

1. [1)] Power control level PCL 5.
2. [2)] Power control level PCL 0.

5.4. Current Consumption

The current of M08-R module in various operating modes is shown in the table below.

Table 28: The Module Current Consumption

Condition	Current Consumption
Voice Call	
GSM850	@power level 5, <300mA, Typ. 250mA @power level 12, Typ. 105mA @power level 19, Typ. 74mA
EGSM900	@power level 5, <300mA, Typ. 238mA @power level 12, Typ. 105mA @power level 19, Typ. 75mA
DCS1800	@power level 0, <250mA, Typ. 175mA @power level 7, Typ. 88mA @power level 15, Typ. 66mA
PCS1900	@power level 0, <250mA, Typ. 162mA @power level 7, Typ. 87mA @power level 15, Typ. 66mA
GPRS Data Transmission	
DATA Mode, GPRS (3 Rx, 2 Tx) CLASS 12	
GSM850	@power level 5, <550mA, Typ. 390mA
EGSM900	@power level 5, <550mA, Typ. 370mA
DCS1800	@power level 0, <450mA, Typ. 270mA
PCS1900	@power level 0, <450mA, Typ. 248mA
DATA Mode, GPRS (2 Rx, 3 Tx) CLASS 12	
GSM850	@power level 5, <600mA, Typ. 476mA
EGSM900	@power level 5, <600mA, Typ. 443mA
DCS1800	@power level 0, <490mA, Typ. 304mA
PCS1900	@power level 0, <490mA, Typ. 282mA

DATA Mode, GPRS (4 Rx,1 Tx) CLASS 12	
GSM850	@power level 5, <350mA, Typ. 262mA
EGSM900	@power level 5, <350mA, Typ. 250mA
DCS1800	@power level 0, <300mA, Typ. 188mA
PCS1900	@power level 0, <300mA, Typ. 174mA
DATA Mode, GPRS (1 Rx, 4 Tx) CLASS 12	
GSM850	@power level 5, <660mA, Typ. 480mA
EGSM900	@power level 5, <660mA, Typ. 456mA
DCS1800	@power level 0, <530mA, Typ. 310mA
PCS1900	@power level 0, <530mA, Typ. 295mA

NOTE

GPRS Class 12 is a default setting. The module can be configured from GPRS Class 1 to Class 12 via **AT+QGPCLASS**. When it is set to a lower GPRS class, the power consumption of the module will be lower as well.

5.5. Electrostatic Discharge

The module is not protected against electrostatic discharge (ESD) in general. Consequently, it should be subject to ESD handling precautions that are typically applied to ESD sensitive components. Proper ESD handling and packaging procedures must be applied throughout the processing, handling, and operation of any application that incorporates the module.

The following table shows the electrostatic discharge characteristics of the M08-R module.

Table 29: Electrostatic Discharge Characteristics (25ºC, 45% Relative Humidity)

Tested Point	Contact Discharge	Air Discharge	Unit
VBAT, GND	±5	±10	KV
RF_ANT	±5	±10	KV

TXD, RXD	±2	±4	KV
Others	±0.5	±1	KV

6 Mechanical Dimensions

This chapter describes the mechanical dimensions of the module. All dimensions are measured in millimeter (mm), and the dimensional tolerances are ±0.05mm unless otherwise specified.

6.1. Mechanical Dimensions of the Module

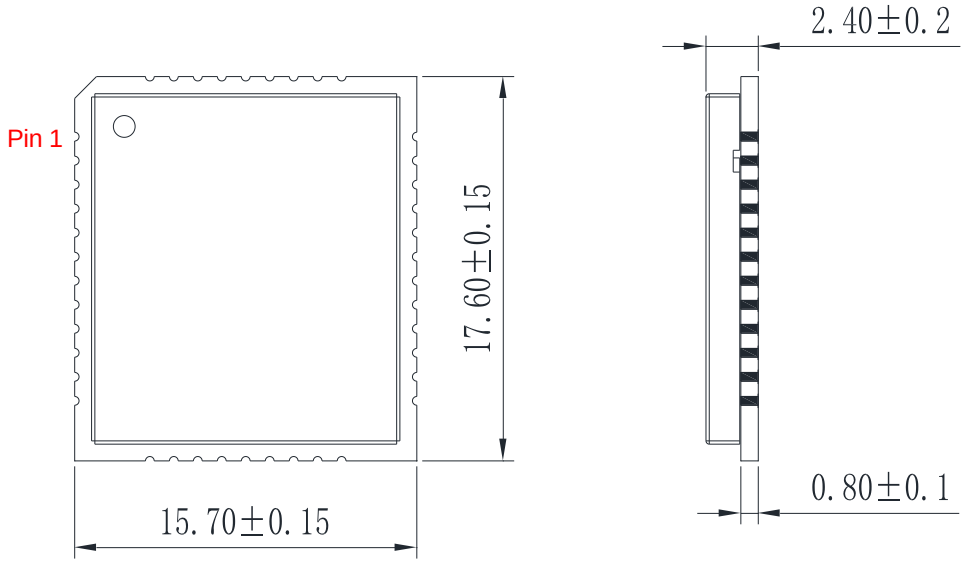

Figure 35: M08-R Module Top and Side Dimensions

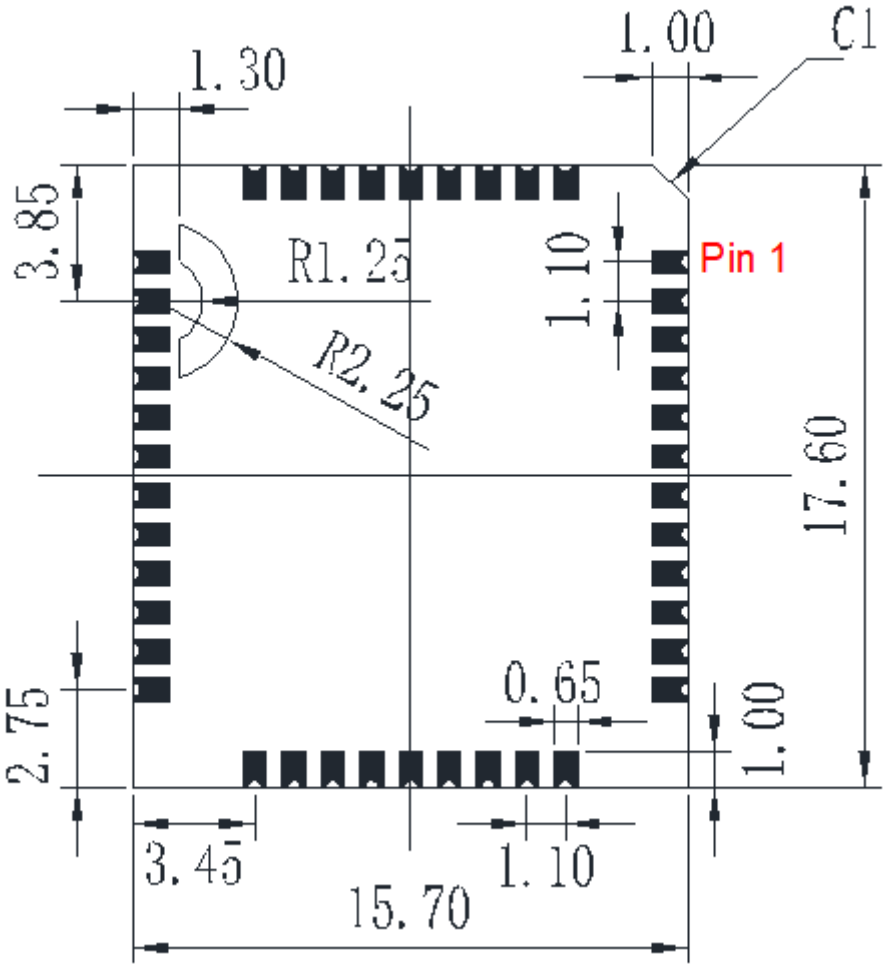

Figure 36: M08-R Module Bottom Dimensions

6.2. Recommended Footprint

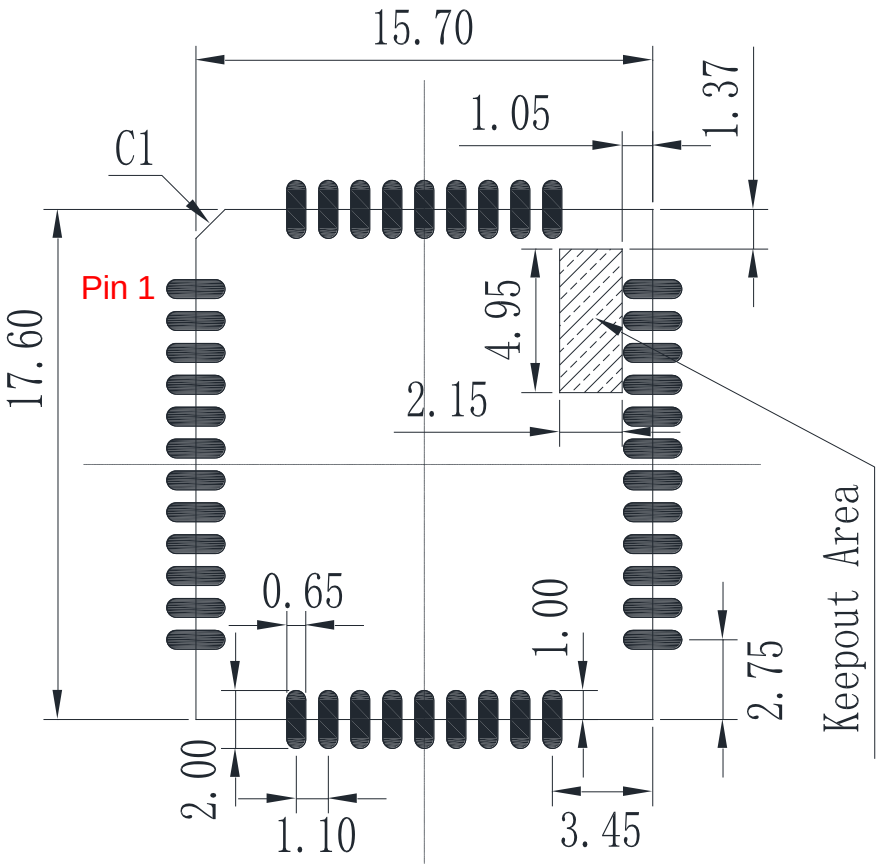

Figure 37: Recommended Footprint (Top View)

NOTE

For easy maintenance of the module, keep about 3mm between the module and other components on the host PCB.

6.3. Top and Bottom Views of the Module

Figure 38: Top View of the Module

Figure 39: Bottom View of the Module

NOTE

These are renderings of the M08-R module. For authentic appearance, please refer to the module that you receive from Quectel.

7 Storage and Manufacturing

7.1. Storage

M08-R is stored in a vacuum-sealed bag. It is rated at MSL 3, and storage restrictions are shown below.

1. Shelf life in the vacuum-sealed bag: 12 months at <40ºC/90%RH.

2. After the vacuum-sealed bag is opened, devices that will be subjected to reflow soldering or other high-temperature processes must be:
   - Mounted within 168 hours at the factory environment of ≤30ºC/60%RH.
   - Stored at <10%RH.

3. Devices require baking before mounting if any circumstance below occurs.
   - When the ambient temperature is 23ºC±5ºC and the humidity indication card shows the humidity is >10% before opening the vacuum-sealed bag.
   - Device mounting cannot be finished within 168 hours at factory conditions of ≤30ºC/60%RH.

4. If baking is required, devices may be baked for 8 hours at 120ºC±5ºC.

NOTE

As the plastic package cannot be subjected to high temperature, it should be removed from devices before high temperature (120ºC) baking. If shorter baking time is desired, please refer to IPC/JEDECJ-STD-033 for the baking procedure.

7.2. Manufacturing and Soldering

Push the squeegee to apply the solder paste on the surface of stencil, thus making the paste fill the stencil openings and then penetrate to the PCB. The force on the squeegee should be adjusted properly so as to produce a clean stencil surface on a single pass. To ensure the module soldering quality, the thickness of the stencil for the module is recommended to be 0.15mm~0.18mm. For more details, please refer to ***document [5]***.

It is suggested that the peak reflow temperature is 238ºC ~245ºC, and the absolute maximum reflow temperature is 245ºC. To avoid damage to the module caused by repeated heating, it is strongly recommended that the module should be mounted after reflow soldering for the other side of PCB has been completed. The recommended reflow soldering thermal profile (lead-free reflow soldering) and related parameters are shown below.

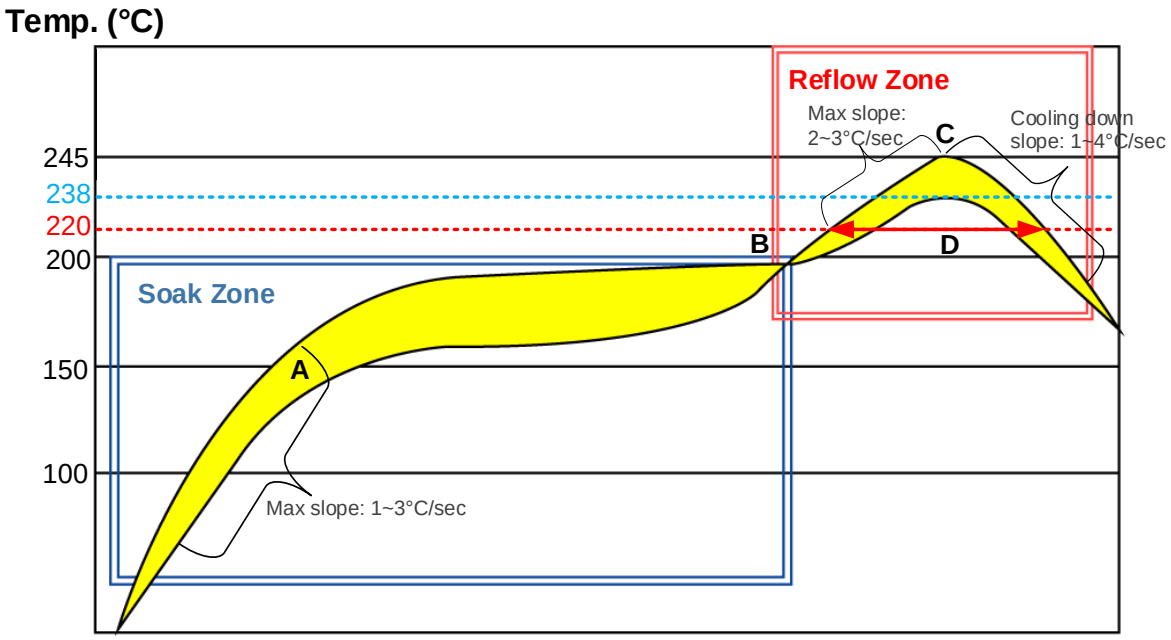

Figure 40: Recommended Reflow Soldering Thermal Profile

Table 30: Recommended Thermal Profile Parameters

Factor	Recommendation
Soak Zone	
Max slope	1 to 3°C/sec
Soak time (between A and B: 150°C and 200°C)	60 to 120 sec
Reflow Zone	
Max slope	2 to 3°C/sec
Reflow time (D: over 220°C)	40 to 60 sec
Max temperature	238°C ~ 245°C
Cooling downslope	1 to 4°C/sec
Reflow Cycle	

Max reflow cycle	1

NOTES

1. During manufacturing and soldering, or any other processes that may contact the module directly, NEVER wipe the module's shielding can with organic solvents, such as acetone, ethyl alcohol, isopropyl alcohol, trichloroethylene, etc. Otherwise, the shielding may become rusted.
2. The shielding can for the module is made of Cupro-Nickel base material. It is tested that after 12 hours' Neutral Salt Spray test, the laser engraved label information on the shielding can is still clearly identifiable and the QR code is still readable, although white rust may be found.

7.3. Packaging

M08-R is packaged in a vacuum-sealed and ESD-protected bag. The bag should not be opened until the devices are ready to be soldered onto the application. The following figures show the packaging details, measured in mm.

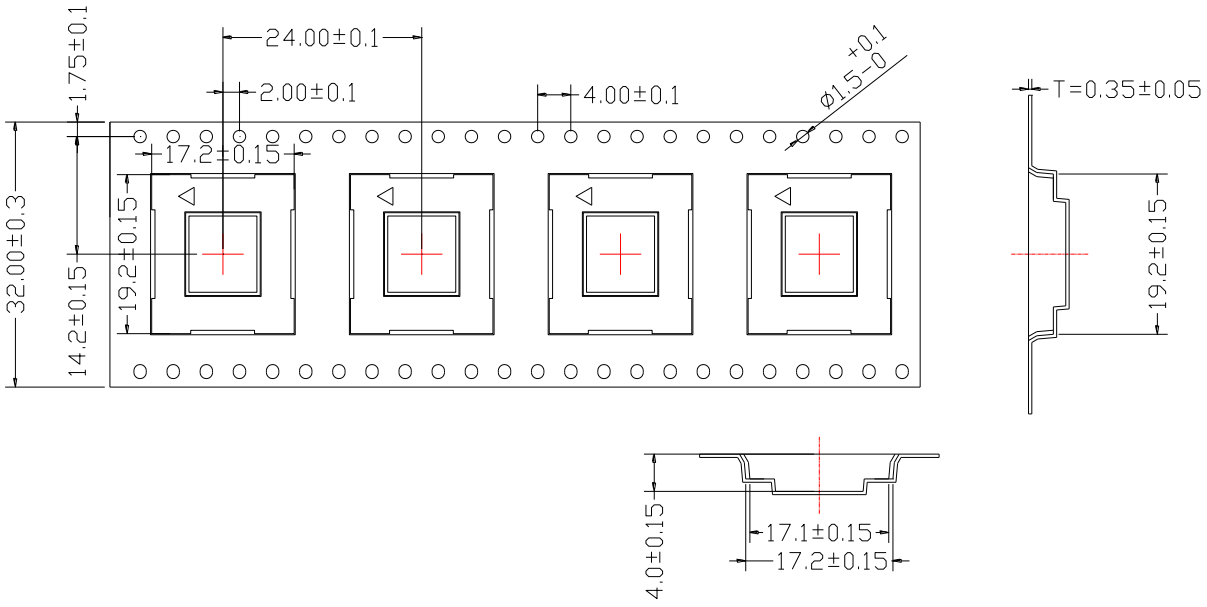

Figure 41: Tape Dimensions (in mm)

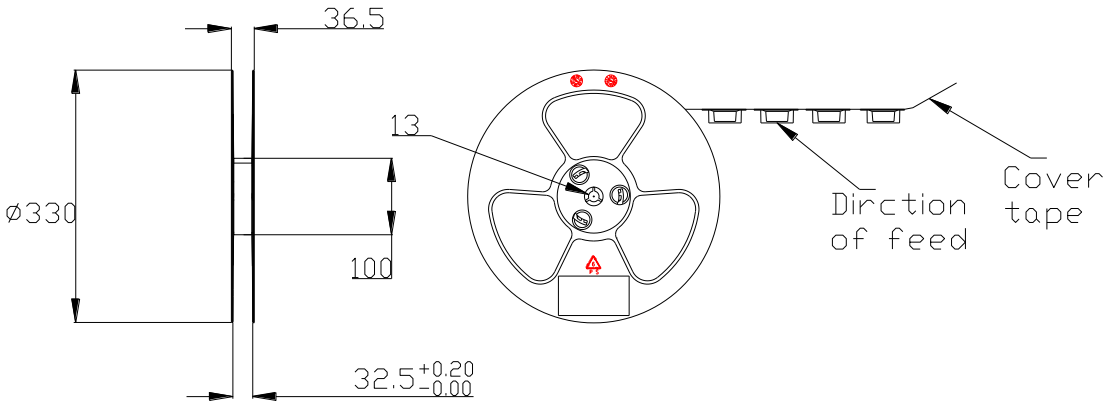

Figure 42: Reel Dimensions (in mm)

Table 31: Reel Packaging

Model Name	MOQ for MP	Minimum Package: 250pcs	Minimum Package x 4=1000pcs
M08-R	250pcs	Size: 370mm × 350mm × 56mm N.W: 0.32kg G.W: 1.08kg	Size: 380mm × 250mm × 365mm N.W: 1.28kg G.W: 4.8kg

8 Appendix A References

Table 32: Reference Documents

SN	Document Name	Remark
[1]	Quectel_M08-R_AT_Commands_Manual	M08-R AT commands manual
[2]	Quectel_GSM_UART_Application_Note	GSM UART port application note
[3]	Quectel_GSM_EVB_User_Guide	GSM EVB user guide
[4]	ITU-T Draft new recommendation V.25ter	Serial asynchronous automatic dialing and control
[5]	Quectel_Module_Secondary_SMT_User_Guide	Module secondary SMT user guide
[6]	Quectel_GSM_Module_Digital_IO_Application_Note	GSM Module Digital IO Application Note
[7]	GSM 07.07	Digital cellular telecommunications (Phase 2+); AT command set for GSM Mobile Equipment (ME)
[8]	GSM 07.10	Support GSM 07.10 multiplexing protocol
[9]	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)
[10]	GSM 11.14	Digital cellular telecommunications (Phase 2+); Specification of the (U)SIM Application Toolkit for the Subscriber Identity module – Mobile Equipment ((U)SIM – ME) interface
[11]	GSM 11.11	Digital cellular telecommunications (Phase 2+); Specification of the Subscriber Identity module – Mobile Equipment ((U)SIM – ME) interface

[12]	GSM 03.38	Digital cellular telecommunications (Phase 2+); Alphabets and language-specific information
[13]	GSM 11.10	Digital cellular telecommunications (Phase 2); Mobile Station (MS) conformance specification; Part 1: Conformance specification

Table 33: Terms and Abbreviations

Abbreviation	Description
ADC	Analog-to-Digital Converter
AMR	Adaptive Multi-Rate
ARFCH	Absolute Radio Frequency Channel Number
ASIC	Application Specific Integrated Circuit
CHAP	Challenge Handshake Authentication Protocol
CS	Coding Scheme
CTS	Clear to Send
DRX	Discontinuous Reception
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
ESD	Electrostatic Discharge
ETS	European Telecommunication Standard
FR	Full Rate
GPRS	General Packet Radio Service

GSM	Global System for Mobile Communications
G.W	Gross Weight
HR	Half Rate
I/O	Input/Output
IC	Integrated Circuit
$I_{O}max$	Maximum Output Load Current
kbps	Kilo Bits Per Second
LED	Light Emitting Diode
ME	Mobile Equipment
MOQ	Minimum Order Quantity
MP	Manufacture Product
MS	Mobile Station (GSM engine)
MT	Mobile Terminated
N.W	Net Weight
PAP	Password Authentication Protocol
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
(U)SIM	(Universal) 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
$V_O$max	Maximum Output Voltage Value
$V_O$norm	Normal Output Voltage Value
$V_O$min	Minimum Output Voltage Value
V_{IH}max	Maximum Input High Level Voltage Value
V_{IH}min	Minimum Input High Level Voltage Value
V_{IL}max	Maximum Input Low Level Voltage Value
V_{IL}min	Minimum Input Low Level Voltage Value
$V_I$max	Absolute Maximum Input Voltage Value
$V_I$norm	Absolute Normal Input Voltage Value
$V_I$min	Absolute Minimum Input Voltage Value
V_{OH}max	Maximum Output High Level Voltage Value
V_{OH}min	Minimum Output High Level Voltage Value
V_{OL}max	Maximum Output Low Level Voltage Value
V_{OL}min	Minimum Output Low Level Voltage Value
Phonebook Abbreviations	
LD	(U)SIM Last Dialing phonebook (list of numbers most recently dialed)
MC	ME list of unanswered MT Calls (missed calls)
ON	(U)SIM (or ME) Own Numbers (MSISDNs) list
RC	ME list of Received Calls
SM	(U)SIM phonebook

9 Appendix B GPRS Coding Schemes

Four coding schemes are used in the GPRS protocol. The differences between them are shown in the following table.

Table 34: 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

The radio block structure of CS-1, CS-2 and CS-3 is shown as the figure below.

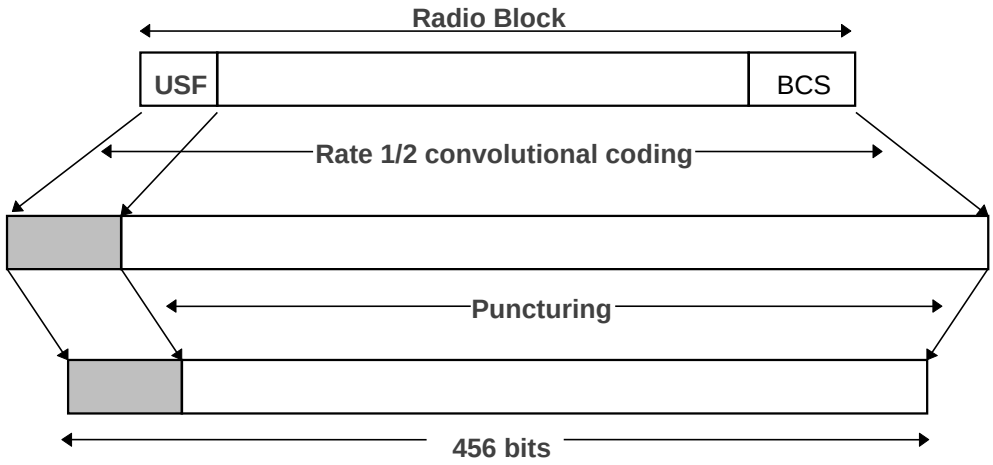

Figure 43: Radio Block Structure of CS-1, CS-2, and CS-3

The radio block structure of CS-4 is shown as the following figure.

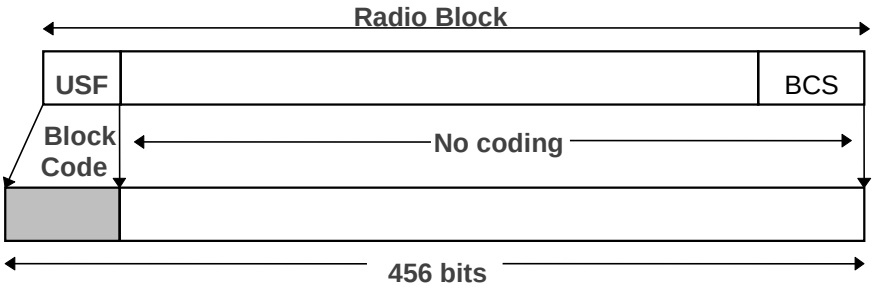

Figure 44: Radio Block Structure of CS-4

10 Appendix C GPRS Multi-slot Classes

Twenty-nine classes of GPRS multi-slot modes are defined for MS in GPRS specification. Multi-slot classes are product dependent, 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 number of downlink timeslots, while the second number indicates the number 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 the following table.

Table 35: 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