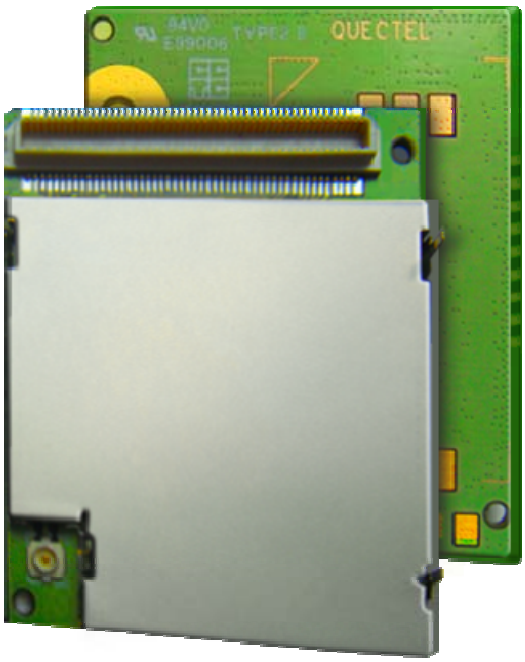
M33

Quectel Cellular Engine



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0 Revision History

Revision	Date	Author	Description of change
1.0	2010-6-26	Yong An	Initial

1 Introduction

This document describes the hardware details of Quectel's M33 module with camera interface. This document can help customer quickly understand module interface specifications, electrical and mechanical details. With the help of this document, associated application notes and user guides, customer can use M33 module to design and fit into security device with camera function and picture transfer capability.

1.1 Related Documents

Table 1: Related documents

SN	Document name	Remark
[1]	M33_ATC	M33 AT Command 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 notes
[11]	M33_EVB_UGD	M33 EVB user guide application notes
[12]	M33_Camera_ATC	M33 AT Command Set for camera function

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
AVI	Audio video Interleave
BER	Bit Error Rate
B2B	Board-to-Board
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
DAI	Digital Acoustic Interface
DCE	Data Communications Equipment (typically module)
DRX	Discontinuous Reception
DSP	Digital Signal Processor
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
FDMA	Frequency Division Multiple Access
FR	Full Rate
GMSK	Gaussian Minimum Shift Keying
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
GPU	Graphic Processing Unit
HR	Half Rate
I/O	Input/Output
IC	Integrated Circuit
IMEI	International Mobile Equipment Identity
Imax	Maximum Load Current
Inorm	Normal Current

Abbreviation	Description
JPEG	Joint Photographic Experts Group
kbps	Kilo Bits per Second
LED	Light Emitting Diode
Li-Ion	Lithium-Ion
MO	Mobile Originated
MS	Mobile Station (GSM engine)
MT	Mobile Terminated
M2M	Machine to Machine
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
SGSN	Service GPRS Support Node
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
VTS	Vehicle Track System
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	
Abbreviation	**Description**
FD	SIM Fix Dialing phonebook
LD	SIM Last Dialing phonebook (list of numbers most recently dialed)
MC	Mobile Equipment list of unanswered MT Calls (Missed Calls)
ON	SIM (or ME) Own Numbers (MSISDNs) list
RC	Mobile Equipment list of Received Calls
SM	SIM phonebook

1.3 Safety Caution

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 M33 module. Manufactures 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.

2 Product Concept

The M33 is a Quad-band GSM/GPRS engine with camera interface that works at frequencies GSM850MHz, GSM900MHz, DCS1800MHz and PCS1900MHz. The M33 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 Appendix A and Appendix B.

With a compact profile of 40.0mm x 32.2mm x 6.1mm, the module is mainly designed for security device supporting camera and picture transfer.

The M33 is a B2B connector type module, which can be embedded in customer applications through its 100-pin connector. It provides all hardware interfaces between the module and customer's board.

The module is designed with power saving technique so that the current consumption is as low as 1.8mA in SLEEP mode when DRX of GSM network is 5.

The M33 is integrated with several Internet protocols; extended Internet service AT commands are developed for customer to use the Internet services easily, which are very useful for those data transfer applications.

The module is fully RoHS compliant to EU regulation.

2.1 Key Features

Table 3: Module key features

Feature	Implementation
Power supply	Single supply voltage 3.4V ~ 4.5V
Power saving	Typical power consumption in SLEEP mode to 1.8mA@ DRX=5 1.6mA@ DRX=9
Frequency band	● Quad-band: GSM850, EGSM 900, DCS1800, PCS1900 ● The module can search these frequency bands automatically ● The frequency bands can be set by AT command ● Compliant to GSM Phase 2/2+
Transmitting power	● Class 4 (2W) 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: -45°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/HTTP/SMTP/MMS ● Support Packet Switched Broadcast Control Channel (PBCCH) ● CSD transmission rates: 2.4, 4.8, 9.6, 14.4 kbps, non-transparent ● Support Unstructured Supplementary Services Data (USSD)
SMS	● MT, MO, CB, Text and PDU mode ● SMS storage: SIM card
FAX	Group 3 Class 1 and Class 2
SIM interface	Support SIM card: 1.8V, 3V
Antenna interface	Connect via 50Ω antenna connector or antenna pad
Audio feature	Speech codec modes: ● Half Rate (ETS 06.20) ● Full Rate (ETS 06.10) ● Enhanced Full Rate (ETS 06.50 / 06.60 / 06.80) ● Adaptive Multi-Rate (AMR) ● Echo Cancellation ● Echo Suppression ● Noise Reduction
Serial interface	Serial Port 1: ● 8 lines on Serial Port 1 ● Use for AT command, GPRS data and CSD data ● Support multiplexing function ● Support baud rate from 75 bps to 115200 bps ● Support Autobauding from 4800 bps to 115200bps Serial Port 2: ● Software debug function ● Two data lines RXD2 and TXD2 Serial Port 3: ● AT command only ● Two data lines RXD3 and TXD3 ● Support baud rate from 75 bps to 115200 bps
SD card interface	● Only support SPI mode ● Support maximum capacity：2GB ● Accessing speed: 350kbps
Camera interface	Input feature: ● Support CCIR656, CCIR601 ● Support YUV422, YUV420, YUV411 type

	● Support up to 300K pixels CMOS sensor ● Support 8-bit video data bus Output feature: ● Encode image to JPEG format ● Encode image to AVI format (Motion JPEG)
Phonebook management	Support phonebook types: SM, FD, LD, RC, ON, MC
SIM Application Toolkit	Support SAT class 3, GSM 11.14 Release 99
Real time clock	Implemented
Alarm function	Programmable via AT command
Physical characteristics	Size: 40.0±0.15 x 32.2±0.15 x 6.1±0.3mm Weight: approx 7.5g
Firmware upgrade	Firmware upgrade over Serial Port 1

1) When the module works in this temperature range, the deviations from the GSM specification might occur. For example, the frequency error or the phase error could increase.

Table 4: Coding schemes and maximum net data rates over air interface

Coding scheme	1 Timeslot	2 Timeslots	4 Timeslots
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 M33 module and illustrates the major functional parts:

- The GSM baseband engine
- Flash and SRAM
- The GSM radio frequency part
- The antenna interface
- The B2B interface
  - —SIM card interface
  - —Audio interface
  - —UART interface
  - —SD interface
  - —Power supply
  - —Camera interface

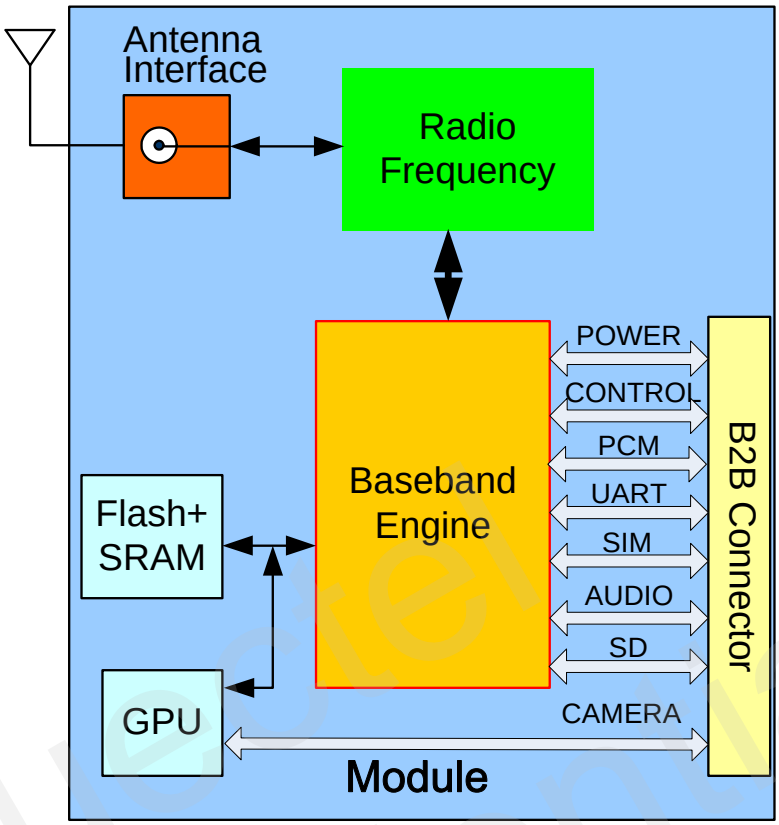


Figure 1: Module functional diagram

2.3 Evaluation Board

In order to help customer on the application of M33, Quectel can supply an Evaluation Board (EVB) that hosts the module directly with appropriate power supply, SIM card holder, RS-232 serial interface, handset RJ11 port, earphone port, antenna, EVB-TE and other peripherals to control or test the module. For details, please refer to the *document [11]*.

3 Application Interface

The module is equipped with a 100-pin 0.5mm pitch B2B connector that connects to the cellular application platform. Sub-interfaces included on this B2B connector are described in details in the following chapters:

- Power supply *(refer to Chapter 3.3)*
- Serial interface *(refer to Chapter 3.9)*
- Audio interface *(refer to Chapter 3.10)*
- SIM interface *(refer to Chapter 3.11)*
- Camera interface *(refer to Chapter 3.21)*

Electrical and mechanical characteristics are specified in *Chapter 5 & Chapter 6.*

3.1 Pin Description

Table 5: Pin description

Power Supply				
PIN NAME	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
VBAT	I	VBAT pins of the B2B are dedicated to connect the supply voltage. The power supply of module has to be a single voltage source of VBAT= 3.4V...4.5V. It must be able to provide sufficient current in a transmitting burst which typically rises to 2A. Mostly, these 5 pins are voltage inputs.	Vmax= 4.5V Vmin=3.4V Vnorm=4.0V	
VCHG	I	Voltage input for the charging circuit	Vmax=6.5V Vmin=1.1 * VBAT Vnorm=5.0V	If unused, keep this pin open. Not supported in default.
VRTC	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=VBAT VImin=2.6V VInorm=2.75V VOmax=2.85V VOmin=2.6V VOnorm=2.75V Iout(max)= 730uA	Recommend to connect to a backup battery or a golden capacitor.

			Iin=2.6~5 uA	
VDD_EXT	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. Recommend to add a 2.2~4.7uF bypass capacitor, when using this pin for power supply.
GND		Digital ground		
Power On or Power Off				
PIN NAME	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
ON/OFF	I	Power on/off key. The pin should be pulled up for a moment to turn on or turn off the system.	VILmax=0.5V VIHmin=1.5V VImax=6V	
Emergency Shutdown				
PIN NAME	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
EMERG_ OFF	I	Emergency off. Pulled down for at least 20ms will turn off the module in case of emergency. Use it only when normal shutdown through ON/OFF pin or AT command can't 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 Status indication/ General Purpose Input/Output				
PIN NAME	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
STATUS	O	Indicate module status. High level indicates module powering on and low level indicates powering down / General purpose input/output port 1	VILmin=0V VILmax=0.67V VIHmin=1.7V VIHmax= VDD_EXT+0.3 VOLmin=GND VOLmax=0.34V VOHmin=2.0V VOHmax= VDD_EXT	If unused, keep this pin open.
GPIO3	I/O	General purpose input/output port 3		If unused, keep this pin open
Audio Interfaces				
PIN NAME	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
MIC1P MIC1N	I	Audio input channel 1. Positive and negative	Audio DC Characteristics refer to Chapter 3.10	If unused, keep these pins open.

		voice inputs.		
MIC2P MIC2N	I	Audio input channel 2. Positive and negative voice inputs.		If unused, keep these pins open.
SPK1P SPK1N	O	Audio output channel 1. Positive and negative voice outputs.		If unused, keep these pins open.
SPK2P	O	Audio output channel 2. Auxiliary voice outputs.		If unused, keep this pin open.
AGND		AGND is a separate ground connection for external audio circuit.		If unused, keep this pin open.
Keypad Interface				
PIN NAME	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
KCOL0~ KCOL4	I	Keypad interface	VILmin=0V VILmax=0.67V VIHmin=1.7V VIHmax= VDD_EXT+0.3 VOLmin=GND VOLmax=0.34V VOHmin=2.0V VOHmax= VDD_EXT	Pulled up to VDD_EXT internally. If unused, keep these pins open.
KROW0~ KROW4	O			If unused, keep these pins open.
Open Drain Output				
NETLIGHT_ OUT	O	Open drain output. Used to drive GSM network light.	Imax=100mA	If unused, keep these pins open.
BUZZER_ OUT	O	Open drain output. Used to drive buzzer.	Imax=100mA	If unused, keep this pin open.
LIGHT_ MOS	O	Open drain output port	Imax=150mA	If unused, keep this pin open.
LED_B	O		Imax=25mA	
LED_R	O			
VIB	O		Imax=250mA	
PCM Interface				
PIN NAME	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
PCM_IN	I	Digital audio data input	VILmin=0V VILmax=0.67V VIHmin=1.7V VIHmax= VDD_EXT+0.3 VOLmin=GND VOLmax=0.34V VOHmin=2.0V VOHmax= VDD_EXT	If unused, keep these pins open.
PCM_SYNC	O	Frame synchronization		
PCM_CLK	O	Serial bit clock		
PCM_OUT	O	Digital audio data output		

Serial Port 1				
PIN NAME	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
DTR1	I	Data terminal ready	VILmin=0V VILmax=0.67V VIHmin=1.7V VIHmax= VDD_EXT+0.3 VOLmin=GND VOLmax=0.34V VOHmin=2.0V VOHmax= VDD_EXT	If only TXD1 and RXD1 are used, recommend to keep other pins open.
RXD1	I	Receive data		
TXD1	O	Transmit data		
RTS1	I	Request to send		
CTS1	O	Clear to send		
RI1	O	Ring indicator		
DCD1	O	Data carrier detection		
DSR1	O	Data set ready		
Serial Port 2				
RXD2	I	Receive data of Serial Port 2	VILmin=0V VILmax=0.67V VIHmin=1.7V VIHmax= VDD_EXT+0.3 VOLmin=GND VOLmax=0.34V VOHmin=2.0V VOHmax= VDD_EXT	If unused, keep these pins open. This serial port is mainly for software debug.
TXD2	O	Transmit data of Serial Port 2		
Serial Port 3				
RXD3	I	Receive data of Serial Port 3	VILmin=0V VILmax=0.67V VIHmin=1.7V VIHmax= VDD_EXT+0.3 VOLmin=GND VOLmax=0.34V VOHmin=2.0V VOHmax= VDD_EXT	If unused, keep these pins open.
TXD3	O	Transmit data of Serial Port 3		
SD Interface				
PIN NAME	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
SPI_CS	O	Chip select	VILmin=0V VILmax=0.67V VIHmin=1.7V VIHmax= VDD_EXT+0.3 VOLmin=GND VOLmax=0.34V VOHmin=2.0V VOHmax= VDD_EXT	If unused, keep these pins open.
SPI_CLK	O	Serial clock		
SPI_I	I	Data input		
SPI_O	O	Data output		
I2C Interface				
PIN NAME	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
SCL	O	Serial clock	VILmin=0V VILmax=0.67V VIHmin=1.7V	If unused, keep these pins open.
SDA	I/O	Serial data		

			VIHmax= VDD_EXT+0.3 VOLmin=GND VOLmax=0.34V VOHmin=2.0V VOHmax= VDD_EXT	
SIM Interface				
PIN NAME	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
SIM_VDD	O	Voltage supply for SIM card	The supply voltage can be decided by module software automatically. 1.8V or 3V	All signals of SIM interface should be protected against ESD with TVS diode. Maximum trace length 200mm from the module pin to SIM card holder.
SIM_DATA	I/O	SIM data，pulled up to SIM_VDD internally through about 10K resistor	When SIM_VDD=3V VILmax=0.4V VIHmin=0.7*SIM_VDD VOHmin=0.8*SIM_VDD VOLmax=0.4V When SIM_VDD=1.8V VILmax=0.2* SIM_VDD VIHmin=0.7*SIM_VDD VOHmin=0.9*SIM_VDD VOLmax=0.2* SIM_VDD	
SIM_CLK	O	SIM clock		
SIM_RST	O	SIM reset		
SIM_ PRESENCE	I	SIM card detection. Pulled down internally.	VILmax=0.67V VIHmin=1.7V VIHmax=VDD_EXT+0.3	If SIM_ PRESENCE goes from low to high, the module would execute a SIM card initialization process. If unused, keep this pin open.
SIM_GND		Digital Ground of SIM Card		This pin is internally connected to GND and dedicated for SIM Card ground.
External Interrupt				
PIN NAME	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
EINT0	I	External interrupt 0	VILmin=0V VILmax=0.67V VIHmin=1.7V	Pulled up to VDD_EXT internally. If
EINT1	I	External interrupt 1		

			VIHmax= VDD_EXT+0.3	unused, keep these pins open.
AUXADC				
PIN NAME	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
ADC0	I	ADC input	Voltage range: 0V to 2.8V	If unused, keep these pins open.
ADC1	I			
Camera Interface				
PIN NAME	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
CS_D0	I	YUV video data	VILmin=-0.3V VILmax=0.8V VIHmin=2.0V VIHmax=3.3V+0.3	Camera interface is dedicated for camera module. If unused, keep these pins open.
CS_D1				
CS_D2				
CS_D3				
CS_D4				
CS_D5				
CS_D6				
CS_D7				
CS_HSYNC	I	Horizontal synchronizing	VILmin=-0.3V VILmax=0.8V VIHmin=2.0V VIHmax=3.6V VOLmin=GND VOLmax=0.4V VOHmin=2.4V VOHmax= 2.8V+0.1	
CS_VSYNC	I	Vertical synchronizing		
CS_PIXCLK	I	Pixel clock output		
CS_RESET	O	Reset for camera		
CS_SCL	O	Serial interface clock		
CS_PWDN	O	Power down mode control		
CS_SDA	I/O	Serial interface data		
CS_ECLK	O	Clock output		

3.2 Operating Modes

The table below briefly summarizes the various operating modes that the module supports.

Table 6: Overview of operating modes

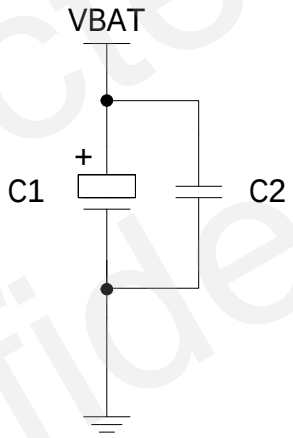
GSM/GPRS part	**Function**	
Normal operation	GSM/GPRS SLEEP	The module will automatically enter SLEEP mode if DTR1 is set to high level when the slow clocking mode is enabled by setting “AT+QSCLK=1” and there is no other task under execution. In this case, the current consumption of module will be reduced to very low level. During SLEEP mode, the module can still receive paging message for voice or SMS from GSM system.
	GSM IDLE	Software is active and the main controller is always running. The module has registered to GSM network thus it can receive

		paging message from network or send request to network.
	GSM TALK	GSM connection is going. 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 going on. 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 shut-down by sending the "AT+QPOWD=1" command, or by using the ON/OFF pin. Emergency shut-down by using the EMERG_OFF[1)] pin. The power supply to the base band part of the module will be turned off, and only the power supply for the RTC is remained. The serial interfaces are not accessible.	
Minimum functionality mode	The "AT+CFUN=0" command can be used to set the module to the minimum functionality mode without removing the power supply. In this mode, both the RF part and SIM card are closed while the serial interface is still accessible. If the slow clocking mode is enabled by "AT+QSCLK=1", the power consumption would be less than 1.4mA.	
Alarm mode	RTC alert function wakes up the module from POWER DOWN mode. The module doesn't attempt to register to GSM network and only part of AT commands can be available. The module would return to POWER DOWN mode if failing to issuing "AT+CFUN=1" within 90 seconds after wakeup.	
GPU part	**Function**	
Camera on mode	Standby	After M33 starts up, send "AT+QCAMON" command to the module to turn on the GPU. Then the GPU will receive continuous video stream from the camera sensor if camera is working properly. In this case, the GPU is not doing JPEG compression. Sending "AT+QCAMSOT" or "AT+QCAMMSOT" or "AT+QCAMAVI" will drive the GPU into Capture mode.
	Capture	After receiving "AT+QCAMSOT" or "AT+QCAMMSOT" or "AT+QCAMAVI", the GPU will capture image from camera sensor. Then encode the raw image into JPEG format and store into SRAM, FLASH or SD card memory.
Camera off mode	Send "AT+QCAMOFF" to turn off the GPU.	

[1] Use the EMERG_OFF pin only while failing to turn off the module by the command "AT+QPOWD=1" or the ON/OFF pin. Please refer to Chapter 3.4.2.4.

3.3 Power Supply

The power supply of the module is from a single voltage source of VBAT= 3.4V ~ 4.5V. The GSM transmitting burst can cause obvious voltage drop at the supply voltage thus the power supply must be carefully designed and is capable of providing sufficient current up to 2A. For the VBAT input, a bypass capacitor of about 100 μF with low ESR is recommended. Multi-layer ceramic chip (MLCC) capacitor can provide the best combination of low ESR and small size but may not be economical. A lower cost choice could be a 100 μF tantalum capacitor with low ESR. A small (0.1μF to 1μF) ceramic capacitor should be in parallel with the 100μF capacitor, which is illustrated in Figure 2. The capacitors should be placed as close as possible to the M33 VBAT pins.



C1=100μF, C2=0.1μF~1μF

Figure 2: Reference bypass capacitors for the VBAT input

The circuit design of the power supply for the module largely depends on the power source. Figure 3 shows a reference design of +5V input power source. The designed output for the power supply is 4.16V, thus a linear regulator can be used. If there's a big voltage difference between the input source and the desired output (VBAT), a switching converter power supply would be preferable for its better efficiency especially with the 2A peak current in burst mode of the module.

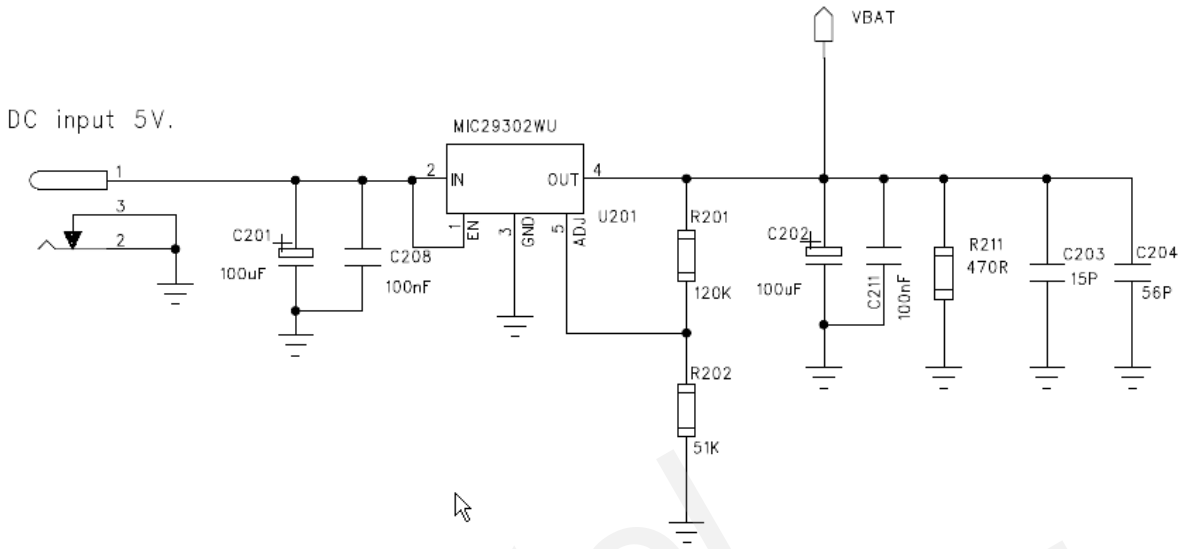


Figure 3: Reference circuit of the source power supply input

When the power supply for the module can't provide current of 2A, proper bigger capacitor is required so as to supply for the current demand during the burst transmission period. Reference capacitors for corresponding limited current supply are listed in Table 7.

Table 7: Recommended bypass capacitors for limited current supply

Maximum current output of power supply	Capacitance	ESR@ +25°C 100KHz (Ω)	Part number	Quantity of application	Vendor
1.5A	1500μF	<=0.045	592D158X06R3R2T20H	1	VISHAY
1A	2200μF	<=0.055	592D228X06R3X2T20H	2	VISHAY

The single 3.6V Li-Ion or Lithium Polymer battery type can be connected to the power supply of the module VBAT directly. The Ni_Cd or Ni_MH battery must be used carefully because their maximum voltage could rise over the absolute maximum voltage for the module and damage it.

A suitable way to charge battery in M2M application is to use an external charging circuit which can charge the battery and put it into idle mode after fully charged. The VBAT is supplied by external power source instead of the battery, but when the external power source is cut off the battery will supply to the VBAT immediately. A reference block diagram for this design is shown in Figure 4.

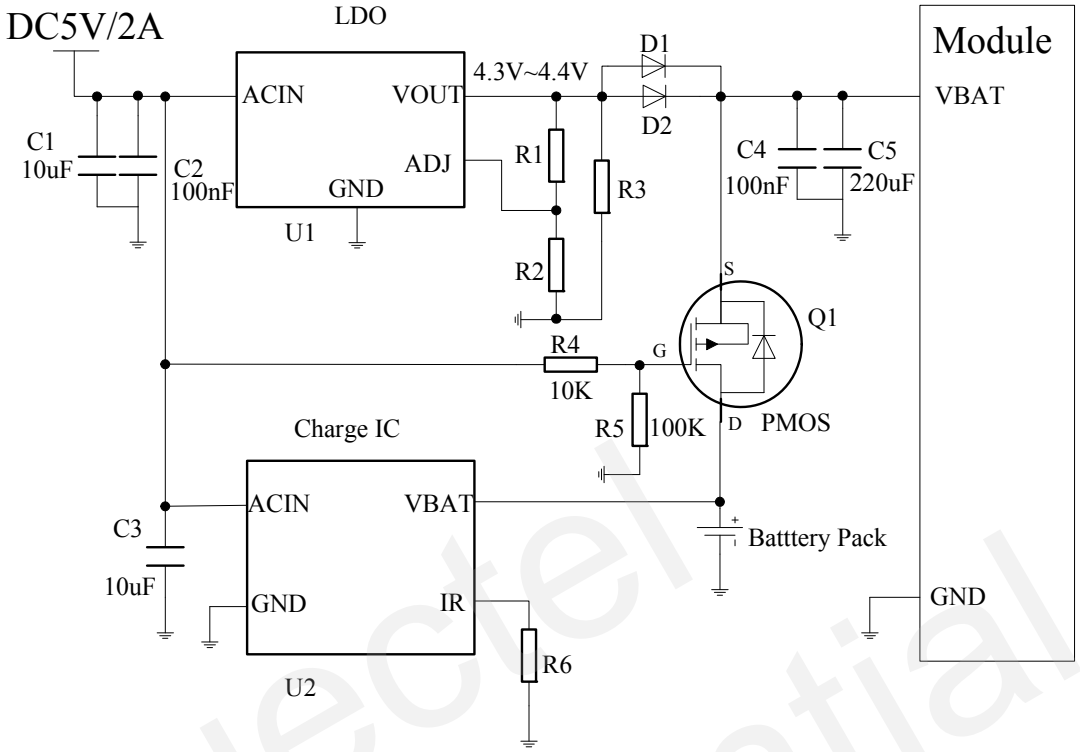


Figure 4: Reference external battery charging circuit

Figure 4 shows the reference battery charging circuit for M2M application. U1 is an LDO which can supply current more than 2A and can output a voltage of 4.3~4.4V through adjusting the resistance of R1 and R2. R3 is the minimum load whose value can usually be found in the datasheet of U1. Both D1 and D2 are Schottky barrier diodes, which is capable of forward current more than 1.5A and has low forward voltage drop and fast switching feature. Q1 is a P-channel MOSFET which acts as a switch between battery supply and external power supply. When the external power supply is present, Q1 is cut off and the module is powered by external supply. Otherwise, Q1 is turned on and the module is supplied by the battery. The Q1 P-channel MOSFET must be able to supply continuous drain current bigger than 2A. Moreover, on-resistance of Drain-to-Source should be as small as possible which means lower thermal power dissipation and voltage drop. U2 is a charging IC, which should be chosen according to the requirements of the application. Since the module is powered by external supply during most of the time in common application, charging current of more than 100mA would be enough. Furthermore, the external 5V DC power supply should be capable of supplying current more than the total sum of maximum charging current and maximum module load current, which is happened in GPRS multi-slot transmission at highest power control level in GSM900MHz or GSM850MHz band.

The RF Power Amplifier current (1.7A peak in GSM/GPRS mode) flows with a ratio of 1/8 of time, around 577us every 4.615ms, in talking mode. Figure 5 shows the VBAT voltage drop and current ripple at the maximum power transmitting phase, while the test conditions are VBAT=4.0V, the maximum output current of VBAT source=2A, C1=100μF tantalum capacitor (ESR=0.7Ω) and C2=1μF.

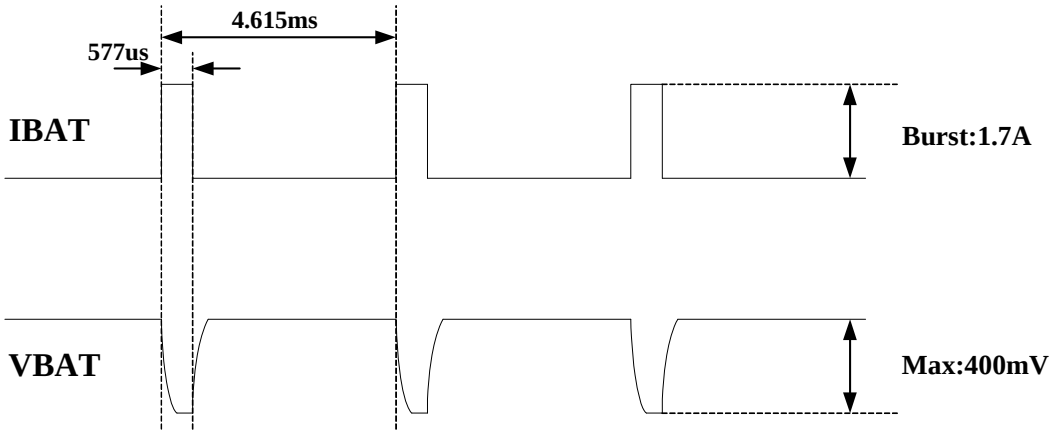


Figure 5: Ripple in supply voltage during transmitting burst

3.3.1 Power Supply Pins

The VBAT pins are dedicated to connect the supply voltage; and the GND pins are for grounding. VRTC pin can be used to connect a rechargeable coin battery or a golden capacitor which can help to maintain the system clock when VBAT supply is not applied.

3.3.2 Minimizing Supply Voltage Drop

Please pay special attention to the power supply design for your applications. Please make sure that the input voltage will never drop below 3.4V even in a transmitting burst during which the current consumption may rise up to 1.7A. If the power voltage drops below 3.4V, the module will turn off **automatically**. The PCB traces from the VBAT pads to the power source must be wide enough to ensure that there isn't too much voltage drop occur in the transmitting burst mode. The width of trace should be **no less than 2mm** and the principle of the VBAT trace is the longer, the wider. The VBAT voltage can be measured by oscilloscope.

3.3.3 Monitoring Power Supply

To monitor the supply voltage, customer can use the "AT+CBC" command which include 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 continuously measured at an interval depending on the operating mode. The displayed voltage (mV) is averaged over the last measuring period before the "AT+CBC" command is executed.
For details please refer to *document [1]*.

3.4 Power On and Power Down Scenarios

3.4.1 Power On

The module can be turned on by various ways, which are described in the following chapters:

- Via the ON/OFF pin: start normal operation mode
- Via RTC interrupt: start ALARM mode

Note: The module is set to autobauding mode (AT+IPR=0) in default configuration. In the autobauding mode, the URC "RDY" is not sent to host controller after powering on. AT command can be sent to the module 2-3 seconds after the module is powered on. Host controller should first 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 module. Then an "AT+IPR=x;&W" should be sent to set a fixed baud rate for module and save the configuration to flash memory of module. After these configurations, the URC "RDY" would be received from the Serial Port of module every time when the module is powered on. Refer to Chapter "AT+IPR" in document [1].

3.4.1.1 Power On Module Using the ON/OFF Pin

Customer's application can turn on the module by driving the pin ON/OFF to a high level voltage for some time and then release it. A GPIO control pin from host board is suggested to directly connect to the ON/OFF pin. A simple reference circuit is illustrated in Figure 6.

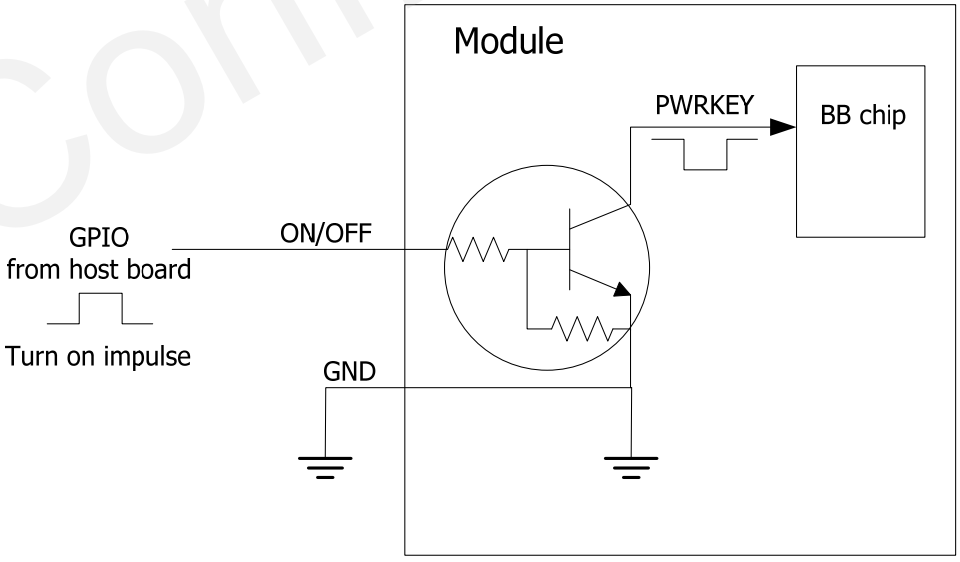


Figure 6: Turn on the module by GPIO

The other way to control the ON/OFF pin is using a button directly. A TVS component is indispensable to be placed near the button for ESD protection. When pressing the key, electrostatic strike may generate from finger. A reference circuit is showed in Figure 7.

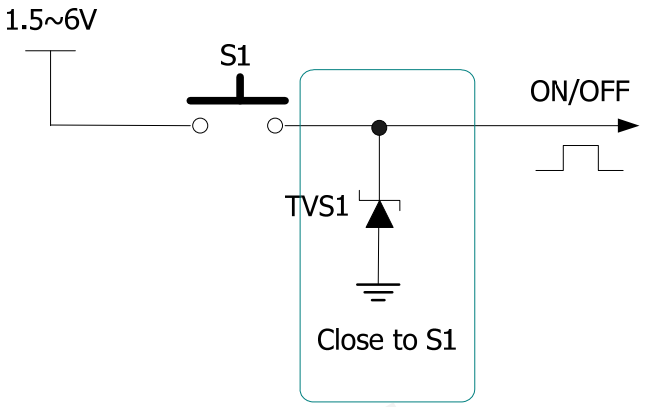


Figure 7: Turn on the module by using button

The power-on scenario is illustrated as in Figure 8.

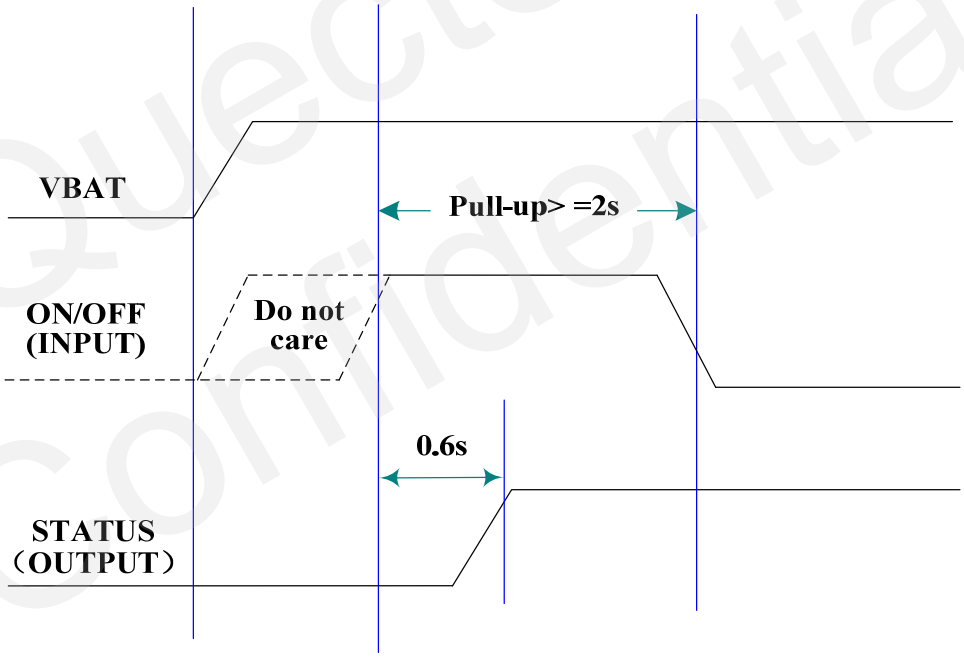


Figure 8: Timing of turn on the module

Note: Customer can connect the STATUS pin to a GPIO of DTE and monitor its voltage level to judge whether module is really start-up or not. After the STATUS pin outputs high level, the ON/OFF pin may be released. Another way without the necessity of monitoring the STATUS pin is to control ON/OFF to high level for more than 2 seconds.

3.4.1.2 Power On Module Using the RTC (Alarm Mode)

Alarm mode is a power-on approach by using the RTC. The alert function of RTC can wake-up the module while it is in power-off state. In alarm mode, the module will not register to GSM network and the GSM protocol stack software is closed. Thus the part of AT commands related

with SIM card and the protocol stack will not be accessible, while the others can be used.

Use the "AT+QALARM" command to set the alarm time. The RTC remains the alarm time if the module is powered off by "AT+QPOWD=1" or by ON/OFF pin. Once the alarm time is expired, the module will go into the alarm mode. In this case, the module will send out an Unsolicited Result Code (URC) when the baud rate of the serial port is set to be fixed.

RDY

ALARM MODE

+CFUN:0

Note: This result code does not appear when autobauding is active because a valid baud rate is not available immediately after powering up the module. Therefore, the module is recommended to set to a fixed baud rate.

During alarm mode, use "AT+CFUN" command to query the status of software protocol stack; it will return 0 which indicates that the protocol stack is closed. After 90 seconds, the module will power down automatically. However, if the GSM protocol stack is started by "AT+CFUN=1" command during the alarm mode, the process of automatic power-off will not be executed. In alarm mode, driving the ON/OFF pin to a high level voltage for a period will cause the module to power down (Please refer to the Chapter 3.4.2).

Table 8 briefly summarizes the AT commands that are frequently used during alarm mode, for details of these instructions please refer to *document [1]*:

Table 8: AT commands used in alarm mode

AT command	Function
AT+QALARM	Set alarm time
AT+CCLK	Set data and time of RTC
AT+QPOWD	Power down the module
AT+CFUN	Start or close the protocol stack

3.4.2 Power Down

The following procedures can turn off the module:

- Normal power down procedure: Turn off module using the ON/OFF 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 ON/OFF Pin

Customer's application can turn off the module by driving the ON/OFF to a high level voltage for certain time. The power-down scenario is illustrated as in Figure 9.

The power-down procedure causes the module logoff from the network and allow the software 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 to a fixed baud rate.

After this moment, AT command cannot 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 the STATUS pin, which will become a low level voltage in this mode.

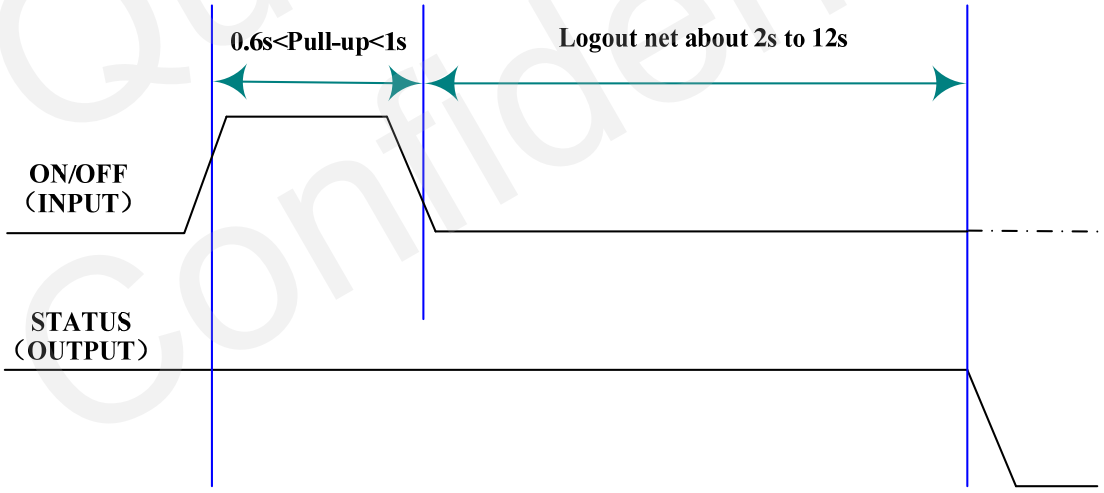


Figure 9: Timing of turn off the module

3.4.2.2 Power Down Module Using AT Command

Customer's application can use an AT command "AT+QPOWD=1" to turn off the module. This command will let the module to log off from the network and allow the software 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 this moment, AT command cannot 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 the STATUS pin, which is a low level voltage in this mode.

Please refer to *document [1]* for detail about the AT command of "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 ≤ 3.5V, the following URC will be presented:

UNDER_VOLTAGE WARNNING

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

OVER_VOLTAGE WARNNING

The uncritical voltage range is 3.4V to 4.6V. If the voltage > 4.6V or < 3.4V, the module would automatically shutdown itself.

If the voltage < 3.4V, the following URC will be presented:

UNDER_VOLTAGE POWER DOWN

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

OVER_VOLTAGE POWER DOWN

Note: These result codes don't 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 this moment, AT command cannot be executed. The module will shut down immediately without logging off from network, but RTC is still active. It can also be indicated by the pin the STATUS pin, which is a low level voltage in this mode.

3.4.2.4 Emergency Shutdown

The module can be shut down by driving the pin EMERG_OFF to a low level voltage for over 20ms and then release it. The EMERG_OFF pin can be driven by an Open Drain/Collector driver or a button. The circuit is illustrated as the following figures.

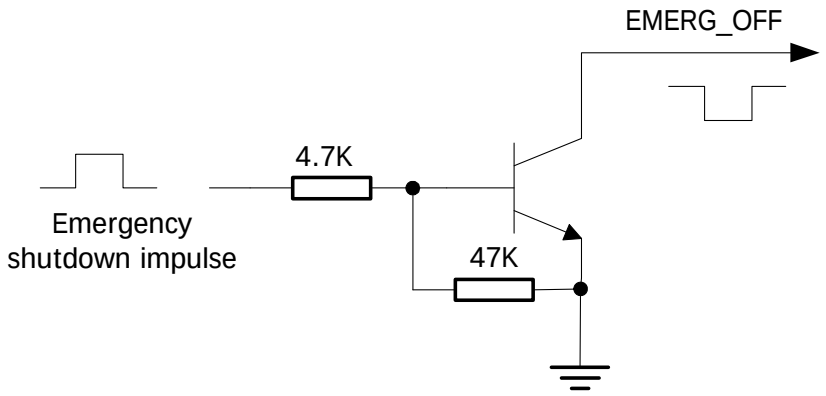


Figure 10: Reference circuit for EMERG_OFF by using driving circuit

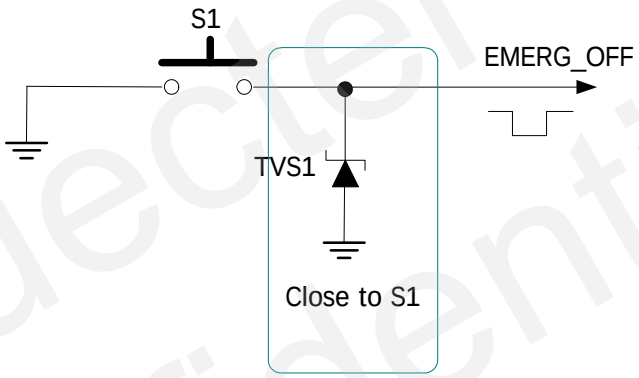


Figure 11: Reference circuit for EMERG_OFF by using button

Be cautious to use the EMERG_OFF pin. It should only be used under emergent situation. For instance, when the module is unresponsive or abnormal, the EMERG_OFF pin can be used to shutdown the system. Although turning off the module by EMERG_OFF has been fully tested and nothing wrong detected, this operation is still a big risk as it could cause destroying of the code or data area of the NOR flash memory in the module. Therefore, it is strongly recommended that the ON/OFF pin or the AT command should always be the preferential way to turn off the system.

3.4.3 Restart Module Using the ON/OFF Pin

Customer's application can restart the module by driving the ON/OFF pin to a high level voltage for certain time, which is similar to the way to turn on module. Before restarting the module, at least 500ms should be delayed after detecting the low level of the STATUS pin. The restart scenario is illustrated as the following figure.

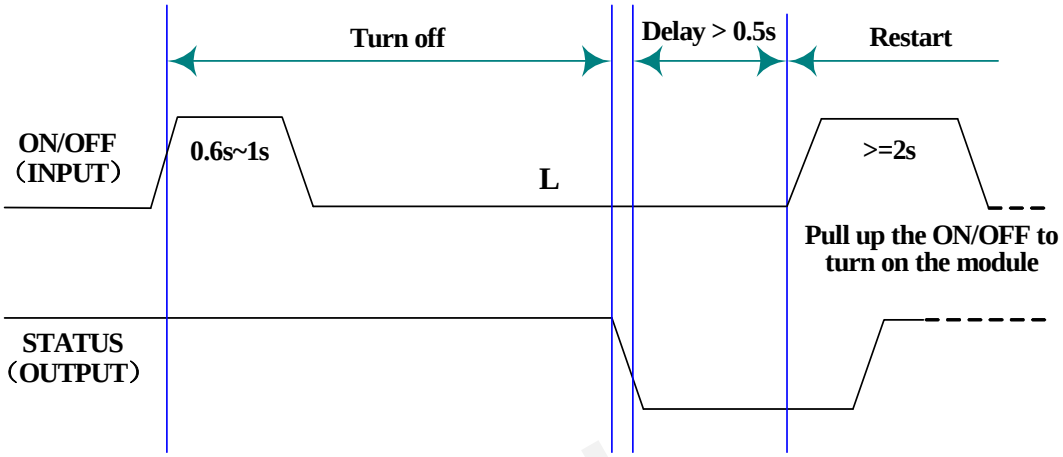


Figure 12: Timing of restart the system

The module can be restarted by the ON/OFF pin after emergency shutdown.

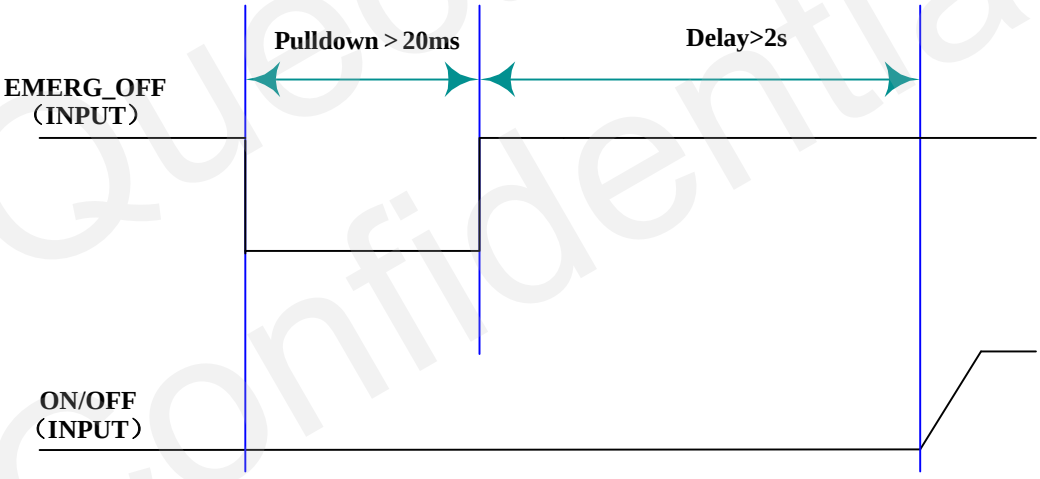


Figure 13: Timing of restart the system after emergency shutdown

3.5 Charging Interface

The module has OPTIONALLY integrated a charging circuit for rechargeable Li-Ion or Lithium Polymer battery, which makes it very convenient for application to manage its battery charging.

A common connection is shown in Figure 14.

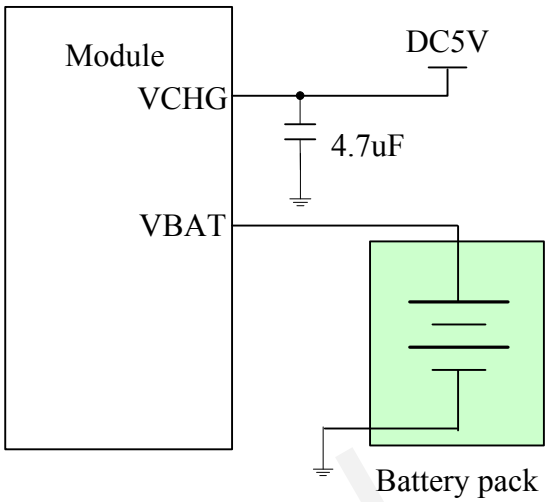


Figure 14: Charging circuit connection

The charging function is not supported in standard M33 module. If customer needs this function, it would be necessary to contact Quectel. Furthermore, when battery charging is done by the charging function supported by the module, the VBAT would be mainly supplied by the battery and the external power source is used to charging the battery. In this case, when the battery is charged full, the charging circuit will stop working, but the charging function would be re-activated when the battery voltage drops to certain level. The battery is either in discharging mode or in charging mode, which would significantly shorten its lifetime. Therefore, it should always be cautious to use the internal charging function in M2M application since an external charging circuit described in Figure 4 could be more suitable.

3.5.1 Battery Pack Characteristics

The module has optimized the charging algorithm for the Li-Ion or Lithium Polymer battery that meets the characteristics listed below. To use the module's charging algorithm properly, it is recommended that the battery pack is compliant with these specifications, as it is important for the AT command "AT+CBC" to monitor the voltage of battery properly, otherwise the "AT+CBC" may return incorrect battery capacity value.

- The maximum charging voltage of the Li-Ion battery pack is 4.2V and the capacity is greater than 500mAh.
- The battery pack should have a protection circuit to avoid overcharging, over-discharging and over-current.
- The internal resistance of the battery and the protection circuit should be as low as possible. It is recommended that the internal resistance of battery cell should not exceed 70mΩ and the internal resistance include battery and protection circuit of battery pack should not exceed 130mΩ.
- The battery pack must be protected from reverse pole connection.
- The Li-Ion/Polymer battery charging protection parameter is required as the following table

Table 9: Recommended battery protection circuit parameter

Item	Min.	Typ.	Max.
Over-charge protect threshold.(V)	4.25	4.3	4.35
Released Voltage from Over-charge(V)	4.1		4.2
Over-discharge protect threshold(V)	2.2		2.35
Released Voltage from Over-discharge(V)	2.35	2.4	2.45

3.5.2 Recommended Battery Pack

The following is the specification of the recommended battery pack:

Table 10: Specification of the recommended battery pack

Item	Remark
Product name & type	SCUD Li-Ion, 3.7V, 800mAh
To obtain more information, Please contact :	SCUD (FU JIAN) Electronic CO., LTD.
Normal voltage	3.7V
Capacity	Minimum 800mAh
Charging Voltage	4.20~4.23V
Max Charging Current	1.2C
Max Discharge Current	2C
Charging Method	CC / CV (Constant Current / Constant Voltage)
Internal resistance	≤130mΩ
Over-charge protect threshold.(V)	4.28 ± 0.025
Released Voltage from Over-charge(V)	4.08 ± 0.05
Over-discharge protect threshold(V)	2.3± 0.1
Released Voltage from Over-discharge(V)	2.4± 0.1

3.5.3 Implemented Charging Technique

There are two pins in the connector related with the internal battery charging function: VCHG and VBAT. The VCHG pin is driven by an external voltage, and this pin can be used to detect an external charger supply and provide most charging current to external battery when it is in constant current charging stage. The module VBAT pin is connected directly to external battery positive terminal.

It is very simple to implement battery charging. Just connect the charger to the VCHG pin and connect the battery to the VBAT pin. When the module detects charger supply and battery are both present, battery charging happens. If there is no charger supply or no battery present, the charging function would not be activated.

Normally, there are three main states in whole charging procedure.

- DDLO charging and UVLO charging
- CC (constant current) charging or fast charging
- CV (constant voltage) charging

DDLO charging and UVLO charging:

DDLO (deep discharge lock out) is the state of battery when its voltage is under 2.4V. And UVLO (under voltage lock out) is the state of battery when the battery voltage is less than 3.2V and more than 2.4V. The battery is not suitable for CC or CV charging when its condition is DDLO or UVLO. The module provides a small constant current to the battery when the battery is in DDLO or UVLO. The module provides current of about 15mA to the battery in the DDLO charging stage, and about 55mA to the battery in the UVLO charging stage.

DDLO charging terminates when the battery voltage reaches 2.4V. UVLO charging terminates when the battery voltage is up to 3.2V. Both DDLO and UVLO charging are controlled by the module hardware only.

CC charging:

When an external charger supply and battery have been inserted and the battery voltage is higher than 3.2V, the module enters CC charging stage. CC charging is controlled by the software. In this charging stage, the module provides a constant current (about 550mA) through VBAT pins to the battery until battery voltage reaches to 4.18±0.02V.

CV charging:

After CC charging ends, the module automatically enters constant voltage charging. When the charging current steadily decreases to 50mA in CV charging mode, the module starts a 30 minutes timer. The charging procedure terminates when this timer expires.

Charging hold:

The charging hold state is exclusively. When the charger is applied, a voice call is connected and the battery voltage is above 4.05V, the module would enter Charge Hold state. The charging will pause until the battery voltage falls below 3.8V or the module goes into idle mode.

Note: The module has a maximum charging time threshold, 6 hours. If the battery is not fully charged after 6 hours' constant charging, the module would terminate the charging operation immediately.

The charging process is shown in Figure 15.

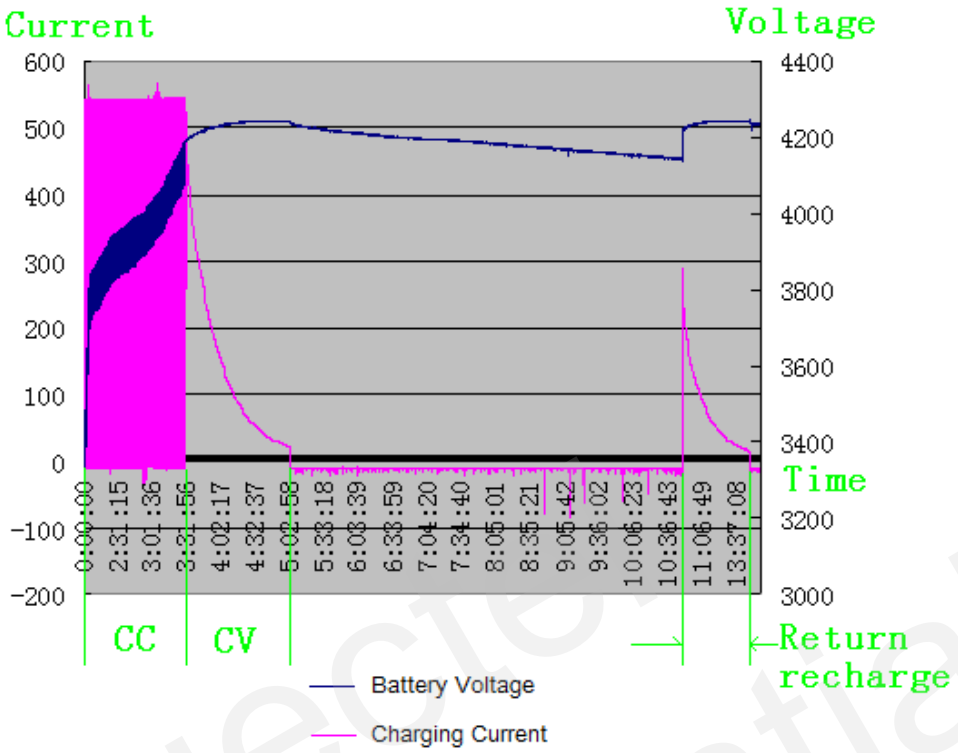


Figure 15: Normal charging process diagram

3.5.4 Operating Modes During Charging

The battery can be charged in various working modes such as SLEEP, TALK and GPRS DATA. It is named as Charging mode.

When a charger is connected to the module's VCHG pin, the battery is connected to the VBAT pin and the module is in POWER DOWN mode, the module enters the GHOST mode (Off and charging). The following table gives the differences between Charging mode and GHOST mode.

Table 11: Operating modes

	How to activate	Features
Charging Mode	Connect charger to the module's VCHG pin after connecting battery to VBAT pin of module and put the module in one of Normal operating modes, including: SLEEP, IDLE, TALK, GPRS STANDBY, GPRS READY and GPRS DATA mode, etc.	The module can normally operate.

GHOST Mode	Connect charger to module's VCHG pin while the module is in POWER DOWN mode. Or power down from Charging mode.	Battery can be charged in GHOST mode. The module is not registered to GSM network. Only a few AT commands are available as listed in Table 12.

When the module is in the GHOST mode, those AT commands listed in Table 12 can be used. For further instruction refer to *document [1]*.

Table 12: AT commands available in the GHOST mode

AT command	Function
AT+QALARM	Set alarm time
AT+CCLK	Set data and time of RTC
AT+QPOWD	Power down the module
AT+CBC	Indicate charging state and voltage
AT+CFUN	Start or close the protocol Send "AT+CFUN=1" to the module will transfer it from GHOST mode to Charging mode.

3.5.5 Charger Requirements

The requirements of a suitable charger to match with the module internal charging function are listed below:

- Output voltage: 4.6V~6.5V，nominal voltage level is 5.0V.
- Charging current limitation: 650mA
- A 10V peak voltage is allowed for maximum 1ms when charging current is switched off.
- A 1.6A peak current is allowed for maximum 1ms when charging current is switched on.

3.6 Power Saving

There are two methods to drive the module to enter low current consumption status. "AT+CFUN" is used to set module into minimum functionality mode and the DTR1 pin can be used to lead system to enter SLEEP mode.

3.6.1 Minimum Functionality Mode

Minimum functionality mode reduces the functionality of the module to minimum level, thus minimizes 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 RF circuits;

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

When the module is set by "AT+CFUN=4", the RF function is closed but the serial port is still active. In this case, all AT commands associated with RF function will not be accessible.

When 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 *document [1]*.

3.6.2 SLEEP Mode

The SLEEP mode is disabled in default software configuration. Customer's application can enable this mode by "AT+QSCLK=1". In another word, the module can't enter SLEEP mode with the default setting "AT+QSCLK=0".

When "AT+QSCLK=1" is set to the module, customer's application can control the module to enter or exit from the SLEEP mode through the DTR1 pin. When DTR1 is set to high level and the controller of the module is in idle mode, the module will enter SLEEP mode automatically. In this mode, the module can still receive voice, SMS or GPRS paging from network but the serial port is not accessible.

3.6.3 Wake Up Module from the SLEEP Mode

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

- DTR1 pin
  If the DTR1 pin is pulled down to a low level, it would wake up the module from SLEEP mode. The serial port will be activated in about 20ms after DTR1 be changed to low level.
- Receiving a voice or data call from network will wake up the module.
- Receiving a SMS from network will wake up the module.
- RTC alarm can wake up the module.

Note: The DTR1 pin should be held low level during communicating between the module and DTE.

3.7 Summary of State Transition (Except SLEEP Mode)

Table 13: Summary of state transition

Current mode	Next mode		
	POWER DOWN	**Normal mode**	**Alarm mode**
POWER DOWN		Use the ON/OFF pin	Turn on the module by RTC alarm
Normal mode	AT+QPOWD, use the ON/OFF pin, or use EMERG_OFF pin		Set alarm by "AT+QALARM", and then turn off the module. When the timer expires, the module turns on automatically and enters Alarm mode.
Alarm mode	Use the ON/OFF pin or wait for module turning off automatically	Use "AT+CFUN=1"	

3.8 RTC Backup

The RTC (Real Time Clock) can be supplied by an external capacitor or battery (rechargeable or non-chargeable) through the VRTC pin. A 3.9 K resistor is integrated in the module for current limiting. A coin-cell battery or a super capacitor can be used to backup power supply for RTC.

The following figures show various sample circuits for RTC backup.

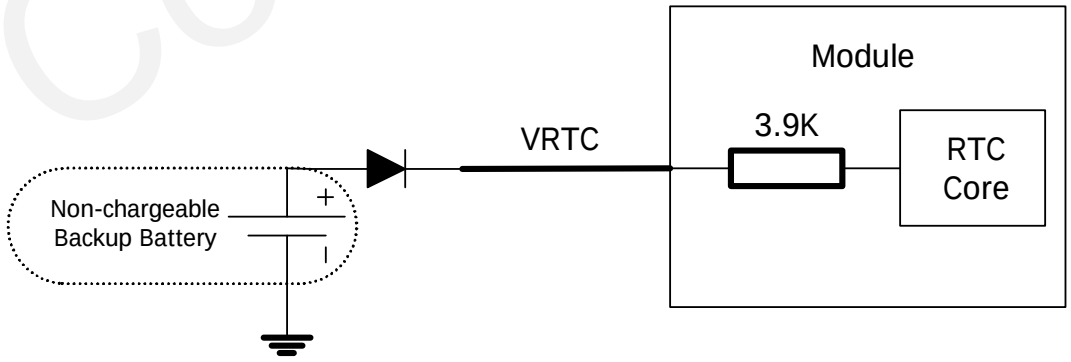


Figure 16: RTC supply from non-chargeable battery

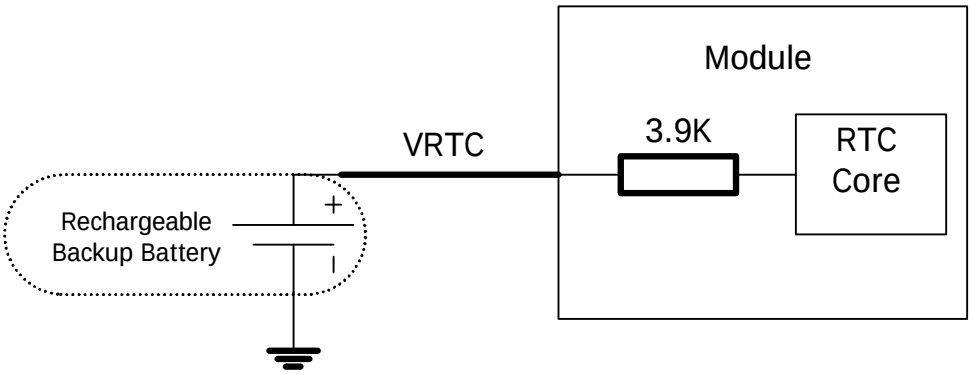


Figure 17: RTC supply from rechargeable battery

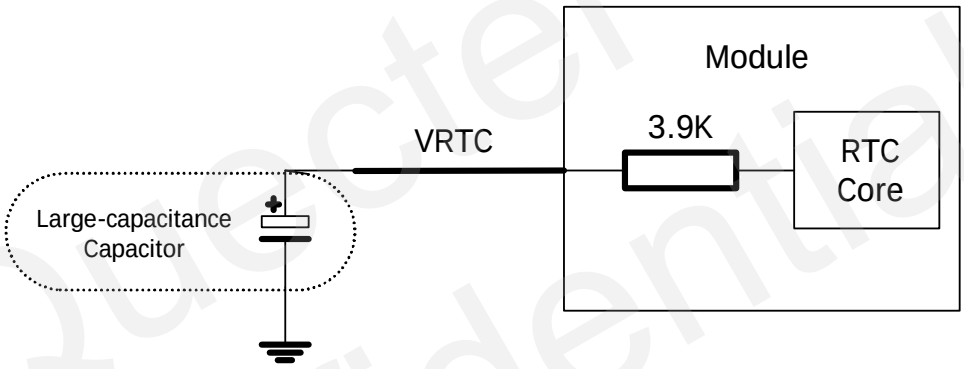


Figure 18: RTC supply from capacitor

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

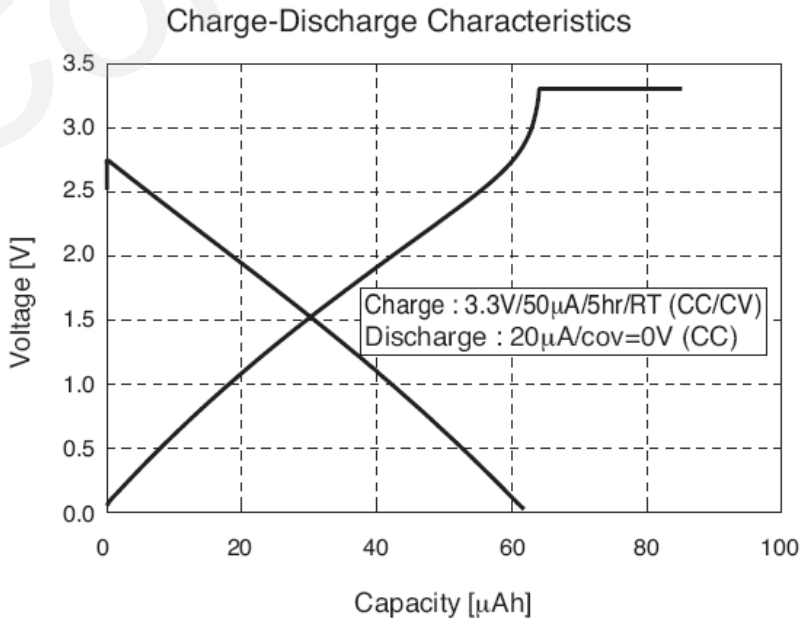


Figure 19: Seiko XH414H-IV01E charging characteristic

3.9 Serial Interface

3.9.1 Asynchronous Serial Interface

The module provides three unbalanced asynchronous serial ports, Serial Port 1, Serial Port 2 and Serial Port 3. The module is designed as a DCE (Data Communication Equipment), following the traditional DCE-DTE (Data Terminal Equipment) connection. The module and DTE can be connected as shown in Figure 20.

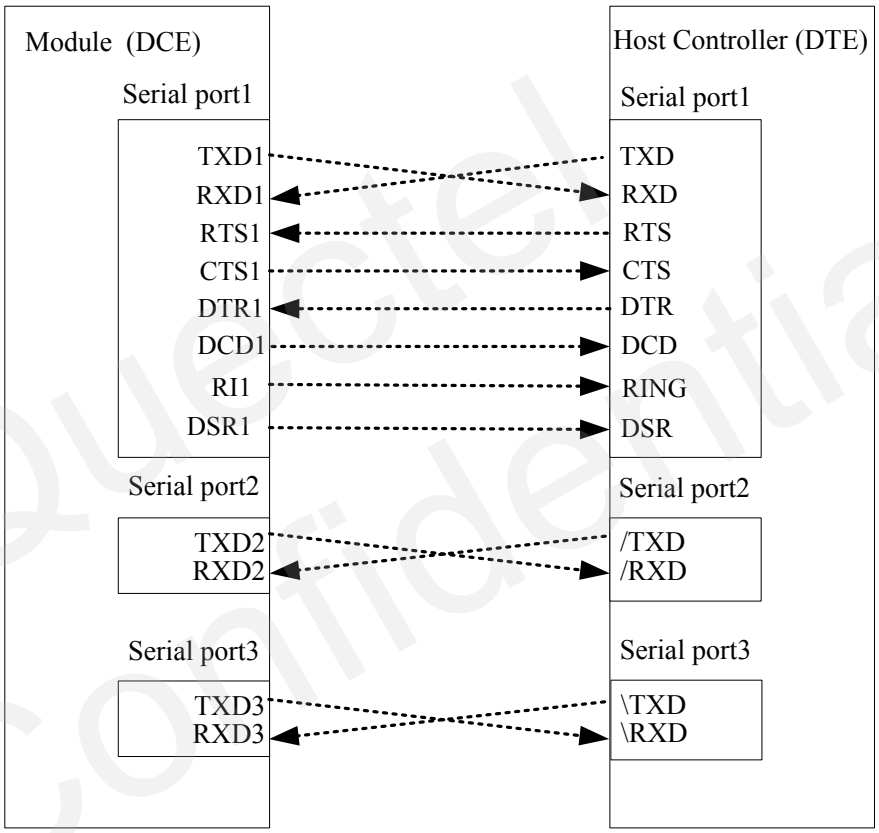


Figure 20: Connection of serial interfaces

Serial Port 1

- TXD1: Send data to the RXD signal line of DTE
- RXD1: Receive data from the TXD signal line of DTE

When hardware flow control is required, RTS1 and CTS1 should also be connected. The module supports hardware flow control in default. When the module is used as a modem, DCD1 and RI1 should be connected. Furthermore, RI1 could indicate host controller when an event happens such as an incoming voice call, a URC data report.

Serial Port 2

- TXD2: Send data to the /RXD signal line of DTE
- RXD2: Receive data from the /TXD signal line of DTE

Serial Port 3

- TXD3: Send data to the \RXD signal line of DTE
- RXD3: Receive data from the \TXD signal line of DTE

The logic levels are described in the following table.

Table 14: Logic levels of serial port

Parameter	Min	Max	Unit
V_{IL}	0	0.67	V
V_{IH}	1.67	VDD_EXT +0.3	V
V_{OL}	GND	0.34	V
V_{OH}	2.0	VDD_EXT	V

Table 15: Pin definition of serial interface

Interface	Name	Pin	Function
Serial Port 1	RI1	69	Ring indicator
	RTS1	72	Request to send
	CTS1	75	Clear to send
	RXD1	71	Receive data of the Serial Port 1
	TXD1	73	Transmit data of the Serial Port 1
	DTR1	76	Data terminal ready
	DCD1	70	Data carrier detection
	DSR1	74	Data set ready
Serial Port 2	RXD2	31	Receive data of the Serial Port 2
	TXD2	30	Transmit data of the Serial Port 2
Serial Port 3	RXD3	32	Receive data of the Serial Port 3
	TXD3	33	Transmit data of the Serial Port 3

3.9.1.1 Function of Serial Ports

Serial Port 1

- 8 lines on serial interface.
- Contain data lines TXD1 and RXD1, hardware flow control lines RTS1 and CTS1, other control lines DTR1, DCD1, DSR1 and RI1.
- Use for AT command, GPRS data, CSD FAX, TCP/IP, etc. Multiplexing function is supported at Serial Port 1. So far only the basic mode of multiplexing is available.
  Support the communication baud rates as the following:
  75,150,300,600,1200,2400,4800,9600,14400,19200,28800,38400,57600,115200 bps.

The default setting is autobauding mode. Support the following baud rates for autobauding function:
4800, 9600, 19200, 38400, 57600, 115200 bps.

After setting a fixed baud rate or autobauding, please send “AT” string at that rate, the serial port is ready when it responds “OK”. Autobauding is not compatible with multiplex mode.

Autobauding allows the module to automatically detect the baud rate of the string “AT” or “at” sent by host controller, which gives the flexibility to put the module into operation without considering which baud rate is used by host controller. Autobauding is enabled in default. To take advantage of the autobauding mode, special attention should be paid to the following requirements:

Synchronization between DTE and DCE:
When DCE (the module) powers on with autobauding, it is recommended to wait for 2 to 3 seconds before sending “AT” or “at” string. After receiving the “OK” response, DTE and DCE are correctly synchronized.

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

Restrictions on autobauding operation

- The serial port has to be operated at 8 data bits, no parity and 1 stop bit (factory setting).
- The A/ and a/ commands can’t be used.
- Only the string “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 but not synchronized.
- Any other Unsolicited Result Codes will be sent at the previous baud rate before the module detects the new baud rate by receiving “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 problem caused by undetermined baud rate between DCE and DTE, it is strongly recommended to configure a fixed baud rate and save instead of using autobauding after start-up. For more details, please refer to Chapter “AT+IPR” in document [1].

Serial Port 2

- Two data lines: TXD2 and RXD2
- Serial port 2 is used for software debugging only. It cannot be used for AT command, GPRS service, CSD call and FAX call. It doesn’t support multiplexing and autobauding function.
- The baud rate is 460800 bps.

Serial Port 3

- Two data lines: TXD3 and RXD3
- Serial port 3 is used for AT command only, **doesn’t support GPRS data, CSD FAX,**

Multiplexing function, etc.

- Support the communication baud rates as the following:
  75,150,300,600,1200,2400,4800,9600,14400,19200,28800,38400,57600,115200 bps.

The default setting is 115200 bps. Customer can modify the baud rate of Serial Port 3 by "AT+QSEDCB" command. For more details, please refer to *document [1]*.

3.9.1.2 Software Upgrade and Software Debug

The TXD1, RXD1 can be used to upgrade software, while TXD2, RXD2 can be used for software debugging. Customer can insert a switch between the ON/OFF and the power supply. The ON/OFF pin must be pulled up during the software upgrade process. Please refer to the following figures for software upgrade and debugging.

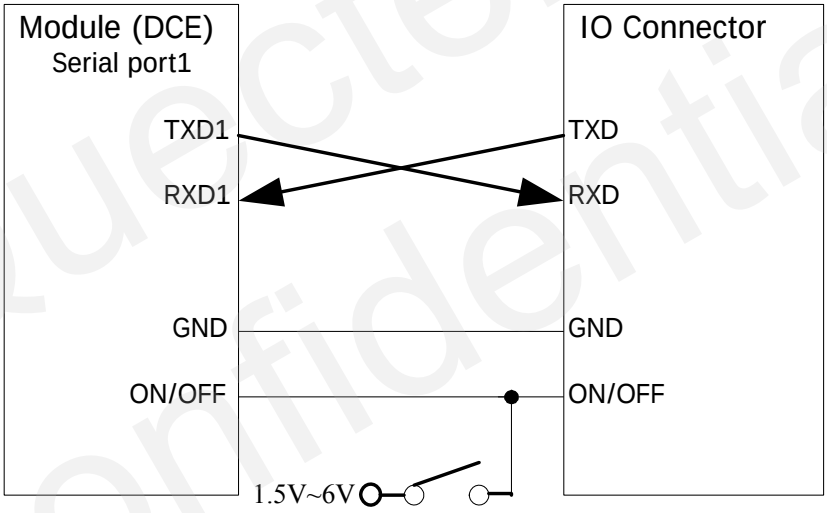


Figure 21: Connection of software upgrade

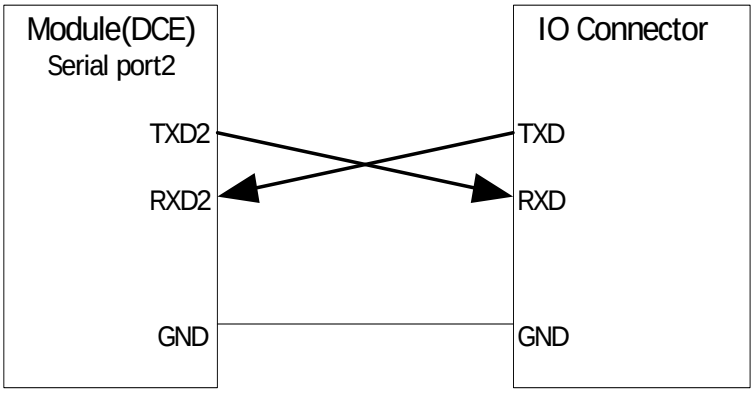


Figure 22: Connection of software debugging

The three serial ports don't support RS-232 level, but only support CMOS level. A level shifter IC or circuit may be inserted between the module and PC. Figure 23 shows a reference level shifter circuit when the module is connected to a PC.

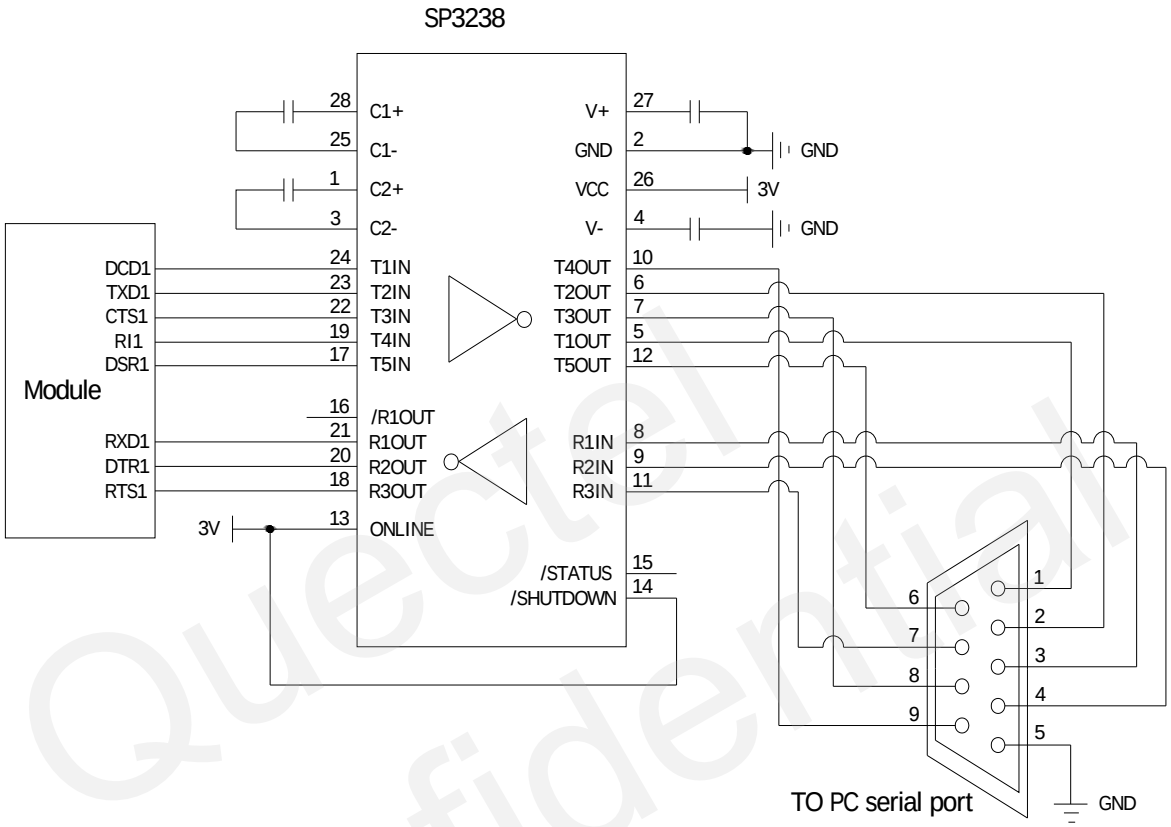


Figure 23: RS-232 level converter circuit

Note：For detailed information about serial port application, please refer to document [10]

3.9.2 Synchronous Serial Interface

The module provides two synchronous serial interfaces, SD and I2C.

3.9.2.1 SD interface

The SD interface is dedicated for accessing SD memory.

Table 16: Pin definition of SD interface

Interface	Name	Pin	I/O	Function
SD	SPI_CS	22	O	Chip select
	SPI_CLK	23	O	Clock
	SPI_I	24	I	Data input
	SPI_O	25	O	Data output

Standard SD card interface has two transmission modes. One is BUS mode, the other is SPI mode. The SD interface of M33 only supports SPI mode, FAT16, FAT32 format and maximum 2GB capacity. Customer may use SD card, mini SD card or micro SD card (T-flash card) to save data. The speed of this SD interface is 350kbps. In SPI mode, all pins must be pulled up to VDD_EXT.

Figure 24 shows the form and pin assignment of SD card. The pin definition in SPI mode is listed in Table 17.

Figure 24: Bottom view of SD card

Table 17: Pin definition of SD card in SPI mode

Pin	Name	I/O	Function
1	CS	I	Chip select
2	DI	I	Data input
3	VSS		GND
4	VCC	I	Supply voltage, 2.7~3.6V
5	CLK	I	Serial clock
6	VSS		GND
7	DO	O	Data output
8	Reserve		Only used for SD mode
9	Reserve		Only used for SD mode

A reference circuit diagram is shown in Figure 25.

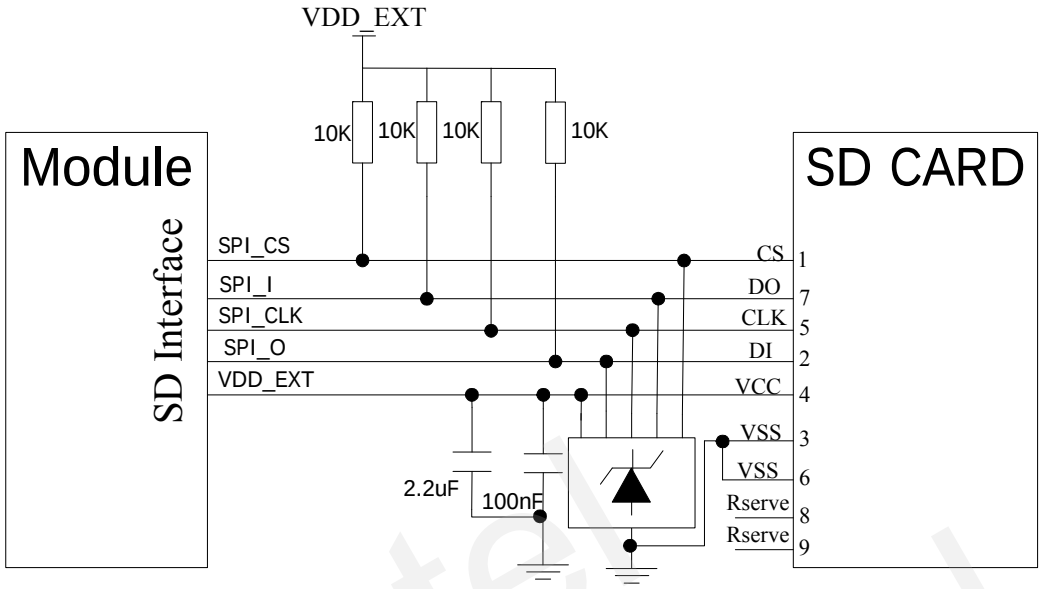


Figure 25: SD card reference circuit in SPI mode

Customer may also use Mini SD card or Micro SD card to implement this function. Table 18 contains the pin assignment of SD card, Mini SD card and Micro SD for SPI mode.

Table 18: Pin assignment of SD family in SPI mode

Pin	SD card	Mini SD card	Micro SD card
1	CS	CS	Reserve
2	DI	DI	CS
3	VSS	VSS	DI
4	VCC	VCC	VCC
5	CLK	CLK	CLK
6	VSS	VSS	VSS
7	DO	DO	DO
8	Reserve	Reserve	Reserve
9	Reserve	Reserve	
10		NC	
11		NC	

3.9.2.2 I2C Interface

The module provides an I2C interface, containing SDA and SCL signal pins.

Table 19: Pin definition of I2C interface

Interface	Name	Pin	I/O	Function
I2C	SCL	44	O	I2C clock
	SDA	46	I/O	Serial data

Note: The I2C function is not provided in default firmware.

3.10 Audio Interfaces

The module provides two audio input channels and two audio output channels and one serial digital audio interface (PCM) in the B2B connector.

- AIN1 and AIN2, which may be used for both microphone and line inputs. An electret microphone is usually used. AIN1 and AIN2 are both differential input channels.
- AOUT1 and AOUT2, which may be used for both receiver and speaker outputs. AOUT1 channel is typically used with a receiver built into a handset, while AOUT2 channel is typically used with headset or hands-free speaker. AOUT1 channel is a differential channel while AOUT2 is a single-ended channel. SPK2P and AGND can establish a pseudo differential mode. If customer needs to play ring of incoming and MIDI music through output channel, please use AOUT2 Channel, because AOUT1 channel can't implement this function.
- These two audio channels can be swapped by "AT+QAUDCH" command. For more details, please refer to *document [1]*.
- 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+QECHO" is to set the parameters for echo cancellation and echo suppression control. "AT+QSIDET" is to set the side-tone gain level. The output volume of incoming call played in AOUT2 can be set by "AT+CRSL".For more details, please refer to *document [1]*.

Note:

Use AT command "AT+QAUDCH" to select audio channel:
0--AIN1/AOUT1 (normal audio channel), the default value is 0.
1--AIN2/AOUT2 (aux_audio channel, use for headset application)
2-- AIN2/AOUT2 (aux_audio channel, use for hands-free application)

Table 20: Pin definition of audio interface

Interface	Name	Pin	Function
(AIN1/AOUT1)	MIC1P	40	Microphone1 input +
	MIC1N	38	Microphone1 input -
	SPK1P	35	Audio1 output +
	SPK1N	37	Audio1 output -
(AIN2/AOUT2)	MIC2P	36	Microphone2 input +
	MIC2N	34	Microphone2 input -
	SPK2P	39	Audio2 output +
	AGND	41	Suggest to be used as the analog ground in external audio circuit. Don't connect it to digital GND of host PCB.

3.10.1 Microphone Interface Configuration

AIN1/AIN2 channels come with internal bias supply for external electret microphone. A reference circuit is shown in Figure 26.

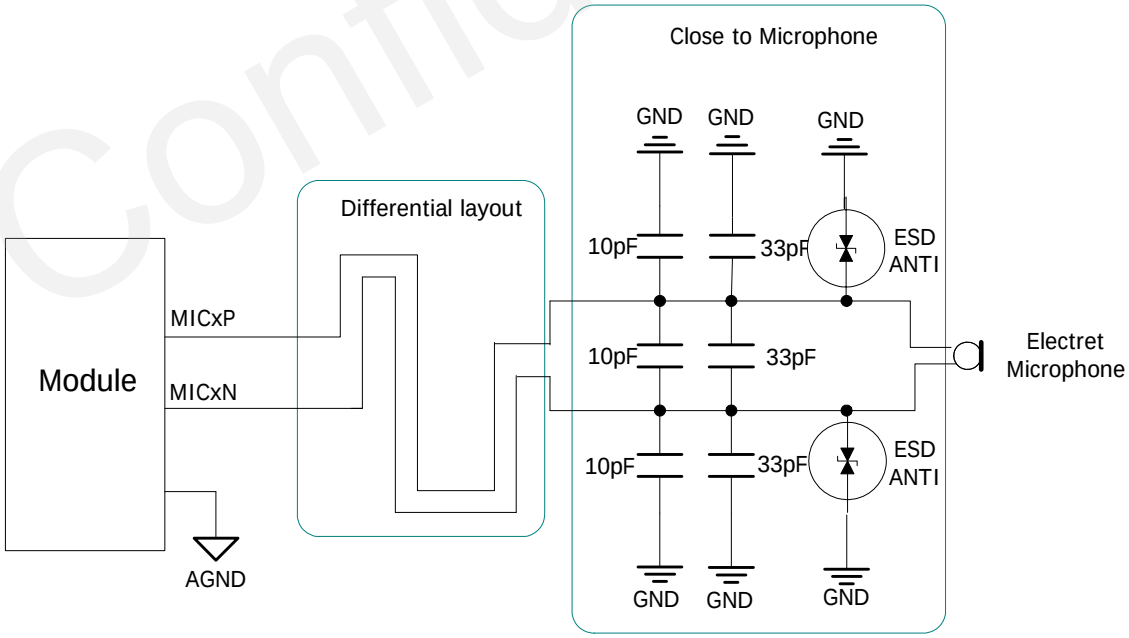


Figure 26: Electret microphone interface configuration of AIN1&AIN2

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 at the

peer party of the voice communication. 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 has to choose the right capacitors by consulting its capacitor vendor or using software tool from capacitor vendor for filtering 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 decide which capacitor to use based on test result. Sometimes, no RF filtering capacitor is required.

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

If AIN1/AIN2 channels are connected to other type of audio signal source instead of electret microphone, for example, an op amp or a moving-coil type microphone, it is recommended to insert two 10μF capacitors for decoupling as shown in Figure 27.

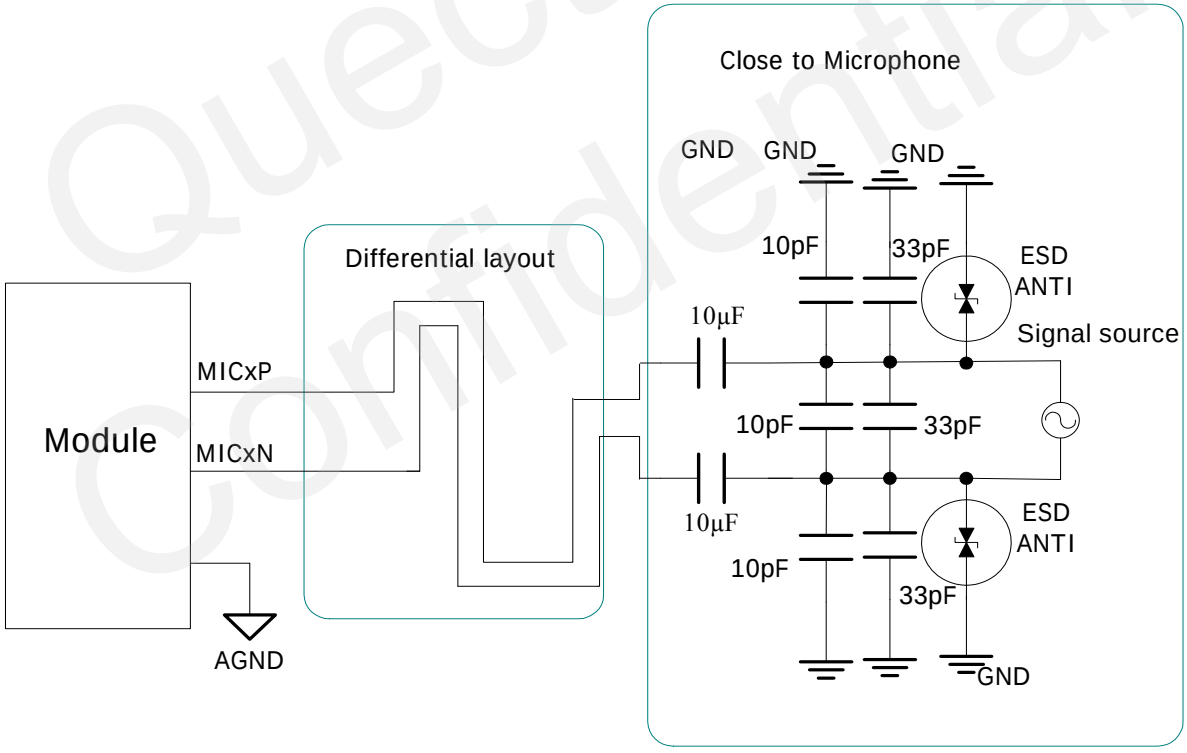


Figure 27: Signal source interface configuration of AIN1/AIN2

3.10.2 Speaker Interface Configuration

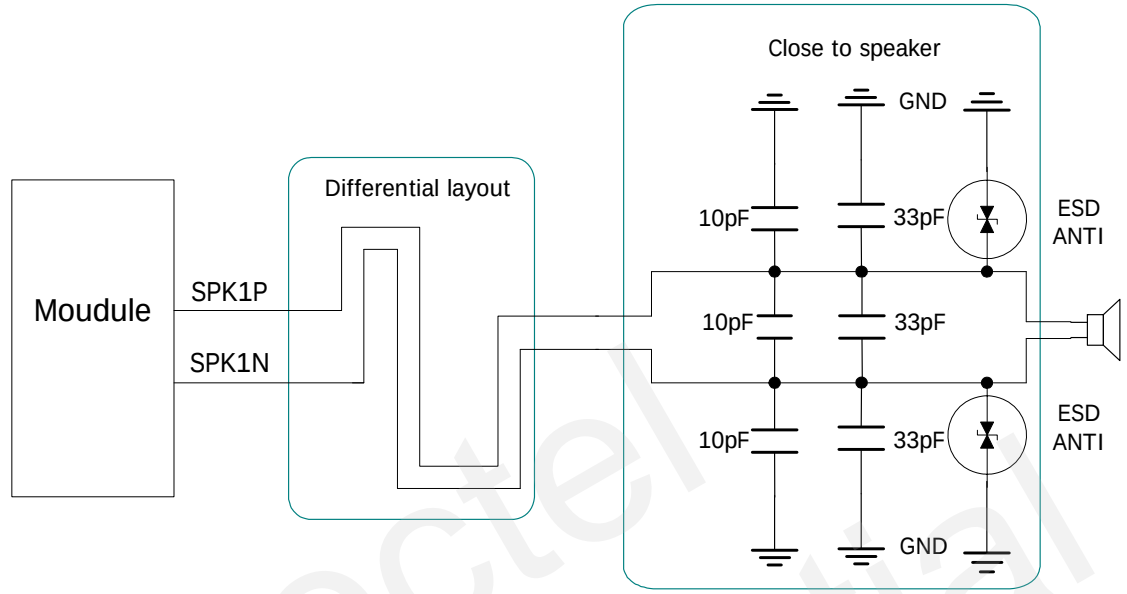


Figure 28: Speaker interface configuration of AOUT1

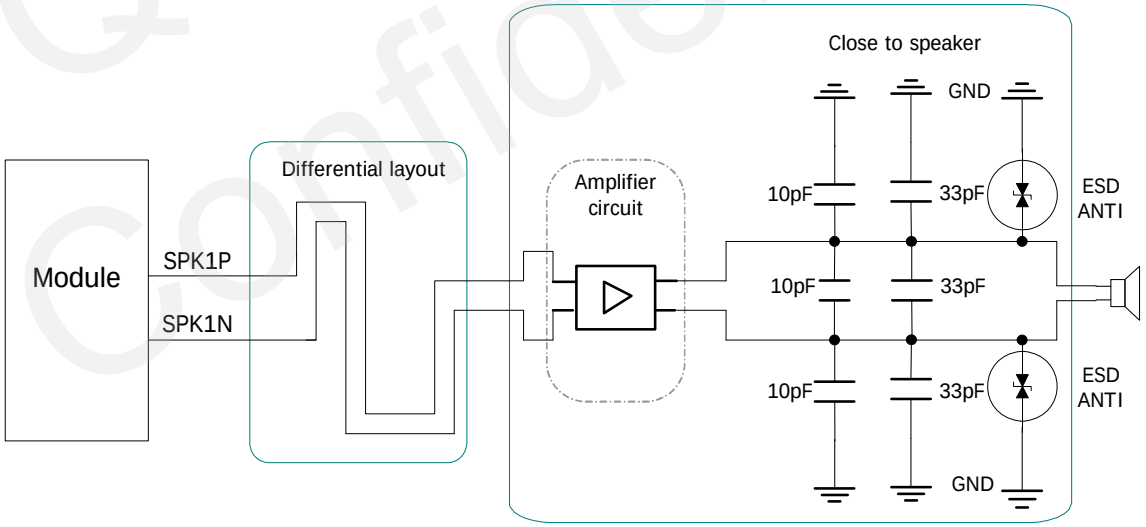


Figure 29: Speaker interface with amplifier in AOUT1

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

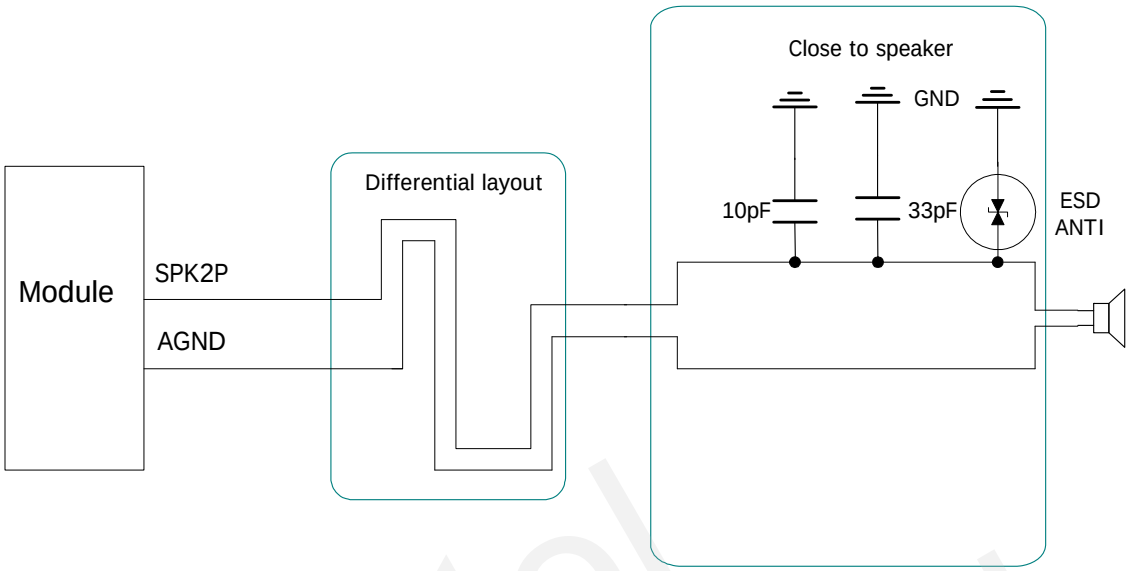


Figure 30: Speaker interface configuration of AOUT2

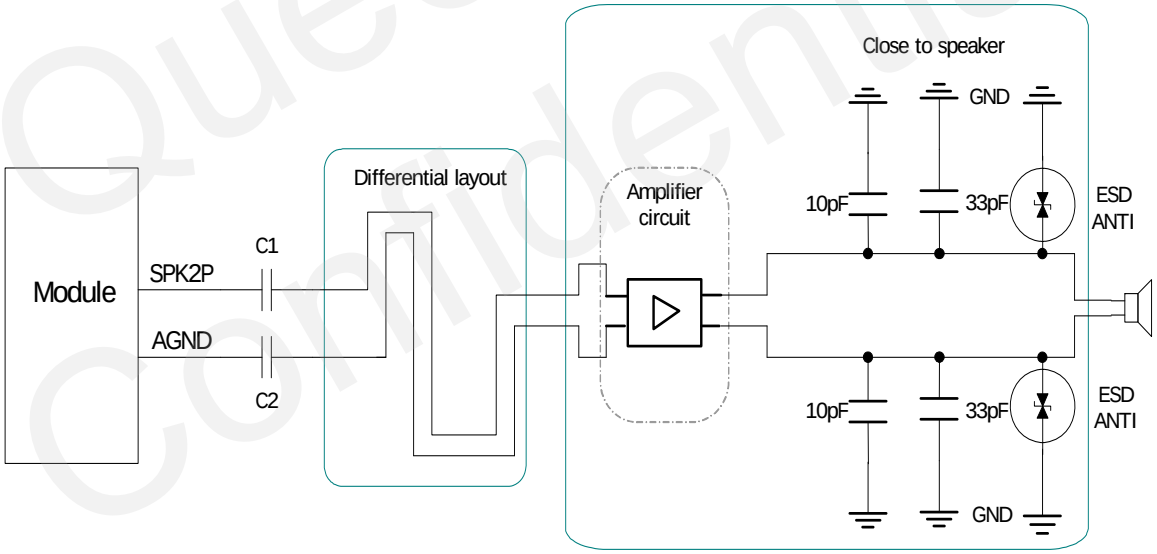


Figure 31: Speaker interface with amplifier in AOUT2

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

3.10.3 Earphone Interface Configuration

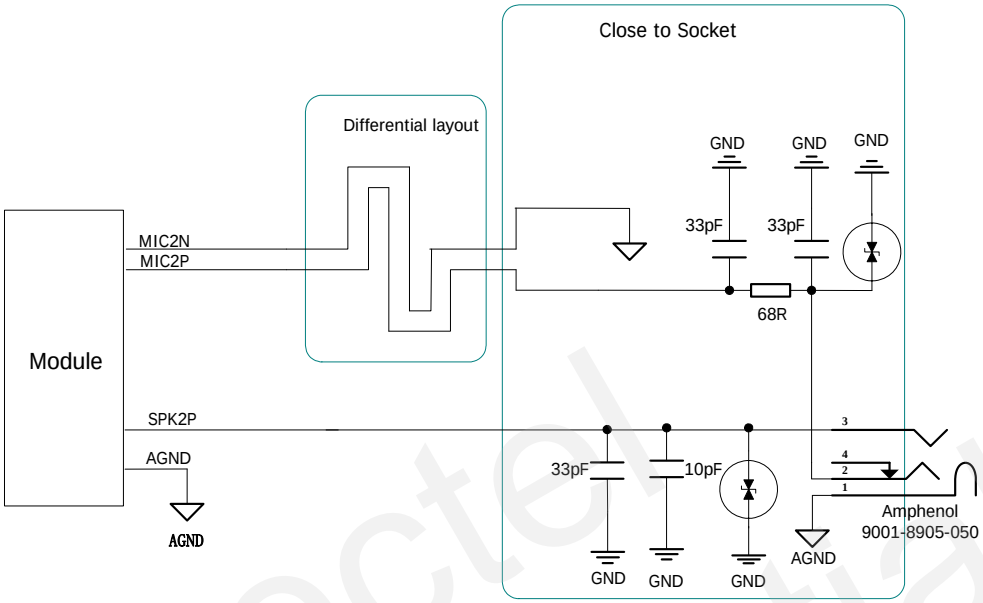


Figure 32: Earphone interface configuration

Table 21: Typical electret microphone input characteristic

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

Table 22: Typical speaker characteristic

Parameter			Min	Typ	Max	Unit
Normal Output(SPK1)	Single Ended	Load resistance	28	32		Ω
		Ref level	0		2.4	Vpp
	Differential	Load resistance	28	32		Ω
		Ref level	0		4.8	Vpp
Auxiliary Output(SPK2)	Single Ended	Load resistance	16	32		Ω
		Ref level	0		2.4	Vpp

Maxim driving current limit of SPK1 and SPK2					50	mA

3.10.4 PCM Interface

The module provides digital audio interface in the B2B connector. This interface can communicate with external digital audio interface, such as BT, CODEC. It only supports master mode and max 32-bit linear data format, and does not support A-law or u-law. Each pin definition of the PCM interface is listed in Table 23.

Table 23: Pin definition of the PCM interface

Interface	Name	Pin	Function
PCM	PCM_IN	26	Receive digital audio signal
	PCM_SYNC	27	Frame synchronization signal
	PCM_OUT	28	Transmit digital audio signal
	PCM_CLK	29	Serial bit clock

The PCM_CLK clock signal is an output, generating a 256KHz bit clock as master. The PCM_SYNC frame sync signal is an output, generating an 8KHz, and both long frame sync and short frame sync are supported. Customer can set long frame or short frame and switch between digital audio interface and analog audio interface by "AT+QPCMCH" command. For more details, please refer to *document [1]*. Figure 33 shows the timing diagram of the PCM interface. Note that the serial data changes when the clock is rising and is latched when the clock is falling.

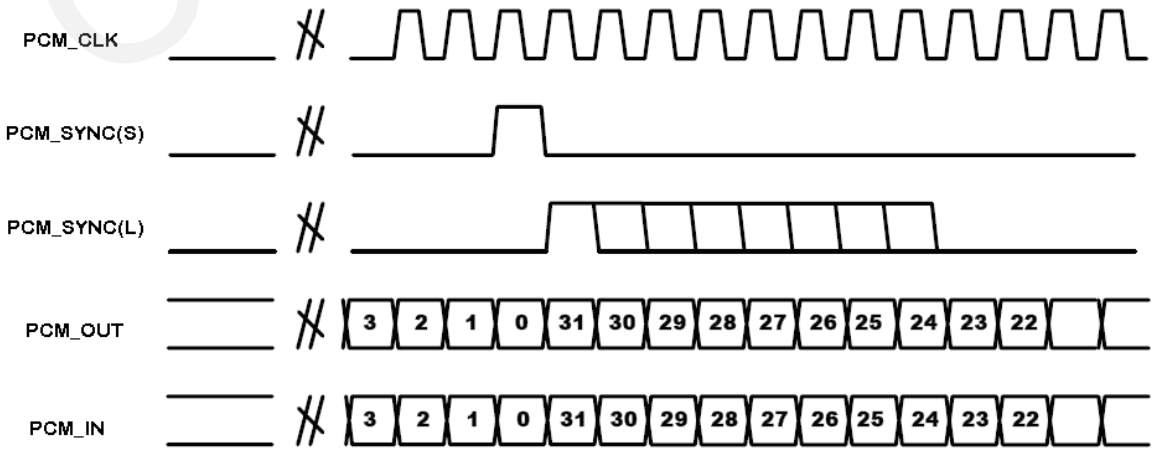


Figure 33: Timing diagram of PCM interface

Note: This function is not supported in the default firmware. If customer needs this function, please contact Quectel for more details.

3.11 SIM Card Interface

3.11.1 SIM Card Application

Customer can get information in SIM card by AT Command. For more information, please refer to *document [1]*.

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.

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

Table 24: Pin definition of the SIM interface

Name	Pin	Function
SIM_VDD	9	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	11	SIM Card Data I/O
SIM_CLK	14	SIM Card Clock
SIM_RST	13	SIM Card Reset
SIM_PRESENCE	12	SIM Card Presence Detection
SIM_GND	96	Digital Ground of SIM Card. Separate ground connection for SIM card to improve EMC.

Figure 34 is the reference circuit for SIM interface, and here an 8-pin SIM card holder is used. In order to offer good ESD protection, it is recommended to add TVS such as ST (www.st.com) ESDA6V1W5 or ON SEMI (www.onsemi.com) SMF05C. The 22Ω resistors should be added in series between the module and SIM card so as to suppress EMI spurious transmission and enhance ESD protection. The SIM card peripheral circuit should be placed as close as possible to the SIM card socket.

To avoid possible cross-talk from SIM_CLK signal to SIM_DATA signal, don't place these 2 lines closely next to each other. A useful approach is to use SIM_GND line to shield SIM_DATA line from SIM_CLK line.

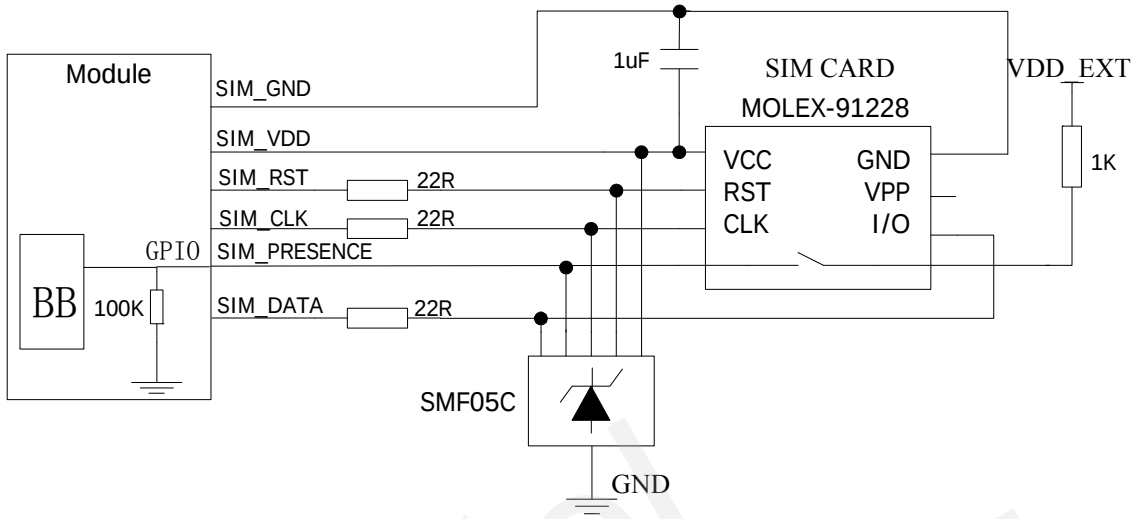


Figure 34: Reference circuit of using 8-pin SIM card socket

In Figure 34, the SIM_PRESENCE pin 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, the SIM_PRESENCE pin is at high level. Regardless of whether SIM card is in the tray or not, the transition of SIM_PRESENCE level from low to high level inspires the module to reinitialize SIM card. In default configuration, SIM card detection function is disabled. Customer's application can use "AT+QSIMDET=0,0" to switch off and "AT+QSIMDET=1,1" to switch on the SIM card detection function. For details of this AT command, please refer to *document [1]*. When "AT+QSIMDET=1,1" is set and the tray with SIM card is removed from SIM socket, the following URC will be presented.

+CPIN: NOT READY

While the tray with SIM card is inserted into SIM socket again, and after the module finishes reading SIM card information for several seconds, the following URC will be presented.

Call Ready

Note: please do not use "AT+QSIMDET=1,0" to enable SIM card detection function when the Figure 34 circuit is adopted.

If customer doesn't 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.

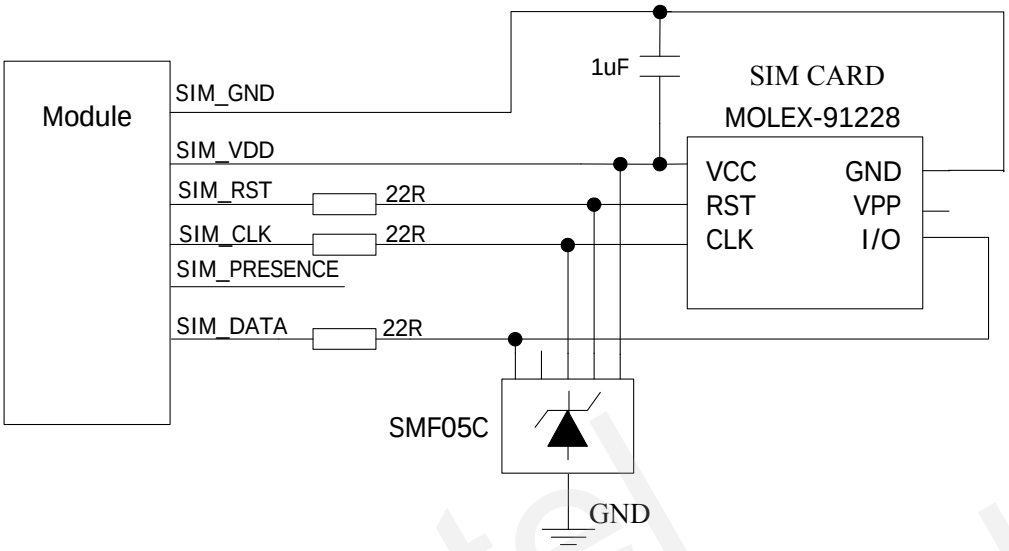


Figure 35: Reference circuit of using 6-pin SIM card socket

3.11.2 Design Considerations for SIM Card Holder

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.

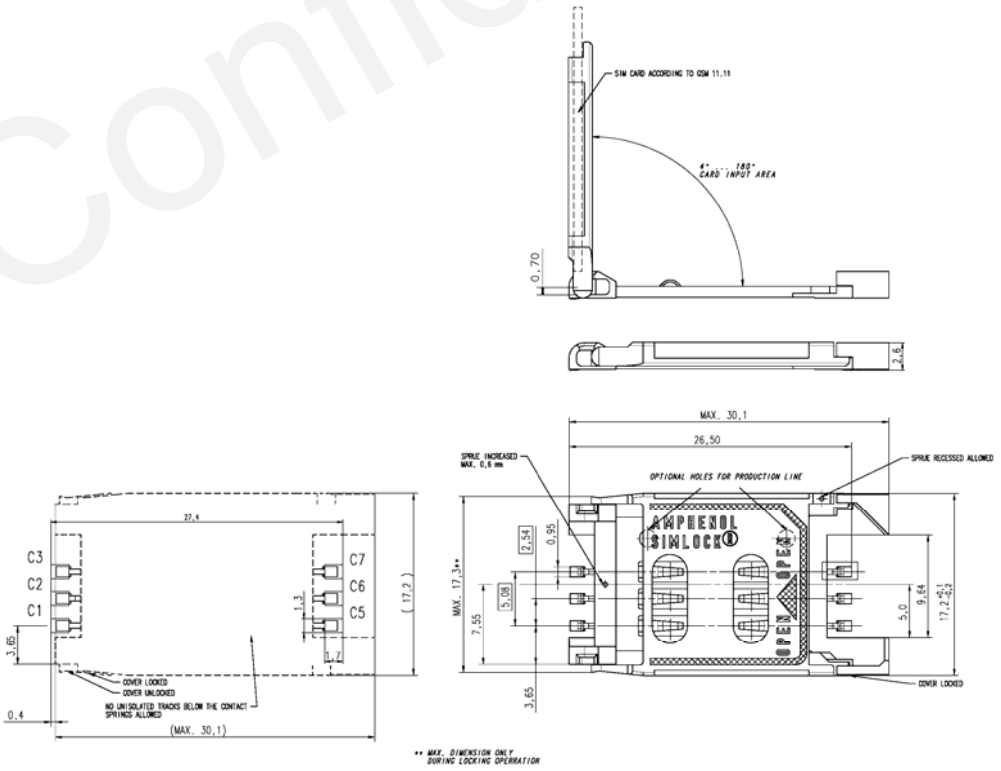


Figure 36: Amphenol C707 10M006 512 2 SIM card holder

Table 25: Pin description of Amphenol SIM card holder

Name	Pin	Function
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

Note: These six pins are also printed on the bottom of M33 as shown in Figure 61. Embedded SIM holder is OPTIONAL, not supported in standard hardware version. If customer needs it, please contact Quectel.

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

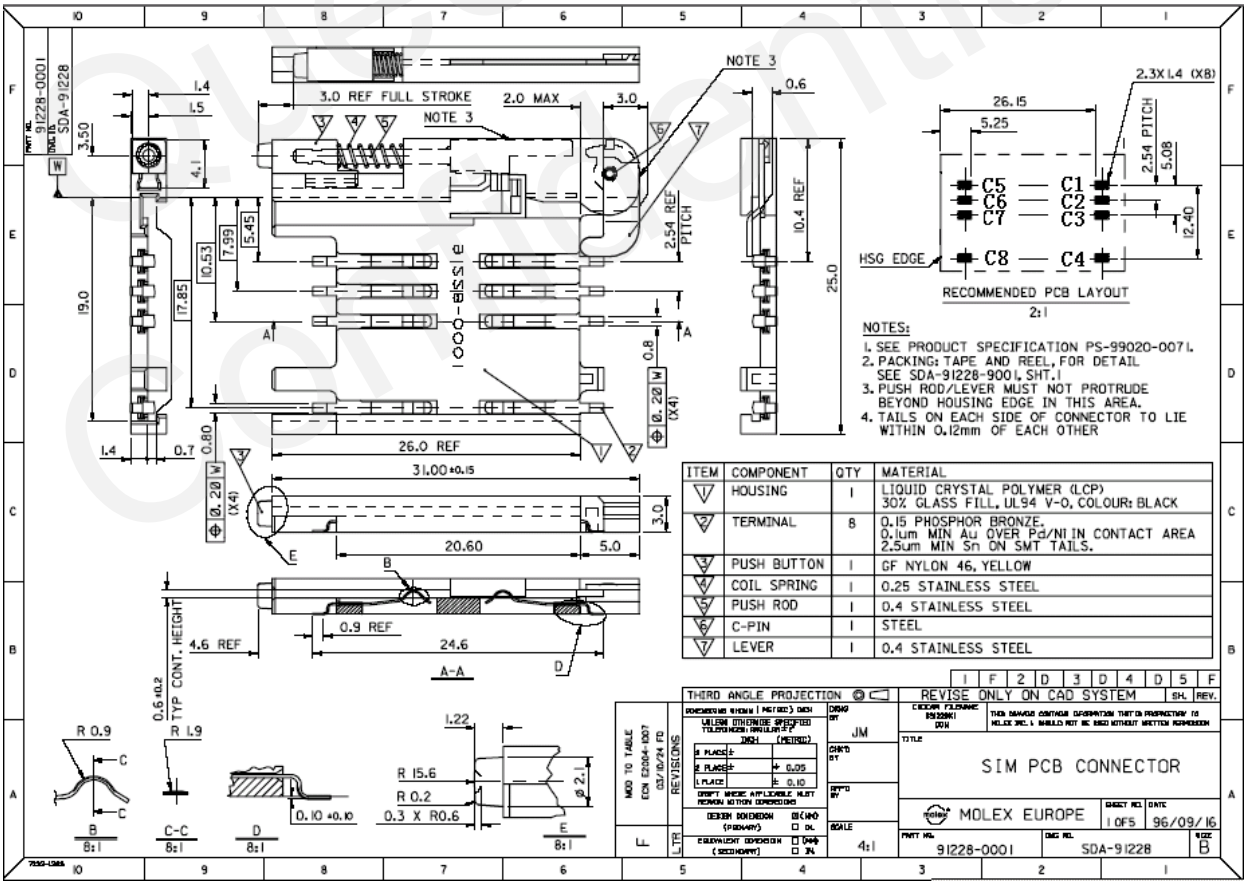


Figure 37: Molex 91228 SIM card holder

Table 26: Pin description of Molex SIM card holder

Name	Pin	Function
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 up to VDD_EXT with external circuit. When the tray is present, C4 is connected to C8.

3.12 Keypad Interface

The keypad interface consists of 5 keypad column outputs and 5 keypad row inputs. The basic configuration is 5 keypad columns and 5 keypad rows, giving 25 keys.

Table 27: Pin definition of the keypad interface

Name	Pin	Function
KCOL0	59	Keypad matrix column
KCOL1	60	
KCOL2	61	
KCOL3	62	
KCOL4	63	
KROW0	68	Keypad matrix row
KROW1	67	
KROW2	66	
KROW3	65	
KROW4	64	

The keypad interface allows a direct external matrix connection. A typical recommended circuit about the keypad matrix is shown in the following figure.

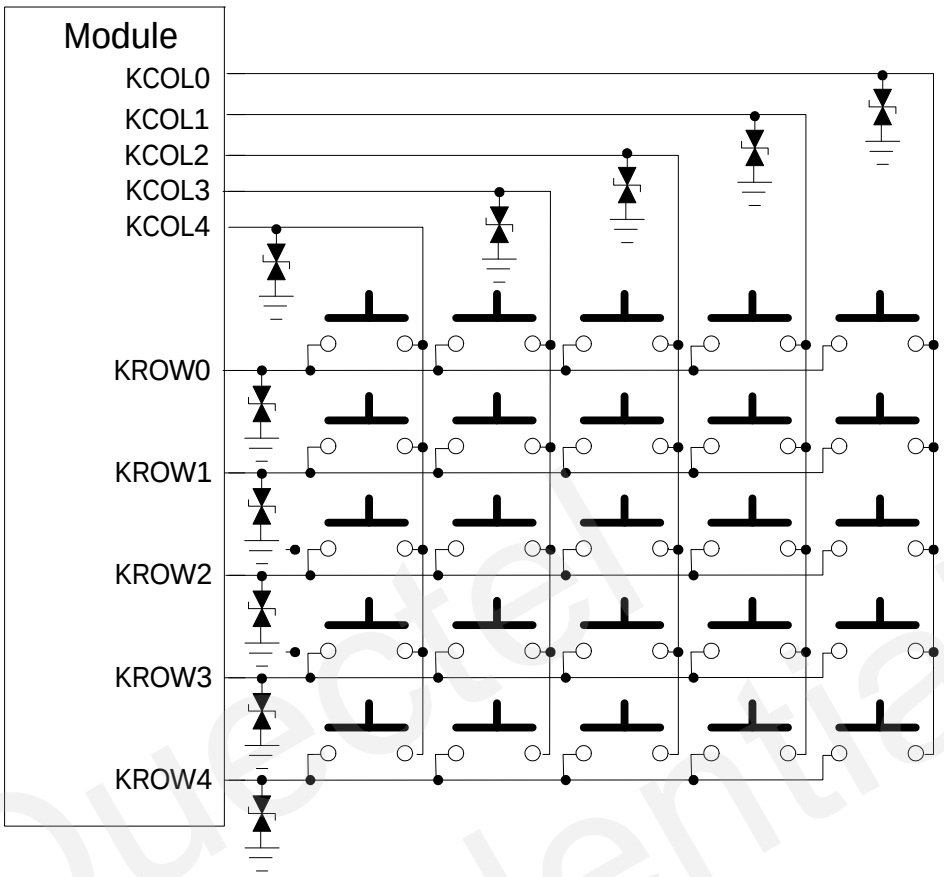


Figure 38: Reference circuit of the keypad interface

Note: This function is not supported in the default firmware but only in OPEN CPU technology.

3.13 ADC

The module provides two ADC input pins to measure external analog voltage. Customer can get the measurement result of ADC0 by AT command "AT+QADC?", and ADC1 by "AT+QEADC?".

Table 28: Pin definition of the ADC

Name	Pin	Function
ADC0	21	Measure analog voltage
ADC1	20	

Table 29: Characteristics of the ADC

Name	Min	Typ	Max	Units
Voltage range	0		2.8	V
ADC Resolution	10		10	bits
ADC accuracy		2.7		mV

3.14 Behavior of the Pin RI1

Table 30: Behaviors of the RI1

State	RI1 respond
Standby	HIGH
Voice calling	Change to LOW, then: （1）Change to HIGH when call is established. （2）Use ATH to hang up the call, change to HIGH. （3）Calling part hangs up, change to HIGH first, and change to LOW for 120ms indicating “NO CARRIER” as an URC, then change 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, change to HIGH. （3）Calling part hangs up, change to HIGH first, and change to LOW for 120ms indicating “NO CARRIER” as an URC, then change to HIGH again. （4）Change to HIGH when SMS is received.
SMS	When a new SMS comes, The RI1 changes to LOW and holds low level for about 120 ms, then changes to HIGH.
URC	Certain URCs can trigger low level on RI1 for 120ms. For more details, please refer to the *document [10]*

When the module is used as a caller, the RI1 pin maintains high except URC is received. On the other hand, when it is used as a receiver, the timing of the RI1 is shown below.

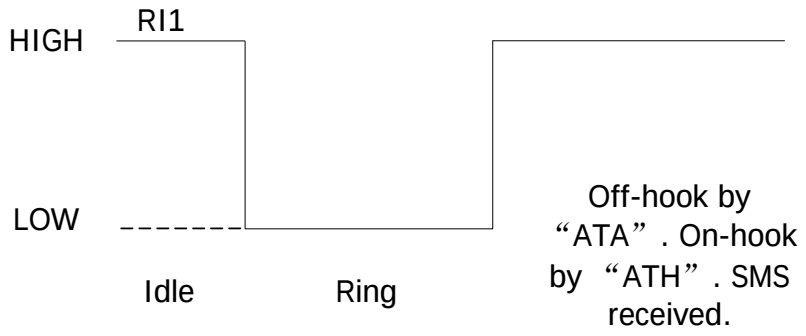


Figure 39: RI1 behaviour of voice calling as a receiver

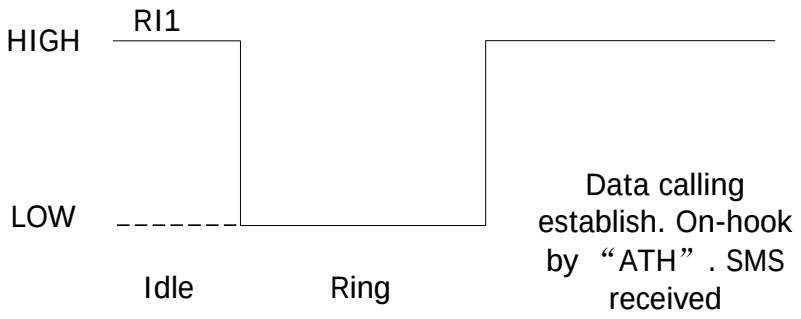


Figure 40: RI1 behaviour of data calling as a receiver

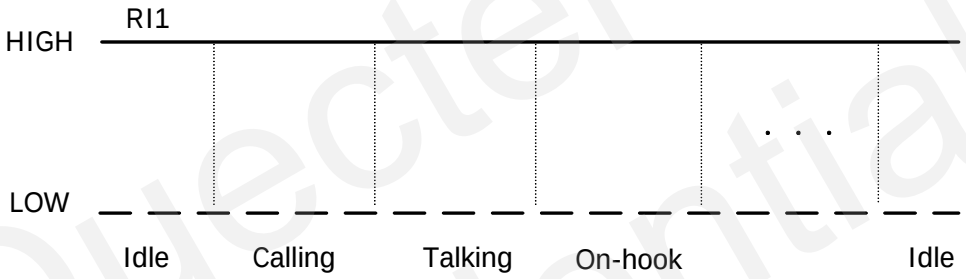


Figure 41: RI1 behaviour as a caller

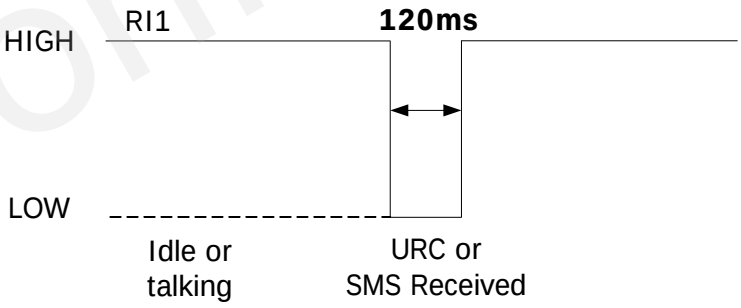


Figure 42: RI1 behaviour of URC or SMS received

3.15 Network Status Indication

The NETLIGHT_OUT signal can be used to drive a network status indication LED. It is an open drain output, which can sink 100mA. The working state of this pin is listed in Table 31.

Table 31: Working state of NETLIGHT_OUT

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 in Figure 43:

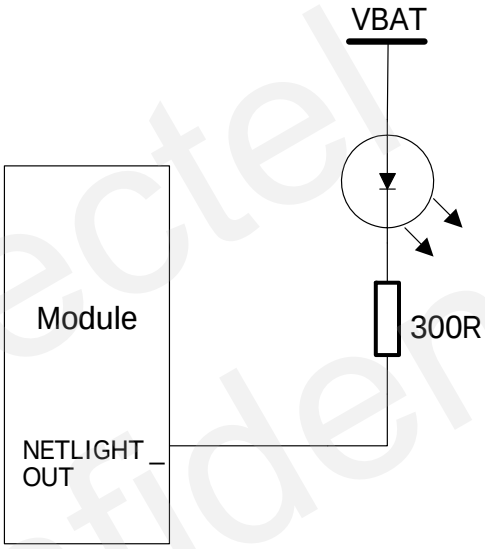


Figure 43: Reference circuit of NETLIGHT_OUT

Table 32: Pin definition of NETLIGHT_OUT

Name	Pin	Function
NETLIGHT_OUT	17	Network status indication light driver

Table 33: NETLIGHT_OUT output characteristic

Parameter	Min	Typ	Max	Unit
Working Current			100	mA

3.16 Buzzer

The BUZZER_OUT pin can be used to drive a buzzer to indicate incoming call. It is an open drain output, which can sink 100mA. The reference circuit for buzzer is shown in Figure 44.

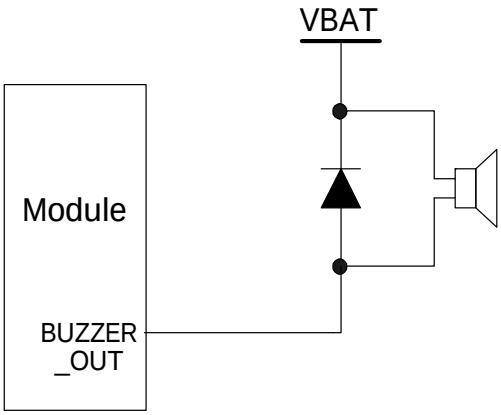


Figure 44: Reference circuit for Buzzer

Table 34: Pin definition of BUZZER_OUT

Name	Pin	Function
BUZZER_OUT	15	Incoming call buzzer driver

Table 35: BUZZER_OUT output characteristic

Parameter	Min	Typ	Max	Unit
Working Current			100	mA

3.17 Module ON or OFF Status Indication

The STATUS pin is set as an output function to indicate whether the module is ON or OFF. In customer design, this pin may be connected to a GPI of external controller to judge the module ON or OFF status, or be used to drive an LED to show the module status. A reference circuit is shown in Figure 45.

Table 36: Pin definition of the STATUS interface

Name	Pin	I/O	Function
STATUS	45	O	Indication of module ON or OFF status

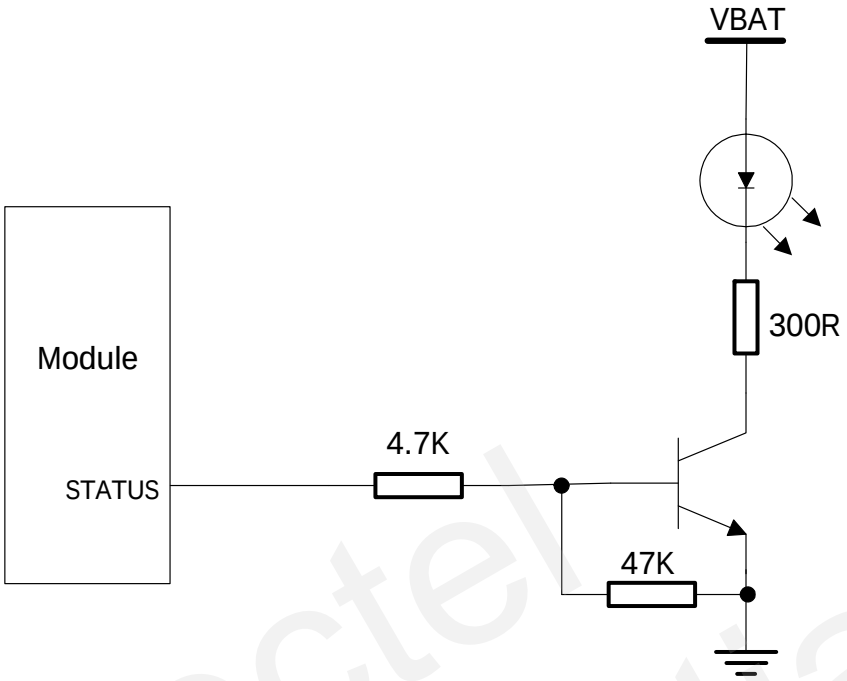


Figure 45: Reference circuit of the STATUS pin

3.18 General Purpose Input & Output (GPIO)

The module provides a General Purpose Input/Output signal pin. The drive current of this pin is 4mA.

Table 37: Pin definition of the GPIO interface

Name	Pin	PU/PD	Function
GPIO3	48	Pulled down internally to 75K resistor	General Purpose Input/Output Port

This GPIO can be configured to be input port or output port of high or low level with "AT+QGPIO" command. Before using this GPIO pin, customer should configure it with "AT+QGPIO=1,x,x,x,x" first. For details, please refer to *document [1]*.

3.19 Open Drain Output

The module provides 4 open drain output pins to control LCD backlight, vibrator, or keyboard backlight. The output LIGHT_MOS can sink 150mA. The output VIB can sink 250mA. Each switch of R/B LED can sink 25mA. The open-drain output switches are high impedance when disabled.

Table 38: Pin definition of the open drain output

Name	Pin	Function
LIGHT_MOS	51	Open drain output port
LED_R	58	
LED_B	53	
VIB	57	

Table 39: Open drain output characteristic

Parameter	Min	Typ	Max	Unit
Working Current(LIGHT_MOS)			150	mA
Working Current(LED_R/B)			25	mA
Working Current(VIB)			250	mA

A reference circuit of the open drain output LIGHT_MOS is shown in Figure 46.

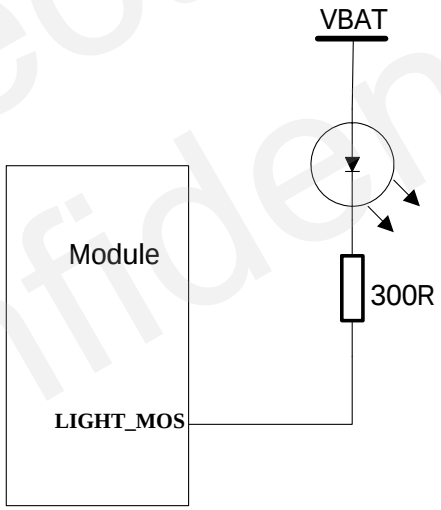


Figure 46: Reference circuit of the OD output

Note: These open drain output functions are not supported in the default firmware. There must be special firmware if customer needs this function. Please contact Quectel for more details.

3.20 External Interrupt

The module provides 2 external interrupt inputs. They can be used for different kind of applications, mainly for event detections. These two interrupt inputs can be configured to be triggered by high to low edge, low to high edge, high level, or low level.

Table 40: Pin definition of the external interrupt

Name	Pin	Function
EINT0	50	External interrupt input
EINT1	49	

Note: This function is not supported in the default firmware. There must be special firmware if customer needs to control these interrupts. Please contact Quectel for more details.

3.21 Camera Interface

M33 module provides an 8-bit CCIR656/CCIR601 digital CMOS camera interface which supports YUV422/YUV411/YUV420 data format and up to 300K pixels CMOS camera signal input. The camera interface can be connected to digital CMOS camera module to take photos or record AVI. These photos or video are encoded to JPEG format. Customer can configure the size, contrast, bright of compressed photo and so on by AT command. For camera associated AT commands, please refer to *document [12]*.

M33 module supports camera module using OV7725 and OV7670 sensor in the default firmware. They can be selected by AT command. Camera module of using other sensors can also be supported upon request.

M33 module supports 8-bit YUV video data bus. However, camera module interface may have 8-bit or 10-bit data bus due to different camera sensors. If a camera module with 10-bit data bus is adopted, the D[9:2] should be used and connected to CS_D[7:0], and discard D[1:0]. Please refer to Figure 47.

Pin definition of camera interface of M33 module is listed in Table 41. It includes 8-bit data bus, an Open-Drain I2C which is dedicated to connecting to the I2C interface of camera module, and other control signals. This I2C interface is for the GPU to control and configure camera module.

Table 41: Pin definition of camera interface

Interface	Name	Pin	I/O	Function
Camera	CS_D0	77	I	YUV video data bus input
	CS_D1	78	I	
	CS_D2	79	I	
	CS_D3	80	I	
	CS_D4	81	I	
	CS_D5	82	I	
	CS_D6	83	I	
	CS_D7	84	I	
	CS_HSYNC	85	I	Horizontal synchronizing

	CS_VSYNC	86	I	Vertical synchronizing
	CS_PIXCLK	87	I	Pixel clock input
	CS_RESET	88	O	Reset output for camera module
	CS_SCL	89	O	I2C serial interface clock output
	CS_PWDN	90	O	Power down mode control output
	CS_SDA	91	I/O	I2C serial interface data I/O
	CS_ECLK	92	O	Clock output for camera module

A reference circuit of 10-bit camera module is shown in the following figure.

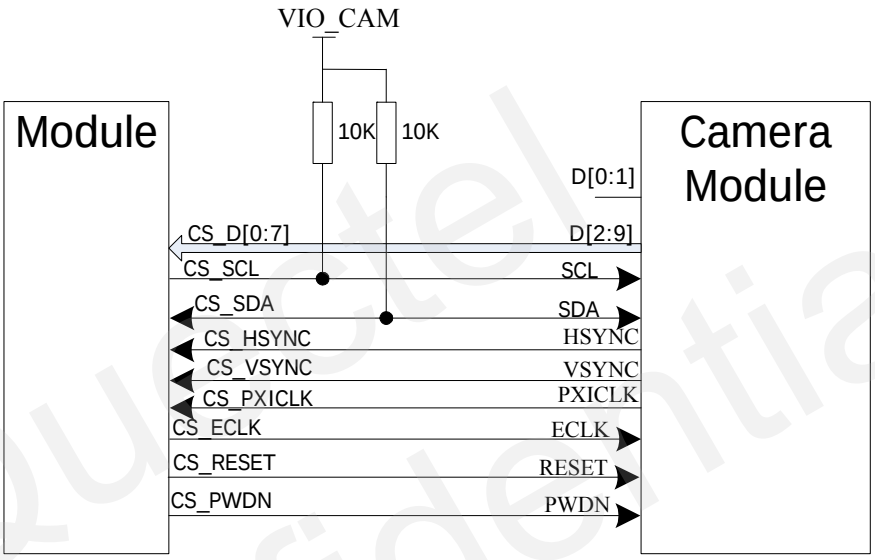


Figure 47: Reference circuit of using digital CMOS sensor

VIO_CAM is the power supply for camera module and should be provided by customer design.

M33 can also be used to connect a decoder for analog CVBS signal (PAL or NTSC composite signal) in order to decode it to digital video data. The output signal must be compatible with CCIR656/CCIR601inYUV422 format. A decoder IC AK8856 from Japanese AKM Co., Ltd is recommended. A reference block diagram is shown in Figure 48.

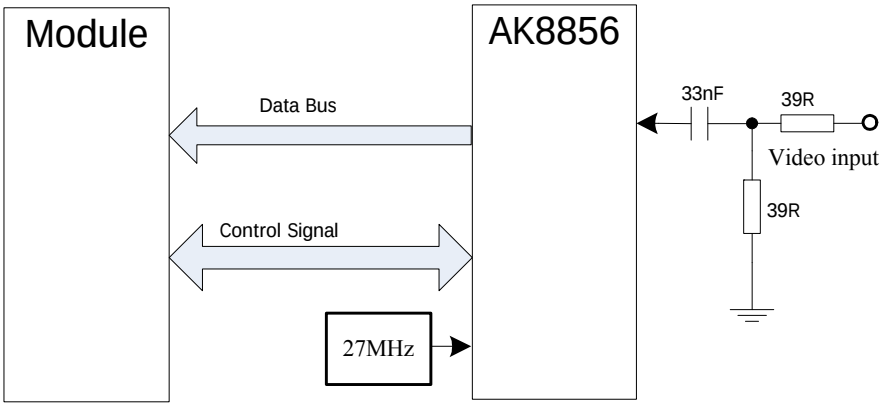


Figure 48: Reference circuit of using decoder IC for CVBS signal

4 Antenna Interface

The RF interface has an impedance of 50Ω. To suit the physical design of individual application, M33 offers two alternatives:

- Recommended approach: RF connector at the component side of the PCB (top view on M33).
- Antenna pad and ground plane placed at the bottom side.

When an antenna cable is soldered to the antenna pad, the RF Hirose connector must be left unconnected and vice versa.

The antenna PAD and RF connector are shown in Figure 49:

Figure 49: Antenna PAD and RF connector

4.1 Antenna Installation

4.1.1 RF Connector

The module adopts Hirose's U.FL-R-SMT RF connector. Customer is recommended to use Hirose's U.FL-LP as the matching connector at the application side. The specification of U.FL-R-SMT is listed in Table 42:

Table 42: Product specifications of U.FL-R-SMT

Item	Specification	Condition
Nominal impedance	50Ω.	Temperature: -40℃ to 90℃
Frequency range	DC to 6GHz.	
Contact resistance	Center: 20mΩ max. Outer: 10mΩ max.	10mA max.
Insulation resistance	500 MΩ min.	100V DC
VSWR	1.5 max	With mated connector
Vibration	No momentary disconnections of 1μs; No damage, cracks and looseness of parts	Frequency of 10 to 100 Hz, single amplitude of 1.5 mm, acceleration of 59m/s2, for 5 cycles in the direction of each of the 3 axes
Shock	No momentary disconnections of 1μs; No damage, cracks and looseness of parts	Acceleration of 735m/s2, 11ms duration for 6 cycles in the direction of each of the 3 axes
Humidity (Steady state)	No damage, cracks or parts dislocation. Insulation resistance 10MΩ min.(humidity high) Insulation resistance 500MΩ min.(dry)	96 hours at temperature of 40℃ and humidity of 95%
Temperature cycle	No damage, cracks or parts dislocation. Contact resistance: 25mΩ max. (Center) 15mΩ max. (Outer)	Temperature: -40℃→+5 to +35℃→+90℃→+5 to +35℃ Time: 30min.→3min.→30min.→3min. 5 cycles
Salt spray	No excessive corrosion	5% salt water solution, 48 hours

For more information about the connector, please contact Hirose dealer or visit Hirose home page http://ww.hirose-connectors.com.

4.1.2 Antenna Pad

When customer connects antenna to the antenna pad via a solderable microwave coaxial cable, it is suggested to choose the RF cable carefully to minimize the loss on it. And the recommended insertion loss should try to meet the following requirements:

- GSM850/EGSM900<0.5dB
- DCS1800/PCS1900<1dB

Material properties of the module:

- M33 PCB: FR4
- Antenna pad: Gold plated

Soldering temperature of the antenna pad is recommended to be around 350℃.
The microwave coaxial cable should be soldered to antenna pad as shown below:

Figure 50: Antenna PAD soldering

Note: The soldering time for antenna pad and GND pad are different, less than 5s for antenna pad and less than 10s for GND plan. The shorter, the better.

4.2 RF Output Power

Table 43: The module conducted 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

Note: Only in GPRS 4 slots TX mode, the max output power is reduced by 2.5dB, which eases the design on power supply at customer side. This is permitted, as described in chapter 13.16 of 3GPP TS 51.010-1.

4.3 RF Receiving Sensitivity

Table 44: The module conducted RF receiving sensitivity

Frequency	Receiving sensitivity
GSM850	< -108.5dBm average
EGSM900	< -108.5dBm average
DCS1800	< -108.5dBm average
PCS1900	< -108.0dBm average

Note: The antenna chosen affects radiated receiving sensitivity.

4.4 Operating Frequency

Table 45: The module operating frequency

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

5 Electrical, Reliability and Radio Characteristics

5.1 PIN Assignment of the Module

Table 46: PIN assignment

PIN NO.	PIN NAME	I/O		PIN NO.	PIN NAME	I/O
1	VBAT	I		2	VBAT	I
3	VBAT	I		4	VBAT	I
5	VDD_EXT	O		6	VCHG	I
7	VRTC	I/O		8	VCHG	I
9	SIM_VDD	O		10	VDD_EXT	O
11	SIM_DATA	I/O		12	SIM_PRESENCE	I
13	SIM_RST	O		14	SIM_CLK	O
15	BUZZER_OUT	O		16	RESERVE	
17	NETLIGHT_OUT	O		18	EMERG_OFF	I
19	ON/OFF	I		20	ADC1	I
21	ADC0	I		22	SPI_CS	O
23	SPI_CLK	O		24	SPI_I	I
25	SPI_O	O		26	PCM_IN	I
27	PCM_SYNC	O		28	PCM_OUT	O
29	PCM_CLK	O		30	TXD2	O
31	RXD2	I		32	RXD3	I
33	TXD3	O		34	MIC2N	I
35	SPK1P	O		36	MIC2P	I
37	SPK1N	O		38	MIC1N	I
39	SPK2P	O		40	MIC1P	I
41	AGND			42	RESERVE	
43	RESERVE			44	SCL	O
45	STATUS	O		46	SDA	I/O
47	RESERVE			48	GPIO3	I/O
49	EINT1	I		50	EINT0	I
51	LIGHT_MOS	O		52	RESERVE	
53	LED_B	O		54	RESERVE	
55	RESERVE			56	RESERVE	
57	VIB	O		58	LED_R	O
59	KCOL0	I		60	KCOL1	I
61	KCOL2	I		62	KCOL3	I

63	KCOL4	I	64	KROW4	O
65	KROW3	O	66	KROW2	O
67	KROW1	O	68	KROW0	O
69	RI1	O	70	DCD1	O
71	RXD1	I	72	RTS1	I
73	TXD1	O	74	DSR1	O
75	CTS1	O	76	DTR1	I
77	CS_D0	I	78	CS_D1	I
79	CS_D2	I	80	CS_D3	I
81	CS_D4	I	82	CS_D5	I
83	CS_D6	I	84	CS_D7	I
85	CS_HSYNC	I	86	CS_VSYNC	I
87	CS_PIXCLK	I	88	CS_RESET	O
89	CS_SCL	O	90	CS_PWDN	O
91	CS_SDA	I/O	92	CS_ECLK	O
93	RESERVE		94	RESERVE	
95	GND		96	SIM_GND	
97	GND		98	GND	
99	GND		100	GND	

Note: Please keep all reserved pins open.

5.2 Absolute Maximum Ratings

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

Table 47: Absolute maximum ratings

Parameter	Min	Max	Unit
VBAT	0	4.7	V
Peak current of power supply	0	2	A
RMS current of power supply (during one TDMA- frame)	0	0.7	A
Voltage at digit pins	-0.3	3.3	V
Voltage at analog pins	-0.3	3.0	V
Voltage at digit/analog pins in POWER DOWN mode	-0.25	0.25	V

5.3 Operating Temperatures

The operating temperatures are listed in the following table:

Table 48: Operating temperature

Parameter	Min	Typ	Max	Unit
Normal temperature	-35	25	80	℃
Restricted operation[1)]	-45 to -35		80 to 85	℃
Storage temperature	-45		+90	℃

[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 could increase.

5.4 Power Supply Ratings

Table 49: 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.	3.4	4.0	4.5	V
	Voltage drop during transmission 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
I_{VBAT} (GPU Off)	Average supply current	POWER DOWN mode SLEEP mode @ DRX=5		65 1.8		uA mA
		Minimum functionality mode AT+CFUN=0 IDLE mode SLEEP mode AT+CFUN=4 IDLE mode SLEEP mode		 12 1.4 12 1.4		 mA mA mA mA
		IDLE mode GSM850/EGSM 900		 12		

		DCS1800/PCS1900		12		mA
I_{VBAT} (GPU On)	Average supply current	SLEEP mode @ DRX=5 Preview mode Capture mode		2.6 58 85		mA mA mA
I_{VBAT}	Peak supply current (during transmission slot)	Power control level for Pout max.		1.7	1.8	A

5.5 Current Consumption

The values for current consumption are shown in Table 50.

Table 50: The module current consumption

Condition	Current Consumption
Voice Call	
GSM850	@power level #5 <300mA,Typical 250mA @power level #12,Typical 130mA @power level #19,Typical 95mA
EGSM 900	@power level #5 <300mA,Typical 250mA @power level #12,Typical 130mA @power level #19,Typical 95mA
DCS 1800	@power level #0 <250mA,Typical 170mA @power level #7,Typical 110mA @power level #15,Typical 90mA
PCS 1900	@power level #0 <250mA,Typical 160mA @power level #7,Typical 100mA @power level #15,Typical 90mA
GPRS Data	
DATA mode, GPRS (1 Rx,1 Tx) CLASS 12	
GSM850	@power level #5 <350mA,Typical 240mA @power level #12,Typical 125mA @power level #19,Typical 90mA
EGSM 900	@power level #5 <350mA,Typical 240mA @power level #12,Typical 125mA @power level #19,Typical 90mA
DCS 1800	@power level #0 <300mA,Typical 170mA @power level #7,Typical 110mA @power level #15,Typical 90mA
PCS 1900	@power level #0 <300mA,Typical 185mA @power level #7,Typical 110mA @power level #15,Typical 90mA

DATA mode, GPRS (3 Rx, 2 Tx) CLASS 12	
GSM850	@power level #5 <550mA,Typical 430mA @power level #12,Typical 230mA @power level #19,Typical 120mA
EGSM 900	@power level #5 <550mA,Typical 430mA @power level #12,Typical 230mA @power level #19,Typical 120mA
DCS 1800	@power level #0 <450mA,Typical 300mA @power level #7,Typical 170mA @power level #15,Typical 140mA
PCS 1900	@power level #0 <450mA,Typical 300mA @power level #7,Typical 170mA @power level #15,Typical 140mA
DATA mode, GPRS (2 Rx, 3 Tx) CLASS 12	
GSM850	@power level #5 <650mA,Typical 560mA @power level #12,Typical 240mA @power level #19,Typical 150mA
EGSM 900	@power level #5 <650mA,Typical 580mA @power level #12,Typical 250mA @power level #19,Typical 150mA
DCS 1800	@power level #0 <490mA,Typical 400mA @power level #7,Typical 200mA @power level #15,Typical 150mA
PCS 1900	@power level #0 <480mA,Typical 360mA @power level #7,Typical 180mA @power level #15,Typical 150mA
DATA mode, GPRS (4 Rx,1 Tx) CLASS 12	
GSM850	@power level #5 <350mA,Typical 270mA @power level #12, Typical 150mA @power level #19,Typical 115mA
EGSM 900	@power level #5 <350mA,Typical 270mA @power level #12, Typical 150mA @power level #19,Typical 115mA
DCS 1800	@power level #0 <300mA,Typical 200mA @power level #7,Typical 130mA @power level #15,Typical 105mA
PCS 1900	@power level #0 <300mA,Typical 210mA @power level #7,Typical 135mA @power level #15,Typical 110mA
DATA mode, GPRS (1 Rx, 4 Tx) CLASS 12	
GSM850	@power level #5 <660mA,Typical 510mA @power level #12,Typical 300mA @power level #19,Typical 180mA

EGSM 900	@power level #5 <660mA,Typical 580mA @power level #12,Typical 350mA @power level #19,Typical 180mA
DCS 1800	@power level #0 <530mA,Typical 400mA @power level #7,Typical 260mA @power level #15,Typical 160mA
PCS 1900	@power level #0 <530mA,Typical 370mA @power level #7,Typical 260mA @power level #15,Typical 160mA

Note: GPRS Class 12 is the default setting. The module can be configured from GPRS Class 1 to Class 12 by "AT+QGPCLASS".

5.6 Electro-static Discharge

Although the module 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 application using the module.

The measured ESD values of module are shown as the following table:

Table 51: The ESD endurance (Temperature: 25℃, Humidity: 45%)

Part	Contact discharge	Air discharge
VBAT, GND	±5KV	±10KV
Antenna port	±5KV	±10KV
ON/OFF, EMERG_OFF	±4KV	±8KV
MIC1P/1N, MIC2P/2N SPK1P/1N, SPK2P, AGND	±4KV	±8KV
Serial Port 1	±4KV	±8KV
SIM card	±4KV	±8KV
Camera interface	±4KV	±8KV

6 Mechanical Dimension

This chapter describes the mechanical dimensions of the module.

6.1 Mechanical Dimensions of Module

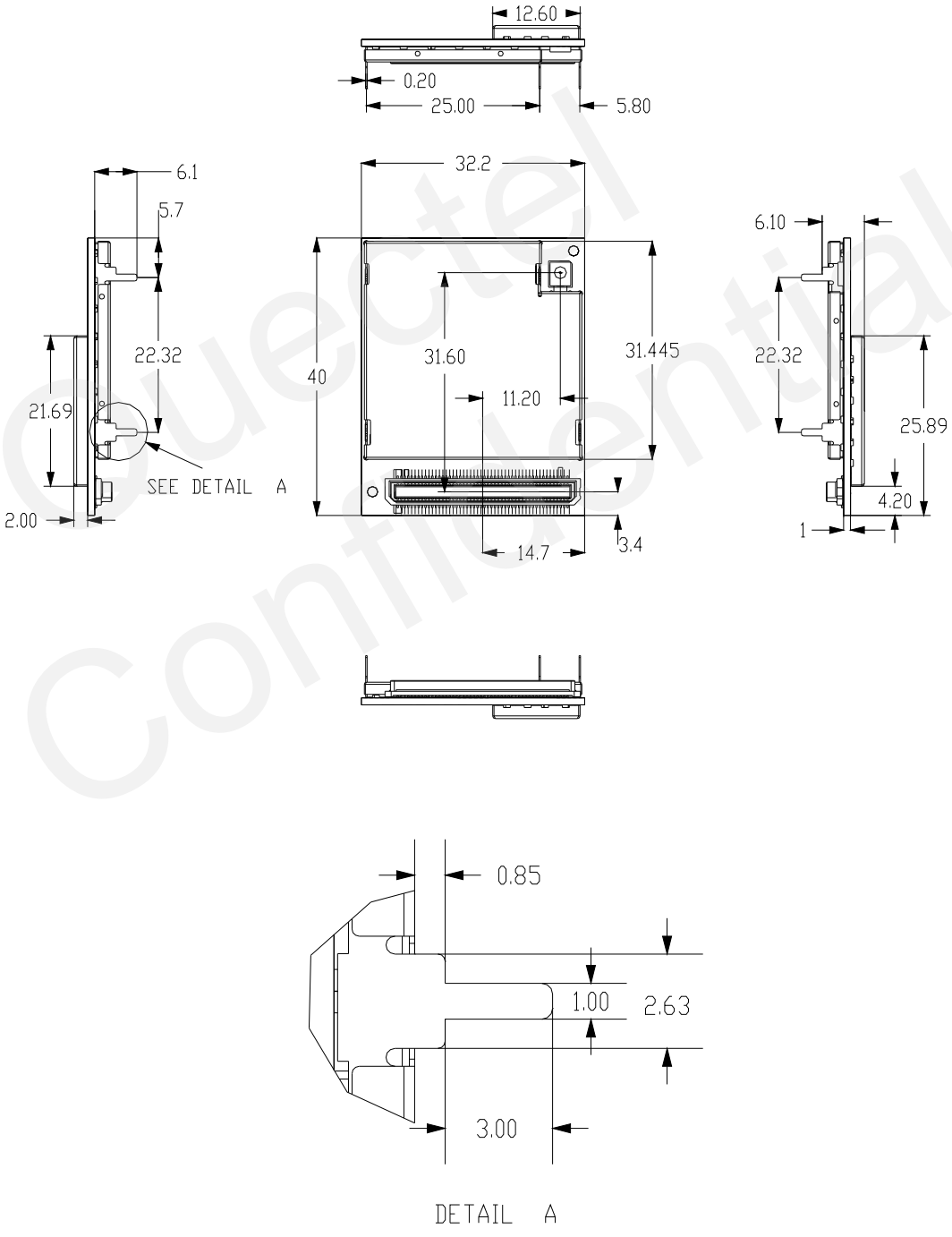


Figure 51: M33 Top and Side dimensions（Unit: mm）

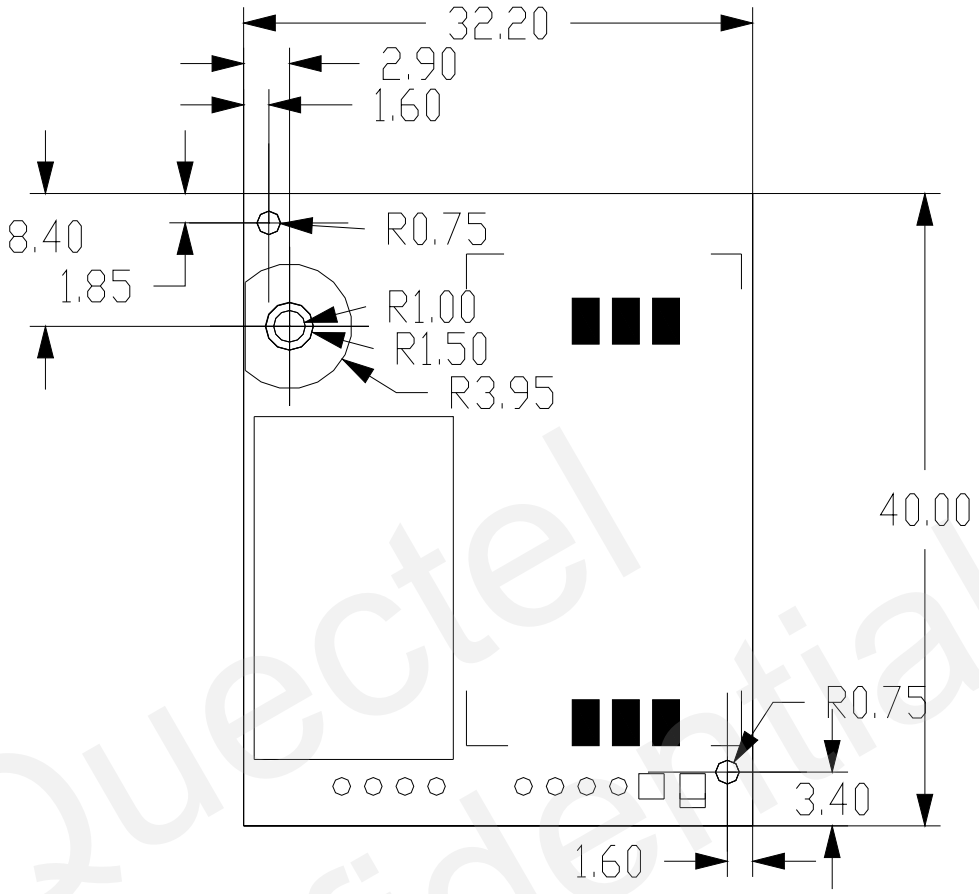


Figure 52: M33 Bottom dimensions（Unit: mm）

6.2 Footprint of Recommendation

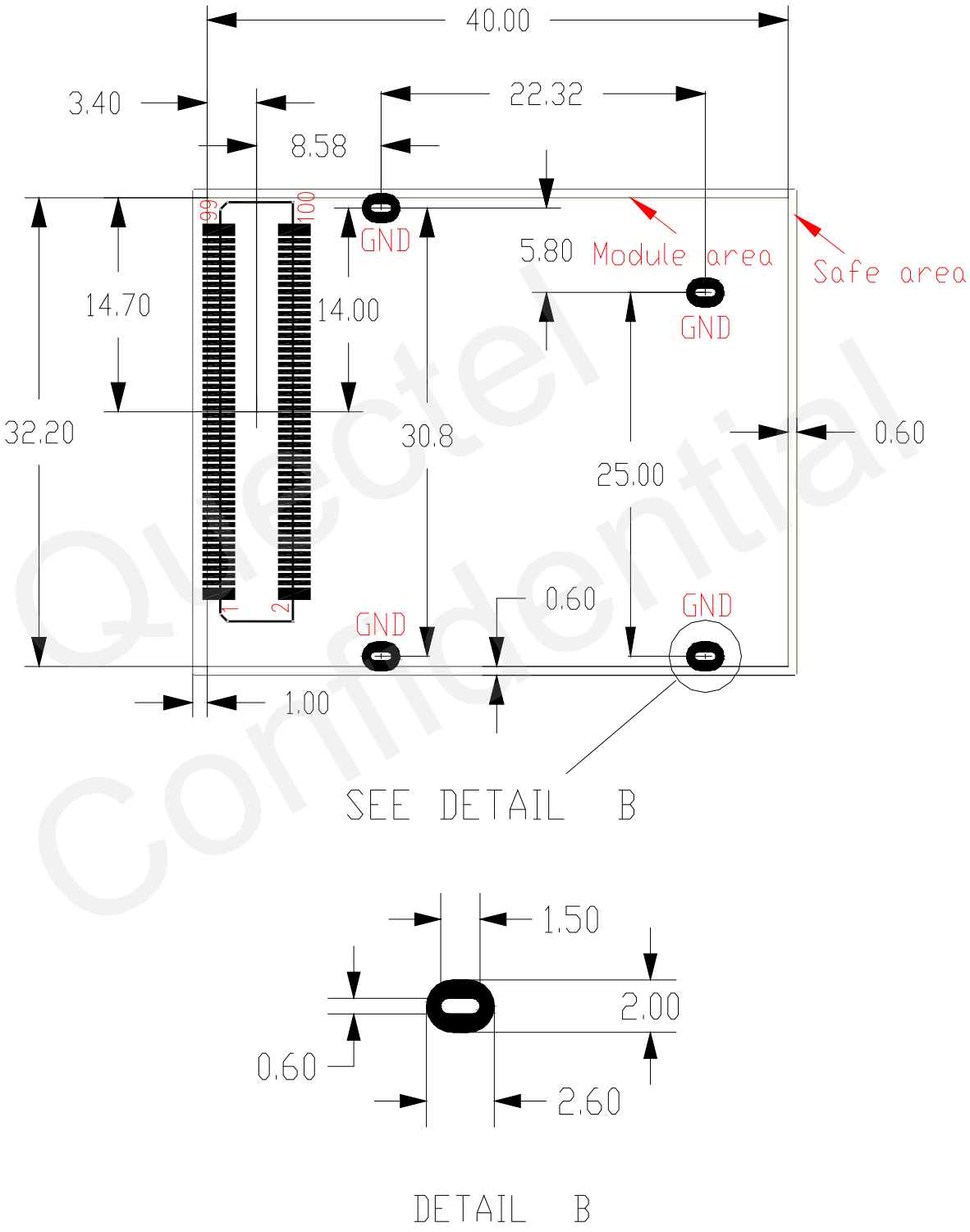


Figure 53: Footprint of recommendation（Unit: mm）

For detailed dimensions of the B2B connector, please refer to section 6.3.2 and 6.3.3.

6.3 Mounting Module in Host PCB

The module provides a B2B connector and four shielding pins to be embedded in host PCB firmly. The four shielding pins must be soldered to GND network on host board for good anti-interference performance and heat dissipation.

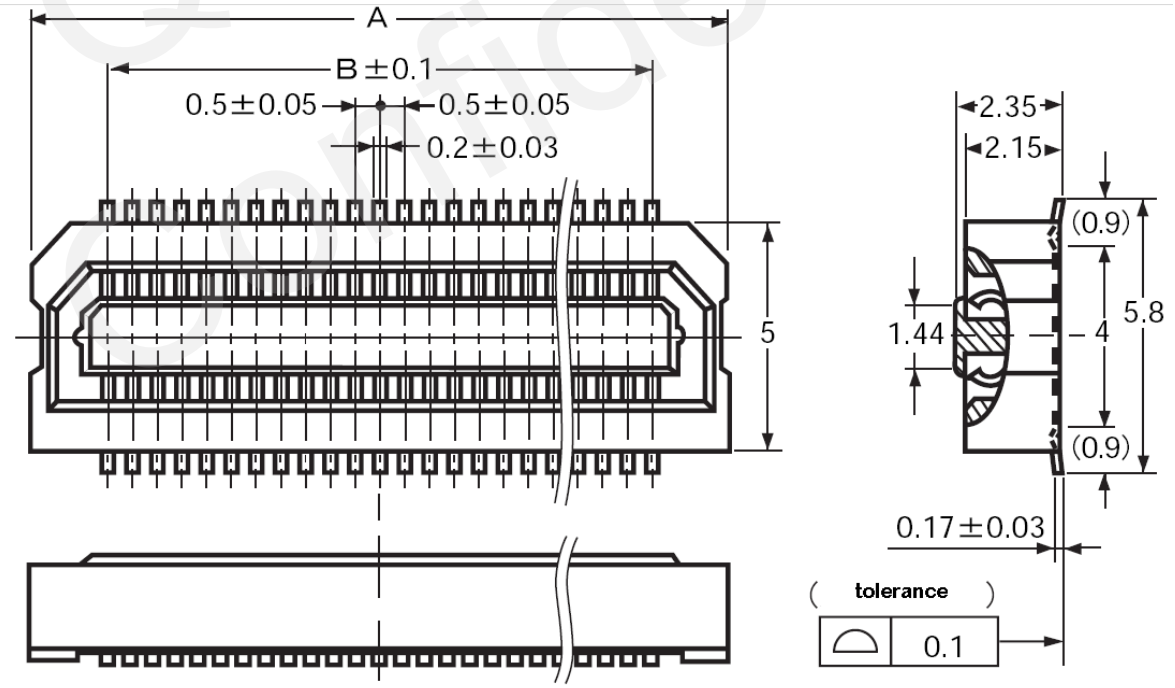
To prevent mechanical damage, be careful not to force, bend or twist the module. Be sure it is positioned flat against the host PCB.

6.3.1 Board-to-board Connector

This section provides specifications for the 100-pin board-to-board connector which serves as physical interface to host PCB. The header assembled on the M33 module is type AXK600347YG of Matsushita. The matched receptacle type AXK500147YG should be used on host board.

Please visit http://panasonic-denko.co.jp/ac/e/control/connector/base-base/p5k/number/index.jsp for more information.

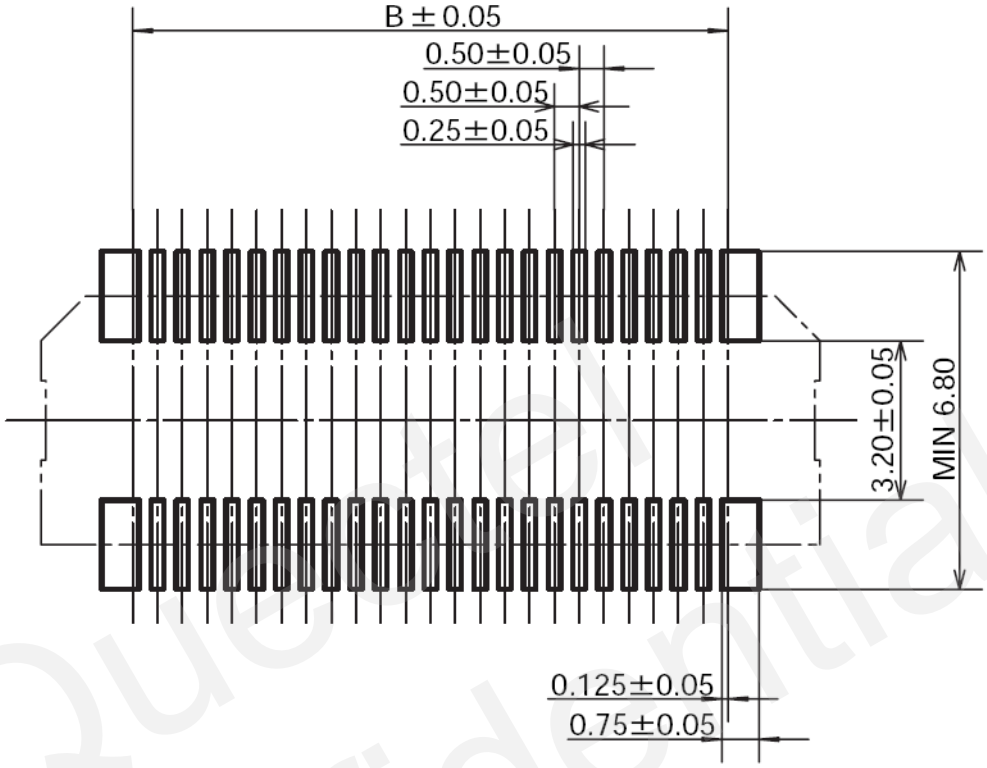
6.3.2 Mechanical Dimensions of AXK500147YG Receptacle



A: 28.2mm B: 24.5mm

Figure 54: Dimensions of the AXK500147YG（Unit: mm）

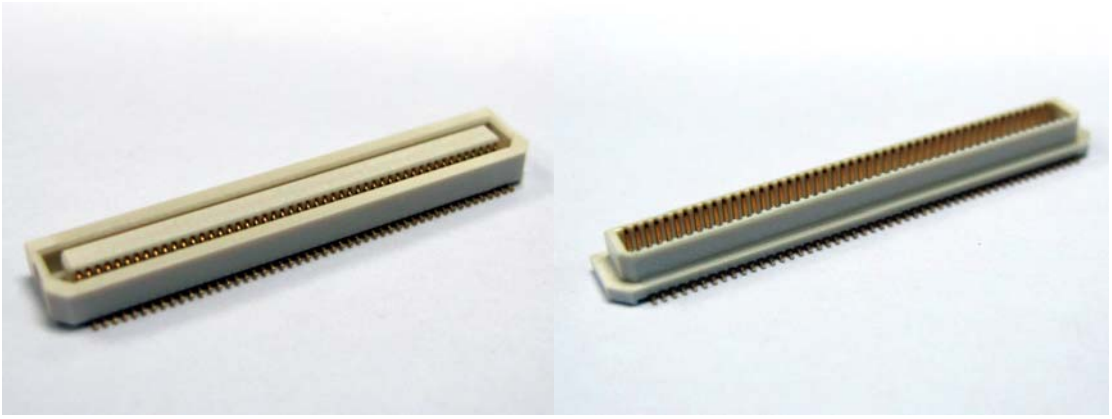
6.3.3 Footprint of AXK500147YG Receptacle



B: 24.5mm

Figure 55: Footprint of AXK500147YG（Unit: mm）

6.3.4 Physical Photo of the Connectors



Receptacle **Header**

Figure 56: Physical photos of the connectors

Note：

The header connector is used at the module side and the receptacle connector is used at the host PCB side.

6.4 RF Connector

6.4.1 Mechanical Dimensions of the UF.L-R-SMT Connector

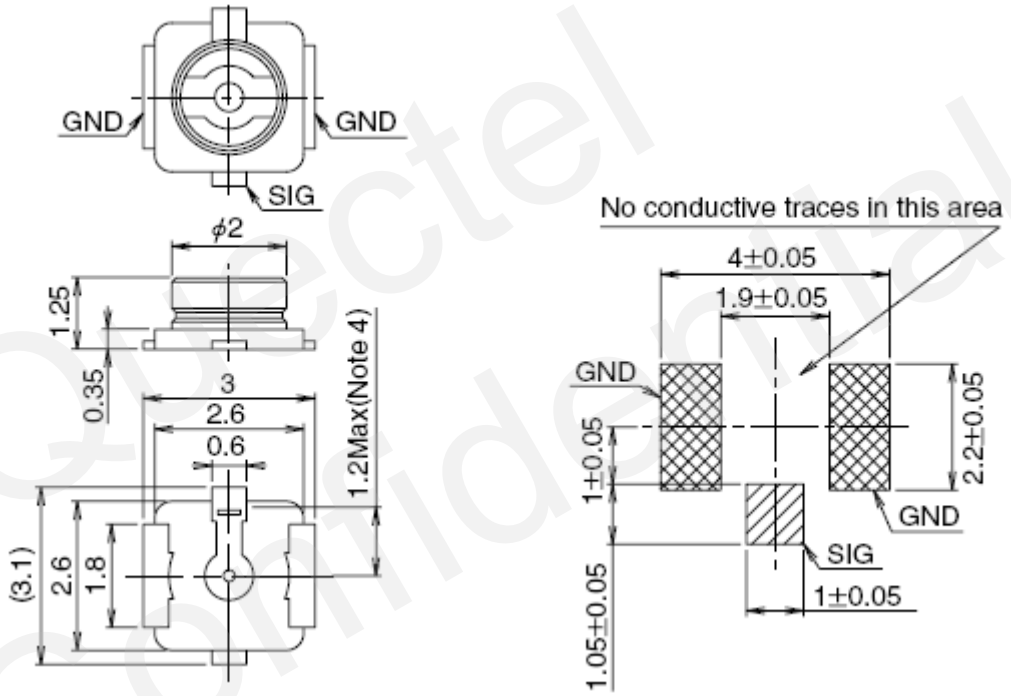


Figure 57: Dimensions of the UF.L-R-SMT connector（Unit: mm）

6.4.2 Matching Connector on Application Side of M33

Five types of female connector can match with UF.L-R-SMT. The mechanical sizes of them are listed in the following figure:

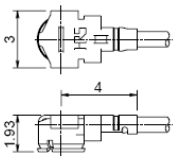
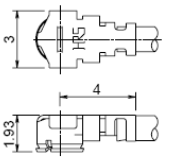
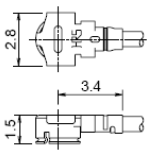
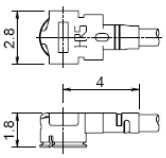
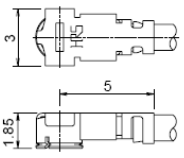
Part No.	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
					
Mated Height	2.5mm Max. (2.4mm Nom.)	2.5mm Max. (2.4mm Nom.)	2.0mm Max. (1.9mm Nom.)	2.4mm Max. (2.3mm Nom.)	2.4mm Max. (2.3mm Nom.)
Applicable cable	Dia. 0.81mm Coaxial cable	Dia. 1.13mm and Dia. 1.32mm Coaxial cable	Dia. 0.81mm Coaxial cable	Dia. 1mm Coaxial cable	Dia. 1.37mm Coaxial cable
Weight (mg)	53.7	59.1	34.8	45.5	71.7
RoHS	YES				

Figure 58: Mechanicals of UF.L-LP connectors

6.4.3 Space Factor of Mated Connector

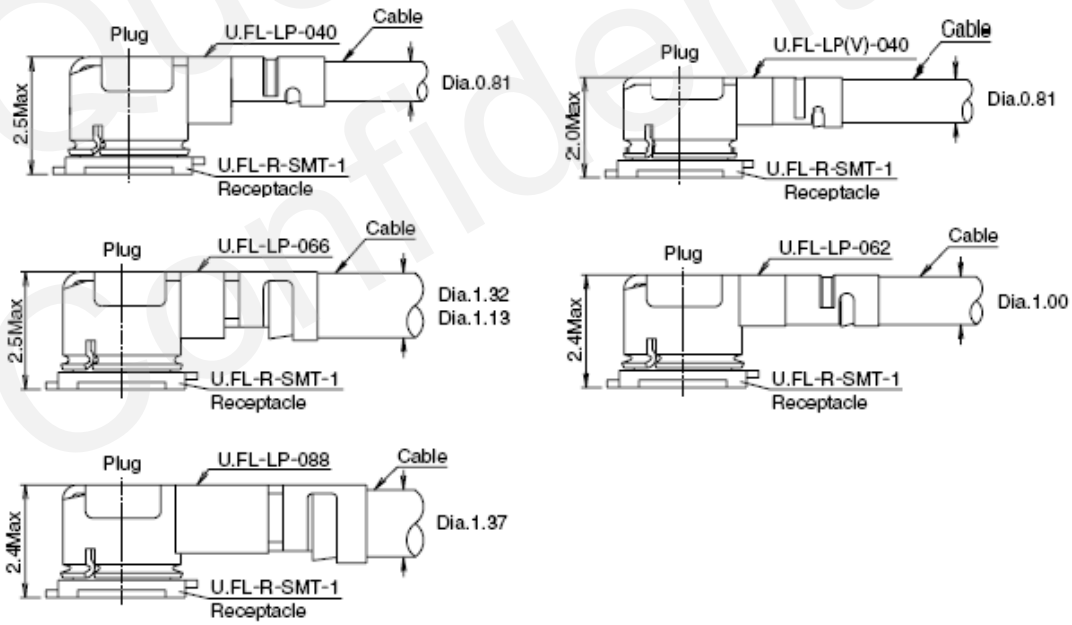


Figure 59: Space factor of mated connector（Unit: mm）

6.5 Top View of the Module

Figure 60: Top view of the module

6.6 Bottom View of the Module

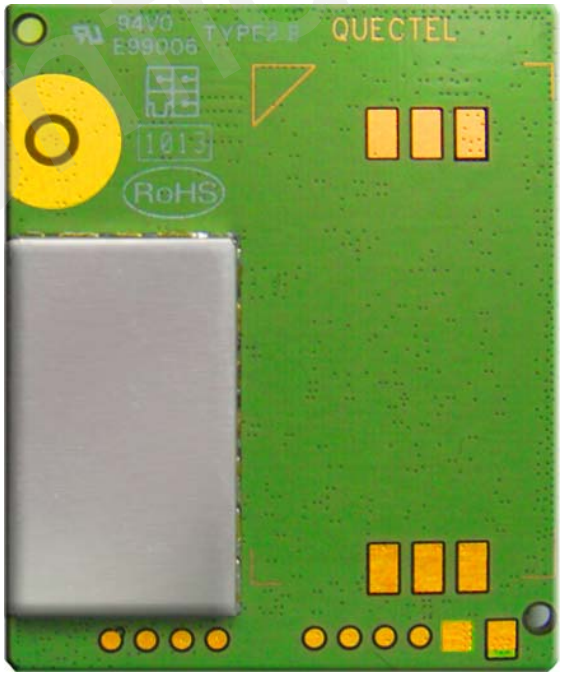


Figure 61: Bottom view of the module

Appendix A: GPRS Coding Schemes

Four coding schemes are used in GPRS protocol. The differences between them are shown in Table 52.

Table 52: Description of different coding scheme

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 62:

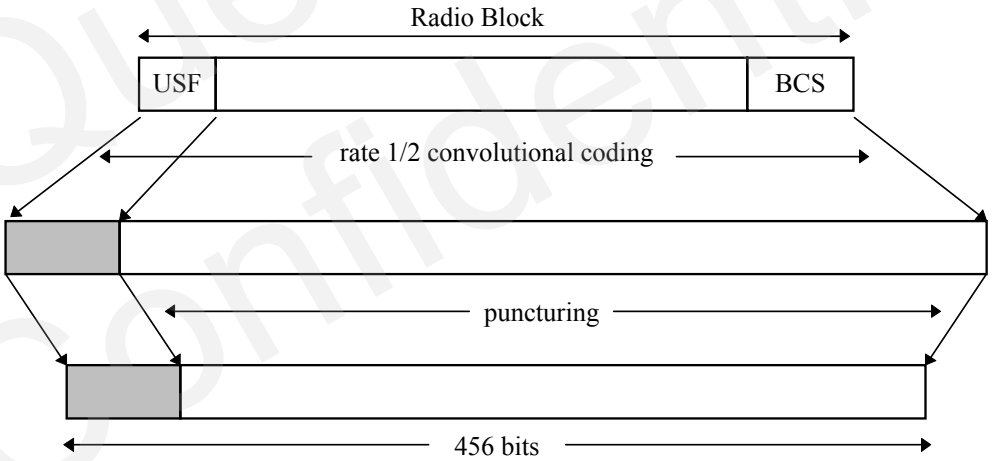


Figure 62: Radio block structure of CS-1, CS-2 and CS-3

Radio block structure of CS-4 is shown as Figure 63:

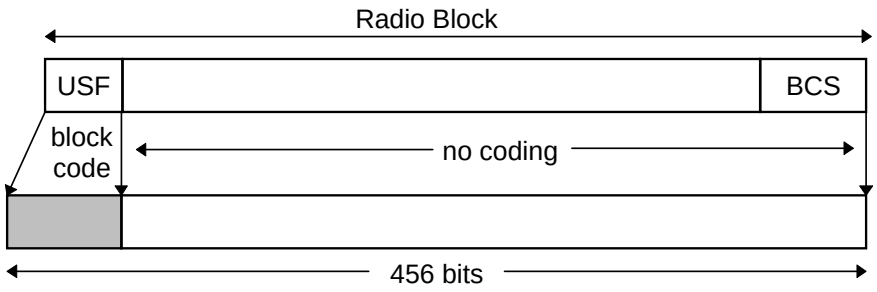


Figure 63: Radio block structure of CS-4

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 53.

Table 53: 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
13	3	3	NA
14	4	4	NA
15	5	5	NA
16	6	6	NA
17	7	7	NA
18	8	8	NA
19	6	2	NA
20	6	3	NA
21	6	4	NA
22	6	4	NA
23	6	6	NA
24	8	2	NA
25	8	3	NA
26	8	4	NA
27	8	4	NA
28	8	6	NA
29	8	8	NA

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