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Neo_M660A GPRS Module Hardware User Guide

Version 1.1

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Notice

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Revision Record

Issue	Changes	Revised By	Date
V1.0	Initial draft	Li Zhongqiu	2014-06
V1.1	Modified the definition of pin 53	Li Zhongqiu	2014-06

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About This Document

This document defines the features, indicators, and test standards of the M660A module and provides reference for the hardware design of each interface. With *Neo_M660A GPRS Module AT Command Set*, this user guide can help you complete wireless communication application easily.

1 Introduction to M660A

M660A is a compact wireless GSM/GPRS module that supports downlink EDGE. It can provide functions of high-quality voice, SMS, and data services and is widely used in industrial and consumer fields.

1.1 Overview

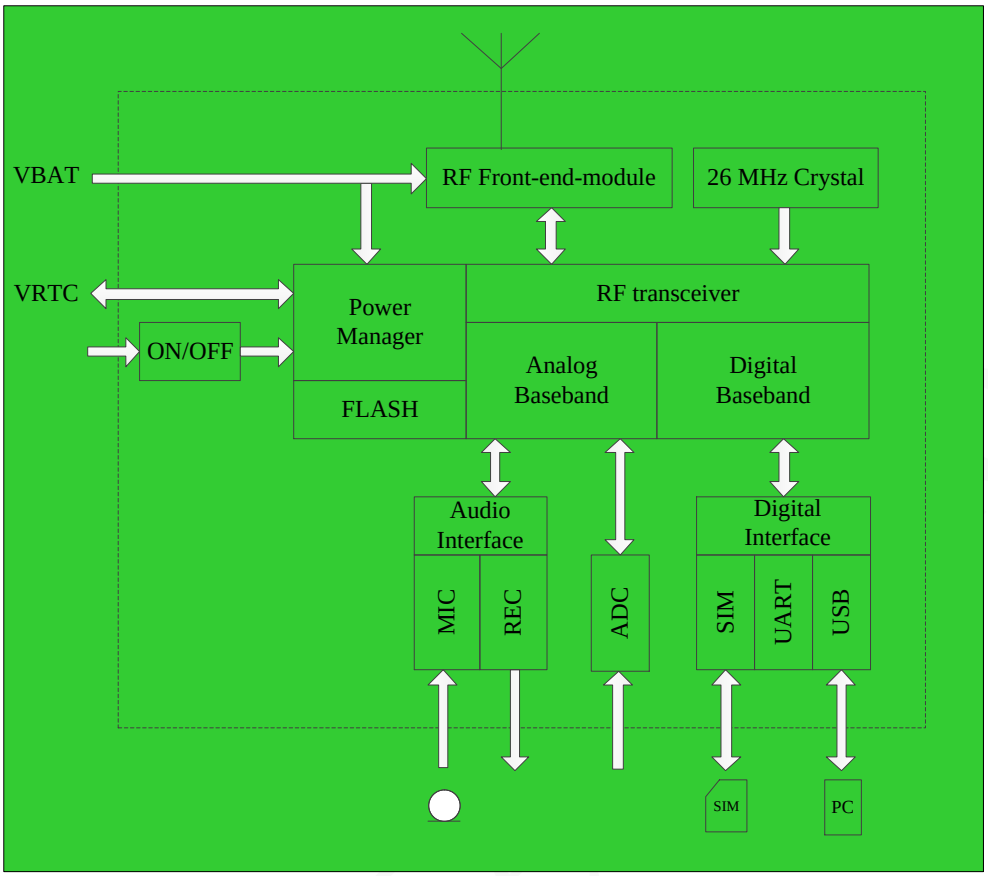
Neoway M660A module adopts 68-pin LCC encapsulation and its dimensions are 24 mm x 24 mm x 2.6 mm, which can meet most customers' requirements. It provides customers the following hardware resources and features:

- UART interfaces, used for data communication, firmware updating and commissioning, and supporting hardware flow control
- Audio interfaces, including one line of MIC input (differential) and one line of receiver output (differential)
- 10-bit ADC input, voltage ranging from 0 V to 2.8 V
- One line of SIM card interface, compatible with 1.8 V and 3.0V SIM card
- RING/LIGHT/DTR (sleep mode) functions
- Time updating and timing power-on/off
- Firmware updating via USB interface

1.2 Block Diagram

The M660A module consists of baseband controller, Flash ROM, RF section, application interfaces, etc. All sections coordinate with each other to provide such communication functions as GPRS data and voice.

The following figure shows the block diagram of M660A.



1.3 Specifications

Table 1-1 M660A specifications

Specifications	Description
Band	GSM850/EGSM900/DCS1800/PCS1900 MHz dual-band/quad-band Supporting band locking
Sensitivity	< -107 dBm
Max. transmit power	• GSM850/EGSM900 Class4(2W) • DCS1800/PCS1900 Class1(1W)
Protocol	Supporting GSM/GPRS Phase 2/2+
AT	• GSM07.07 • Extended AT commands
Audio	Supporting the following audio coding: • HR • FR • EFR • AMR

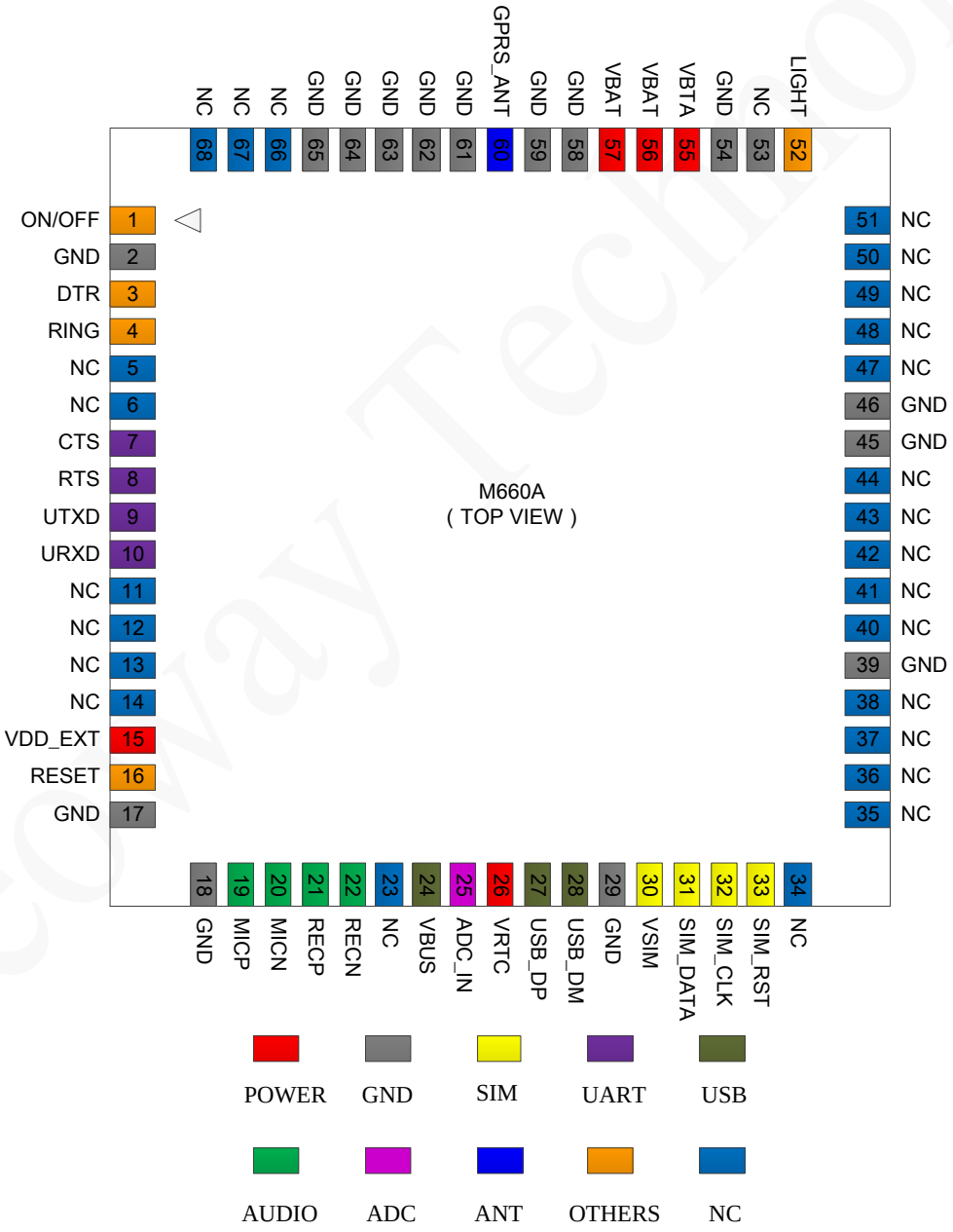
	Supporting echo suppression Supporting recording and DTMF check function
SMS	• TEXT/PDU • Supporting SMS message receiving and sending and ring for new SMS messages • Supporting SMS message management: reading/deleting/storage/list
GPRS feature	• GPRS CLASS 12 • Max. theoretic uplink rate: 85.6 Kbit/s • Max. theoretic downlink rate: 85.6 Kbit/s • Built-in TCP/IP protocol, supporting multiple links • Supporting server and client modes
Circuit Switch Data	• CSD • USSD
Supplementary service	• Call forwarding • Call waiting • Call holding and multi-way calling
UART	• Supporting hardware flow control, RTS and CTS controlled via AT commands • Supporting multiplexing • Supporting AT sending, data transmission, and software download • Supporting baudrate from 1200 bit/s to 115200 bit/s
RTC	• Supporting real-time clock and time updating • Supporting timing power-on/off
CPU	ARM7-EJ@360MHz
Antenna feature	50 Ω impedance
Operating temperature	-40℃ to +85℃
Operating voltage	3.5 V to 4.3 V (3.9 V is recommended)
Peak current	Max 2.0 A
Idle current	18 mA
Current in sleep mode	< 2 mA (live network)
	< 1 mA (instrument, DRX=9)

2 Pin Description and PCB Foot Print

2.1 Specifications and Encapsulation

Specifications	M660A
Dimensions	24 mm x 24 mm x 2.6 mm (H x W x D)
Weight	2.6 g
Encapsulation	68-pin LGA

Figure 2-1 Top view of the M660A module



2.2 Pin Definition

Table 2-1 M660A pin definition

Pin	Name	I/O	Function	Reset Status	Level Feature (V)	Remarks
Power Supply and Switch Interfaces						
55, 56, 57	VBAT	P	Main power supply input			3.5 V to 4.3 V (3.9 V is recommended)
15	VDD_EXT	P	2.8 V power supply output			Supply power for IO level shifting circuit. Load capability: less than 50 mA
26	VRTC	P	RTC power supply			2.8 V, maximum output charging current 2 mA
2, 17, 18, 29, 39, 45, 46, 53, 54, 58, 59, 61-65	GND	P	Ground			
1	ON/OFF	DI	ON/OFF control input	I/PU	$0<V_{IL}<0.6$ $2.1<V_{IH}<VBAT$	Low level pulse can change the ON/OFF state.
16	RESET	DI	Reset input			Internal 2.8V pull-up Low level reset
Audio Interface						
19	MICP	AI	Positive electrode of differential MIC output			Vpp≤200 mV
20	MICN	AI	Negative electrode of differential MIC output			
21	RECP	AO	Positive electrode of differential receiver output			32 Ω receiver driving output
22	RECN	AO	Negative electrode of differential receiver output			
UART Interface						

7	CTS	DI	Clear to send	I/PU	$0<V_{IL}<0.6$ $2.1<V_{IH}<3.1$ $0<V_{OL}<0.42$ $2.38<V_{OH}<2.8$	With internal 47K resistors to respectively pull CTS and URXD up to 2.8 V
8	RTS	DO	Request to send	I/PU		
9	UTXD	DO	UART data transmit	O/PU		
10	URXD	DI	UART data receive	I/PU		
SIM Card						
30	VSIM	P	SIM card power supply output		$0<V_{IL}<0.25*VSIM$ $0.75*VSIM<V_{IH}<VSIM$ $0<V_{OL}<0.15*VSIM$ $0.85*VSIM<V_{OH}<VSIM$	Compatible with 1.8/3.0 V SIM card
31	SIM_DATA	DI/O	SIM card data I/O		$0<V_{IL}<0.6$ $2.1<V_{IH}<3.1$ $0<V_{OL}<0.42$ $2.38<V_{OH}<2.8$	
33	SIM_CLK	DO	SIM card clock output			
32	SIM_RST	DO	SIM card reset output			
LED Indicators						
52	LIGHT	DO	Status LED	I/PD		2.8 V/4 mA output
Sleep Mode Controlling						
3	DTR	DI	Sleep mode controlling input	I/PD	$0<V_{IL}<0.6$ $2.1<V_{IH}<3.1$ $0<V_{OL}<0.42$ $2.38<V_{OH}<2.8$	Low level by default Used together with AT commands
SMS and Incoming Call Ring						
4	RING	DO	Ring output	I/PD	$0<V_{IL}<0.6$ $2.1<V_{IH}<3.1$ $0<V_{OL}<0.42$ $2.38<V_{OH}<2.8$	Detect incoming SMS messages or calls
ADC Detecting						
25	ADC_IN	AI	10-bit ADC input			Detectable voltage range: 0 V to 2.8 V
GPRS Antenna						
60	GPRS_ANT	AI/O	GPRS antenna interface I/O			50 Ω impedance

USB Interfaces						
24	VBUS	AI	USB voltage test			
27	USB_DP	DI/O	USB interface differential data cable		Complying with the USB1.1 standard	Used for firmware download
28	USB_DM	DI/O				
Reserved Pins						
5, 6, 11~14, 23, 34~38, 40~44, 47~51, 66~68	NC					Must be left disconnected. Cannot connect to power supply or ground.

NOTE

P: indicates power supply pins

NC: indicates pins that are not supported and must not be connected

DI: indicates digital signal input pins

DO: indicates digital signal output pins

I/PD: indicates digital signal input pins with pull-down

I/PU: indicates digital signal input pins with pull-up

AI: indicates analogy signal input pins

AO: indicates analogy signal output pins

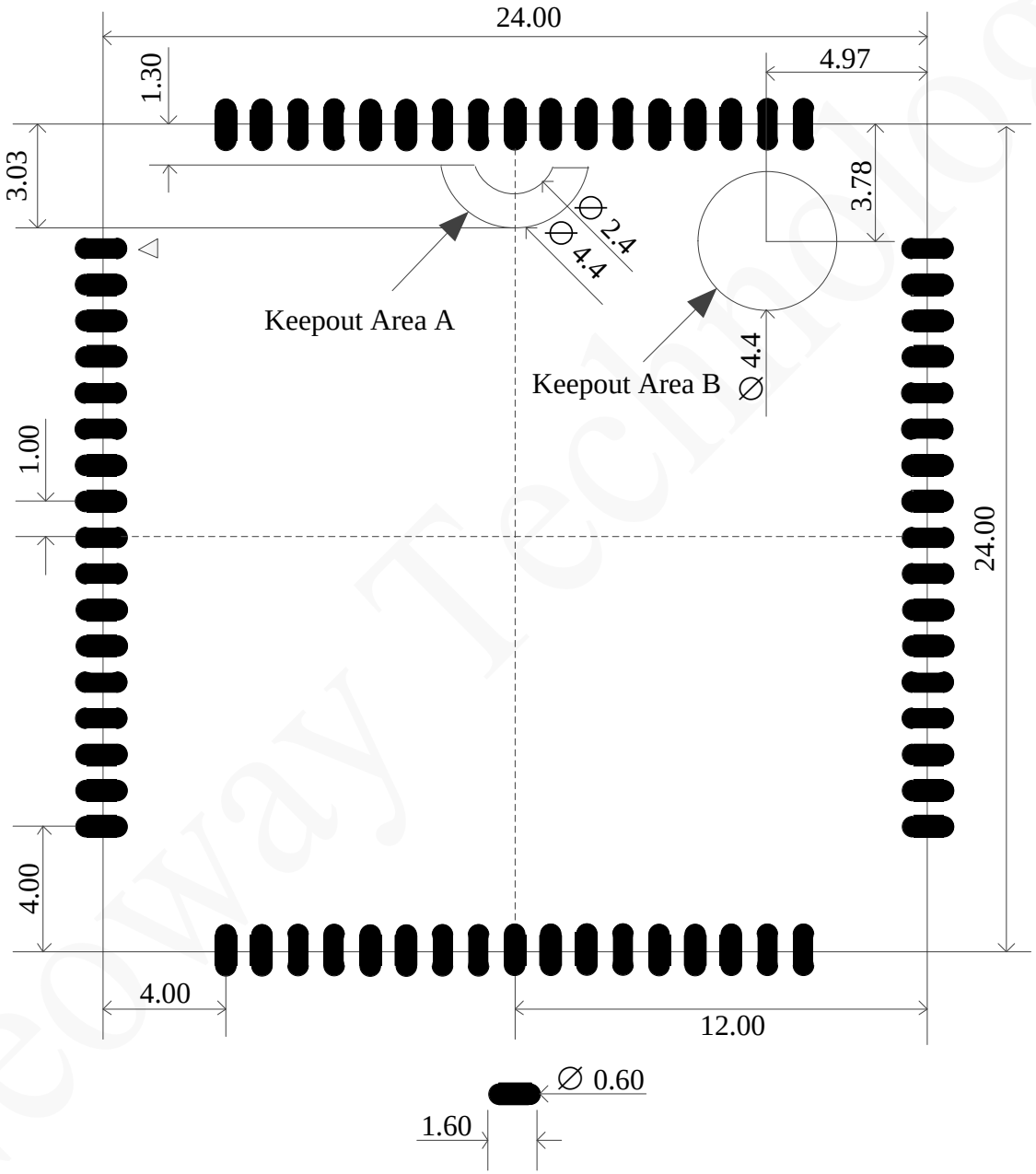
CAUTION

The maximum input voltage at all IO ports (including peak signal current) cannot exceed 3.1 V because the module uses a 2.8 V IO power system. In the application of the module, the IO output voltage from the 3.3 V power supply system of the external circuit might greatly overshoot 3.1 V due to the signal integrity design. In this situation, the IO pins of the module might be damaged if the IO signals are connected to the IO port on the 2.8-V system. To rectify this issue, take measures to match the level. For details, see the 3.2 UART.

2.3 PCB Foot Print

LCC packaging is adopted to package the pins of the M660A module. Figure 2-2 shows the recommended PCB foot print.

Figure 2-2 PCB foot print recommended for M660A (unit: mm)



CAUTION

No trace or copper is allowed in the keepout aera.

3 Interface Design

3.1 Power Supply and Switch Interfaces

Table 3-1 Power supply and switch interface

Pin Name	I/O	Function	Remarks
VBAT	P	Main power supply input	3.5 V to 4.3 V (3.9 V is recommended)
VDD_EXT	P	2.8 V power supply output	Loading capability < 50 mA
VRTC	P	RTC power supply input	2.8 V, 2 mA at most
ON/OFF	DI	ON/OFF input	Triggered by low level
RESET	DI	Module reset input	Triggered by low level Keep more than 100 ms

3.1.1 VBAT

VBAT is the main power supply of the module. Its input voltage ranges from 3.5 V to 4.3 V and the preferable value is 3.9V. In addition to digital signals and analog signals, it supplies power for RF power amplifier.

The performance of VBAT is a critical path to module's performance and stability. The peak input current at the VBAT pin can be up to 2 A when the signal is weak and the module works at the maximum transmitting power. The voltage will encounter a drop in such a situation. If the voltage drops lower than 3.5 V, the module might restart.

Figure 3-1 Current peaks and voltage drops

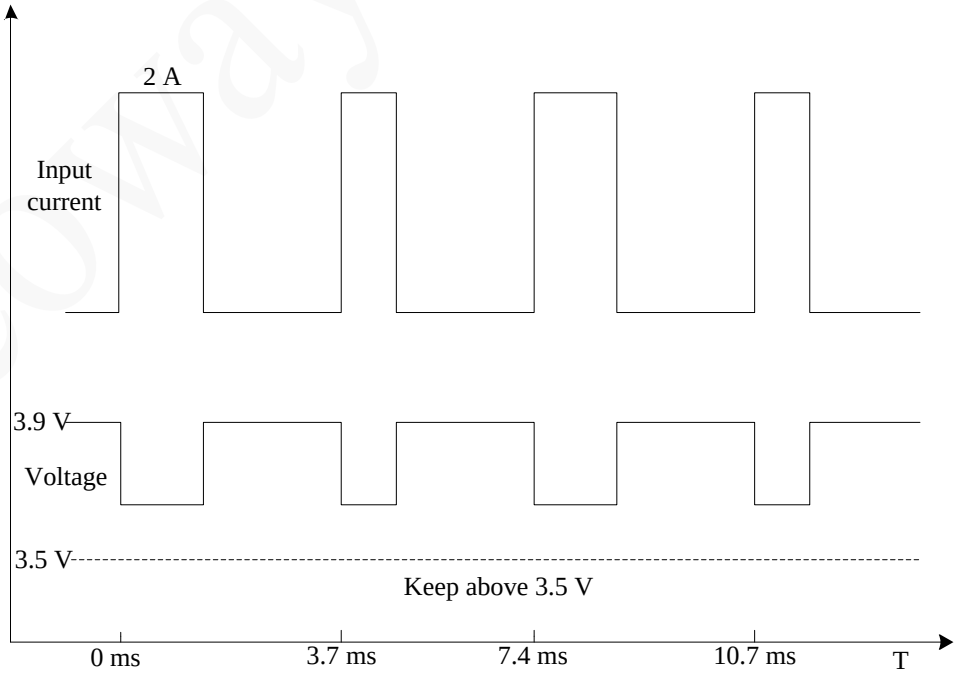
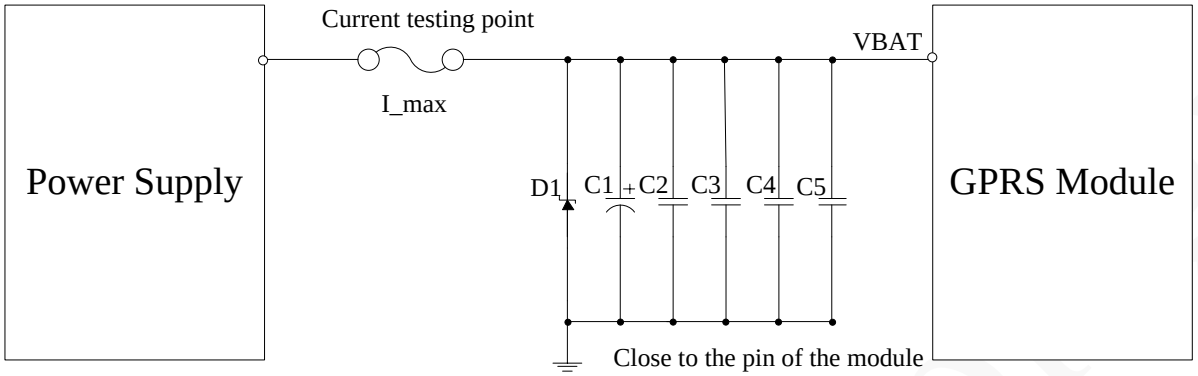


Figure 3-2 shows a recommended power supply design for the module.

Figure 3-2 Reference design d for the power supply

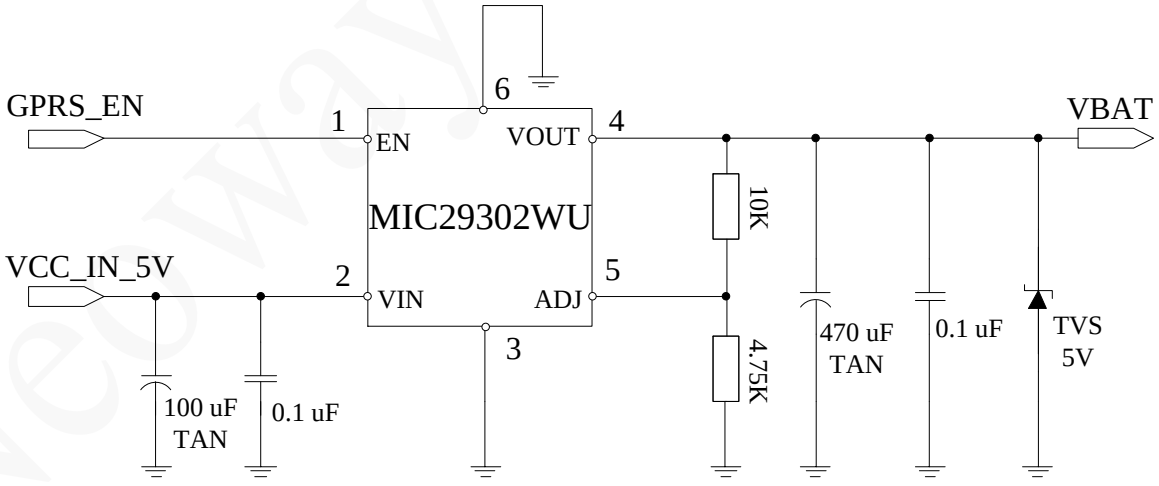


In the circuit, you can use TVS at D1 to enhance the performance of the module during a burst. SMF5.0AG (Vrwm=5V&Pppm=200W) is recommended. A large bypass tantalum capacitor (220 μF or 100 μF) or aluminum capacitor (470 μF or 1000 μF) is expected at C1 to reduce voltage drops during bursts together with C2 (10 μF capacitor). In addition, you need to add 0.1 μF, 100 pF, and 33 pF filter capacitors to enhance the stability of the power supply.

A controllable power supply is preferable if used in harsh conditions. The module might fail to reset in remote or unattended applications, or in an environment with great electromagnetic interference (EMI). If you adapt 5 V power supply, you can use the EN pin on the LDO or DC/DC chipset to control the switch of the power supply as shown in Figure 3-3.

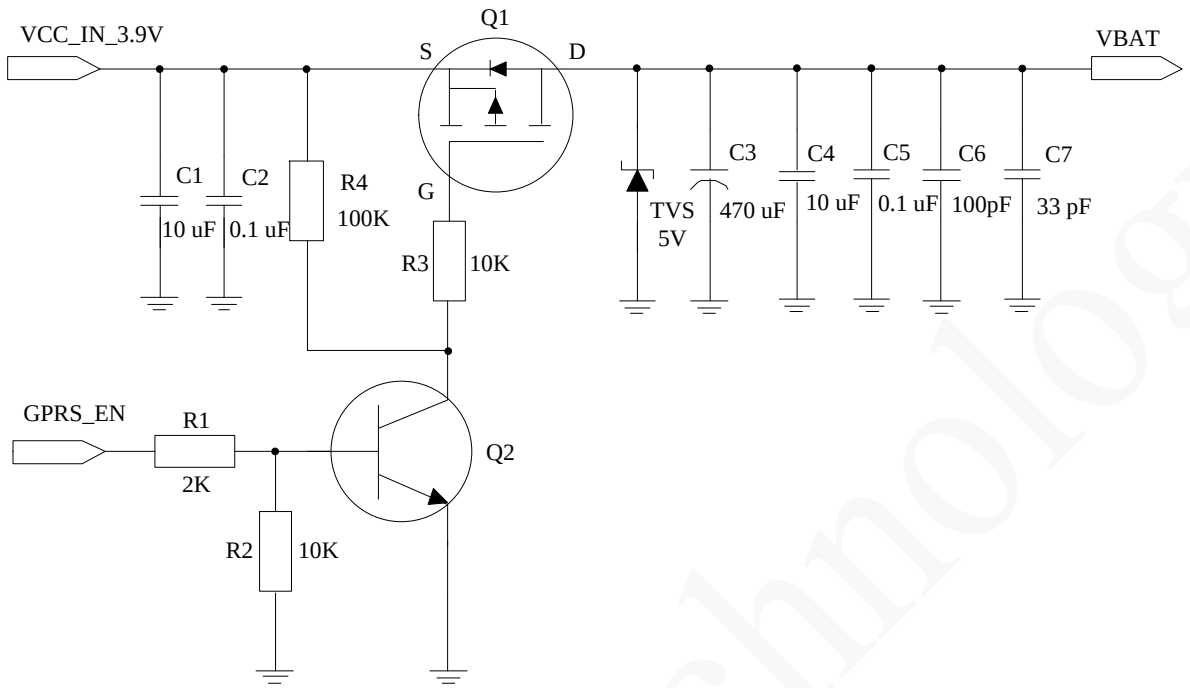
MIC29302WU in the following figure is an LDO, which can output 3 A current.

Figure 3-3 Reference design of power supply control



The alternative way is to use a p-MOSFET to control the module's power supply, as shown in Figure 3-4. When the external MCU detects the exceptions such as no response from the module or the disconnection of GPRS, power off/on can rectify the module exceptions.

Figure 3-4 Reference design of power supply controlled by p-MOSFET



In Figure 3-4, the module is powered on when GPRS_EN is set to high level.

Q2 is added to eliminate the need for a high enough voltage level of the host GPIO. In case that the GPIO can output a high voltage greater than VCC_IN_3.9V - $|V_{GS(th)}|$, where $V_{GS(th)}$ is the Gate Threshold Voltage, Q2 is not needed.

Reference components:

- Q1 can be IRML6401 or Rds(on) p-MOSFET which has higher withstand voltage and drain current.
- Q2: a common NPN transistor, e.g. MMBT3904; or a digital NPN transistor, e.g. DTC123. If digital transistor is used, delete R1 and R2.
- C3: 470 μF tantalum capacitor rated at 6.3 V; or 1000 μF aluminum capacitor. If lithium battery is used to supply power, C3 can be 220 μF tantalum capacitor.

Protection

Place a TVS diode (V_{RWM}=5 V) on the VBAT power supply to ground, especially in automobile applications. For some stable power supplies, zener diodes can decrease the power supply overshoot. MMSZ5231B1T1G from ONSEMI and PZ3D4V2 from Prisemi are options.

Trace

The trace width of primary loop lines for VBAT on PCB must be able to support the safe transmission of 2A current and ensure no obvious loop voltage decrease. Therefore, the trace width of VBAT loop line is required at least 2 mm and the ground should be as complete as possible.

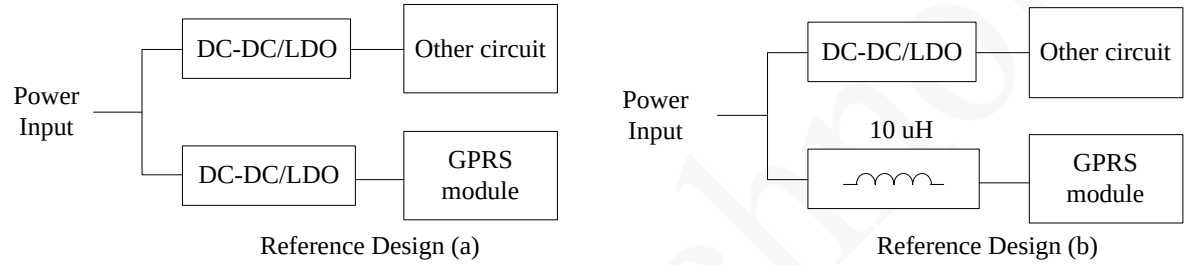
Separating

As shown in Figure 3-1, the GPRS module works in burst mode that generates voltage drops on power supply. And furthermore this results in a 217 Hz TDD noise through power (One of the way generating noise. Another way is through RF radiation). Analog parts, especially the audio circuits, are subjected to this noise, known as a "buzz noise" in GSM systems. To prevent other parts from being affected, it's better to use separated power supplies. The module shall be supplied by an independent power, like a DC/DC or LDO. See Figure 3-5.

DC/DC or LDO should output rated peak current larger than 2 A.

The inductor used in Reference Design (b) should be a power inductor and have a very low resistance. 10 μH with average current ability greater than 1.2 A and low DC resistance is recommended.

Figure 3-5 Reference designs of separated power supply



EMC Considerations

Place transient overvoltage protection components like TVS diode on power supply, to absorb the power surges. SMAJ5.0A/C could be a choice.

CAUTION

Never use a diode to make the drop voltage between a higher input and module power. Otherwise, Neoway will not provide warranty for product issues caused by this. In this situation, the diode will obviously decrease the module performances, or result in unexpected restarts, due to the forward voltage of diode will vary greatly in different temperature and current.

3.1.2 VDD_EXT

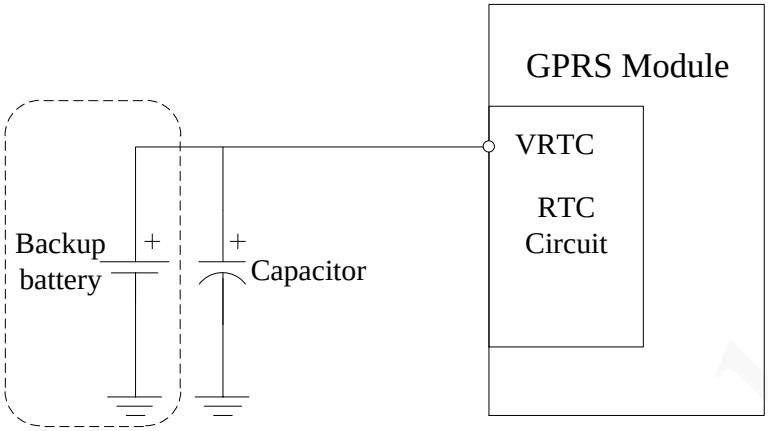
It is recommended that VDD_EXT is only used for interface level shifting. VDD_EXT can output 2.8 V and 50 mA. It stops output after the module is shut down.

3.1.3 VRTC

VRTC is the external power supply pin of RTC inside the module. It can be connected to external battery or supercapacitor. When VBAT works properly, VRTC outputs 2.8 V and maximum 2 mA and can be connected to battery or supercapacitor to charge. When VBAT is disconnected, the module can discharge the battery or capacitor to supply power for RTC circuit in short time. Leave this pin disconnected if not used.

0 shows the reference design of the VRTC power supply.

Figure 3-6 VRTC reference design



3.1.4 Power On/Off Procedure

Prior to turning on the module, power on the host MCU and finish the UART initialization. Otherwise conflictions may occur during initialization, due to unstable conditions.

ON/OFF is a low level pulse active input, used to turn on or off the module.

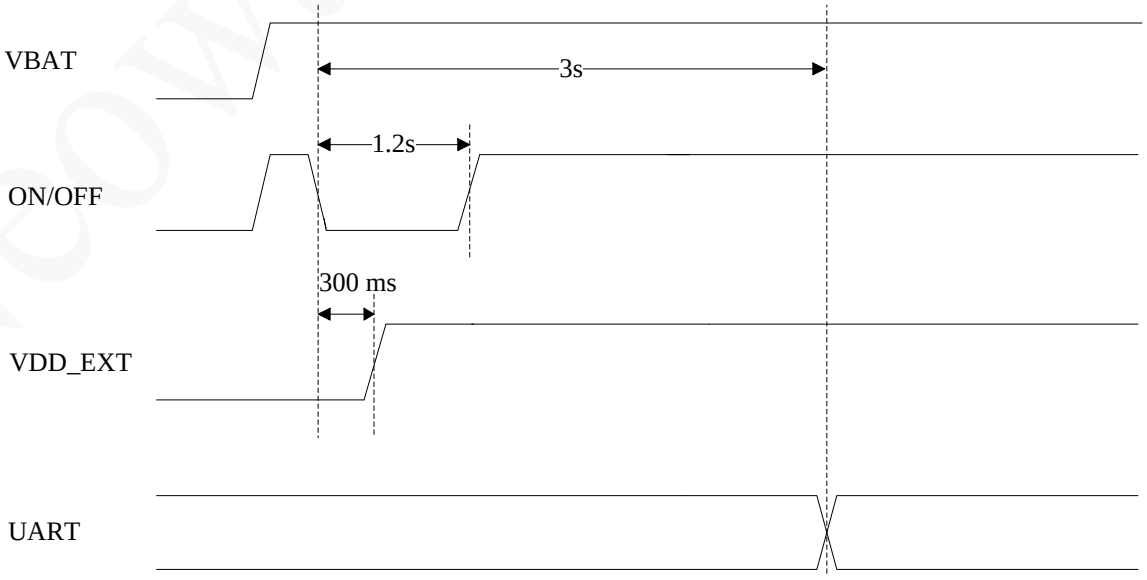
Turning on the Module

While the module is off, power on the module, drive the ON/OFF pin to ground for at least **1.2 second** and then release. The module starts. After the module is started up, keep the ON/OFF pin at high level. The UART port will send an unsolicited message (MODEM:STARTUP), indicating the powering on of the module and can respond to the AT commands.

When you design your program, you can use the unsolicited message (MODEM:STARTUP) to check whether the module is started or reset improperly.

Figure 3-7 shows the procedure of powering on the module.

Figure 3-7 Turning on procedure



Turning off the Module

While the module is on, drive the ON/OFF pin to ground for at least 5**00 ms** and then release. The module will detach to network and 2 seconds later it will shut down. Then shut down the main power supply. Figure 3-8 shows the procedure of turning off the module. Another approach to turn off the module is using AT commands. For details, see *Neo_M660A GPRS Module AT Command Set*.

Figure 3-8 Turning off procedure

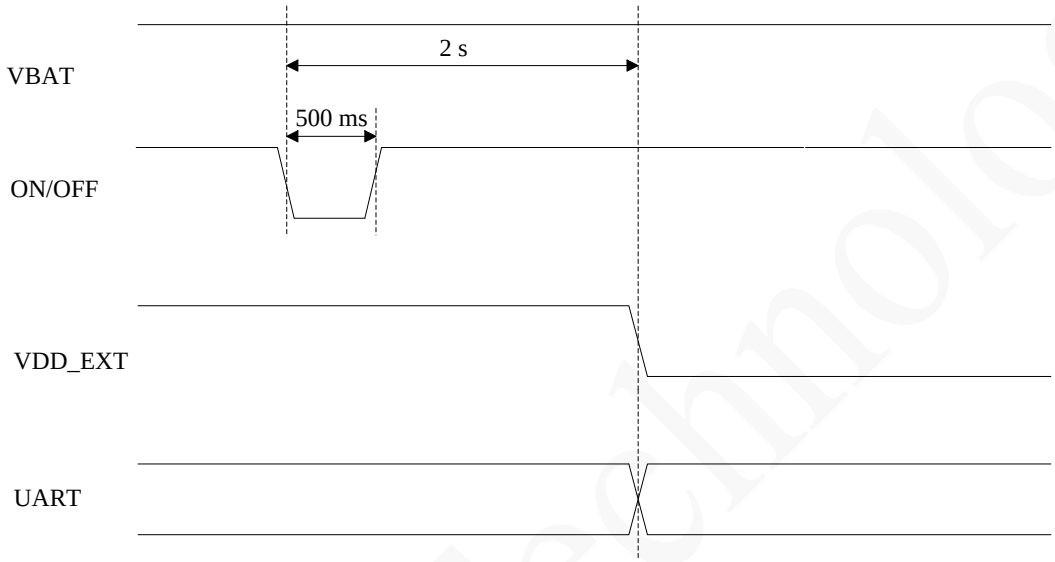


Figure 3-9 shows a reference circuit for ON/OFF control with inverted control logic.

Figure 3-9 Reference circuit for ON/OFF controlled by low level

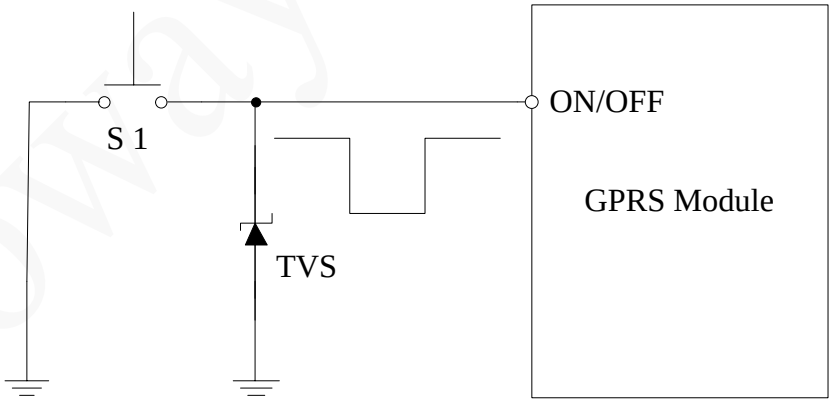
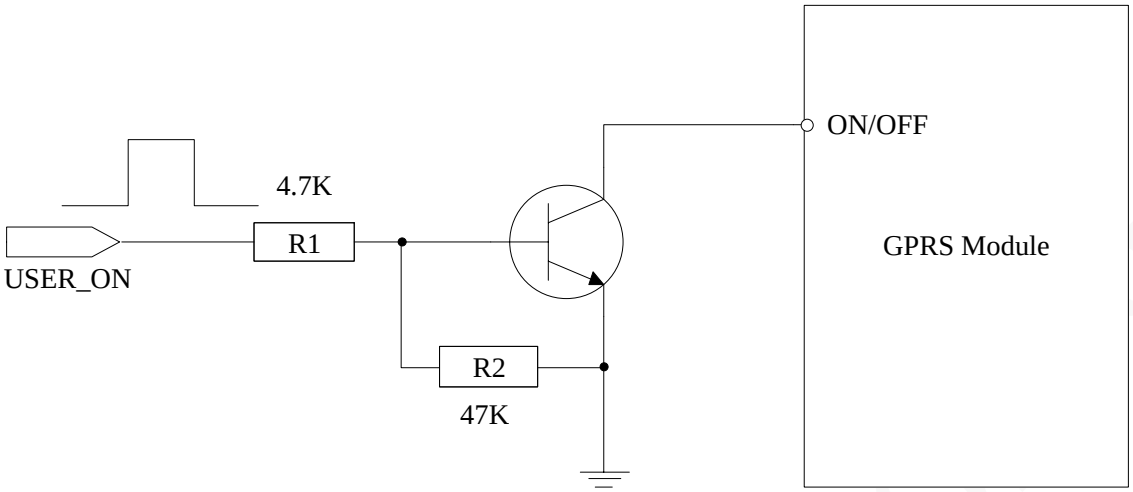


Figure 3-10 Reference circuit for power-on controlled by high level



In Figure 3-10, high level takes effect for ON/OFF on the user side (USER_ON). R1 and R2 can be adjusted according to the driving capability of the USER_ON pin. Use a common NPN transistor, e.g. MMBT3904; or a digital NPN transistor, e.g. DTC123. If digital transistor is used, delete R1 and R2.

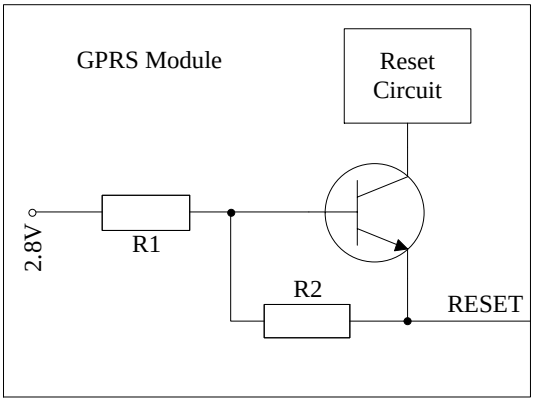
CAUTION

- Level abnormalities at interfaces connected to the external MCU, especially the UART port, might affect the power on procedure of the module. For example, when a module is turned on, the IO ports of the MCU are still in output status because they have not been initialized completely. The module might fails to start if the UTXD signal (output pin) is forced to pull up or down.
- The better way to rescue the module from abnormal condition, is to apply a power OFF-ON procedure, rather than using the ON/OFF control signal. In fact ON/OFF signal is software-dependent.

3.1.5 RESET

Pull the RESET signal to low level for more than 100 ms to reset the module. A pull-up resistor is internally included and the typical high level is 2.8 V. The RESET pin can be left disconnected if not used. A triode has been used in the internal RESET circuit. Please refer to Figure 3-11.

Figure 3-11 Reset circuit with triode separating



3.2 UART

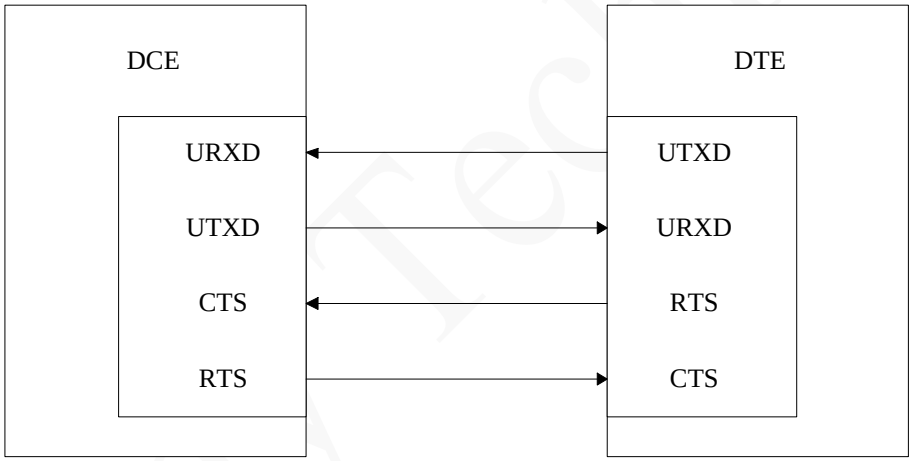
Table 3-2 UART

Pin Name	I/O	Function Description	Remarks
RTS	DO	Request to send	
CTS	DI	Clear to send	
URXD	DI	UART data receive	
UTXD	DO	UART data transmit	

UART is used for AT commands, data sending/receiving, firmware updating, etc.

Figure 3-12 shows the signal connection between the module (DCE) and the terminal (DTE).

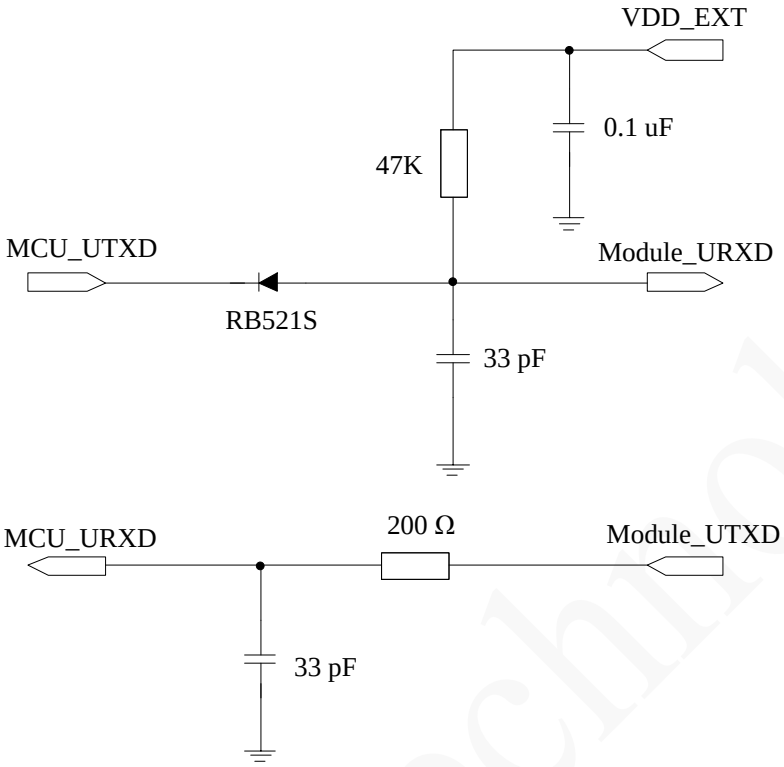
Figure 3-12 Signal connection between DCE and DTE



The UART of M660A works at **2.8 V** CMOS logic level. The voltages for input high level should **not** exceed 3.1 V. Supported baud rates range from 300 bit/s to 921600 bit/s and the default rate is **115200 bit/s**. For more details about baudrate, see *Neo_M660A GPRS Module Hardware User Guide*.

If the UART is interfacing with an MCU that has 3.3 V logic levels, resistors should be connected in series with the signals.

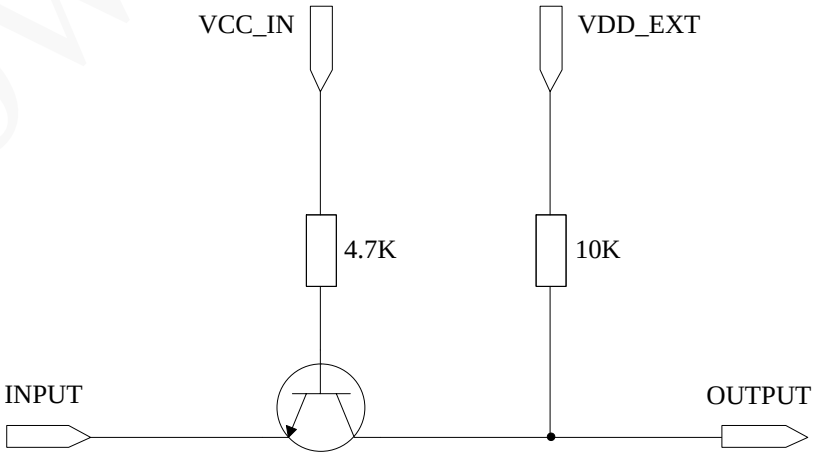
Figure 3-13 Recommended communication circuit between 3.3V MCU and UART



In Figure 3-13, 100 pF filter capacitor should be placed near the receive pin of the module. Resistor (200 Ω to 470 Ω) and capacitor (100 pF to 470 pF) can be selected based on the tested signal wave. Great serial resistance and filter capacity will decrease the signal level significantly, resulting in undesired signal wave distortion and the low adaptable UART communication baudrate. RB521S-30TE-61, RB521SM-30GJT2R, and LRB521S-30T1G are recommended for separating diode.

When the external MCU adopts 5 V IO system, level shifting is required for both UART receive and transmit. Figure 3-14 shows a reference circuit design.

Figure 3-14 Recommended communication circuit between 5V MCU and UART



INPUT is connected to TXD of the MCU and VCC_IN is connected to the 5 V power supply of the external MCU. OUTPUT is connected to RXD of the module. If the circuit is far away from the VDD_EXT pin, add a 0.1 μF decoupling capacitor to VDD_EXT.

Level shifting between RXD of the MCU and TXD of the module can be designed in the similar way.

The pull-up resistor R3 ranges from 4.7 K to 10 K; R2 ranges from 2 K to 10 K. Resistors are selected based on the voltage of the power supply and UART baudrate. You can select resistors with great resistance to reduce the power consumption when the power supply has great voltage or the baudrate is low. But, the resistance will affect the quality of the square wave. In addition, the circuit performance is affected by the signal traces during PCB layout.

It is recommended that you choose a high-speed NPN transistor because the Q1 switch rate will affect the wave quality after level shifting. MMBT3904 or MMBT2222 is recommended.

CAUTION

Avoid data produced at UART when the module is turned on. You are advised to send data to the UART 3 seconds after the module is turned on so that the module would not respond wrongly.

3.3 USB Interfaces

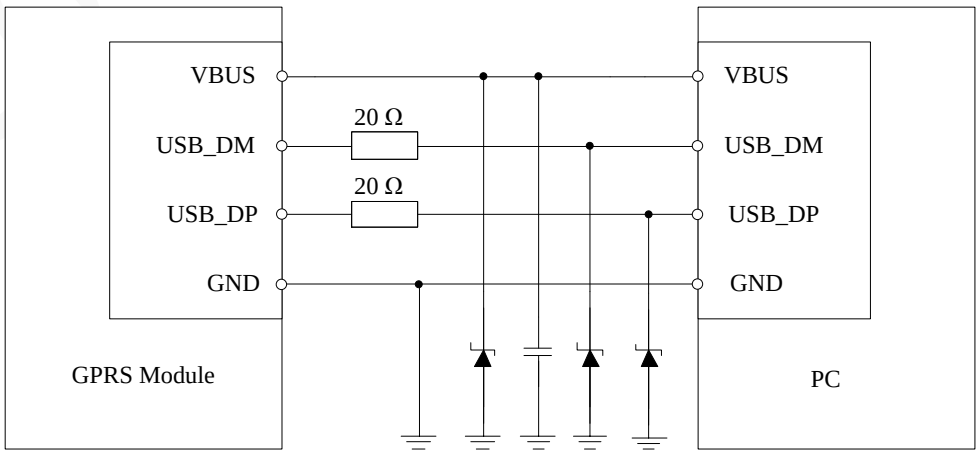
Table 3-3 USB interface

Pin Name	I/O	Function	Remarks
VBUS	AI	USB voltage check	4.3 V < VBUS < 7 V, typical value: 5 V
USB_DP	DIO	Positive signal of USB data	
USB_DM	DIO	Negative signal of USB data	

For M660A modules, you can download firmware through USB interfaces. Before download the firmware, connect the USB interface to a computer and power on the module. A dedicated download tool is required.

Figure 3-15 shows the recommended connection between the module and a computer.

Figure 3-15 USB circuit



Parallel a 1 μF filter capacitor on VBUS and place it as close to the pin as possible. You must also add TVS to the VBUS power cable. Use TVS diodes with a capacity of lower than 12 pF for protection on the data cables of USB_DP and USB_DM and adopt Differential Signal trace for USB_DP and USB_DM and ensure complete ground for separation.

CAUTION

USB interface is used only for software download.

3.4 DTR and RING

Table 3-4 DTR and RING pins

Pin Name	I/O	Function	Remarks
DTR	DI	Signal for controlling sleep mode	Low level by default Left disconnected if not used
RING	DO	Ring output	Left disconnected if not used

3.4.1 DTR Pin

Generally DTR is used to control sleep mode together with AT commands. For details, see *Neo_M660A GPRS Module AT Command Set*. Based on the setting of the selected mode, pulling DTR low will bring the module into sleep mode if the module is idle. In this mode, the idle current is less than 2 mA, depending on the DRX setting of network.

In sleep mode, the module can respond to the incoming call, SMS, and GPRS data. The host MCU can also control the module to exit sleep mode by controlling DTR.

Process of entering the sleep mode:

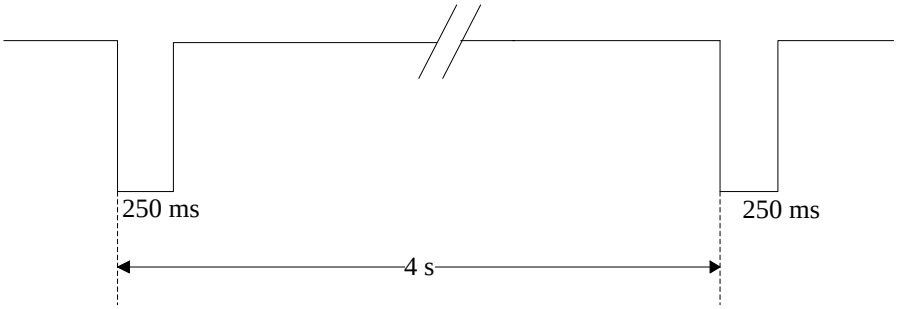
1. Keep DTR high level in normal working mode. Activate the sleep mode by using the **AT+ENPWRSAVE=1** command.
2. Pull DTR low, and the module will enter sleep mode, but only after process and pending data finished.
3. In the sleep mode, the external MCP can pull DTR high so that the module will exit from sleep mode actively. Then the module can transmit data and initiate calls. After processing is finished, pull DTR low again to take the module back to sleep mode.
4. In sleep mode, the module can be woken up by the events of incoming voice call, received data, or SMS. Meanwhile the module will send out the unsolicited messages through the UART.

   Upon receipt of the unsolicited messages, the host MCU should pull DTR high firstly, otherwise the module will resume sleep mode in two minutes after the service processing. And then the host MCU can process the voice call, received data, or SMS. After processing is finished, pull DTR low again to put the module into sleep mode.

3.4.2 RING Signal Indicator

- Calling: Once a voice call is coming, UART output "RING" character strings and meanwhile the RING pin outputs 250 ms low pulses at 4s period. After the call is answered, the high level restores.

Figure 3-16 RING indicator for incoming call



- SMS: Upon receipt of SMS, the module outputs one 600 ms low pulse.

Figure 3-17 RING indicator for SMS

3.5 SIM Card Interface

Table 3-5 SIM card interface

Pin Name	I/O	Function Description	Remarks
VSIM	P	SIM card power supply output	1.8/3.0V
SIM_CLK	DO	SIM card clock output	
SIM_RST	DO	SIM card reset output	
SIM_DATA	DI/O	SIM card data IO	With internal pull-up resistor

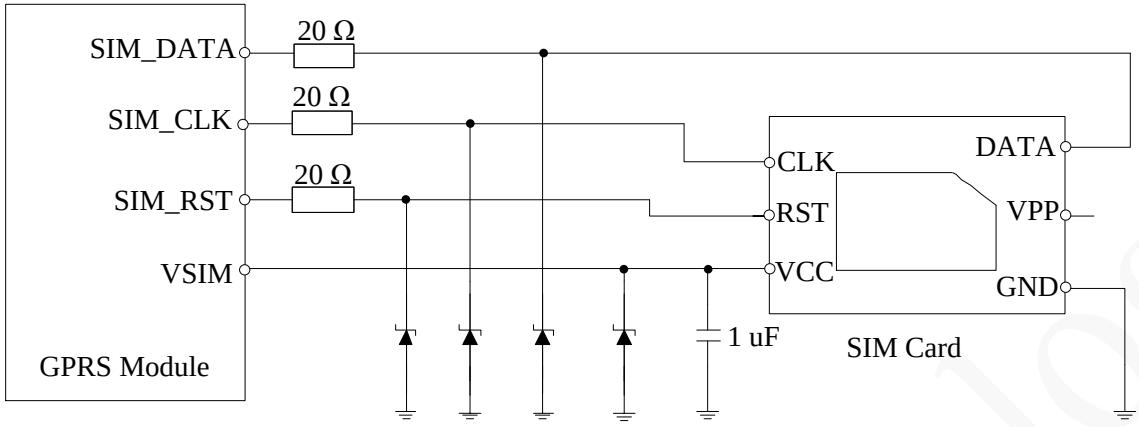
M660A supports 3.0 V and 1.8 V SIM cards. VSIM supplies power for SIM card at Max. 30 mA.

SIM_DATA is pulled up by an internal resistor. You do not have to add and external pull-up resistor in your design.

SIM_CLK can work at several frequencies at 3.25 MHz typically. SIM card is sensitive to GSM TDD noise and RF interference. So, the PCB design should meet the following requirements:

- The antenna especially build-in antenna should be installed a long distance away from the SIM card and SIM card traces.
- The PCB traces of SIM should be as short as possible and shielded with GND copper.

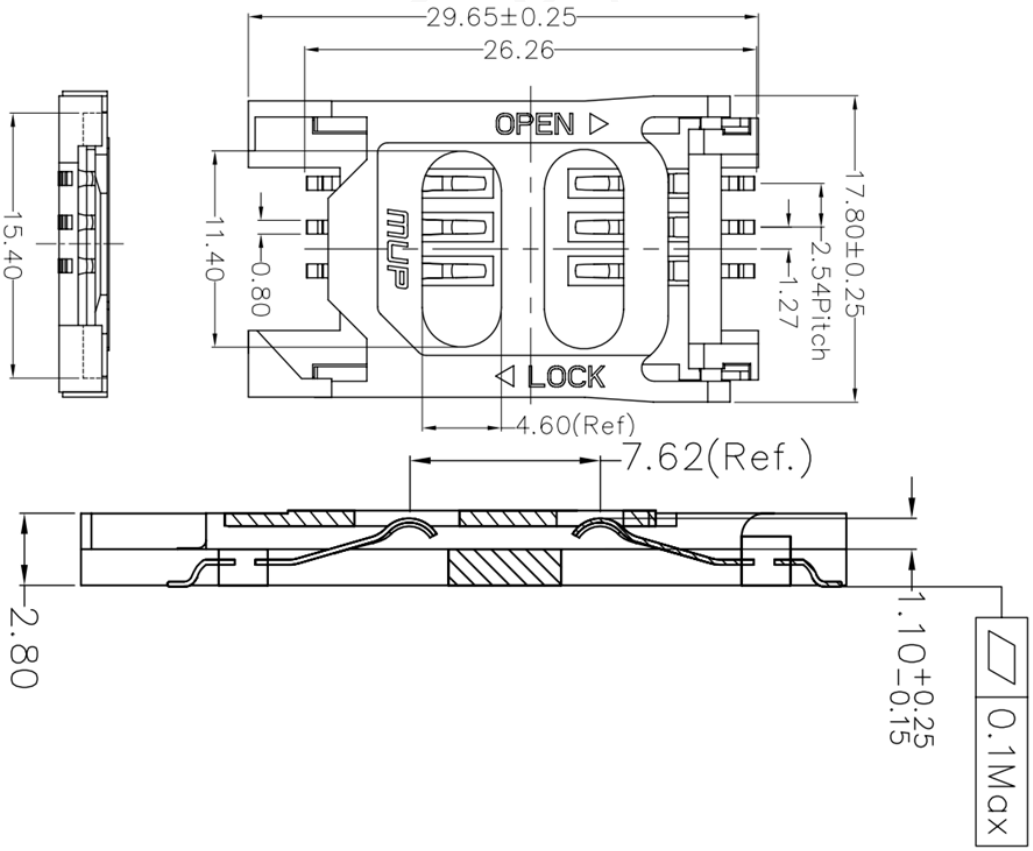
Figure 3-18 Reference design of SIM card interface



ESD protectors, such as ESD diodes (lower than 33 pF) or ESD varistors, are recommended on the SIM signals, especially in automotive electronics or other applications with badly ESD. In other applications, replace ESD diodes with 27 pF to 33 pF grounding capacitors. The ESD diodes or small capacitors should be close to the SIM card pin on the socket.

If you use 6-pin SIM card sockets, MCP-C713(H2.8) is recommended. Figure 3-19 shows its encapsulation.

Figure 3-19 Reference of SIM card socket



3.6 Running LED Indicator

Table 3-6 LED indicator

Pin Name	I/O	Function	Remarks
LIGHT	DO	Indicates running status	2.8 V output, max. 4 mA

When the module is running, the LED indicator is driven by the LIGHT pin to indicate different module status with its various blink behaviors. For how to set the LED indicator, see *Neo_M660A GPRS Module AT Command Set*.

LIGHT can output 4 mA current and 2.8 V high level, therefore the LED can be directly connected to this pin with a resistor in series. For better luminance, drive the LED with a transistor instead.

Figure 3-20 LED indicator directly driven by high level

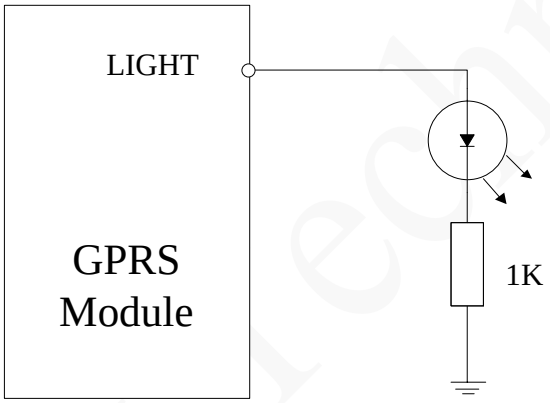
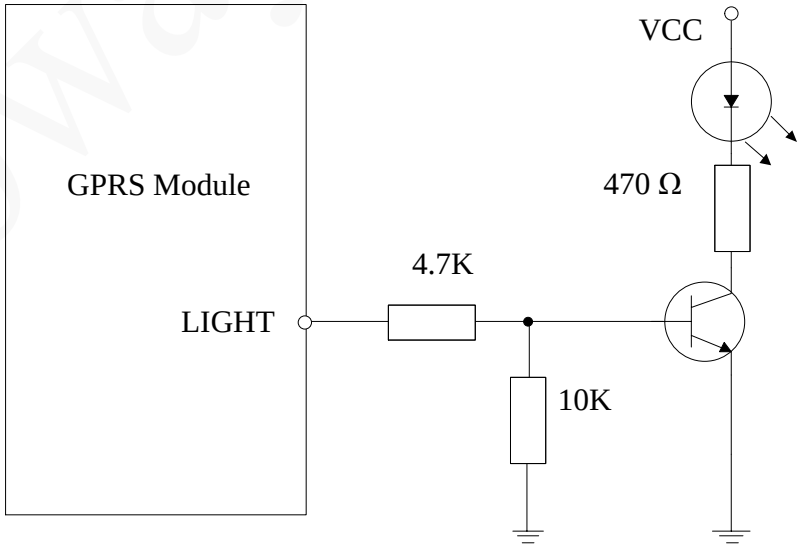


Figure 3-21 LED indicator driven by transistor



3.7 Audio Interface

Table 3-7 Audio interface

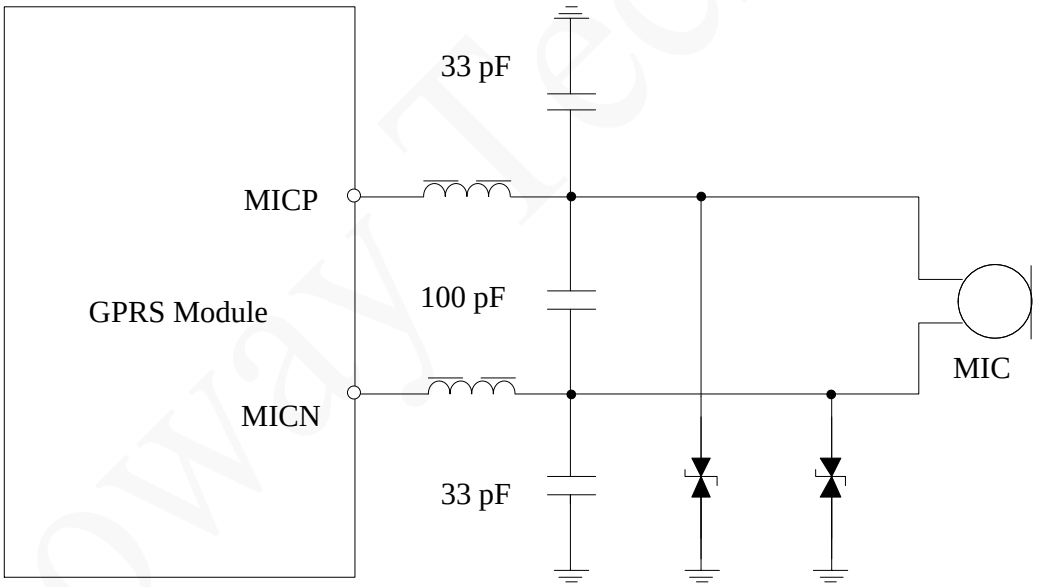
Pin Name	I/O	Function	Remarks
MICP	AI	Positive electrode of MIC output	Vpp≤200 mV
MICN	AI	Negative electrode of MIC output	
RECP	AO	Positive electrode of receiver output	32Ω receiver driving output
RECN	AO	Negative electrode of receiver output	

M660A supports two lines of audio interfaces. You can switch the audio channels and adjust the volume via AT commands. For details, see *Neo_M660A GPRS AT Command Set*.

Figure 3-22 shows a reference audio interface design. The peak voltage routed to MICP/MICN should not exceed 200 mV AC. AGC circuit is integrated inside the module. Electret microphone is suited.

The module can meet the requirements of common handsets with AGC and volume control.

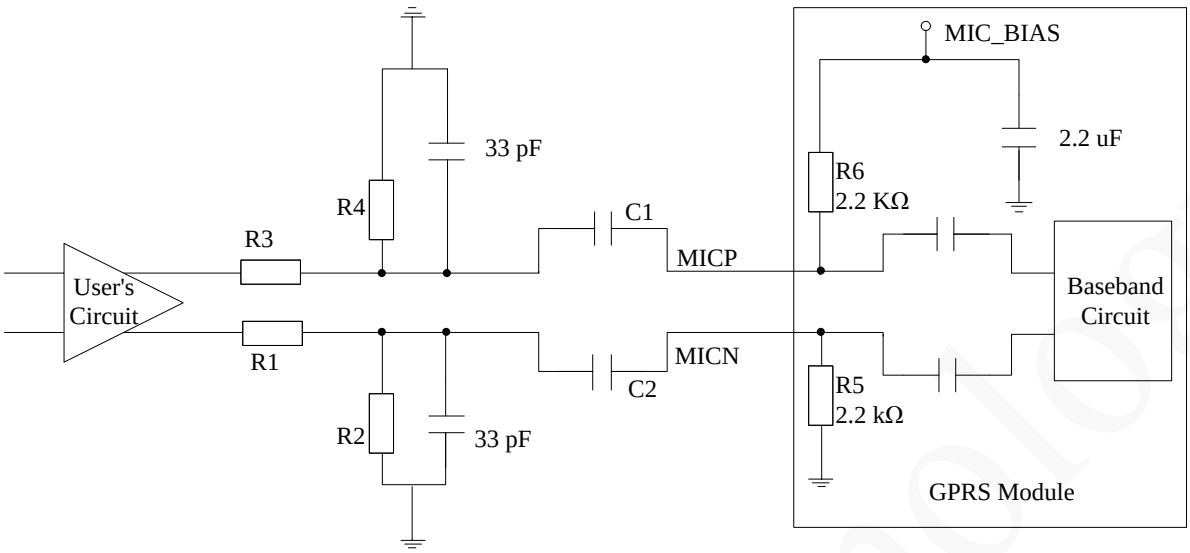
Figure 3-22 Reference design of MIC differential connections



In Figure 3-23, a bias voltage for microphone is provided through MICP and MICN. But if an amplifier is used between the microphone and module, capacitors like C1 and C2, should be placed between the outputs of amplifier and module, to block the bias voltage.

For a peak voltage greater than 200 mV AC, an attenuation circuit comprised of R1-R4 should be used.

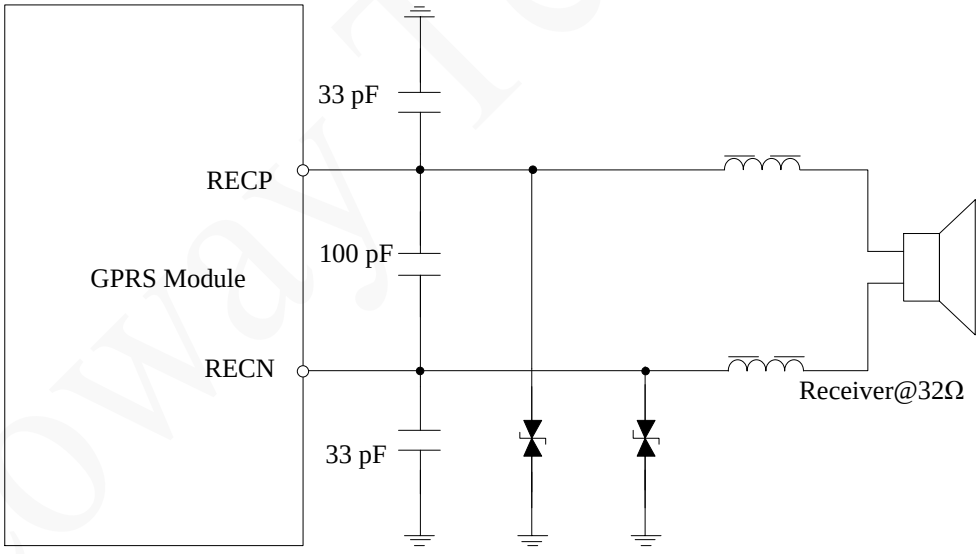
Figure 3-23 Reference design for common audio input



In Figure 3-22 and Figure 3-23, the audio input circuits are designed to meet the requirements for small audio signal, far away from interference source and masking PCB routing by ground.

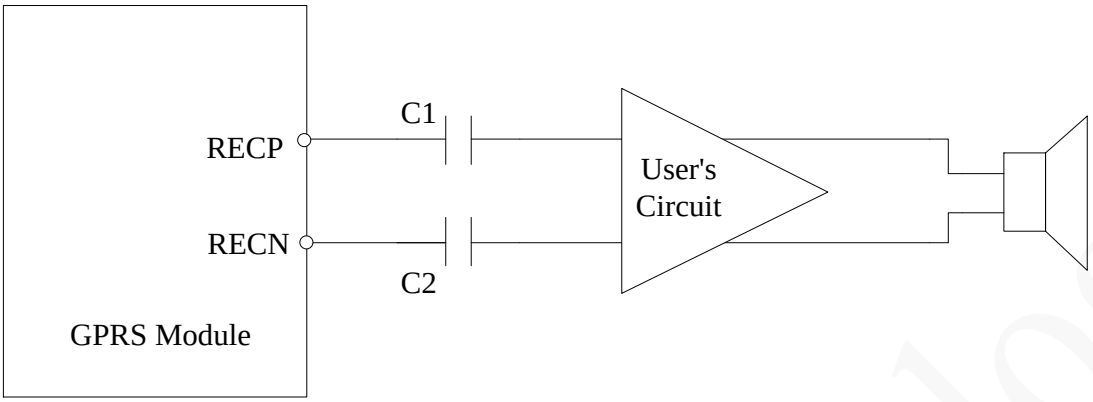
Figure 3-24 shows a reference design for the receiver interface, which can drive a 32 Ω receiver directly.

Figure 3-24 Reference design for receiver output



If an external amplifier is used for driving the speakers, coupling capacitors of 2.2 μF to 4.7 μF should be used to block the DC voltage, as shown in Figure 3-25.

Figure 3-25 Coupling capacitor interfacing



3.8 RF Interface

3.8.1 RF Design and PCB Layout

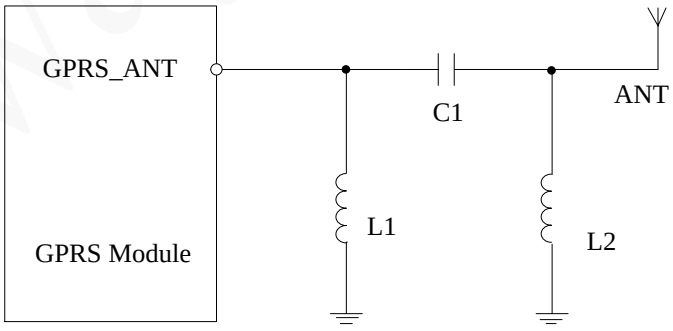
GPRS_ANT is the antenna interface of the module. A 50 Ω antenna is required. VSWR ranges from 1.0 to 1.5. The antenna should be well matched to achieve best performance. It should be installed far away from high speed logic circuits, DC/DC power, or any other strong disturbing sources.

For multiple-layer PCB, the trace between the antenna pad of module and the antenna connector, should have a 50 Ω characteristic impedance, and be as short as possible. The trace should be surrounded by ground copper. Place plenty of via holes to connect this ground copper to main ground plane, at the copper edge.

If the trace between the module and connector has to be longer than 10 mm, or built-in antenna is used, a π-type matching circuit should be added, as shown in Figure 3-26. The types and values of C1, L1, and L2 should be verified by testing using network analyzer instrument. If the characteristic impedance is well matched, and VSWR requirement is met, just use a 0 Ω resistor for C1 and leave L1, L2 un-installed.

Avoid any other traces crossing the antenna trace on neighboring layer.

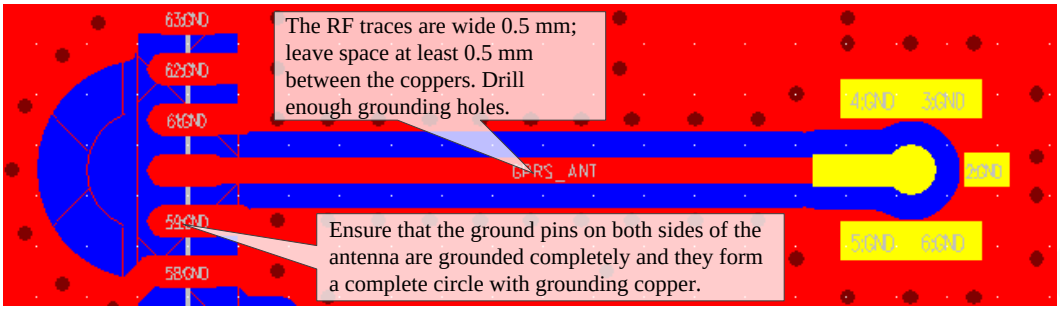
Figure 3-26 Reference design for antenna interface



On two−layer boards which cannot control resistance properly, the RF route should be as short (less than 10 mm) and smooth as possible and at a width of 0.5 mm; the RF is 0.5 mm away from the ground.

Figure 3-27 shows a two-layer board application. The RF is connected to GSC RF connector through traces on PCB, which is connected to the antenna via cable.

Figure 3-27 RF layout reference



CAUTION

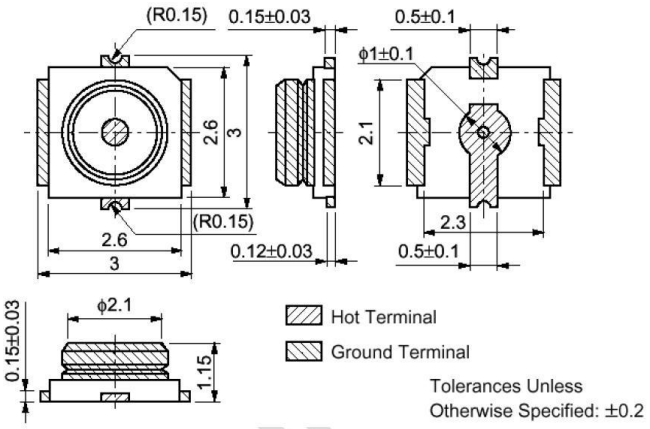
ESD protection is built in module. For special ESD protection, an ESD diode can be placed close to the antenna. But ensure using a low junction capacitance ESD diode. The junction capacitance should be less than 0.5 pF, otherwise the RF signal will be attenuated. RCLAMP0521P from Semtech, or ESD5V3U1U from Infineon, can be used here.

On the PCB, keep the RF signals and RF components away from high-speed circuits, power supplies, transformers, great inductors, the clock circuit of single-chip host, etc.

3.8.2 Recommended RF Connection

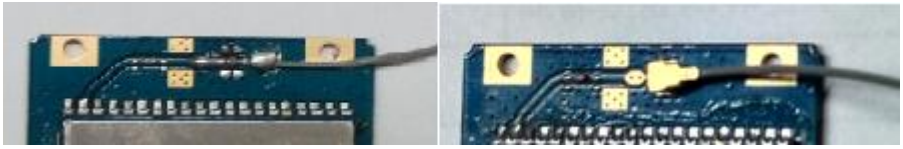
If you adopts RF cables for connections, the GSC RF connector MM9329-2700RA1 from Murata is recommended. Figure 3-28 shows the encapsulation specifications.

Figure 3-28 Encapsulation specifications of Murata RF connector



RF cable can also be connected to the module by soldering. In this manner, you must ensure proper soldering in case of damage that lowers RF performance. Figure 3-29 shows the pictures of these two connections.

Figure 3-29 RF connections



4 Electric Features and Reliability

4.1 Electric Feature

Table 4-1 Electric feature of the module

Parameter		Minimum Value	Typical Value	Maximum Value
VBAT	Vin	3.5 V	3.9 V	4.3 V
	Iin	/	/	2 A
VBUS		4.3 V	5 V	7 V
VDD_EXT	Vout	/	2.8 V	/
	Iout	/	/	50 mA
DIO	Vout	2.3 V	2.8 V	3.1 V
	Iout	/	/	4 mA
	Vin	-0.3 V	0 V	0.6 V
	Iin	/	/	22.5 μA

CAUTION

If the voltage is too low, the module might fail to start. If the voltage is too high or there is a voltage burst during the startup, the module might be damaged permanently.

If you use LDO or DC-DC to supply power for the module, ensure that it output at least 2 A current.

4.2 Temperature

Table 4-2 Temperature Feature

Module Status	Minimum Value	Typical Value	Maximum Value
Working	-40℃	25℃	85℃
Storage	-45℃		90℃

CAUTION

If the module works in temperature exceeding the thresholds, its RF performance (e.g. frequency deviation or phase deviation) might be worse but it can still work properly.

4.3 Current

Table 4-3 Current feature

Parameter	Testing Conditions		Testing Result (Average Current)
Testing voltage	3.9 V Agilent power supply		/
Idle mode	Set the instrument and power on the module.		18 mA
Off leakage current	Power on the module or use AT command to shut the module down.		60 μA
Average network searching current	Set the instrument. Start the module. Wait until the module registers the instrument.		60 mA
Sleep mode	On a live network, the module registers the network and then enters the sleep mode.		1.8 mA
	Set the instrument properly (DRX=9)		992 μA
Voice service	Maximum power level in full rate mode	GSM850	210 mA
		EGSM900	200 mA
		DCS1800	135 mA
		PCS1900	140 mA
GPRS class 12	4TX,1RX(4Up/1Down)	GSM850	425 mA
		EGSM900	422 mA
		DCS1800	260 mA
		PCS1900	275 mA
	1TX,4RX(1Up/4Down)	GSM850	200 mA
		EGSM900	185 mA
		DCS1800	155 mA
		PCS1900	140 mA

NOTE

The data in the above table is typical values obtained during tests in lab. It might be a little bit different caused by the difference of the module hardware. Also, the test results might be various due to different setting or testing methods.

4.4 ESD Protection

Electronics need to pass sever ESD tests. The following table shows the ESD capability of key pins of our module. It is recommended that you add ESD protection to those pins in accordance to the application to ensure your product quality when designing your products.

Humility: 45%

Temperature: 25℃

Table 4-4 ESD feature of the module

Testing Point	Contact Discharge	Air Discharge
VBAT	±8KV	±15KV
GND	±8KV	±15KV
ANT	±8KV	±15KV
Cover	±8KV	±15KV
RXD/TXD	±4KV	±8KV
USB	±4KV	±8KV
MIC/ REC	±4KV	±8KV
Others	±4KV	±8KV

5 RF Features

5.1 Work Band

Table 5-1 Work band

Work Band	Uplink	Downlink
GSM850	824~849MHz	869~894MHz
EGSM900	880~915MHz	925~960MHz
DCS1800	1710~1785MHz	1805~1880MHz
PCS1900	1850~1910MHz	1930~1990MHz

5.1.2 Transmitting Power

Table 5-2 Transmitting power (GSM850&EGSM900)

PCL	Transmitting Power	Threshold Range
5	33 dBm	±2 dBm
6	31 dBm	±3 dBm
7	29 dBm	±3 dBm
8	27 dBm	±3 dBm
9	25 dBm	±3 dBm
10	23 dBm	±3 dBm
11	21 dBm	±3 dBm
12	19 dBm	±3 dBm
13	17 dBm	±3 dBm
14	15 dBm	±3 dBm
15	13 dBm	±5 dBm
16	11 dBm	±5 dBm
17	9 dBm	±5 dBm
18	7 dBm	±5 dBm
19	5 dBm	±5 dBm

Table 5-3 Transmitting power (DCS1800&PCS1900)

PCL	Transmitting Power	Threshold Range
0	30 dBm	±2 dBm

1	28 dBm	±3 dBm
2	26 dBm	±3 dBm
3	24 dBm	±3 dBm
4	22 dBm	±3 dBm
5	20 dBm	±3 dBm
6	18 dBm	±3 dBm
7	16 dBm	±3 dBm
8	14 dBm	±3 dBm
9	12 dBm	±3 dBm
10	10 dBm	±4 Bm
11	8 dBm	±4 Bm
12	6 dBm	±4 Bm
13	4 dBm	±4 dBm
14	2 dBm	±5 dBm
15	0 dBm	±5 dBm

5.1.3 Receiving Sensitivity

Band	Typical
GSM800&EGSM900	<-107 dBm
DCS1800&PCS1900	<-107 dBm

NOTE

The data in the above tables is obtained by connecting the module to RF test instrument (e..g. CMU200, CWM500, or Agilent8960) in lab tests. It is for reference only.

6 Mounting the Module onto the Application Board

M660A is compatible with industrial standard reflow profile for lead-free SMT process.

The reflow profile is process dependent, so the following recommendation is just a start point guideline:

- Only one flow is supported.
- Quality of the solder joint depends on the solder volume. Minimum of 0.15 mm stencil thickness is recommended.
- Use bigger aperture size of the stencil than actual pad size.
- Use a low-residue, no-clean type solder paste.

7 Package

M660Amodules are packaged in sealed bags on delivery to guarantee a long shelf life. Package the modules again in case of opening for any reasons.

If exposed in air for more than 48 hours at conditions not worse than 30℃/60% RH, a baking procedure should be done before SMT. Or, if the indication card shows humidity greater than 20%, the baking procedure is also required.

The baking should last for at least 12 hours at 90℃.

8 Abbreviations

ADC	**Analog-Digital Converter**
AFC	Automatic Frequency Control
AGC	Automatic Gain Control
AMR	Acknowledged multirate (speech coder)
CSD	Circuit Switched Data
CPU	Central Processing Unit
DAI	Digital Audio interface
DAC	Digital-to-Analog Converter
DCE	Data Communication Equipment
DSP	Digital Signal Processor
DTE	Data Terminal Equipment
DTMF	Dual Tone Multi-Frequency
DTR	Data Terminal Ready
EFR	Enhanced Full Rate
EGSM	Enhanced GSM
EMC	Electromagnetic Compatibility
EMI	Electro Magnetic Interference
ESD	Electronic Static Discharge
ETS	European Telecommunication Standard
FDMA	Frequency Division Multiple Access
FR	Full Rate
GPRS	General Packet Radio Service
GSM	Global Standard for Mobile Communications
HR	Half Rate
IC	Integrated Circuit
IMEI	International Mobile Equipment Identity
LCD	Liquid Crystal Display
LED	Light Emitting Diode
MS	Mobile Station
PCB	Printed Circuit Board
PCS	Personal Communication System

RAM	Random Access Memory
RF	Radio Frequency
ROM	Read-only Memory
RMS	Root Mean Square
RTC	Real Time Clock
SIM	Subscriber Identification Module
SMS	Short Message Service
SRAM	Static Random Access Memory
TA	Terminal adapter
TDMA	Time Division Multiple Access
UART	Universal asynchronous receiver-transmitter
VSWR	Voltage Standing Wave Ratio