



Quectel Cellular Engine

GSM UART Port Application Notes

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0. Revision history

Revision	Date	Author	Description of change
1.00	2009-06-25	Jay XIN / Ken JI	Initial
1.01	2009-11-16	Doron ZHANG	<ol style="list-style-type: none">1. Add the description of baud rate2. Modify behavior of RI and figure 8, 9, 10, 11.3. Modify figure 1, 2, 3, 4, 6.

1. Introduction

This document describes the UART port of Quectel GSM module and how to use it in customer's application design. This document can help you quickly understand the UART port of the module.

Note: AT command can be input through UART port only after module is powered on and the Unsolicited Result Code "RDY" is output (if the module is set to autobauding mode, "RDY" is not output. Please refer to Chapter 7 for autobauding description).

2. Connection

Data Terminal Equipment (DTE), such as MCU or external controller, can communicate with the module through its UART port which can implement AT command, GPRS transfer, upgrade firmware. The voltage level of UART port interface is 2.8 Volts. If the voltage level of DTE's UART pins doesn't match with the module, level shifter circuit should be inserted.

The UART pins include Transmitting data (TXD), Receiving data (RXD), Request To Send (RTS), Clear To Send (CTS), Data Terminal Ready (DTR), Data Carrier Detect (DCD) and Ring Indicator (RI). Not all UART pins are necessary in customer's application. If the module is used as a modem, all pins are needed. The modem control signal RI can be used to indicate to the DTE that a call or Unsolicited Result Code (URC) is received. Hardware handshake using the RTS and CTS signals and XON/XOFF software flow control are both supported.

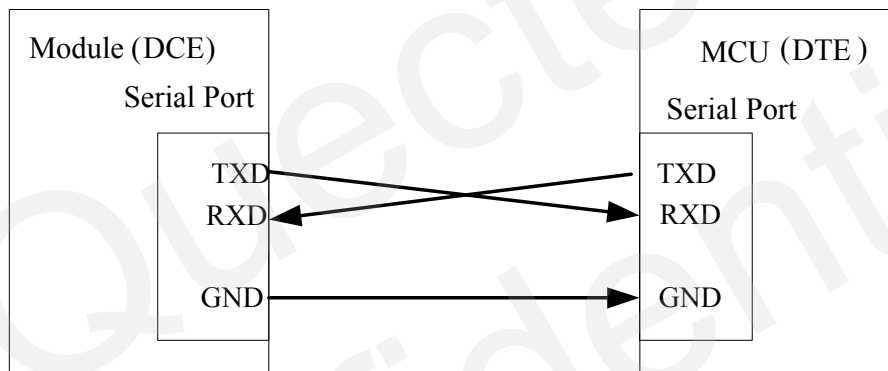


Figure 1: Connecting TXD and RXD

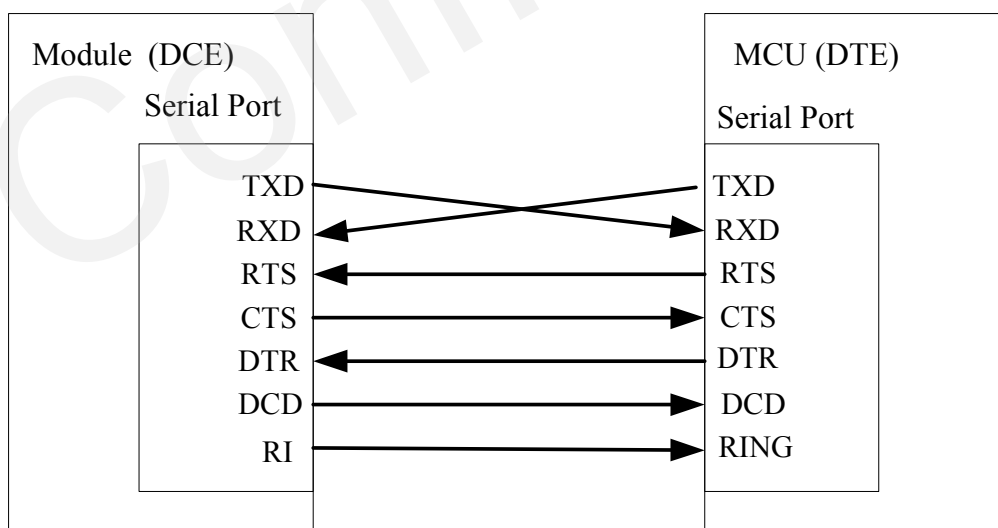


Figure 2: Connecting Full Function UART signals

3. Level Shifter

Normally, the voltage of VDD_EXT is 2.8V and the DC characteristics of UART port are listed in Table 1.

Table 1: Logic levels of the UART port

Symbol	MIN	MAX	Unit
V _{IL}	0	0.67	V
V _{IH}	1.7	VDD_EXT+0.3	V
V _{OL}	0	0.34	V
V _{OH}	2.0	VDD_EXT	V

Note: If the voltage level of UART pins in DTE doesn't match with the module, a level shifter circuit should be inserted.

3.1. Communicate with DTE

It is recommended to design the level shift circuit by choosing open drain output buffer (e.g. NC7WZ07) or discrete transistor.

Note: VDD_EXT is supplied by the module(2.8V). VCC_MCU is the voltage for host MCU UART interface

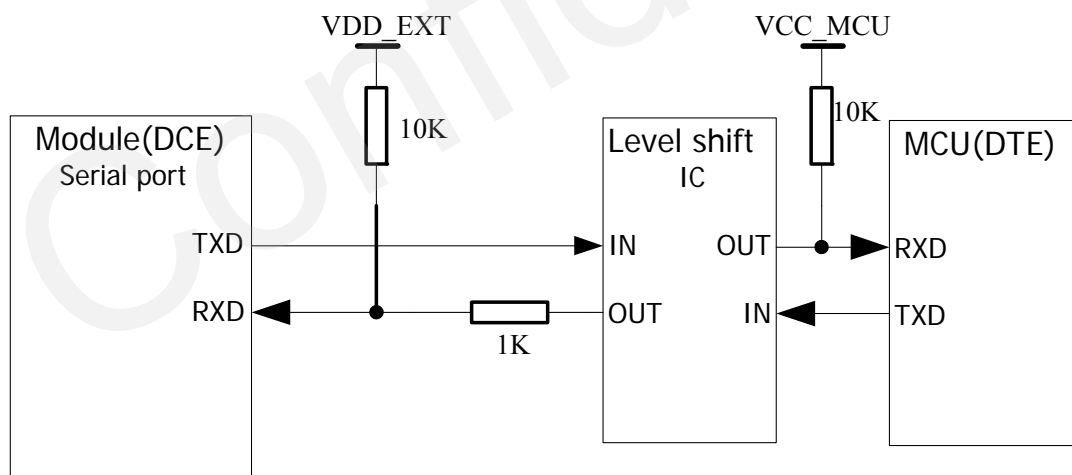


Figure 3: The reference level shifter by using open drain

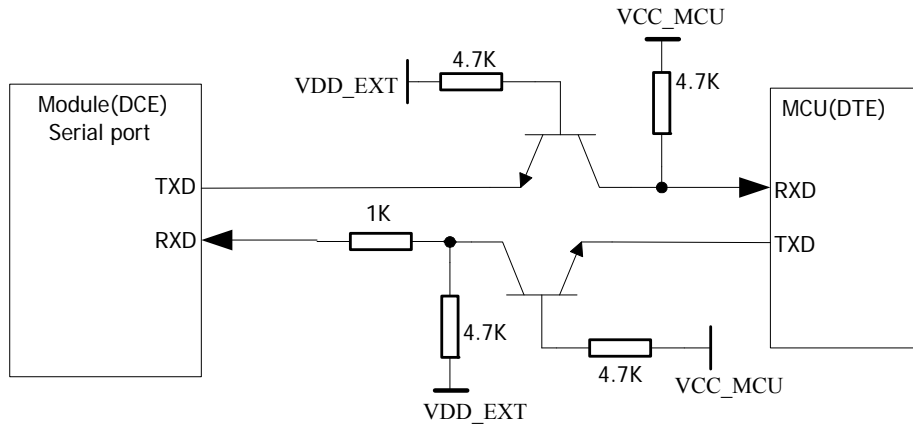


Figure 4: The reference level shifter by using bipolar transistor

3.2. Communicate with the RS-232 port of PC

Table 2: The voltage of RS-232

Logic level	Transmitter capable	Receiver capable	Unit
Logic 0	+5~+15	+3~+25	V
Logic 1	-5~-15	-3~-25	V
Undefined		-3~+3	V

It is suggested to design the level shifter by using RS-232 transceivers, e.g. SP3238E or MAX3221.

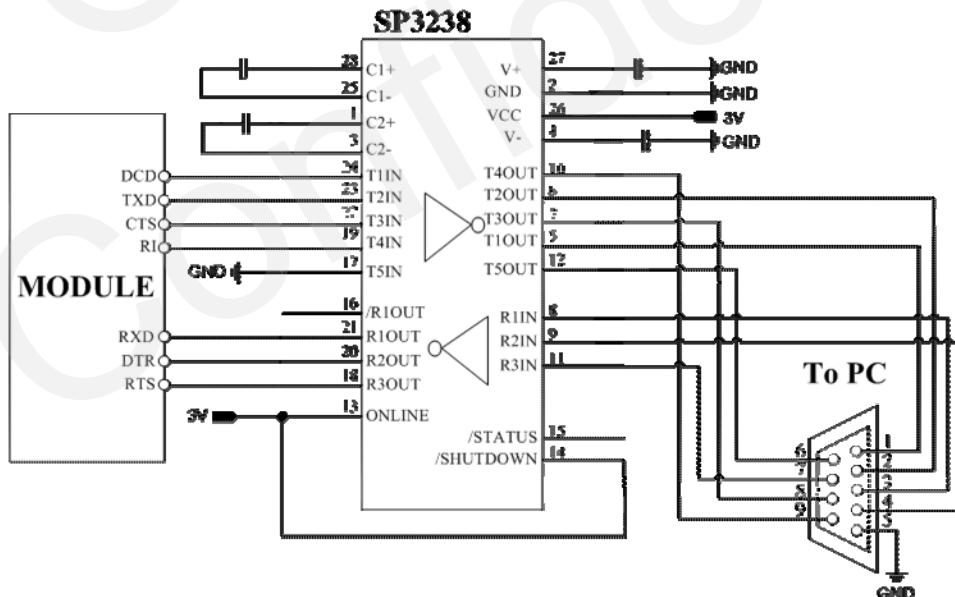


Figure 5: The reference level shifter by using SP3238

If only the RXD and TXD pins need to be connected, MAX3221 could be chosen for the level shifter.

4. Firmware Upgrade on board

To upgrade module firmware in the future, it is strongly recommended to reserve 5 test points in host board according to the description in the document of GSM_FW_UPGRADE_AN. In most applications, there is an external MCU controlling the module. In this case, a suitable resistor should be inserted between the TXD of the external MCU and the RXD of the module as shown in Figure 6. This resistor is used to block the signal of TXD in the external MCU when the firmware upgrade connection is established in a reserved IO connector or the test points. The PWRKEY should be pulled down during firmware upgrade period. If the module to be upgraded can't be powered by the host board, an external power supply from the VBAT pin of the IO connector or the test points would be required.

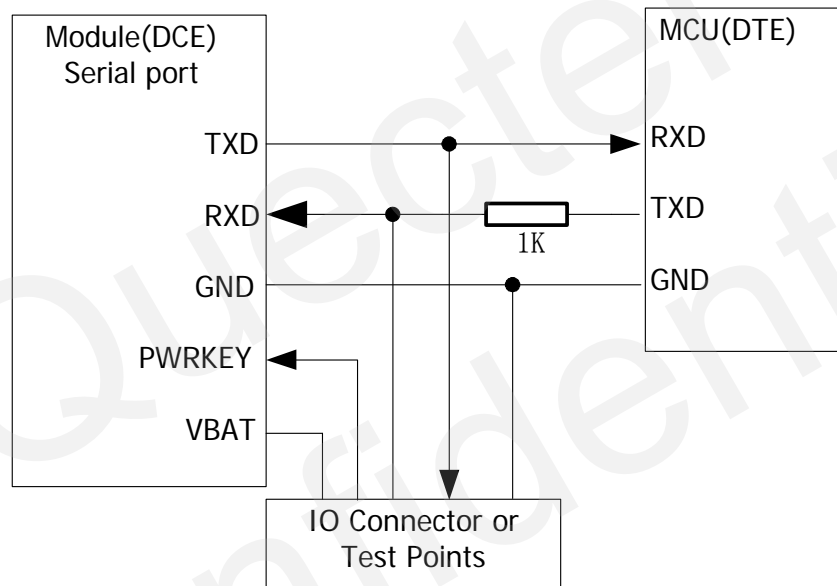


Figure 6: Blocking TXD of MCU by inserting a 1kΩ resistor

5. Flow control

Flow control is essential to prevent loss of data or avoid errors in a data or fax call when the sending device is transferring data faster than the receiving side is ready to accept. When the receiving buffer reaches its capacity, the receiving device should be capable to cause the sending device to pause until it catches up.

There are basically two approaches to achieve data flow control: software flow control and hardware flow control.

5.1. Software flow control (XON/XOFF flow control)

Software flow control sends different characters to stop (XOFF, decimal 19) and resume (XON, decimal 17) data flow. It is quite useful in some applications that only use three wires on the serial interface.

The default flow control approach of the module is hardware flow control (RTS/CTS flow control). To enable software flow control in the DTE interface and within GSM engine, type the following AT command:

```
AT+HFC=1, 1
```

This setting is stored volatile. In order to keep this configuration, AT&W should be executed to save the configuration in the user profile.

To use the software flow control of module, ensure using software flow control in communication software package such as ProComm Plus, Hyper Terminal and WinFax Pro.

Note:

Software flow control should not be used for data calls where binary data will be transmitted or received (e.g. TCP/IP) as the DTE interface may interpret binary data as flow control characters.

5.2. Hardware flow control (RTS/CTS flow control)

Hardware flow control achieves the data flow control by controlling the RTS/CTS line. When the data transfer should be suspended at the module side, the CTS line is set inactive until the transfer from the receiving buffer of module has completed. When the receiving buffer is ready to receive more data, CTS goes active once again.

To achieve hardware flow control, ensure that the RTS/CTS lines are present on your application platform.

6. Control Signals

6.1. DCD

The DCD pin will be active (low) after establishing a data connection. When the data connection is turned off, the DCD pin will go to inactive (high).

6.2. DTR

The module would automatically go into SLEEP mode, if the DTR is set to high level and “AT+QSCLK=1” has been already set, and that there is no specific task for the module to handle. In this case, the current consumption of module will reduce to the minimal level. During the SLEEP mode, the module can still receive paging message and SMS normally. If the DTR Pin is pulled down, the module would exit from SLEEP mode. The UART port will be active if the DTR is changed to low level for 20ms and after the UART port is waited for about 600ms again.

DTE can use the DTR pin to control the active or inactive state of the SLEEP mode as shown in Figure 7.

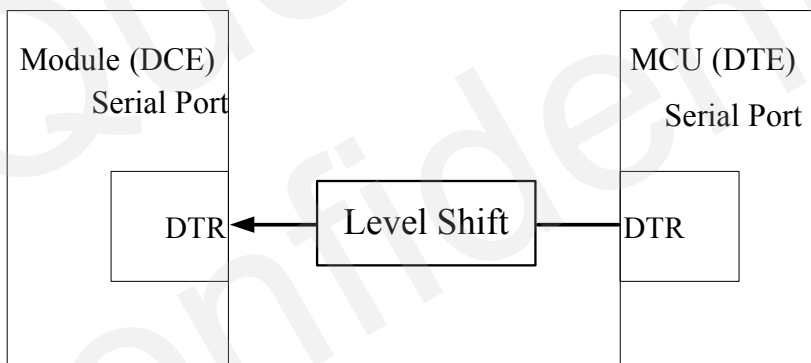


Figure 7: DTR for waking up

The DTR pin can also be used to switch from data mode to command mode. To use this method, AT&D1 should be set firstly. Depending on the state of the DTR pin, there are 2 ways to implement this function.

1. If the DTR pin is set to low in data mode, setting it to high for about 600ms would result in switching to command mode.
2. If the DTR pin is set to high in data mode, pulling it to low level for about 1000ms and then pulling it up for about 600ms would also switch the module from data mode to command mode.

When the module successfully switches from data mode to command mode, a URC “OK” will be returned to indicate the command mode.

Note: The setting AT&D1 can be stored using AT&W.

6.3. RI

If the module is used as a caller, the RI pin would keep high level except URC or SMS is received. On the other hand, when it is used as a receiver, the timing of the RI is shown in Table 3.

Table 3: Behaviours of the RI

State	RI respond
Standby	HIGH
Voice calling	Change to LOW, then: <ol style="list-style-type: none"> (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: <ol style="list-style-type: none"> (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 RI changes to LOW and holds low level for about 120 ms, then changes to HIGH.
URC	Certain URCs can trigger 120ms low level on RI. For more details of URC, please refer to the AT Commands Set.

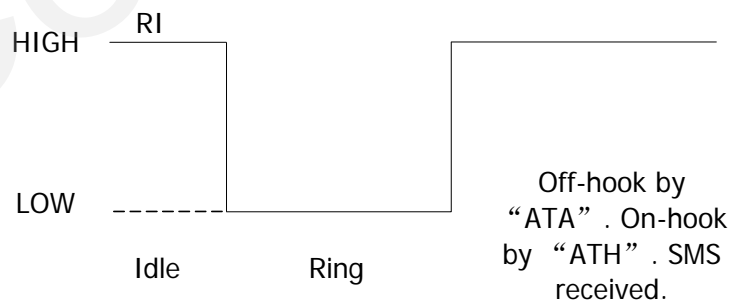


Figure 8: RI behaviour of voice calling as a receiver

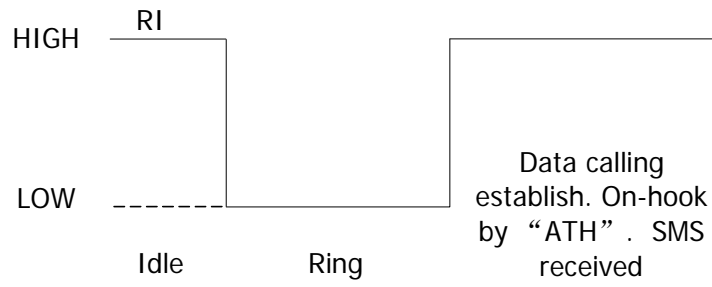


Figure 9: RI behaviour of data calling as a receiver

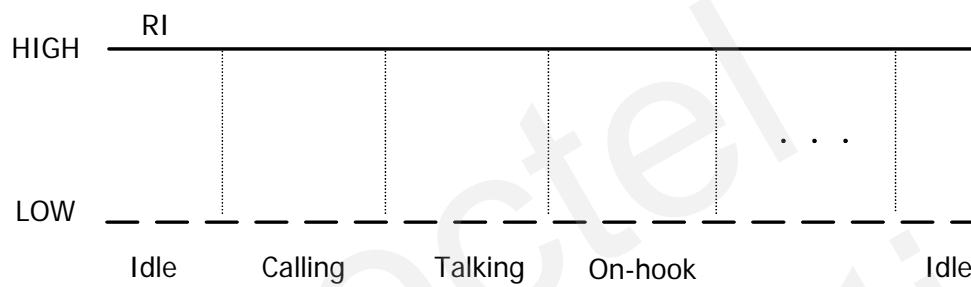


Figure 10: RI behaviour as a caller

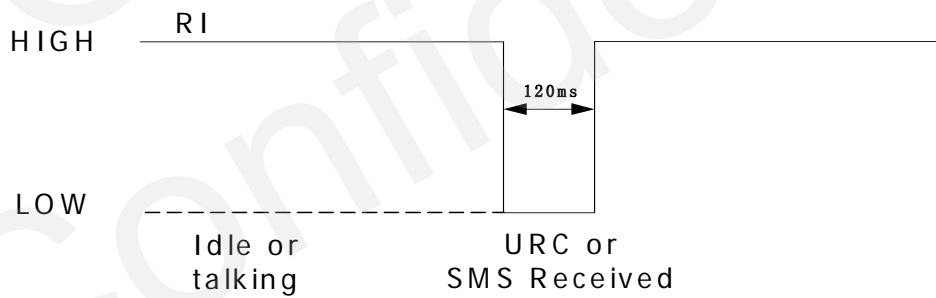


Figure 11: RI behaviour of URC or SMS received

7. Baud Rate

7.1. AT+IPR

The command AT+IPR can be used to set the TE-TA interface baud rate. **The default configuration of AT+IPR is autobauding enabled (AT+IPR=0).**

- If a fixed baud rate is set, make sure that both TE (DTE, usually external processor) and TA (DCE, Quectel GSM module) are configured to the same rate. If autobauding is enabled, the TA could automatically recognize the baud rate currently used by the TE after receiving “AT” or “at” string.
- The value of AT+IPR can’t be restored with AT&F and ATZ, but it is still storable with AT&W and visible in AT&V.
- In multiplex mode, the baud rate can’t be changed by the write command AT+IPR=<rate>, and the setting is invalid and not stored even if AT&W is executed after the write command.
- A selected baud rate takes effect after the write commands is executed and acknowledged by “OK”.

7.2. Autobauding

To take advantage of autobauding mode, specific attention must be paid to the following requirements:

- Autobauding synchronization between TE and TA
 - Ensure that TE and TA are correctly synchronized and the baud rate used by the TE is detected by the TA. To allow the baud rate to be synchronized simply use an “AT” or “at” string. This is necessary after customer activates autobauding or when customer starts up the module with autobauding enabled.
 - It is recommended to wait for 2 to 3 seconds before sending the first “AT” or “at” string after the module is started up with autobauding enabled. Otherwise undefined characters might be returned.
- Restriction on autobauding operation
 - The serial interface shall be used with 8 data bits, no parity and 1 stop bit (factory setting).
 - The command “A/” can’t be used.
 - Only the string “AT” or “at” can be detected (neither “At” nor “aT”).
 - URCs that may be issued before the TA detects a new baud rate by receiving the first AT character, and they will sent message at the previously detected baud rate.
 - If TE’s baud rate is changed after TA has recognized the earlier baud rate, loss of synchronization between TE and TA would be encountered and an “AT” or “at” string must be re-sent by TE to regain synchronization on baud rate. To avoid undefined characters during baud rate re-synchronization and the possible malfunction of resynchronization, it is not recommended to switch TE’s baud rate when autobauding is

- enabled. Especially, this operation is forbidden in data mode.
- Autobauding and baud rate after restarting.
 - In the autobauding mode, the detected baud rate is not saved. Therefore, resynchronization is required after restarting the module.
 - Unless the baud rate is determined, an incoming CSD call can't be accepted. This must be taken into account when autobauding and auto-answer mode ($ATS0 \neq 0$) are enabled at the same time, especially if SIM PIN 1 authentication is done automatically and the setting $ATS0 \neq 0$ is stored to the user profile with AT&W.
 - Until the baud rate is synchronized, URCs after restarting will not be output when autobauding is enabled.
 - Autobauding and multiplex mode
If autobauding is active it is not recommended to switch to multiplex mode.
 - Autobauding and Windows modem
 - The baud rate used by Windows modem can be detected while setting up a dial-up GPRS/CSD connection. However, some Windows modem drivers switch TE's baud rate to default value automatically after the GPRS call is terminated. In order to prevent no response to the Windows modem when it happens, it is not recommended to establish the dial-up GPRS/CSD connection in autobauding mode.
 - Based on the same considerations, it is also not recommended to establish the FAX connection in autobauding mode for PC FAX application, such as WinFax.

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.

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