# UC20 Mini PCIe

# Hardware Design

**UMTS/HSPA Module Series**

Rev. UC20_Mini_PCIe_Hardware_Design_V1.2

Date: 2014-06-28

**Our aim is to provide customers with timely and comprehensive service. For any assistance, please contact our company headquarters:**

**Quectel Wireless Solutions Co., Ltd.**
Office 501, Building 13, No.99, Tianzhou Road, Shanghai, China, 200233
Tel: +86 21 5108 6236
Mail: info@quectel.com

**Or our local office, for more information, please visit:**
http://www.quectel.com/support/salesupport.aspx

**For technical support, to report documentation errors, please visit:**
http://www.quectel.com/support/techsupport.aspx

## GENERAL NOTES

QUECTEL OFFERS THIS INFORMATION AS A SERVICE TO ITS CUSTOMERS. THE INFORMATION PROVIDED IS BASED UPON CUSTOMERS' REQUIREMENTS. QUECTEL MAKES EVERY EFFORT TO ENSURE THE QUALITY OF THE INFORMATION IT MAKES AVAILABLE. QUECTEL DOES NOT MAKE ANY WARRANTY AS TO THE INFORMATION CONTAINED HEREIN, AND DOES NOT ACCEPT ANY LIABILITY FOR ANY INJURY, LOSS OR DAMAGE OF ANY KIND INCURRED BY USE OF OR RELIANCE UPON THE INFORMATION. THE INFORMATION SUPPLIED HEREIN IS SUBJECT TO CHANGE WITHOUT PRIOR NOTICE.

## COPYRIGHT

# About the Document

## History

| Revision | Date | Author | Description |
|---|---|---|---|
| 1.0 | 2013-10-12 | Radom XIANG | Initial |
| 1.1 | 2014-01-22 | Radom XIANG | 1. Updated Table 1 and Table 2<br>2. Added details of UART_DTR in Chapter 3.4 |
| 1.2 | 2014-06-28 | Huik LI | 1. Added UC20-G Mini PCIe to UC20 Mini PCIe series.<br>2. Added I2C function. |

# Contents

# Table Index

# Figure Index

# 1 Introduction

This document defines UC20 Mini PCIe module and describes its hardware interfaces which are connected with your application and air interfaces.

This document can help you to quickly understand the interface specifications, electrical and mechanical details and related product information of the UC20 Mini PCIe module. To facilitate its application in different fields, relevant reference design documents are also provided. Associated with application notes and user guide of UC20 Mini PCIe module, you can use the module to design and set up mobile applications easily.

## 1.1. Safety Information

The following safety precautions must be observed during all phases of the operation, such as usage, service or repair of any cellular terminal or mobile incorporating UC20 Mini PCIe module. Manufacturers of the cellular terminal should send the following safety information to users and operating personnel and to incorporate these guidelines into all manuals supplied with the product. If not so, Quectel does not take on any liability for customer failure to comply with these precautions.

| | |
|---|---|
|  | Full attention must be given to driving at all times in order to reduce the risk of an accident. Using a mobile while driving (even with a handsfree kit) cause distraction and can lead to an accident. You must comply with laws and regulations restricting the use of wireless devices while driving. |
|  | 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. Consult the airline staff about the use of wireless devices on boarding the aircraft, if your device offers a Airplane Mode which must be enabled prior to boarding an aircraft. |
|  | Switch off your wireless device when in hospitals or clinics or other health care facilities. These requests are desinged to prevent possible interference with sentitive medical equipment. |
|  | 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. |
|  | Your cellular terminal or mobile contains a transmitter and receiver. When it is ON, it receives and transmits radio frequency energy. RF interference can occur if it is used close to TV set, radio, computer or other electric equipment. |
|  | In locations with potencially explosive atmospheres, obey all posted signs to turn off wireless devices such as your phone or other cellular terminals. Areas with potencially exposive atmospheres including fuelling areas, below decks on boats, fuel or chemical transfer or storage facilities, areas where the air contains chemicals or particles such as grain, dust or metal powders. |

# 2 Product Concept

## 2.1. General Description

UC20 Mini PCIe module, based on the MDM6200 platform of Qualcomm, is a combination of UMTS/HSPA, GSM/GPRS, GPS/GLONASS and PCI Express Mini Card 1.2 standard interface. It supports embedded operating system such as WinCE, Linux and Android etc., and also provides voice and high-speed data transmission functionality for your applications.

UC20 Mini PCIe module can be applied in the following fields:

- PDAs and Laptop Computer
- Remote Monitor System
- Vehicle System
- Wireless POS System
- Intelligent Meter Reading System
- Wireless Router and Switch
- Other Wireless Terminal Device

This chapter generally introduces the following aspects of UC20 Mini PCIe module:

- Product Series
- Key Features
- Functional Diagram

## 2.2. Description of Product Series

The product series of UC20 Mini PCIe contains Telematics version and Data Only version. Telematics version supports voice and data, while Data Only version only supports data. The following table shows the product series of UC20 Mini PCIe module.

**Table 1: Description of UC20 Mini PCIe**

| Product Series | Description |
|---|---|
| UC20-E Mini PCIe | Support GSM850, EGSM900, DCS1800, PCS1900<br>Support UMTS 900/2100MHz<br>Support GPS/GLONASS<br>Support digital audio* |
| UC20-A Mini PCIe | Support UMTS 850/1900MHz<br>Support GPS/GLONASS<br>Support digital audio* |
| UC20-G Mini PCIe | Support GSM850, EGSM900, DCS1800, PCS1900<br>Support UMTS 800/850/900/1900/2100MHz<br>Support GPS/GLONASS<br>Support digital audio* |

**NOTE**

"*" means digital audio (PCM) function is only supported in Telematics version.

## 2.3. Key Features

The following table describes the detailed features of UC20 Mini PCIe module.

**Table 2: Key Features of UC20 Mini PCIe**

| Feature | Details |
|---|---|
| Function Interface | PCI Express Mini Card 1.2 Standard Interface |
| Power Supply | Supply voltage: 3.0~3.6V Typical supply voltage: 3.3V |
| Frequency Bands | **GPS:** 1575.42MHz.<br>**GLONASS:** 1597.5~1605.8MHz<br>**UC20-E Mini PCIe:**<br>900/2100MHz @UMTS<br>850/900/1800/1900MHz @GSM<br>**UC20-A Mini PCIe:**<br>850/1900MHz @UMTS, 3G only<br>**UC20-G Mini PCIe:**<br>800/850/900/1900/2100MHz @UMTS |

| | |
|---|---|
| | 850/900/1800/1900MHz @GSM |
| Transmission Data | HSPA R6: Max 14.4Mbps (DL)/Max 5.76Mbps (UL)<br>UMTS R99: Max 384kbps (DL)/Max 384kbps (UL)<br>EDGE: Max 236.8kbps (DL)/Max 236.8kbps (UL)<br>GPRS: Max 85.6kbps (DL)/Max 85.6kbps (UL)<br>CSD: 14.4kbps |
| Transmitting Power | Class 4 (33dBm±2dB) for GSM850 and EGSM900<br>Class 1 (30dBm±2dB) for DCS1800 and PCS1900<br>Class E2 (27dBm±3dB) for GSM850 and EGSM900 8-PSK<br>Class E2 (26dBm+3/-4dB) for DCS1800 and PCS1900 8-PSK<br>Class 3 (24dBm+1/-3dB) for UMTS 800/850/900/1900/2100 |
| HSPA and UMTS Features | HSPA data rate is corresponded with 3GPP R6. 14.4 Mbps on downlink and 5.76 Mbps on uplink.<br>WCDMA data rate is corresponded with 3GPP R99/R4. 384 kbps on downlink and 384kbps on uplink.<br>Support both QPSK and 16-QAM modulations. |
| GSM/GPRS/EDGE Data Features | **GPRS:** Support GPRS multi-slot class 12 (10 by default)<br>Coding scheme: CS-1, CS-2, CS-3 and CS-4<br>Maximum of four Rx time slots per frame<br>**EDGE:** Support EDGE multi-slot class 12 (12 by default)<br>Support GMSK and 8-PSK for different MCS (Modulation and Coding Scheme)<br>Downlink coding schemes: CS 1-4 and MCS 1-9<br>Uplink coding schemes: CS 1-4 and MCS 1-9<br>**CSD:** CSD transmission rates: 14.4 kbps non-transparent<br>Support Unstructured Supplementary Services Data (USSD) |
| Internet Protocol Features | Support TCP/PPP/UDP/FTP/HTTP/MMS/SMTP protocols<br>Support the protocols PAP (Password Authentication Protocol) and CHAP (Challenge Handshake Authentication Protocol) usually used for PPP connections |
| SMS | Text and PDU mode<br>Point to point MO and MT<br>SMS cell broadcast<br>SMS storage: ME by default |
| USIM Interface | Support USIM card: 1.8V, 3.0V<br>Support USIM and SIM |
| UART Interface | Support seven lines on UART interface<br>Support RTS and CTS hardware flow control<br>Baud rate can reach up to 230400 bps, 115200 bps by default<br>Used for AT command and data transmission<br>Support multiplexing function |
| PCM Interface | Support 8-bit A-law, μ-law and 16-bit linear data formats<br>Support long frame sync and short frame sync |

| | |
|---|---|
| | Support master and slave mode, but must be the master in long frame sync |
| USB Interface | Compliant with USB 2.0 specification (slave only), the data transfer rate can reach up to 480 Mbps.<br>Used for AT command communication, data transmission, GNSS NMEA output, software debug and firmware upgrade.<br>USB Driver: Support Windows XP, Windows 7, Windows Vista, Windows 8, Linux 2.6/3.0, WinCE 5.0/6.0, Android 2.3/4.0. |
| Antenna Interface | Include main GSM/UMTS antenna, UMTS diversity antenna,<br>GNSS antenna (active/passive) |
| GNSS Features | gpsOne Gen8 of Qualcomm (GPS and GLONASS)<br>Protocol: NMEA 0183 |
| Rx-diversity | Support UMTS Rx-diversity |
| AT Commands | Compliant with 3GPP TS 27.007, 27.005 and Quectel enhanced AT commands |
| Physical Characteristics | Size: 51.0 × 30.0 × 4.9mm Weight: approx. 9.8g |
| Temperature Range | Normal operation: -30°C ~ +70°C<br>Restricted operation: -40°C ~ -30°C and +70°C ~ +80°C▲<br>Storage temperature: -45°C ~ +90°C |
| Firmware Upgrade | USB interface |
| RoHS | All hardware components are fully compliant with EU RoHS directive |

**NOTE**

"▲" means when the module works within this temperature range, RF performance might degrade. For example, the frequency error or the phase error may increase.

## 2.4. Functional Diagram

The following figure shows a block diagram of UC20 Mini PCIe and illustrates the major functional parts:

- One USIM card interface (1.8V/3.0V)
- One USB 2.0 specification interface
- One UART interface (seven lines and supports hardware flow control)
- One PCM&I2C interface
- Support LED status indication
- Support disabling wireless communication function
- Support hardware reset function
- Support three antenna interfaces
- One optional USIM holder

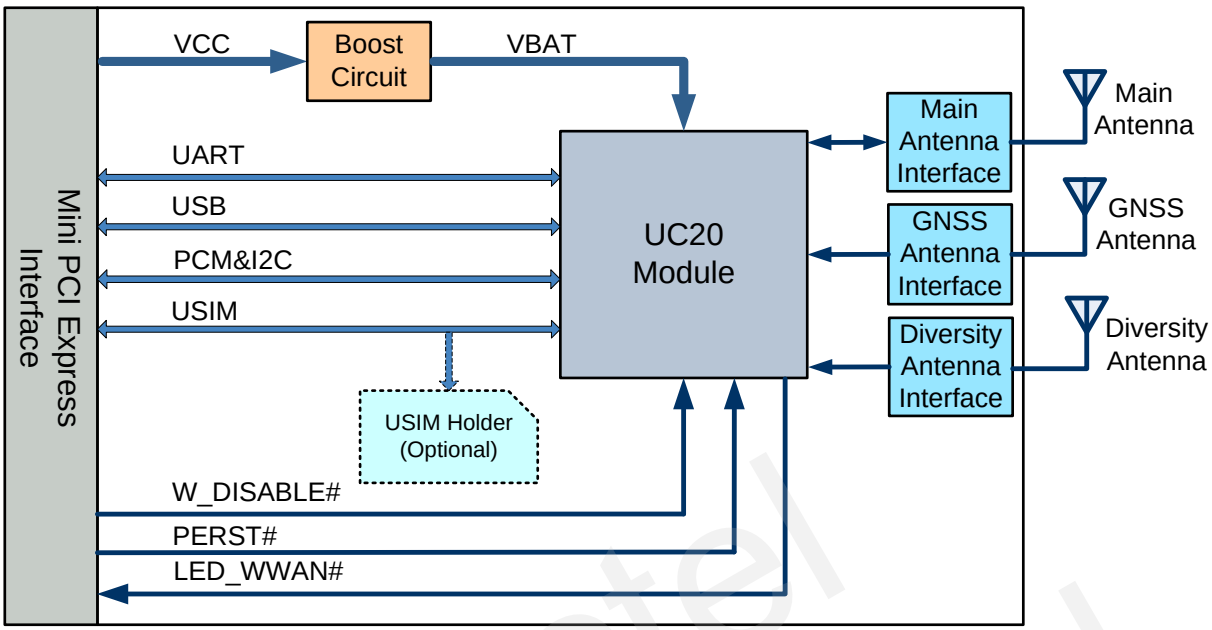



**Figure 1: Functional Diagram**

# 3 Application Interface

## 3.1. General Description

The physical connections and signal levels of UC20 Mini PCIe comply with PCI Express Mini CEM specifications. This chapter mainly describes the following interface definition and application of UC20 Mini PCIe:

- Power supply
- UART interface
- USIM interface
- USB interface
- PCM&I2C interface
- Antenna interface
- Control signals (W_DISABLE#, PERST# and LED_WWAN#)

## 3.2. UC20 Mini PCIe Interface

### 3.2.1. Definition of Interface

The following tables show the pin assignments of UC20 Mini PCIe on the 52-pin application.

**Table 3: Definition of IO Parameters**

| Type | Description |
|---|---|
| IO | Bidirectional input/output |
| DI | Digital input |
| DO | Digital output |
| PI | Power input |
| PO | Power output |
| OC | Open collector |

**Table 4: Description of Pin**

| Pin No. | Mini PCI Express Standard Name | UC20 Mini PCIe Pin Name | I/O | Description | Comment |
|---|---|---|---|---|---|
| 1 | WAKE# | RESERVED | — | Reserved | |
| 2 | 3.3Vaux | VCC_3V3 | PI | 3.3V DC supply. | |
| 3 | COEX1 | RESERVED | — | Reserved | |
| 4 | GND | GND | | Mini Card ground. | |
| 5 | COEX2 | RESERVED | — | Reserved | |
| 6 | 1.5V | NC | — | — | |
| 7 | CLKREQ# | RESERVED | — | Reserved | |
| 8 | UIM_PWR | USIM_VDD | PO | Power source for the USIM/SIM card. | |
| 9 | GND | GND | | Mini Card ground. | |
| 10 | UIM_DATA | USIM_DATA | IO | USIM/SIM data signal. | |
| 11 | REFCLK- | UART_RX | DI | UART receive data. | Connect to DTE's TX. |
| 12 | UIM_CLK | USIM_CLK | DO | USIM/SIM clock signal. | |
| 13 | REFCLK+ | UART_TX | DO | UART transmit data. | Connect to DTE's RX. |
| 14 | UIM_RESET | USIM_RST | DO | USIM/SIM reset signal. | |
| 15 | GND | GND | | Mini Card ground. | |
| 16 | UIM_VPP | RESERVED | — | Reserved | |
| 17 | RESERVED | UART_RI | DO | UART ring indicator. | Connect to DTE's RI. |
| 18 | GND | GND | | Mini Card ground. | |
| 19 | RESERVED | RESERVED | — | Reserved | |
| 20 | W_DISABLE# | W_DISABLE# | DI | Disable wireless communications. | Active low. |
| 21 | GND | GND | | Mini Card ground. | |
| 22 | PERST# | PERST# | DI | Functional reset to the card. | Active low. |
| 23 | PERn0 | UART_CTS | DI | UART clear to send. | Connect to DTE's RTS. |
| 24 | 3.3Vaux | RESERVED | — | Reserved | |

| | | | | | |
|---|---|---|---|---|---|
| 25 | PERp0 | UART_RTS | DO | UART request to send. | Connect to DTE's CTS. |
| 26 | GND | GND | | Mini Card ground. | |
| 27 | GND | GND | | Mini Card ground. | |
| 28 | 1.5V | NC | — | — | |
| 29 | GND | GND | | Mini Card ground. | |
| 30 | SMB_CLK | I2C_SCL | OD | I2C serial clock. | External pull-up resistor is required. 1.8V only. |
| 31 | PETn0 | UART_DTR | DI | UART data terminal ready. | Connect to DTE's DTR. |
| 32 | SMB_DATA | I2C_SDA | OD | I2C serial data. | External pull-up resistor is required. 1.8V only. |
| 33 | PETp0 | UART_DCD | DO | UART data carrier detection. | Connect to DTE's DCD. |
| 34 | GND | GND | | Mini Card ground. | |
| 35 | GND | GND | | Mini Card ground. | |
| 36 | USB_D- | USB_DM | IO | USB differential data (-). | |
| 37 | GND | GND | | Mini Card ground. | |
| 38 | USB_D+ | USB_DP | IO | USB differential data (+). | |
| 39 | 3.3Vaux | VCC_3V3 | PI | 3.3V DC supply. | |
| 40 | GND | GND | | Mini Card ground. | |
| 41 | 3.3Vaux | VCC_3V3 | PI | 3.3V DC supply. | |
| 42 | LED_WWAN# | LED_WWAN# | OC | Active-low LED signal for indicating the state of the card. | |
| 43 | GND | GND | | Mini Card ground. | |
| 44 | LED_WLAN# | RESERVED | — | Reserved | |
| 45 | RESERVED | PCM_CLK* | IO | PCM clock signal. | |
| 46 | LED_WPAN# | RESERVED | — | Reserved | |

| | | | | |
|---|---|---|---|---|
| 47 | RESERVED | PCM_DOUT* | DO | PCM data output. |
| 48 | 1.5V | NC | — | — |
| 49 | RESERVED | PCM_DIN* | DI | PCM data input. |
| 50 | GND | GND | | Mini Card ground. |
| 51 | RESERVED | PCM_SYNC* | IO | PCM frame sync. |
| 52 | 3.3Vaux | VCC_3V3 | PI | 3.3V DC supply. |

**NOTES**

1. The typical supply voltage is 3.3V.
2. Keep all NC, reserved and unused pins unconnected.
3. Pay attention to the height of Mini PCI Express connector located on DTE and notice USIM pins 8, 10, 12 and 14 cannot be used at the same time when you use the optional USIM holder.
4. "*" means digital audio (PCM) function is only supported in Telematics version.

### 3.2.2. Pin Assignment

The following figure shows the pin assignment of UC20 Mini PCIe module. The top side contains UC20 module and antenna connectors.

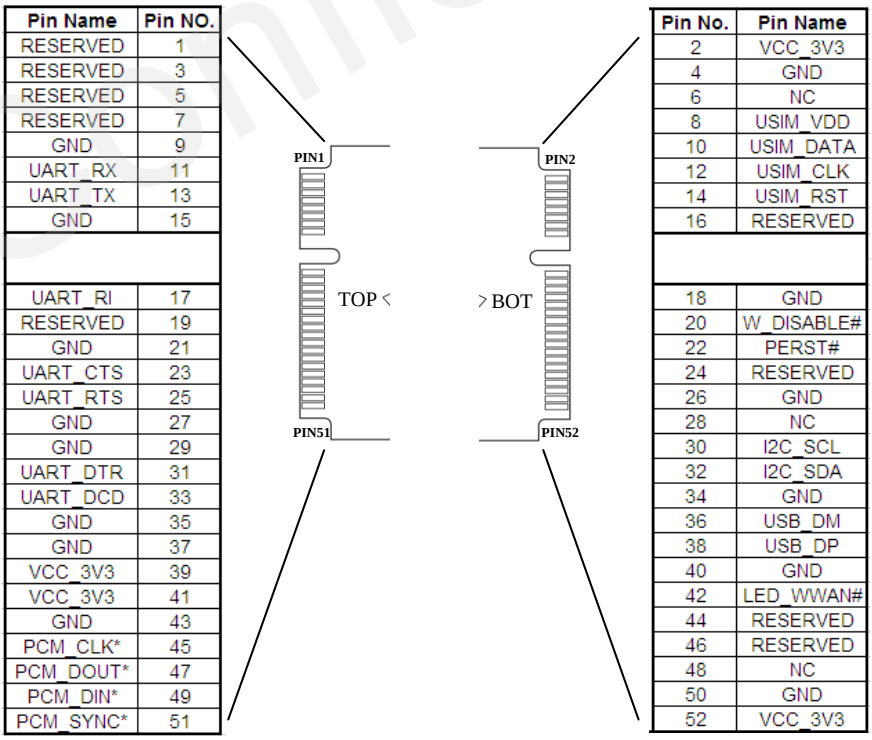



**Figure 2: Pin Assignment**

**NOTE**

"*" means digital audio (PCM) function is only supported in Telematics version.

## 3.3. Power Supply

The following table shows the VCC_3V3 pins and ground pins.

**Table 5: VCC_3V3 and GND Pins**

| Pin No. | UC20 Mini PCIe Pin Name | I/O | Description |
|---|---|---|---|
| 2, 39, 41, 52 | VCC_3V3 | PI | 3.3V DC supply. |
| 4, 9, 15, 18, 21, 26, 27, 29, 34, 35, 37, 40, 43, 50 | GND | | Mini Card ground. |

The typical supply voltage of UC20 Mini PCIe is 3.3V. In the 2G networks, the input peak current may reach 2.7A during the transmitting time, therefore the power supply must be able to provide enough current, and a bypass capacitor of no less than 100 μF with low ESR should be used to prevent the voltage from dropping.

The following figure shows a reference design of power supply. The precision of resistor R2 and R3 is 1%, and the capacitor C3 needs a low ESR.

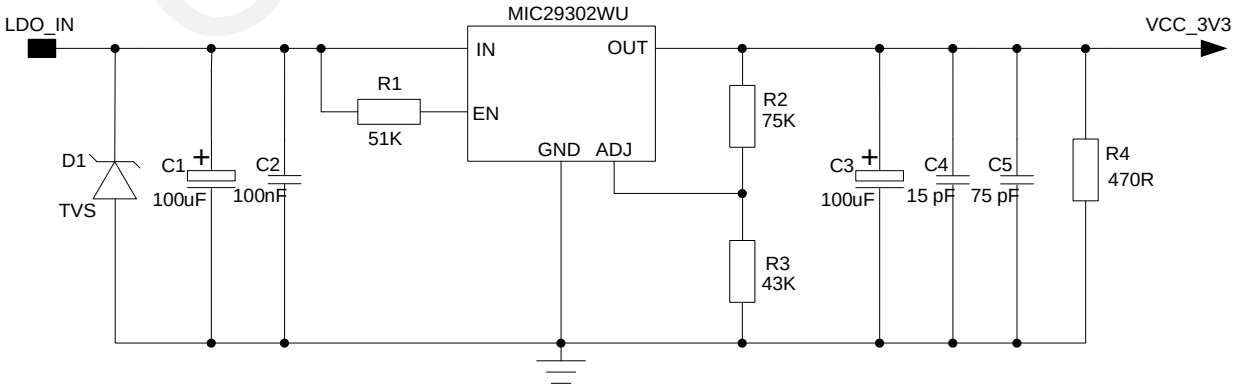



**Figure 3: Reference Design of Power Supply**

## 3.4. UART Interface

The following table shows the pin definition of the UART interface.

**Table 6: Pin Definition of the UART Interface**

| Pin No. | UC20 Mini PCIe Pin Name | I/O | Power Domain | Description |
|---|---|---|---|---|
| 11 | UART_RX | DI | 3.3V | UART receive data |
| 13 | UART_TX | DO | 3.3V | UART transmit data |
| 17 | UART_RI | DO | 3.3V | UART ring indicator |
| 23 | UART_CTS | DI | 3.3V | UART clear to send |
| 25 | UART_RTS | DO | 3.3V | UART request to send |
| 31 | UART_DTR | DI | 3.3V | UART data terminal read |
| 33 | UART_DCD | DO | 3.3V | UART data carrier detection |

The UART interface supports 9600, 19200, 38400, 57600, 115200 and 230400bps baud rate. The default is 115200bps. Autobauding is not supported. This interface can be used for data transmission and AT communication.

UC20 Mini PCIe is designed as the DCE, and the DCE-DTE connection of UART interface is shown as below.

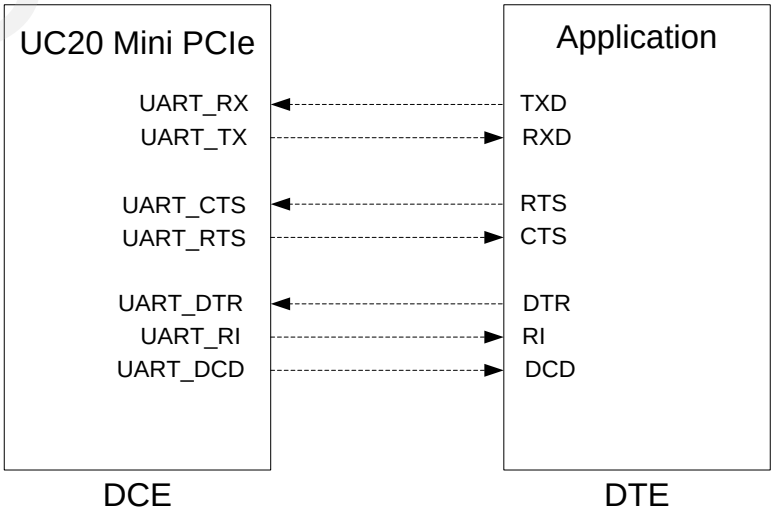



**Figure 4: The DCE-DTE Connection of UART Interface**

The following figure is an example of connection between UC20 Mini PCIe and PC. Since the UART interface does not support the RS-232 level, A RS-232 level translator IC must be inserted between module and PC. A RS-232 level shifter SN65C3238 provided by ***Texas Instruments*** is recommended. The following figure shows the reference design of RS232 level match circuit.

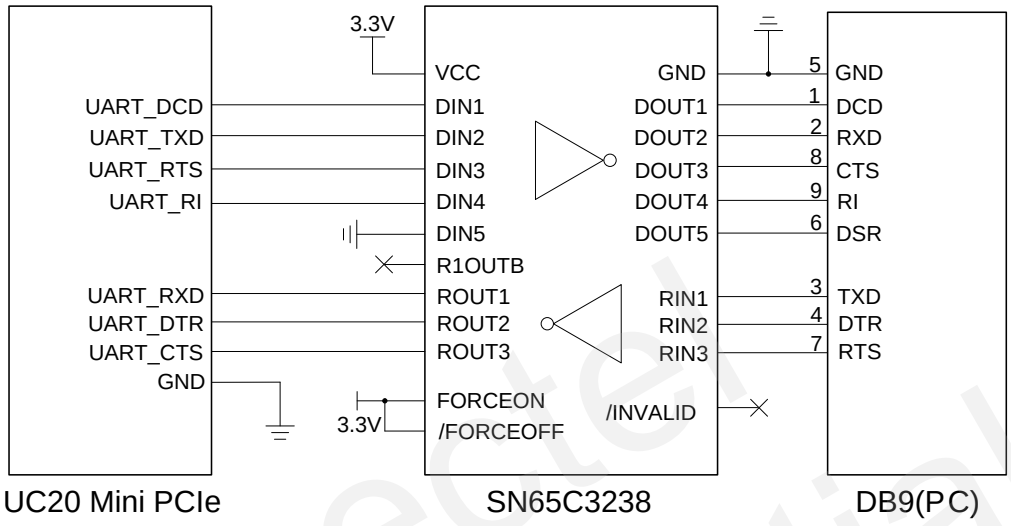



**Figure 5: RS232 Level Match Circuit**

**NOTES**

1. The hardware flow control is disabled by default. AT command **AT+IFC=2,2** is used to enable the hardware flow control. AT command **AT+IFC=0,0** is used to disable the hardware flow control. For more details, please refer to ***document [2]***.
2. AT command **AT+IPR** is used to set the baud rate of the UART. Please refer to ***document [2]*** for details.
3. UART_DTR supports sleep control function, drive it to low level will wake up the module. AT command **AT+QCFG="pwrsavedtr",0** is used to disable the sleep control function.

## 3.5. USIM Card Interface

The following table shows the pin definition of the USIM card interface.

**Table 7: Pin Definition of the USIM Card Interface**

| Pin No. | UC20 Mini PCIe Pin Name | I/O | Power Domain | Description |
|---|---|---|---|---|
| 8 | USIM_VDD | PO | 1.8V/3.0V | Power source for the USIM/SIM card. |

| | | | | |
|---|---|---|---|---|
| 10 | USIM_DATA | IO | 1.8V/3.0V | USIM/SIM data signal. |
| 12 | USIM_CLK | DO | 1.8V/3.0V | USIM/SIM clock signal. |
| 14 | USIM_RST | DO | 1.8V/3.0V | USIM/SIM reset signal. |

UC20 Mini PCIe supports 1.8V and 3.0V USIM cards. The following figure shows the reference design of the 6-pin USIM card.

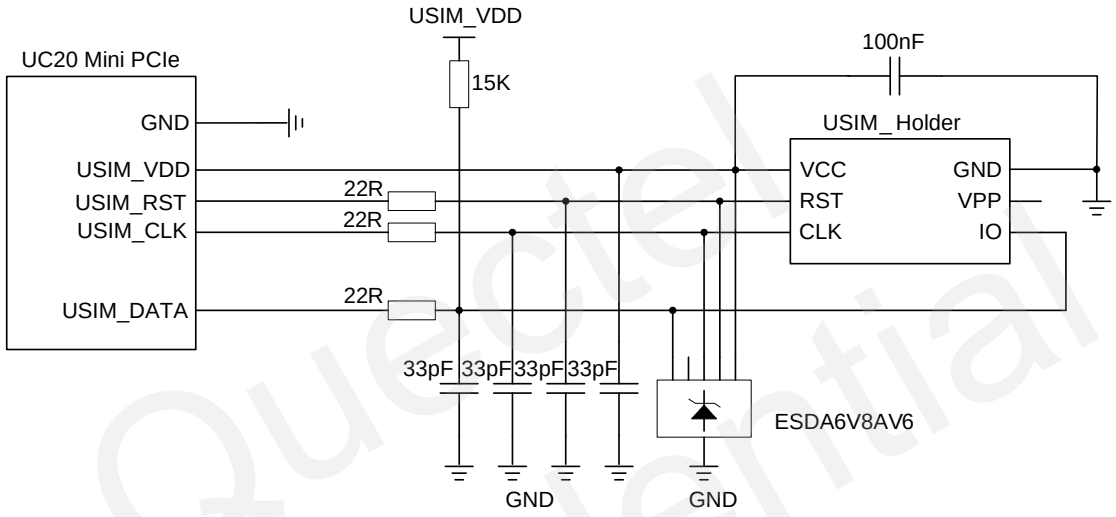



**Figure 6: Reference Circuit of the 6 Pin USIM Card**

In order to enhance the reliability and availability of the USIM card in your application, please follow the following criteria in the USIM circuit design:

- Keep layout of USIM card as close to the module as possible. Assure the length of the trace as less than 200mm as possible.
- Keep USIM card signal away from RF and power supply alignment.
- Ensure the ground between module and USIM cassette is short and wide. Keep the width between ground and USIM_VDD no less than 0.5mm to maintain the same electric potential. The decouple capacitor of USIM_VDD should be less than 1uF and must near to USIM cassette.
- To avoid cross-talk between USIM_DATA and USIM_CLK, keep them away from each other and shield them with surrounding ground.
- In order to offer good ESD protection, it is recommended to add TVS such as WILL (http://www.willsemi.com) ESDA6V8AV6. The 22Ω resistors should be added in series between the module and USIM card so as to suppress the EMI spurious transmission and enhance the ESD protection. The 33pF capacitors are used for filtering interference of GSM850/EGSM900. Please note that the USIM peripheral circuit should be close to the USIM card socket.
- The pull-up resistor on USIM_DATA line can improve anti-jamming capability when long layout trace and sensitive occasion are applied.

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

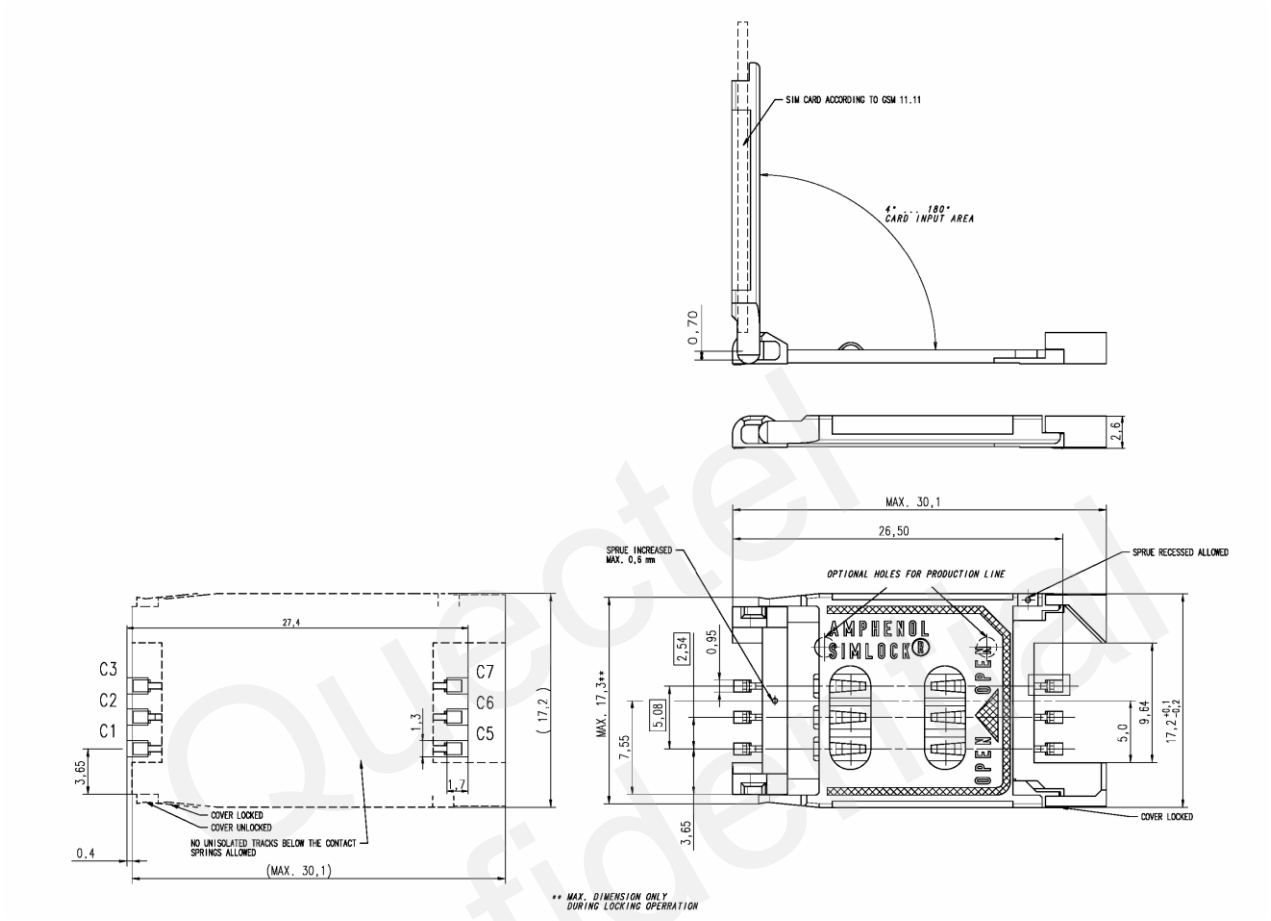



**Figure 7: Amphenol C707 10M006 512 2 USIM Card Holder**

**Table 8: Pin Description of Amphenol USIM Card Holder**

| Name | Pin | Function |
|---|---|---|
| VDD | C1 | USIM card power supply. |
| RST | C2 | USIM card reset. |
| CLK | C3 | USIM card clock. |
| GND | C5 | Ground. |
| VPP | C6 | Not connected. |
| DATA I/O | C7 | USIM card data. |

## 3.6. USB Interface

The following table shows the pin definition of USB interface.

**Table 9: USB Pin Description**

| Pin No. | UC20 Mini PCIe Pin Name | I/O | Description | Comment |
|---|---|---|---|---|
| 36 | USB_DM | IO | USB differential data (-). | Require differential impedance of 90Ω. |
| 38 | USB_DP | IO | USB differential data (+). | Require differential impedance of 90Ω. |

UC20 Mini PCIe is compliant with USB 2.0 specification. It can only be used as a slave device. Meanwhile, it supports high speed (480 Mbps), full speed (12 Mbps) and low speed (1.5 Mbps) mode. The USB interface is primarily used for AT command, data transmission, GNSS NMEA output and firmware upgrade. The following figure shows the reference circuit of USB interface.

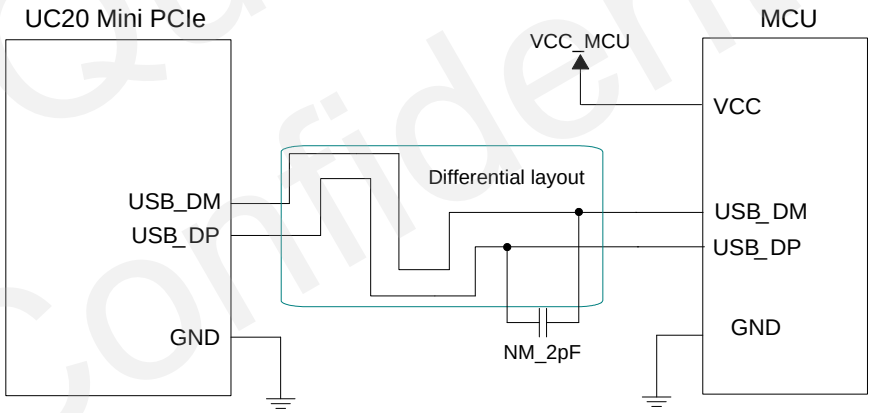



**Figure 8: Reference Circuit of USB Interface**

To ensure the USB interface design corresponds with the USB 2.0 specification, please comply with the following principles:

- It is important to route the USB signal traces as differential pairs with total grounding. The impedance of USB differential trace is 90ohm.
- Do not route signal traces under crystals, oscillators, magnetic devices and RF signal traces. It is important to route the USB differential traces in inner-layer with ground shielding, and not only upper and lower layer but also right and left side should be shielded.
- If you use the USB connector, you should keep the ESD components as close to the USB connector as possible. Pay attention to the influence of junction capacitance of ESD component on USB data lines. Typically, the capacitance value should be less than 2pF (e.g.ESD9L5.0ST5G).

**NOTES**

There are three preconditions when enabling UC20 Mini PCIe to enter the sleep mode:

1. Execute AT command **AT+QSCLK=1** to enable the sleep mode. Refer to ***document [2]***.
2. UART_DTR pin should be kept high level (pull-up internally).
3. USB interface on Mini PCIe must be connected with your USB interface and please guarantee USB devices are in the suspended state.

## 3.7. PCM and I2C Interface

The following table shows the pin definition of PCM interface that can be applied in audio codec design.

**Table 10: Pin Definition of PCM Interface**

| Pin No. | UC20 Mini PCIe Pin Name | I/O | Power Domain | Description |
|---|---|---|---|---|
| 45 | PCM_CLK | IO | 1.8V | PCM clock signal. |
| 47 | PCM_DOUT | DO | 1.8V | PCM data output. |
| 49 | PCM_DIN | DI | 1.8V | PCM data input. |
| 51 | PCM_SYNC | IO | 1.8V | PCM frame sync. |
| 30 | I2C_SCL | OD | 1.8V | I2C serial clock. |
| 32 | I2C_SDA | OD | 1.8V | I2C serial data. |

UC20 Mini PCIe provides one PCM digital interface, which supports 8-bit A-law and μ-law, 16-bit linear data formats and the following modes:

- Primary mode (short sync, works as either master or slave)
- Auxiliary mode (long sync, works as master only)

In primary mode, the data is sampled on the falling edge of the PCM_CLK and transmitted on the rising edge; the PCM_SYNC falling edge represents the MSB. In this mode, PCM_CLK supports 128 kHz, 256 kHz, 512 kHz, 1024 kHz, 2048 kHz and 4096 kHz. The following figure shows timing relationship in primary mode with 8 kHz PCM_SYNC and 2048 kHz PCM_CLK.

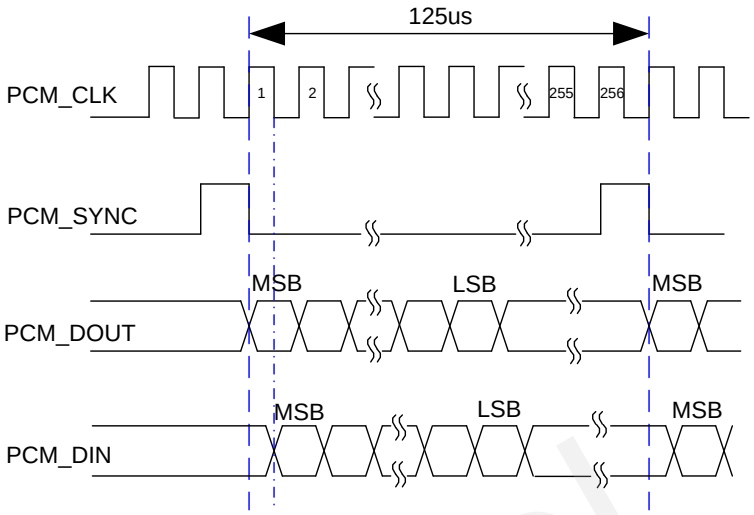



**Figure 9: Timing of Primary Mode**

In auxiliary mode, the data is sampled on the falling edge of the PCM_CLK and transmitted on the rising edge; while the PCM_SYNC rising edge represents the MSB. In this mode, PCM interface operates with a 128 kHz PCM_CLK and an 8 kHz, 50% duty cycle PCM_SYNC only. The following figure shows the timing relationship in auxiliary mode with 8 kHz PCM_SYNC and 128 kHz PCM_CLK.

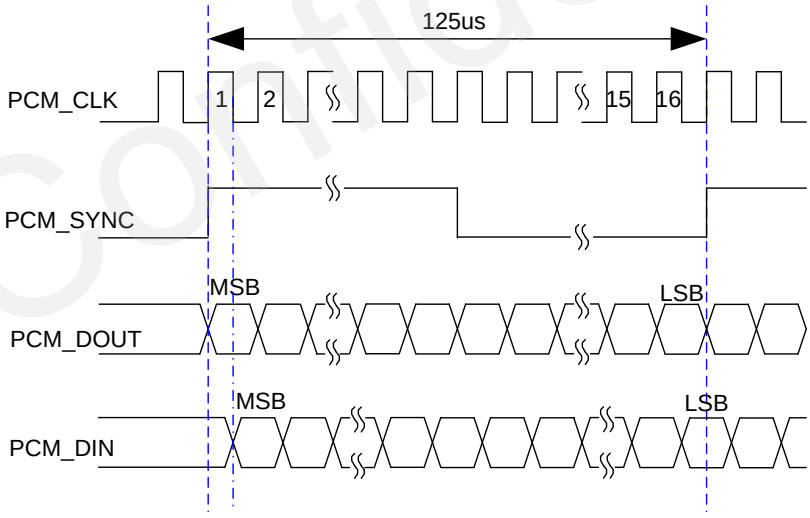



**Figure 10: Timing of Auxiliary Mode**

It is recommended to reserve RC (R=22Ω, C=22pF) circuit on the PCM lines, especially for PCM_CLK. Clock and mode can be configured by AT command, and the default configuration is master mode using short sync data format with 2048kHz PCM_CLK and 8kHz PCM_SYNC. In addition, UC20 Mini PCIe's firmware has integrated the configuration on NAU8814 application with I2C interface. Refer to ***document [2]*** about the command **AT+QDAI** for details.

The following figure shows the reference design of PCM interface with external codec IC.

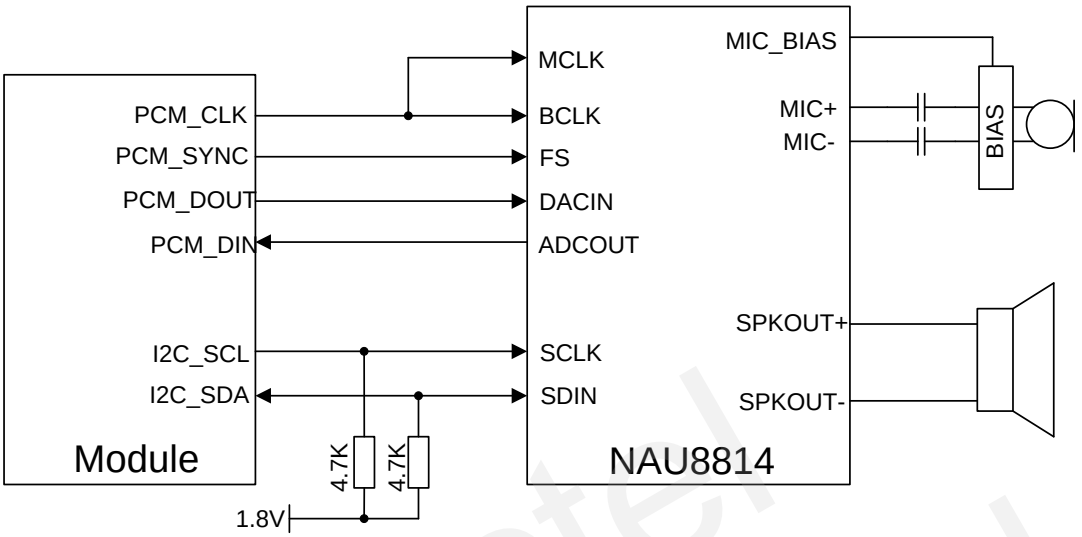



**Figure 11: Reference Circuit of PCM Application with Audio Codec**

## 3.8. Control Signals

The following table shows the pin definition of control signals.

**Table 11: Description of Control Signal Pins**

| Pin No. | UC20 Mini PCIe Pin Name | I/O | Power Domain | Description |
|---|---|---|---|---|
| 20 | W_DISABLE# | DI | 3.3V | Disable wireless communications. Active low. |
| 22 | PERST# | DI | 3.3V | Functional reset to the card. Active low. |
| 42 | LED_WWAN# | OC | — | Active-low LED signal for indicating the state of the card. |

### 3.8.1. W_DISABLE# Signal

UC20 Mini PCIe provides W_DISABLE# signal to disable wireless communications through hardware operation. The following table shows the radio operational states of module. Please refer to ***document [2]*** for related AT commands.

**Table 12: Radio Operational States**

| W_DISABLE# | AT Commands | Radio Operation |
|---|---|---|
| High Level | AT+CFUN=1 | Enabled |
| High Level | AT+CFUN=0<br>AT+CFUN=4 | Disabled |
| Low Level | AT+CFUN=0<br>AT+CFUN=1<br>AT+CFUN=4 | Disabled |

### 3.8.2. PERST# Signal

The PERST# signal can be used to force a hardware reset on the card. You can reset the module by driving the PERST# to a low level voltage of more than 150ms and then release it. The reset scenario is illustrated in the following figure.

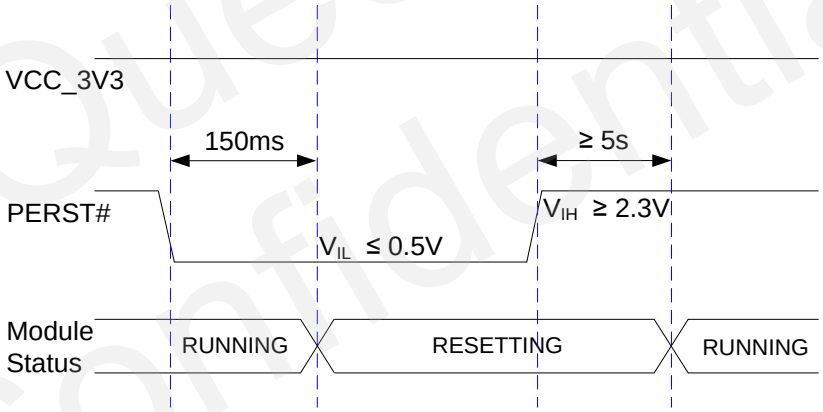



**Figure 12: Timing of Resetting Module**

### 3.8.3. LED_WWAN# Signal

The LED_WWAN# signal of UC20 Mini PCIe is used to indicate the network status of the module, which can absorb the current up to 40mA. According to the following circuit, in order to reduce the current of the LED, a resistor must be placed in series with the LED. The LED is emitting light when the LED_WWAN# output signal is active low.

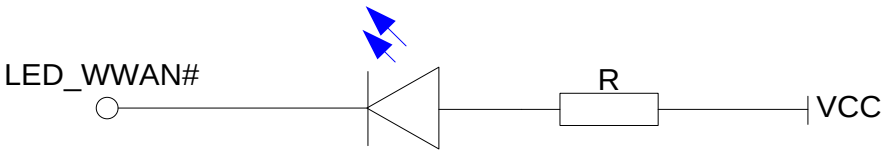



**Figure 13: LED_WWAN# Signal Reference Circuit Diagram**

The following table shows the indications of network status of the LED_WWAN# signal.

**Table 13: Indication of Network Status**

| LED_WWAN# | Description |
|---|---|
| Low Level (Light on) | Registered network. |
| High-impedance (Light off) | ● No network coverage or not registered.<br>● W_DISABLE# signal is in low level. (Disable the RF)<br>● AT+CFUN=0, AT+CFUN=4. |

## 3.9. Antenna Interface

UC20 Mini PCIe antenna interfaces include a main UMTS/GSM antenna interface, a UMTS Rx-diversity antenna interface and a GNSS antenna interface. All of these connectors are ECT818000117.

The following figures show the location of antenna interfaces and describe the overall sizes of RF connector.

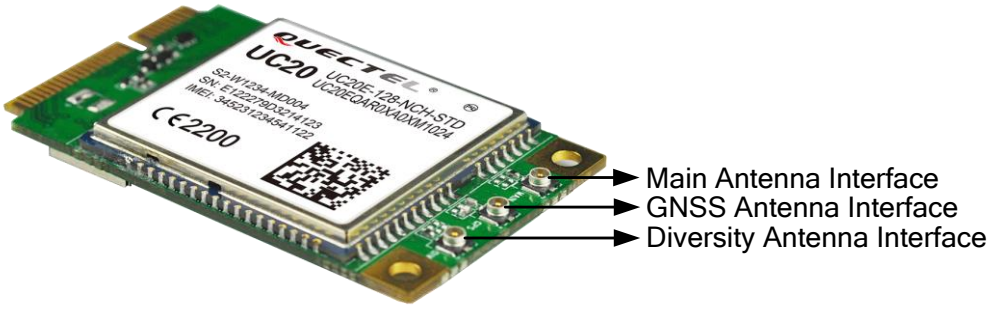



**Figure 14: UC20 Mini PCIe Antenna Interface**

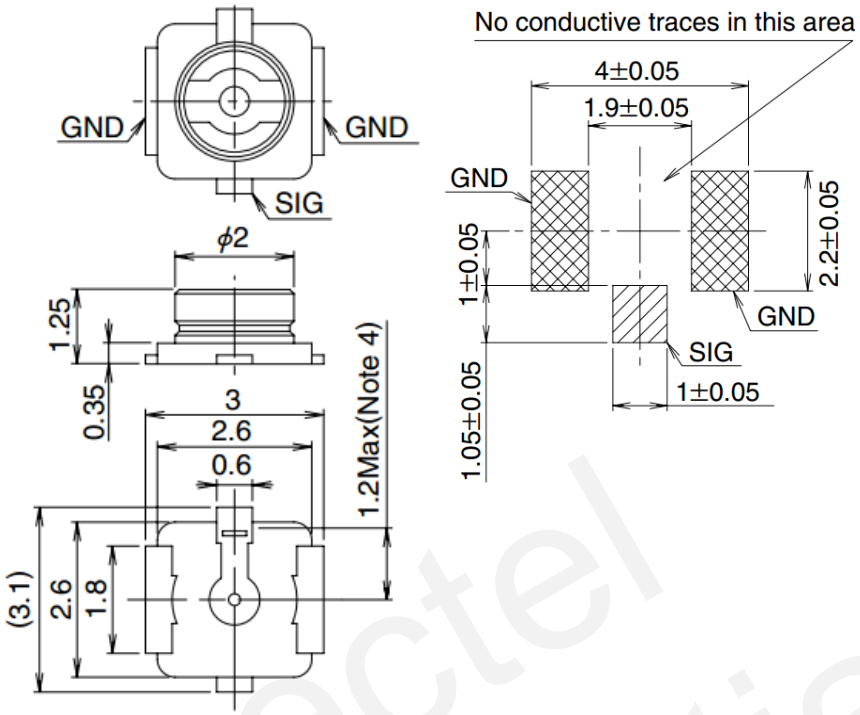



**Figure 15: Dimensions of the RF Connector (Unit: mm)**

You can use U.FL-LP serial connector listed in the following figure to match the ECT818000117. For more details, please visit http://www.hirose.com.

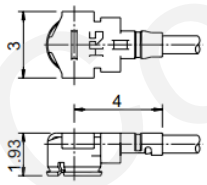
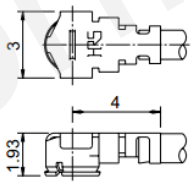
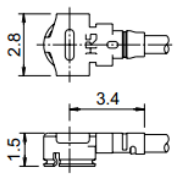
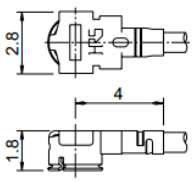
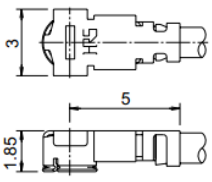
| Part No. | U.FL-LP-040 | U.FL-LP-066 | U.FL-LP(V)-040 | U.FL-LP-062 | U.FL-LP-088 |
|---|---|---|---|---|---|
| |  |  |  |  |  |
| Mated Height | 2.5mm Max. (2.4mm Nom.) | 2.5mm Max. (2.4mm Nom.) | 2.0mm Max. (1.9mm Nom.) | 2.4mm Max. (2.3mm Nom.) | 2.4mm Max. (2.3mm Nom.) |
| Applicable cable | Dia. 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 16: Mechanicals of UF.L-LP Connectors**

# 4 Electrical and Radio Characteristics

## 4.1. General Description

This chapter mainly describes the following electrical and radio characteristics of UC20 Mini PCIe:

- Power supply requirements
- IO requirements
- Current consumption
- RF characteristics
- GNSS receiver
- ESD characteristics

## 4.2. Power Supply Requirements

The input voltage of UC20 Mini PCIe is 3.3V ± 9%, as specified by PCI Express Mini CEM Specifications 1.2. The following table shows the power supply requirements of UC20 Mini PCIe.

**Table 14: Power Supply Requirements**

| Parameter | Description | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| VCC_3V3 | Power Supply | 3.0 | 3.3 | 3.6 | V |

## 4.3. IO Requirements

The following table shows the IO requirements of UC20 Mini PCIe.

**Table 15: IO Requirements**

| Parameter | Description | Min. | Max. | Unit |
|---|---|---|---|---|
| $V_{IH}$ | Input High Voltage | 0.7*VDDIO | VDDIO+0.3 | V |
| $V_{IL}$ | Input Low Voltage | -0.3 | 0.3*VDDIO | V |
| $V_{OH}$ | Output High Voltage | VDDIO-0.5 | VDDIO | V |
| $V_{OL}$ | Output Low Voltage | 0 | 0.4 | V |

**NOTES**

1. The PCM interface belongs to 1.8V power domain, and other IO interfaces belong to 3.3V power domain.
2. The maximum value of $V_{IL}$ for PERST# signal and W_DISABLE# signal is 0.5V.

## 4.4. Current Consumption

The current consumptions of UC20 Mini PCIe in different scenarios are respectively shown below.

**Table 16: Current Consumption**

| Description | Conditions | Typ. | Unit |
|---|---|---|---|
| Idle | (USB active)GSM @DRX=2 | 43 | mA |
| | (USB deactive)GSM @DRX=2 | 35 | |
| | (USB active)UMTS @DRX=6 | 42 | |
| | (USB deactive)UMTS @DRX=6 | 35 | |
| Sleep | GSM/GPRS @DRX=2 | 4.8 | mA |
| | GSM/GPRS @DRX=5 | 3.6 | |
| | GSM/GPRS @DRX=9 | 3.1 | |
| | UMTS @DRX=6 | 4.7 | |
| | UMTS @DRX=7 | 3.6 | |
| | UMTS @DRX=8 | 3.1 | |

| | | | |
|---|---|---|---|
| | UMTS @DRX=9 | 3.0 | |
| GSM Voice Call | GSM850 @PCL5 | 348 | mA |
| | EGSM900 @PCL5 | 309 | |
| | GSM1800 @PCL0 | 262 | |
| | GSM1900 @PCL0 | 328 | |
| UMTS Voice Call | UMTS2100 @max power | 483 | mA |
| | UMTS900 @max power | 556 | |
| GPRS Data Transfer | GPRS850(1UL/1DL) @PCL5 | 322 | mA |
| | GPRS850(1UL/4DL) @PCL5 | 345 | |
| | GPRS850(4UL/1DL) @PCL5 | 618 | |
| | GPRS900(1UL/1DL) @PCL5 | 295 | |
| | GPRS900(1UL/4DL) @PCL5 | 301 | |
| | GPRS900(4UL/1DL) @PCL5 | 681 | |
| | DCS1800(1UL/1DL) @PCL0 | 266 | |
| | DCS1800(1UL/4DL) @PCL0 | 274 | |
| | DCS1800(4UL/1DL) @PCL0 | 566 | |
| | PCS1900(1UL/1DL) @PCL0 | 289 | |
| | PCS1900(1UL/4DL) @PCL0 | 296 | |
| | PCS1900(4UL/1DL) @PCL0 | 675 | |
| EDGE Data Transfer | EDGE850(1UL/1DL) @PCL8 | 201 | mA |
| | EDGE850(1UL/4DL) @PCL8 | 201 | |
| | EDGE850(4UL/1DL) @PCL8 | 522 | |
| | EDGE900(1UL/1DL) @PCL8 | 201 | |
| | EDGE900(1UL/4DL) @PCL8 | 201 | |
| | EDGE900(4UL/1DL) @PCL8 | 502 | |
| | DCS1800(1UL/1DL) @PCL2 | 207 | |
| | DCS1800(1UL/4DL) @PCL2 | 207 | |
| | DCS1800(4UL/1DL) @PCL2 | 553 | |
| | PCS1900(1UL/1DL) @PCL2 | 211 | |
| | PCS1900(1UL/4DL) @PCL2 | 218 | |
| | PCS1900(4UL/1DL) @PCL2 | 570 | |
| UMTS Data Transfer | UMTS2100(HSDPA) @max power | 533 | mA |
| | UMTS2100(HSUPA) @max power | 532 | |
| | UMTS900(HSDPA) @max power | 599 | |
| | UMTS900(HSUPA) @max power | 598 | |

**NOTE**

The above values are obtained when the GNSS engine is switched off.

## 4.5. RF Characteristics

The following tables show output power and receiving sensitivity of conducted RF of UC20 Mini PCIe module.

**Table 17: Output Power of Conducted RF**

| Frequency | Max. | Min. |
|---|---|---|
| GSM850 | 33dBm±2dB | 5dBm±5dB |
| EGSM900 | 33dBm±2dB | 5dBm±5dB |
| DCS1800 | 30dBm±2dB | 0dBm±5dB |
| PCS1900 | 30dBm±2dB | 0dBm±5dB |
| GSM850(8-PSK) | 27dBm±3dB | 5dBm±5dB |
| EGSM900(8-PSK) | 27dBm±3dB | 5dBm±5dB |
| DCS1800(8-PSK) | 26dBm+3/-4dB | 0dBm±5dB |
| PCS1900(8-PSK) | 26dBm+3/-4dB | 0dBm±5dB |
| UMTS2100 | 24dBm+1/-3dB | <-50dBm |
| UMTS1900 | 24dBm+1/-3dB | <-50dBm |
| UMTS900 | 24dBm+1/-3dB | <-50dBm |
| UMTS850 | 24dBm+1/-3dB | <-50dBm |
| UMTS800 | 24dBm+1/-3dB | <-50dBm |

**Table 18: Receiving Sensitivity of Conducted RF**

| Frequency | Receive Sensitivity (Typ.) |
|---|---|
| GSM850 | -108.5dBm |
| EGSM900 | -108.5dBm |
| DCS1800 | -108dBm |

| | |
|---|---|
| PCS1900 | -108dBm |
| UMTS2100 | -110dBm |
| UMTS1900 | -110dBm |
| UMTS900 | -110dBm |
| UMTS850 | -110dBm |
| UMTS800 | -110dBm |

## 4.6. GNSS Receiver

UC20 Mini PCIe integrates a GNSS receiver that supports the latest generation gpsOne Gen8 of Qualcomm (GPS and GLONASS), and can apply Qualcomm gpsOneXTRA technology (one kind of A-GNSS). This technology will download XTRA file from the internet server to enhance the TTFF. XTRA file contains predicted GPS and GLONASS satellites coordinates and clock biases valid for up to 7days. It is best if XTRA file is downloaded once every 1-2 days. Additionally, UC20 Mini PCIe can support standard NMEA-0183 protocol and output NMEA messages with 1Hz via USB NMEA interface.

UC20 Mini PCIe GNSS engine is switched off by default. You must switch on it by AT command. Please refer to ***document [3]*** for more details about GNSS engine technology and configurations. In addition, it is recommended to use active antenna because the GNSS interface has been connected to a 2.85V supply internally.

The following table shows performance of UC20 Mini PCIe GNSS.

**Table 19: GNSS Performance**

| Parameter | Description | Conditions | Typ. | Unit |
|---|---|---|---|---|
| Sensitivity | Cold start | Passive antenna | -145 | dBm |
| | | Active antenna | -147 | dBm |
| | Reacquisition | Passive antenna | -154 | dBm |
| | | Active antenna | -159 | dBm |
| | Tracking | Passive antenna | -155 | dBm |
| | | Active antenna | -161 | dBm |

| | | | | |
|---|---|---|---|---|
| TTFF | Cold start @Open sky | Autonomous | 32 | s |
| | | XTRA enabled | 22 | s |
| | Warm start @Open sky | Autonomous | 29 | s |
| | | XTRA enabled | 3 | s |
| | Hot start @Open sky | Autonomous | 2.5 | s |
| | | XTRA enabled | 2 | s |
| Accuracy | CEP-50 @Open sky | Autonomous | <1.5 | m |

## 4.7. ESD Characteristics

The following table shows characteristics of UC20 Mini PCIe ESD.

**Table 20: ESD Characteristics**

| Part | Contact Discharge | Air Discharge | Unit |
|---|---|---|---|
| Power Supply and GND | +/-5 | +/-10 | kV |
| Antenna Interface | +/-4 | +/-8 | kV |
| USB Interface | +/-4 | +/-8 | kV |
| USIM Interface | +/-4 | +/-8 | kV |
| Others | +/-0.5 | +/-1 | kV |

# 5 Mechanical Dimensions

## 5.1. General Description

This chapter mainly describes the following dimensions of UC20 Mini PCIe:

- Mechanical Dimensions of UC20 Mini PCIe
- Standard Dimensions of Mini PCI Express
- Packaging

## 5.2. Mechanical Dimensions of UC20 Mini PCIe

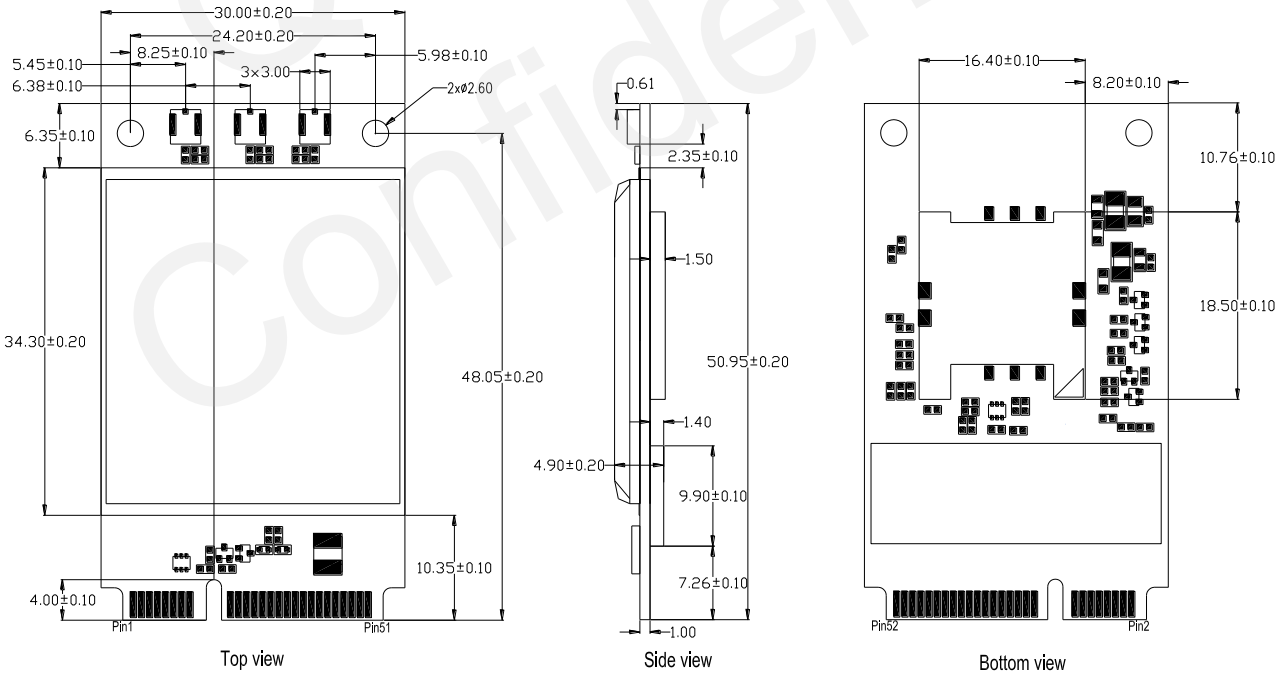



**Figure 17: Mechanical Dimensions of UC20 Mini PCIe (Unit: mm)**

## 5.3. Standard Dimensions of Mini PCI Express

The following figure shows the standard Dimensions of Mini PCI Express. Please refer to ***document [1]*** for detail A and B.

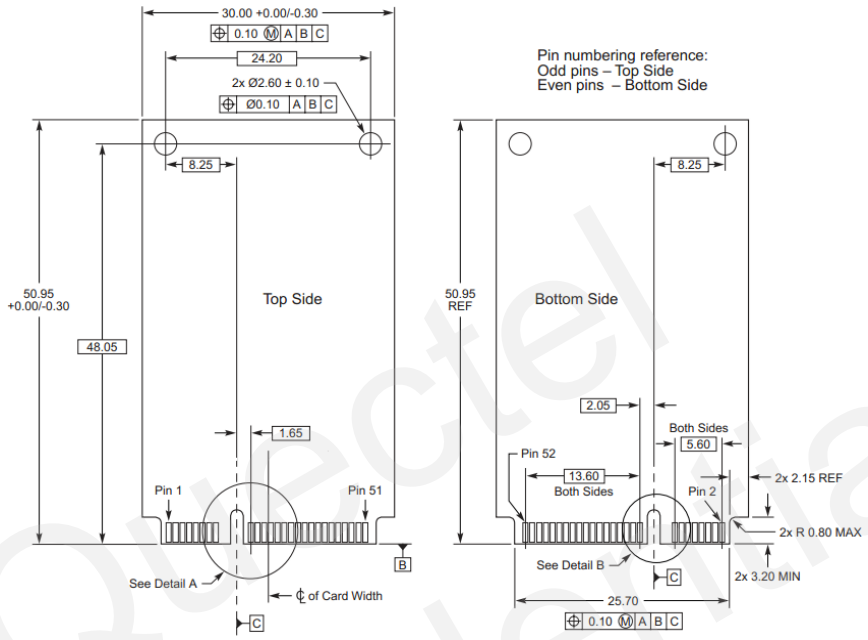



**Figure 18: Standard Dimensions of Mini PCI Express (Unit: mm)**

UC20 Mini PCIe adopts a standard Mini PCI Express connector which compiles with the directives and standards listed in the ***document [1]***. The following figure takes the Molex 679100002 as an example.

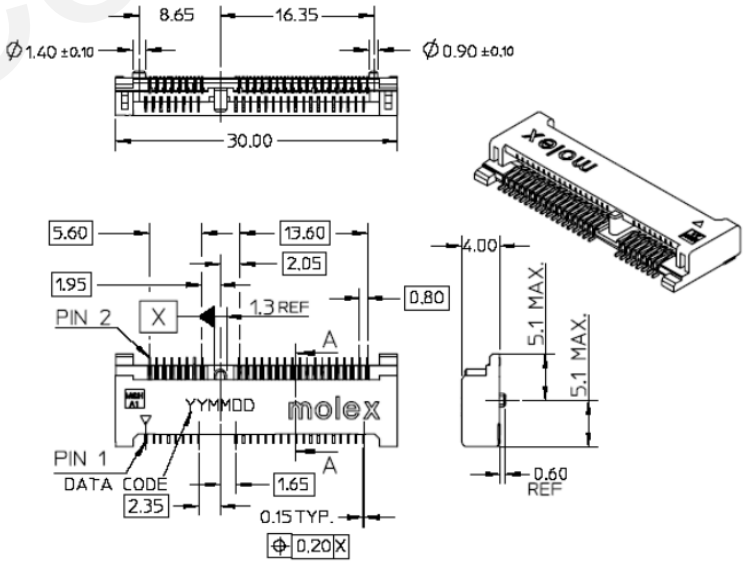



**Figure 19: Dimensions of the Mini PCI Express Connector (Unit: mm)**

## 5.4. Packaging

The UC20 Mini PCIe is packaged in tray. Each tray contains 10pcs of modules. The smallest package of UC20 Mini PCIe contains 100pcs.

# 6 Appendix Reference

**Table 21: Related Documents**

| SN | Document Name | Remark |
|---|---|---|
| [1] | PCI Express Mini Card Electromechanical Specification Revision 1.2 | Mini PCI Express Specification. |
| [2] | Quectel_UC20_AT_Commands_Manual | UC20 AT Commands Manual. |
| [3] | Quectel_UC20_GNSS_AT_Commands_Manual | UC20 GNSS AT Commands Manual. |

**Table 22: Terms and Abbreviations**

| Abbreviation | Description |
|---|---|
| bps | Bits Per Second |
| CS | Coding Scheme |
| CSD | Circuit Switched Data |
| CTS | Clear To Send |
| DCE | Data Communications Equipment (typically module) |
| DL | Down Link |
| DTE | Data Terminal Equipment (typically computer, external controller) |
| DTR | Data Terminal Ready |
| EMC | Electromagnetic Compatibility |
| ESD | Electrostatic Discharge |
| GLONASS | GLObalnaya NAvigatsionnaya Sputnikovaya Sistema, the Russian Global Navigation Satellite System |
| GMSK | Gaussian Minimum Shift Keying |

| | |
|---|---|
| GNSS | Global Navigation Satellite System |
| GPS | Global Positioning System |
| GSM | Global System for Mobile Communications |
| HSPA | High Speed Packet Access |
| I/O | Input/Output |
| kbps | Kilo Bits Per Second |
| LED | Light Emitting Diode |
| Mbps | Million Bits Per Second |
| MMS | Multimedia Messaging Service |
| MO | Mobile Originated |
| MS | Mobile Station (GSM engine) |
| MT | Mobile Terminated |
| PAP | Password Authentication Protocol |
| PCM | Pulse Code Modulation |
| PDU | Protocol Data Unit |
| PPP | Point-to-Point Protocol |
| RF | Radio Frequency |
| RX | Receive Direction |
| SIM | Subscriber Identification Module |
| SMS | Short Message Service |
| TDMA | Time Division Multiple Access |
| TE | Terminal Equipment |
| TTFF | Time to First Fix |
| TX | Transmitting Direction |
| UART | Universal Asynchronous Receiver & Transmitter |

| | |
|---|---|
| UL | Up Link |
| UMTS | Universal Mobile Telecommunications System |
| URC | Unsolicited Result Code |
| USSD | Unstructured Supplementary Service Data |
| WCDMA | Wideband Code Division Multiple Access |