UC20 Mini PCIe

Hardware Design

UMTS/HSPA Module Series

Rev. UC20_Mini_PCIe_Hardware_Design_V1.3

Date: 2015-12-09

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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 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 2. Added I2C function
1.3	2015-12-09	Lyndon LIU	1. Updated functional diagram 2. Updated pin 1 definition 3. Updated USB introduction 4. Updated PCM timing 5. Added UART_RI signal introduction in Chapter 3.8.4 6. Added WAKE# signal introduction in Chapter 3.8.5

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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 Support UMTS 900/2100MHz Support GPS/GLONASS Support digital audio*
UC20-A Mini PCIe	Support UMTS 850/1900MHz Support GPS/GLONASS Support digital audio*
UC20-G Mini PCIe	Support GSM850, EGSM900, DCS1800, PCS1900 Support UMTS 800/850/900/1900/2100MHz Support GPS/GLONASS 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. **GLONASS:** 1597.5~1605.8MHz **UC20-E Mini PCIe:** 900/2100MHz @UMTS 850/900/1800/1900MHz @GSM **UC20-A Mini PCIe:** 850/1900MHz @UMTS, 3G only **UC20-G Mini PCIe:** 800/850/900/1900/2100MHz @UMTS

	850/900/1800/1900MHz @GSM
Transmission Data	HSPA R6: Max 14.4Mbps (DL)/Max 5.76Mbps (UL)
	UMTS R99: Max 384kbps (DL)/Max 384kbps (UL)
	EDGE: Max 236.8kbps (DL)/Max 236.8kbps (UL)
	GPRS: Max 85.6kbps (DL)/Max 85.6kbps (UL)
	CSD: 14.4kbps
Transmitting Power	Class 4 (33dBm±2dB) for GSM850 and EGSM900
	Class 1 (30dBm±2dB) for DCS1800 and PCS1900
	Class E2 (27dBm±3dB) for GSM850 and EGSM900 8-PSK
	Class E2 (26dBm+3/-4dB) for DCS1800 and PCS1900 8-PSK
	Class 3 (24dBm+1/-3dB) for UMTS 800/850/900/1900/2100
HSPA and UMTS Features	HSPA data rate is corresponded with 3GPP R6. 14.4Mbps on downlink and 5.76 Mbps on uplink.
	WCDMA data rate is corresponded with 3GPP R99/R4. 384kbps on downlink and 384kbps on uplink.
	Support both QPSK and 16-QAM modulations.
GSM/GPRS/EDGE Data Features	**GPRS:** Support GPRS multi-slot class 12 (10 by default)
	Coding scheme: CS-1, CS-2, CS-3 and CS-4
	Maximum of four Rx time slots per frame
	EDGE: Support EDGE multi-slot class 12 (12 by default)
	Support GMSK and 8-PSK for different MCS (Modulation and Coding Scheme)
	Downlink coding schemes: CS 1-4 and MCS 1-9
	Uplink coding schemes: CS 1-4 and MCS 1-9
	CSD: CSD transmission rates: 14.4 kbps non-transparent
	Support Unstructured Supplementary Services Data (USSD)
Internet Protocol Features	Support TCP/PPP/UDP/FTP/HTTP/MMS/SMTP protocols
	Support the protocols PAP (Password Authentication Protocol) and CHAP (Challenge Handshake Authentication Protocol) usually used for PPP connections
SMS	Text and PDU mode
	Point to point MO and MT
	SMS cell broadcast
	SMS storage: ME by default
USIM Interface	Support USIM card: 1.8V, 3.0V
	Support USIM and SIM
UART Interface	Support RTS and CTS hardware flow control
	Baud rate can reach up to 230400bps, 115200bps by default
	Used for AT command and data transmission
	Support multiplexing function
PCM Interface	Support 8-bit A-law, µ-law and 16-bit linear data formats
	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 480Mbps. Used for AT command communication, data transmission, GNSS NMEA output, software debug and firmware upgrade. 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, GNSS antenna (active/passive)
GNSS Features	gpsOne Gen8 of Qualcomm (GPS and GLONASS) 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 Restricted operation: -40°C ~ -30°C and +70°C ~ +80°C▲ 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 (support 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
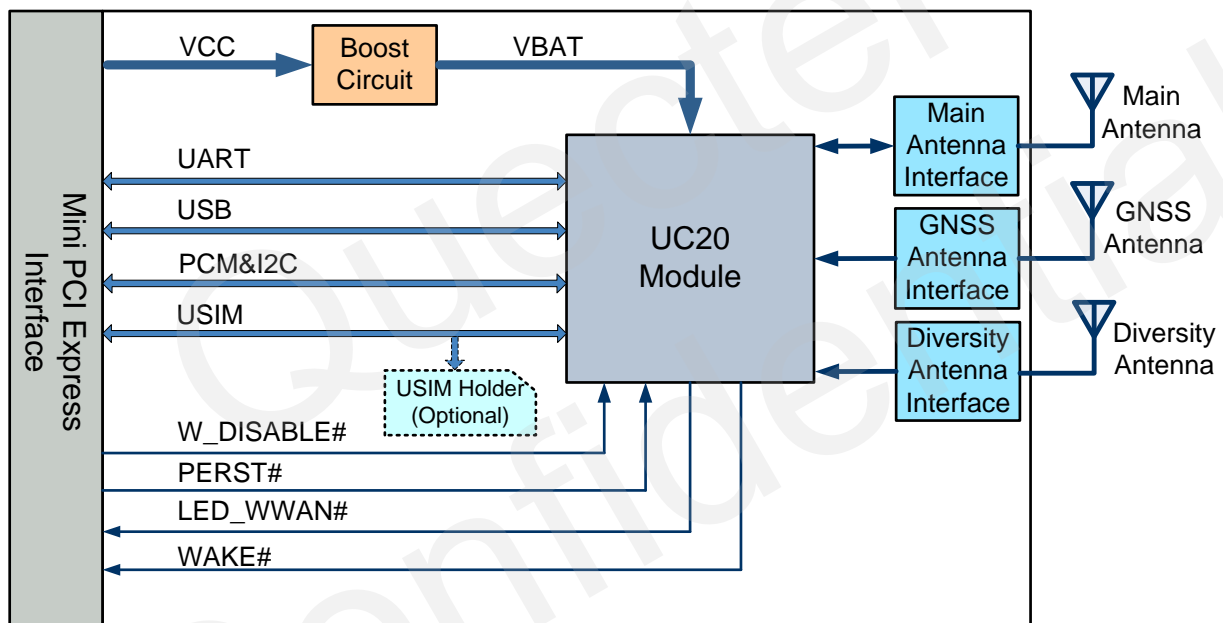
Figure 1: Functional Diagram

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# , WAKE# 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#	WAKE#	OC	Output signal can be used to wake up the host.	External pull-up resistor is required.
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.

Pin Name	Pin No.
WAKE#	1
RESERVED	3
RESERVED	5
RESERVED	7
GND	9
UART_RX	11
UART_TX	13
GND	15
UART_RI	17
RESERVED	19
GND	21
UART_CTS	23
UART_RTS	25
GND	27
GND	29
UART_DTR	31
UART_DCD	33
GND	35
GND	37
VCC_3V3	39
VCC_3V3	41
GND	43
PCM_CLK*	45
PCM_DOUT*	47
PCM_DIN*	49
PCM_SYNC*	51

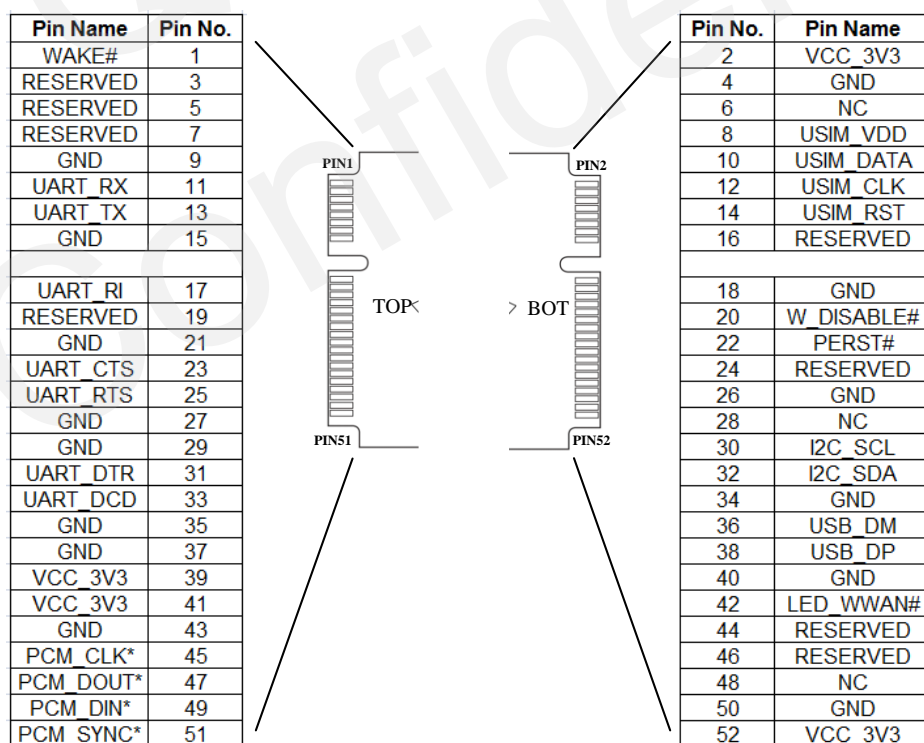| Pin No.	Pin Name
2	VCC_3V3
4	GND
6	NC
8	USIM_VDD
10	USIM_DATA
12	USIM_CLK
14	USIM_RST
16	RESERVED
18	GND
20	W_DISABLE#
22	PERST#
24	RESERVED
26	GND
28	NC
30	I2C_SCL
32	I2C_SDA
34	GND
36	USB_DM
38	USB_DP
40	GND
42	LED_WWAN#
44	RESERVED
46	RESERVED
48	NC
50	GND
52	VCC_3V3

Figure 2: Pin Assignment

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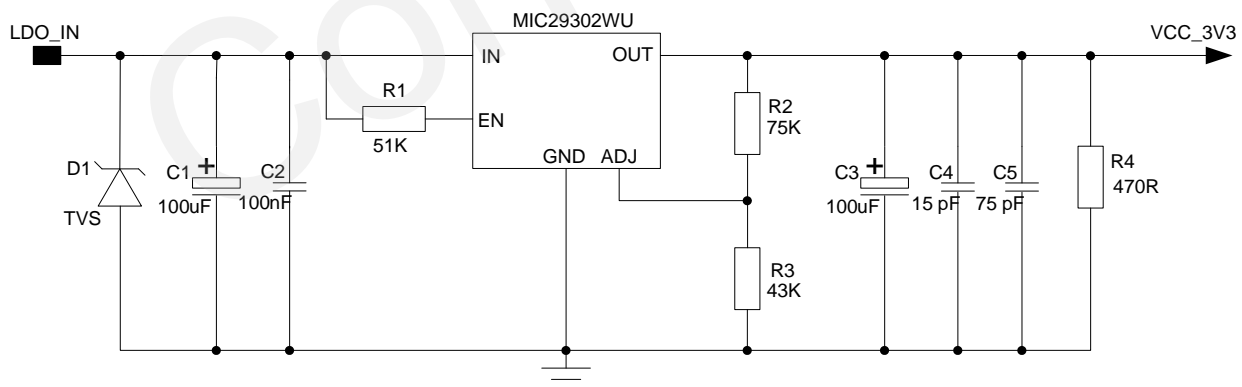
Figure 3: Reference Design of Power Supply

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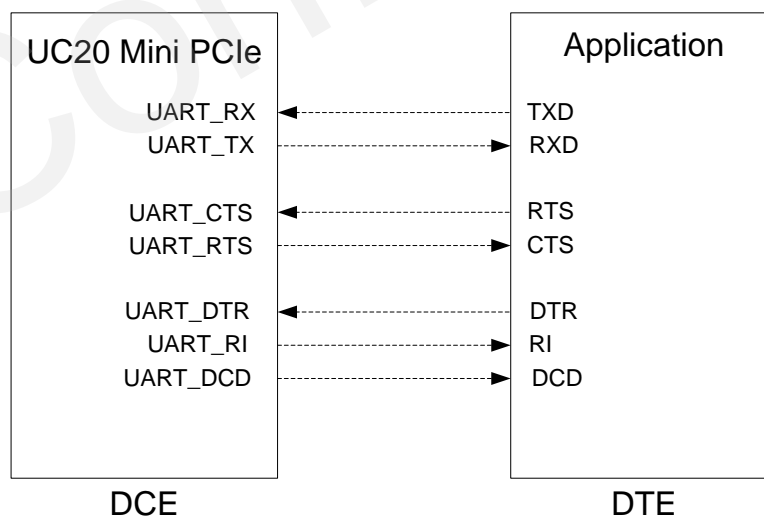
Figure 4: The DCE-DTE Connection of UART Interface

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, driving it to low level will wake up the module. AT command **AT+QCFG="pwrsavedtr",0** is used to disable the sleep control function.
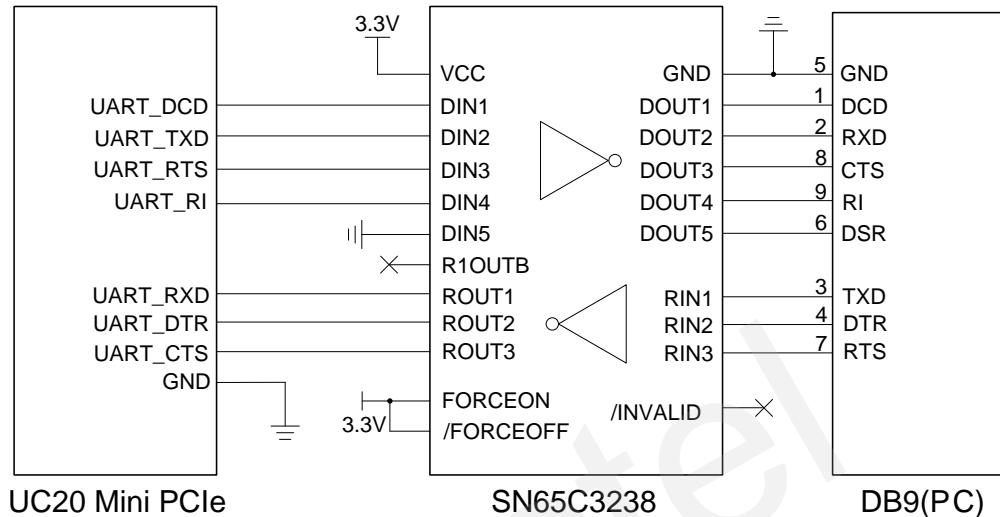
3.5. USIM Card Interface

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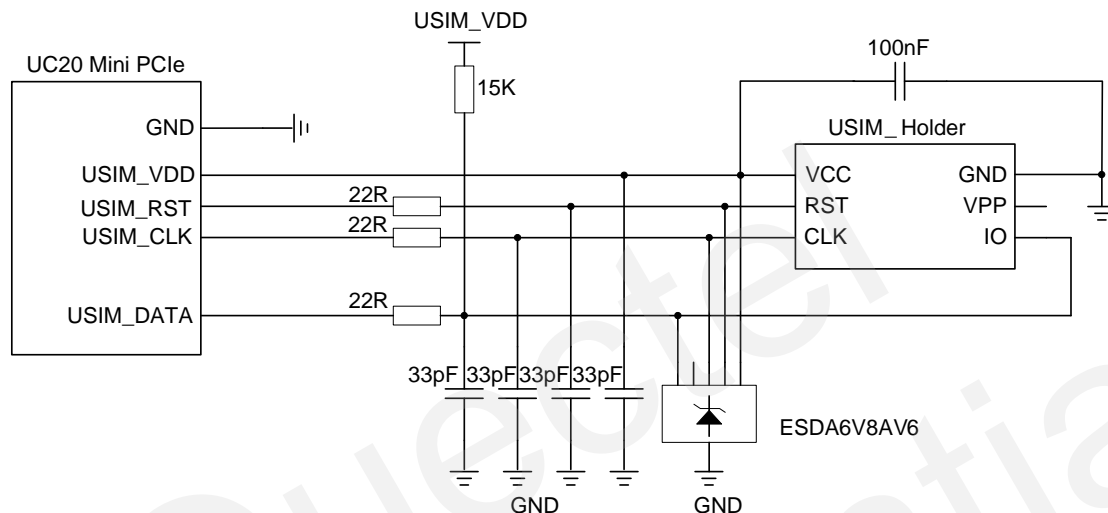
Figure 6: Reference Circuit of the 6 Pin USIM Card

In order to enhance the reliability and availability of the USIM card in your application, please comply with 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 (480Mbps), full speed (12Mbps) and low speed (1.5Mbps) 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.
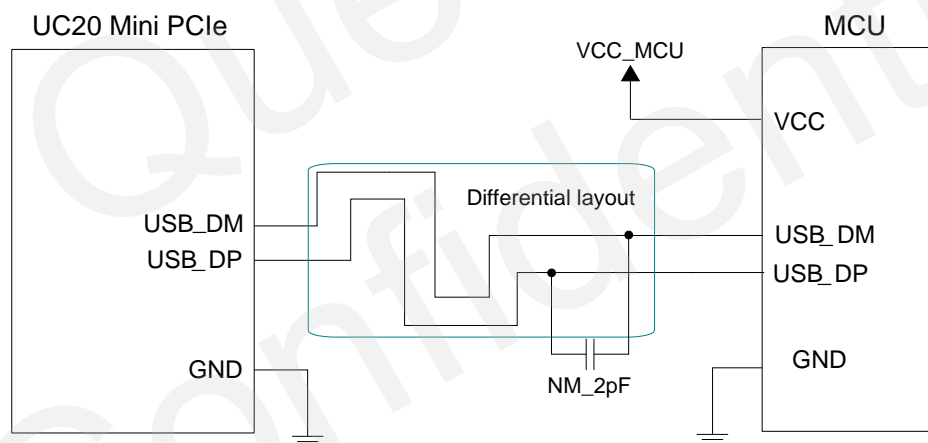
Figure 8: Reference Circuit of USB Interface

The USB interface is recommended to be reserved for firmware upgrade in your design. The following figure shows the recommended test points.

Figure 9: USB Test Points for Firmware Upgrade

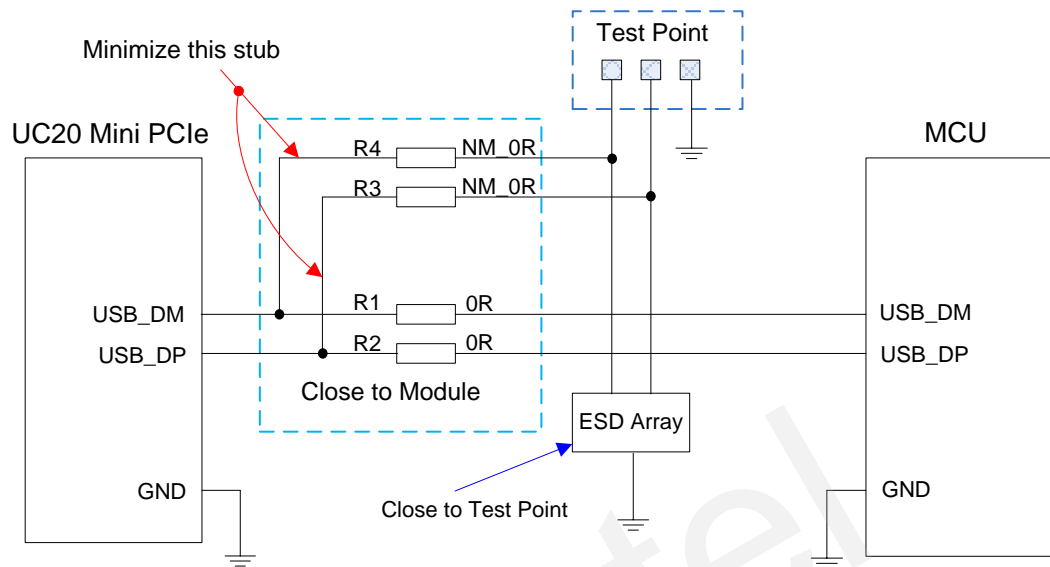In order to keep USB data line signal integrity, the component R1, R2, R3 and R4 must be placed close to the module and these resistors should be placed close to each other as well. The extra stubs of trace must be as short as possible.

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 in 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 128kHz, 256kHz, 512kHz, 1024kHz, 2048kHz and 4096kHz. The following figure shows timing relationship in primary mode with 8 kHz PCM_SYNC and 2048 kHz PCM_CLK.
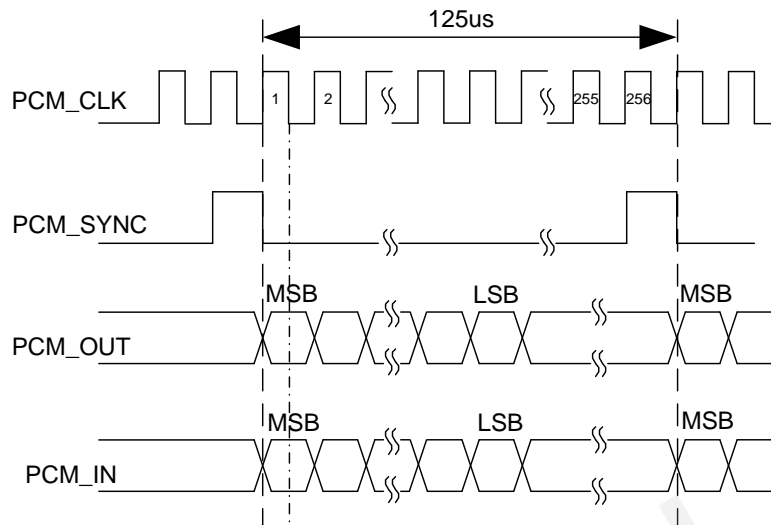
Figure 10: Timing of Primary Mode

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.
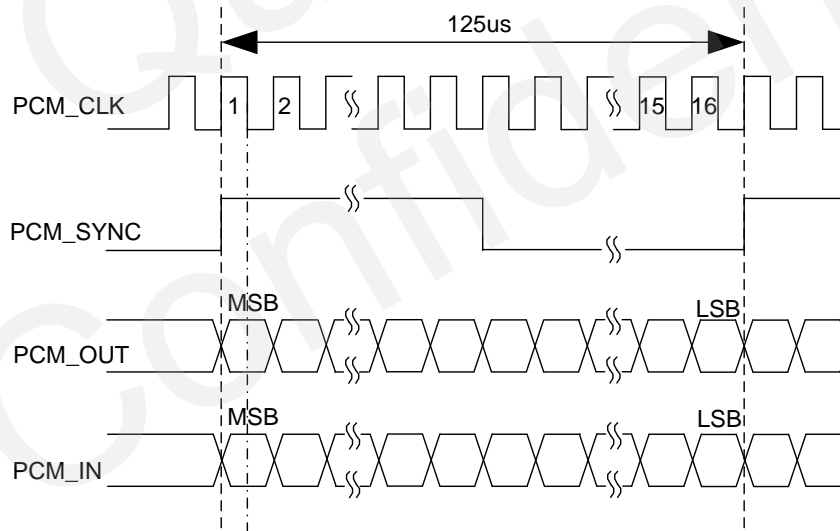
Figure 11: Timing of Auxiliary Mode

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.
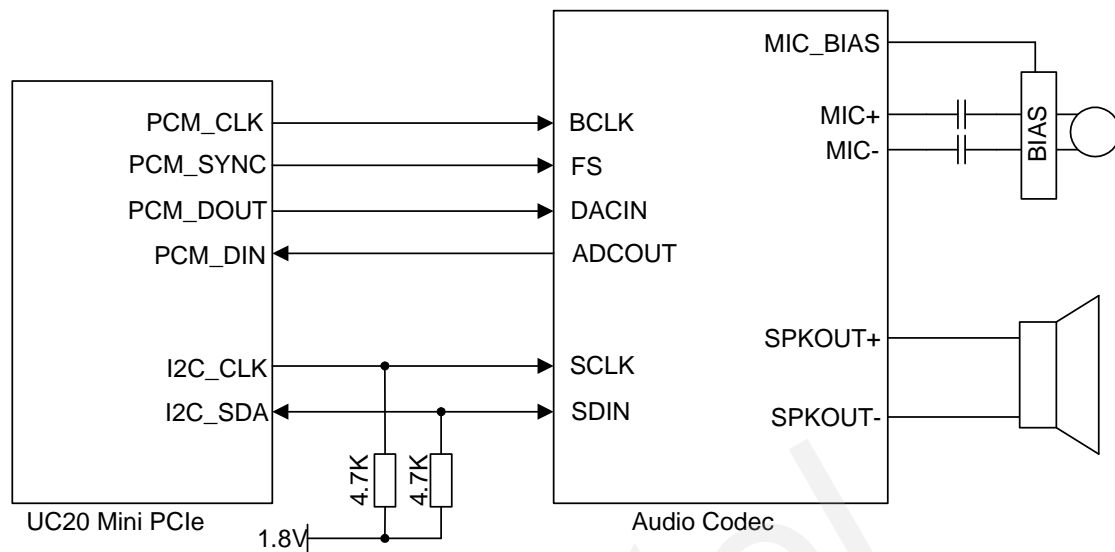
Figure 12: Reference Circuit of PCM Application with Audio Codec

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
1	WAKE#	OC	—	Output signal can be used to wake up the host.
17	UART_RI	DO	3.3V	URC ring indication, can be used to wake up the host.
20	W_DISABLE#	DI	3.3V	Disable wireless communications. Active low.
22	PERST#	DI	3.3V	Functional reset to the card. Active low.
31	UART _DTR	DI	3.3V	Sleep mode control.
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 AT+CFUN=4	Disabled
Low Level	AT+CFUN=0 AT+CFUN=1 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.
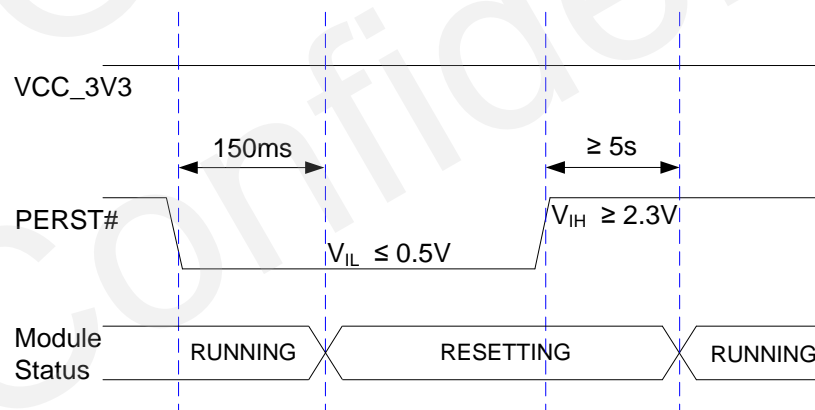
Figure 13: Timing of Resetting Module

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.
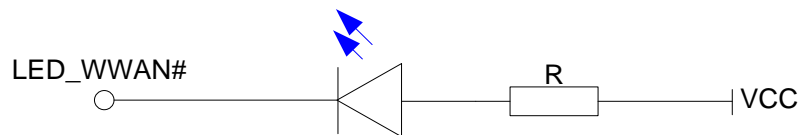
Figure 14: LED_WWAN# Signal Reference Circuit Diagram

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 to network
High-impedance (Light off)	● No network coverage or not registered. ● W_DISABLE# signal is in low level. (Disable the RF) ● AT+CFUN=0, AT+CFUN=4.

3.8.4. UART_RI Signal

The UART_RI signal can be used to wake up the host. When URC returns, there will be the following behavior on the UART_RI pin after executing AT command **AT+QCFG="risignaltype","physical"**.
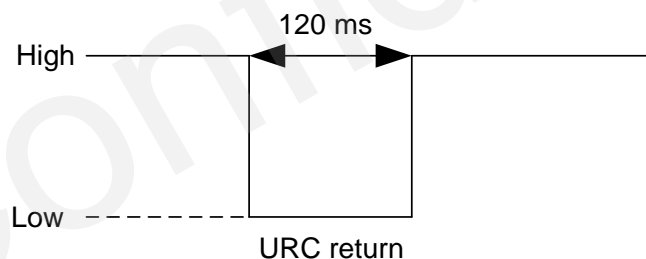
Figure 15: UART_RI Behavior

3.8.5. WAKE# Signal

The WAKE# signal is an open collector signal which is similar to UART_RI signal. But a host pull-up resistor and AT command **AT+QCFG="risignaltype","physical"** are required. When URC returns, there will be 120ms low level pulse output as below.
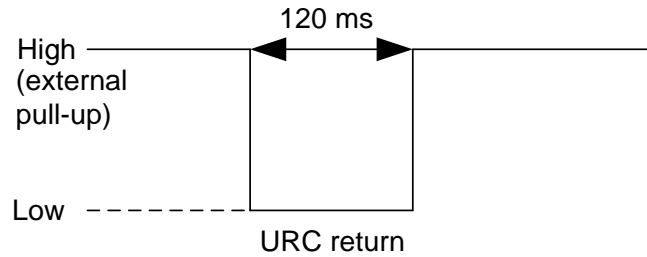
Figure 16: WAKE# Behavior

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.
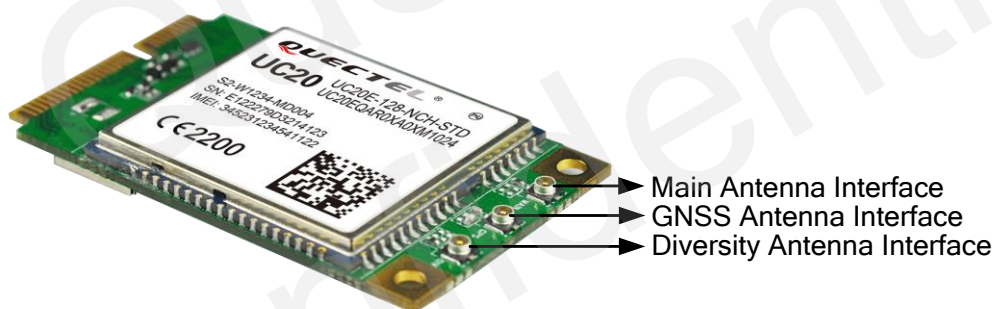
Figure 17: UC20 Mini PCIe Antenna Interface
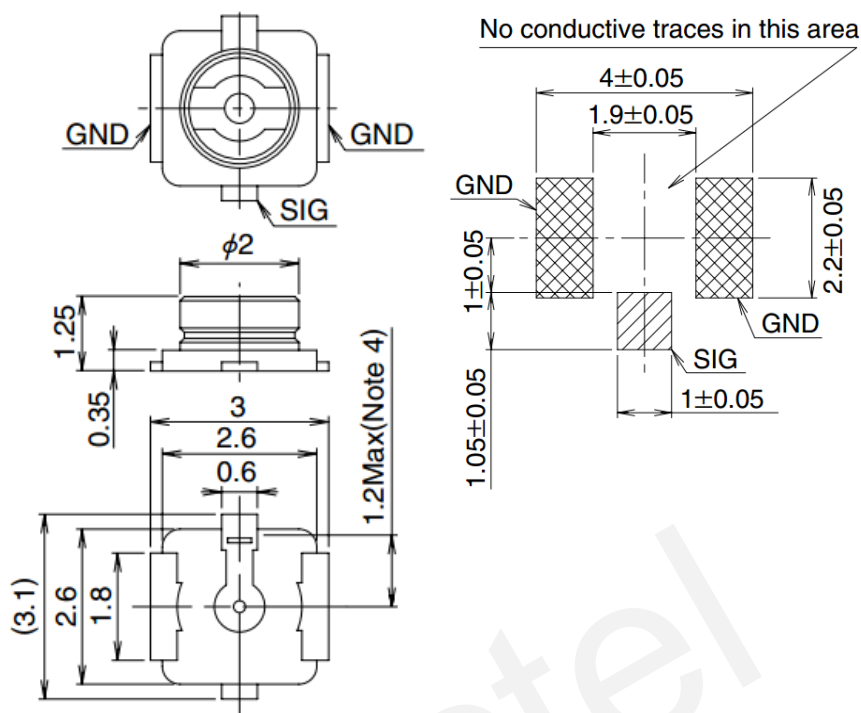
Figure 18: Dimensions of the RF Connector (Unit: mm)

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.

	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
Part No.					
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 19: 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
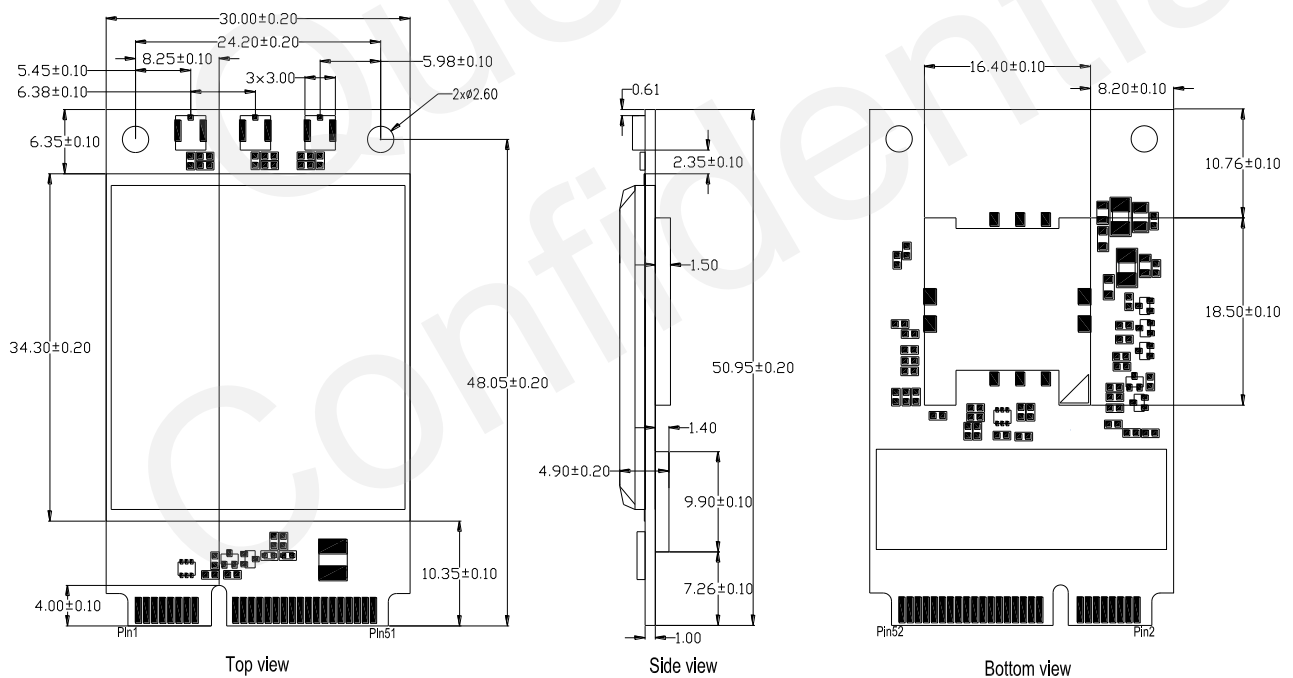- Packaging

5.2. Mechanical Dimensions of UC20 Mini PCIe

Figure 20: 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.
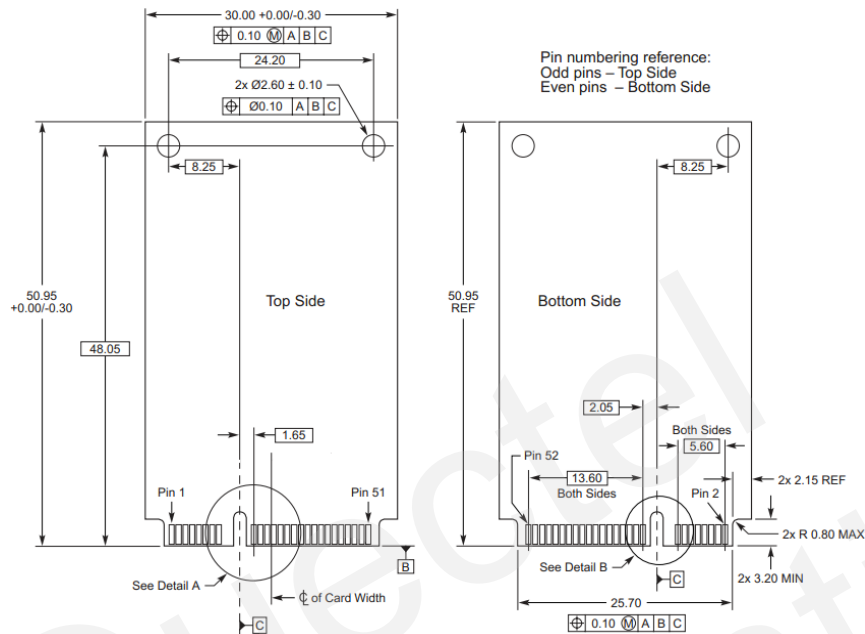

Figure 21: Standard Dimensions of Mini PCI Express (Unit: mm)

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.

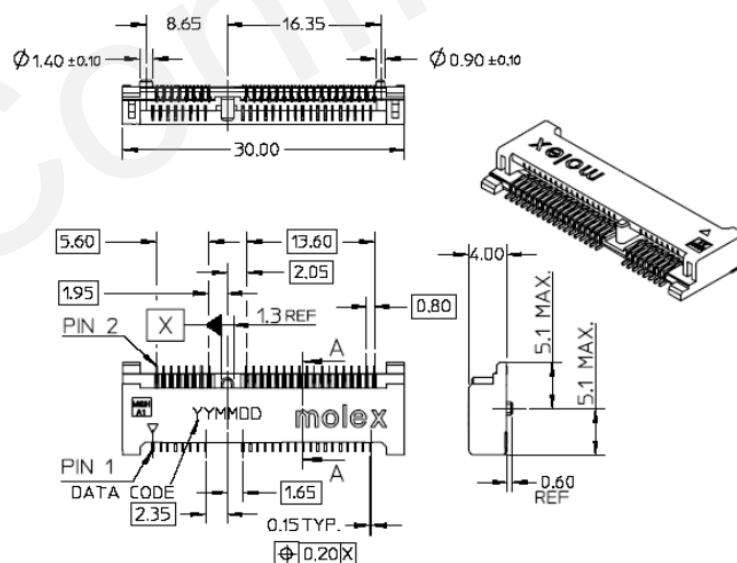
Figure 22: Dimensions of the Mini PCI Express Connector (Unit: mm)

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