

Mini PCIe EVB

User Guide

UMTS/HSPA+/LTE Standard/LPWA Module Series

Rev: Mini_PCIe_EVB_User_Guide_V1.2

Date: 2019-11-08

Status: Released



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About the Document

History

Revision	Date	Author	Description
1.0	2015-03-03	Radom XIANG	Initial
1.1	2015-06-10	Radom XIANG	Deleted +5V adapter parts in EVB accessories
1.2	2019-11-08	Jouni YANG/ Woody WU	1. Removed jumper J304 and the transfer's VDD_A is fixed to 3.0V. 2. Added diodes D202 and D203 to prevent current from flowing backward. 3. Added capacitors C101, C102, C103, C104, C403, C409, C431, C406, C434 and removed capacitor C522. 4. Added resistors R509, R510 and R511. 5. Used TPS54319RTER to replace AAT2138 on U201. 6. Added a delay circuit to meet the codec power-on scenario. 7. Separated the analog ground and the digital ground for codec audio circuit. 8. Added applicable modules (Chapter 1.1). 9. Added a test point CLK_OUT (Chapter 4.9). 10. Updated USB serial port in communication via UART connector (Figure 30) and COM port setting field on QCOM (Figure 31)

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1 Introduction

This document describes how to use the evaluation board of Mini PCIe modules. It is an assistant tool to develop and test Quectel Mini PCIe modules.

1.1. Applicable Modules

Mini PCIe EVB is applicable to the following modules. Please refer to **document [1]** to get more details about these modules.

- UC15 Mini PCIe
- UC20 Mini PCIe
- EC20 R2.0 Mini PCIe
- EC20 R2.1 Mini PCIe
- EC21 Mini PCIe
- EC25 Mini PCIe
- EG25-G Mini PCIe
- EG21-G Mini PCIe
- BG96 Mini PCIe
- BG95 Mini PCIe

1.2. Safety Information

The following safety precautions must be observed during all phases of operation, such as usage, service or repair of any cellular terminal or mobile incorporating Mini PCIe modules. Manufacturers of the cellular terminal should send the following safety information to users and operating personnel, and incorporate these guidelines into all manuals supplied with the product. If not so, Quectel assumes no liability for customers' 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) causes distraction and can lead to an accident. Please comply with laws and regulations restricting the use of wireless devices while driving.



Switch off the cellular terminal or mobile before boarding an aircraft. The operation of wireless appliances in an aircraft is forbidden to prevent interference with communication systems. If the device offers an Airplane Mode, then it should be enabled prior to boarding an aircraft. Please consult the airline staff for more restrictions on the use of wireless devices on boarding the aircraft.



Wireless devices may cause interference on sensitive medical equipment, so please be aware of the restrictions on the use of wireless devices when in hospitals, clinics or other healthcare facilities.



The cellular terminal or mobile contains a transmitter and receiver. When it is ON, it receives and transmits radio frequency signals. RF interference can occur if it is used close to TV set, radio, computer or other electric equipment.



In locations with potentially explosive atmospheres, obey all posted signs to turn off wireless devices such as your phone or other cellular terminals. Areas with potentially explosive atmospheres include 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, etc.

2 General Overview

Quectel supplies the Mini PCIe EVB to facilitate application design based on Quectel Mini PCIe modules. It can test module basic functionalities.

2.1. Key Features

The following table describes the detailed features of Mini PCIe EVB.

Table 1: Key Features of Mini PCIe EVB

Features	Description
Power Supply	● DC supply: 4.5V~5.5V, typically: 5.0V ● VBAT: 3.3V for J204
USB Interface	A micro-USB interface compliant with USB 2.0 standard
Audio Interfaces	● Two analog audio interfaces used for handset (J503) and earphone (J501) connecting to codec to test the PCM function; Support ALC5616 codec ● Two analog audio interfaces used for handset (J502) and earphone (J504)
(U)SIM Interface	● A (U)SIM card (6-pin) connector with push loading ● Support (U)SIM card: 1.8V/3.0V
UART Interface	● COM: serial interface for data communication and AT command communication ● Max baud rate: 460800bps (115200bps by default)
Status Indicators	2 LEDs are available for signal indication
Switch and Button	● A power supply ON/OFF control switch ● A button used to reset the module
Jumper	A jumper used to match the PCM signal level between the Mini PCIe module and the codec on the EVB
Physical Characteristics	Size: 94mm × 58mm

2.2. Component Placement of Mini PCIe EVB

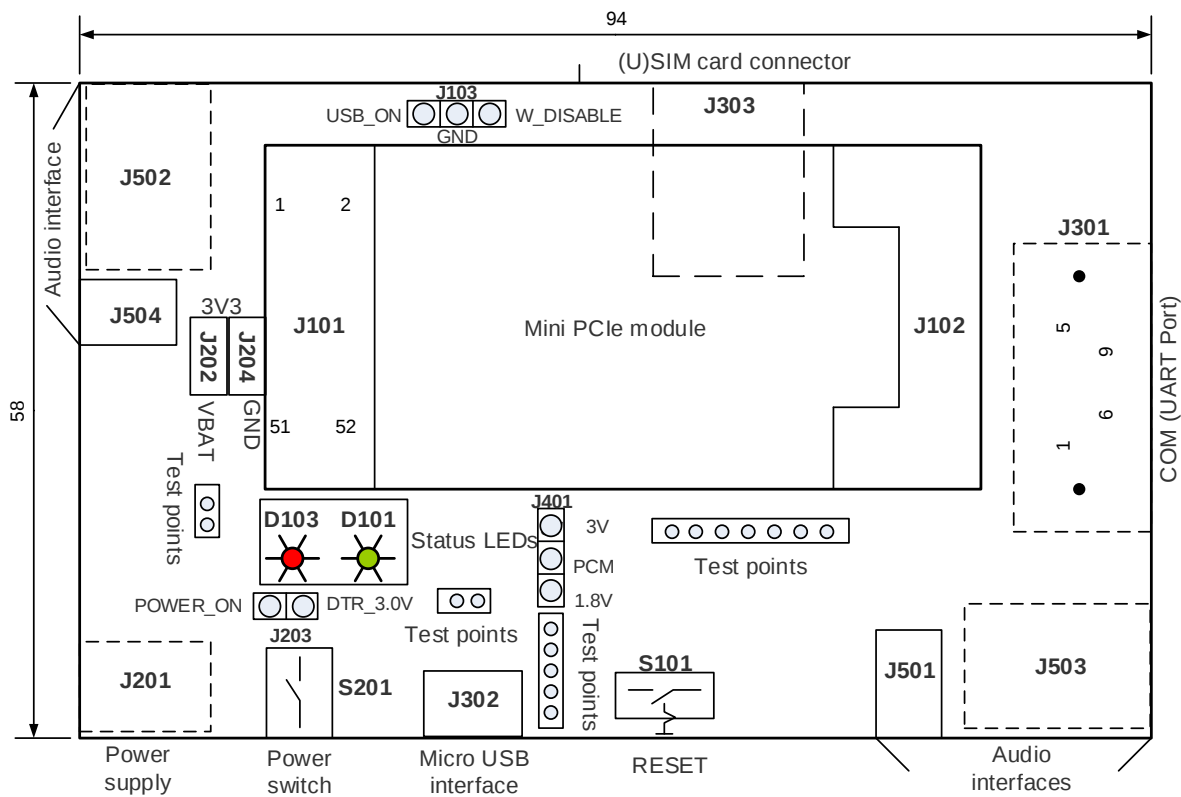


Figure 1: Component Placement of EVB Top Side (Unit: mm)

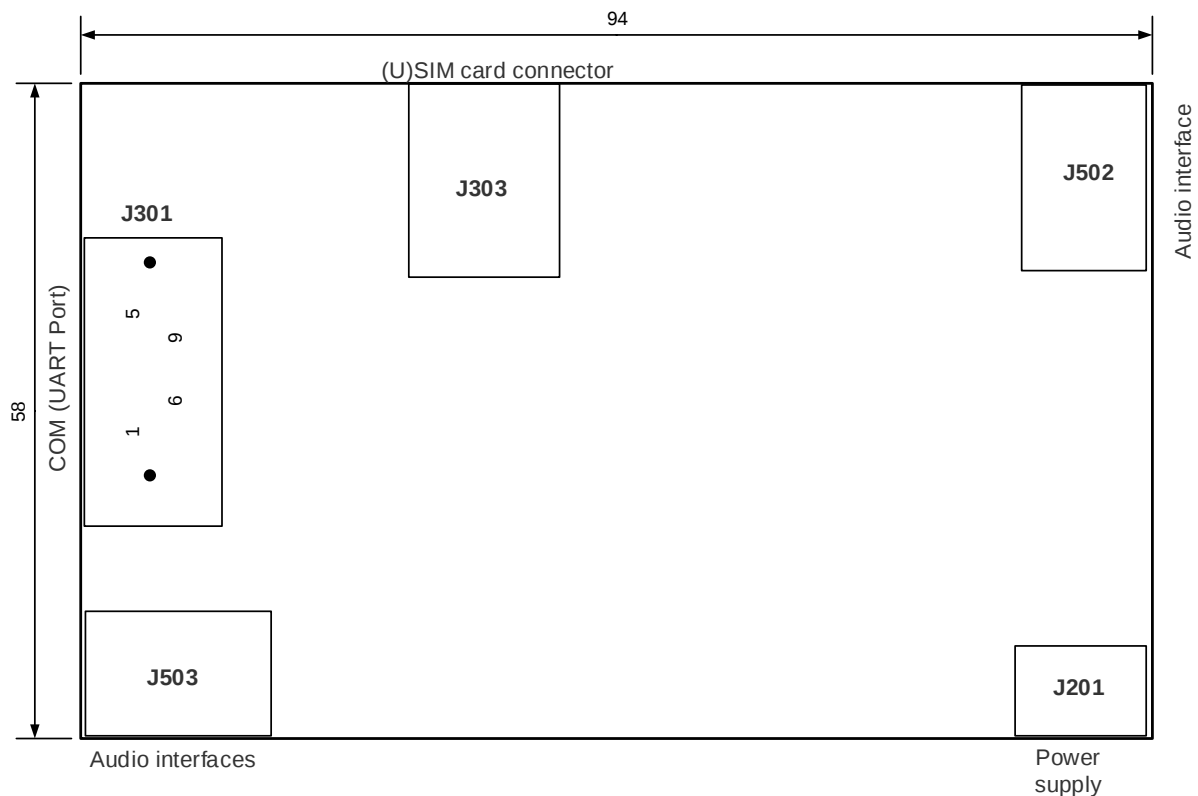


Figure 2: Component Placement of EVB Bottom Side (Unit: mm)

Table 2: Component Functions of Mini PCIe EVB

Functions	Component No.	Description
Power Supply	J201 (bottom side)	- The power jack on the EVB - Typical supply voltage: +5V
Power ON/OFF Switch	S201	VBAT ON/OFF control
RESET	S101	- Reset button - Used to reset the Mini PCIe module
USB	J302	- Micro-USB connector - Can be used for USB connection detection and EVB power supply
Audio	J501	- Used for $\Phi 3.5\text{mm}$ CTIA earphone by default - Used to test the Mini PCIe module's PCM function
	J503 (bottom side)	- Handset connector - Used to test the Mini PCIe module's PCM function

	J502 (bottom side)	● Handset connector ● Used to test the analog audio function of UC15 Mini PCIe only.
	J504	● Used for $\Phi 3.5\text{mm}$ CTIA earphone by default. ● Used to test the analog audio function of UC15 Mini PCIe only
(U)SIM	J303 (bottom side)	(U)SIM card connector
COM	J301 (bottom side)	UART port
Status Indicators	D101, D103	● D101 is used to indicate the network status of the Mini PCIe module ● D103 is VBAT ON/OFF indicator.
Mini PCIe Slot	J101	● Mini PCI Express connector for Mini PCIe module
Spring Latch	J102	● Spring latch for Mini PCIe module
Reserved	J202	● J202 or R207 can be used to control the connection between the DC-DC output and the VBAT of the module
	J204	● Used to input external 3.3V voltage and test the modules' current
	J103	● Used to connect the pin W_DISABLE# to GND to enable the airplane mode ● USB_ON function is reserved
	J203	● Used to control the VBAT ON/OFF through pin DTR_3.0V
Jumper	J401	Used to match the PCM signal level between the Mini PCIe module and the codec on the EVB
Test Points	See Chapter 4.9	Used to test the UART/PCM signals.

2.3. Top and Bottom Views of EVB

The top and bottom views of the Mini PCIe EVB are shown as below.

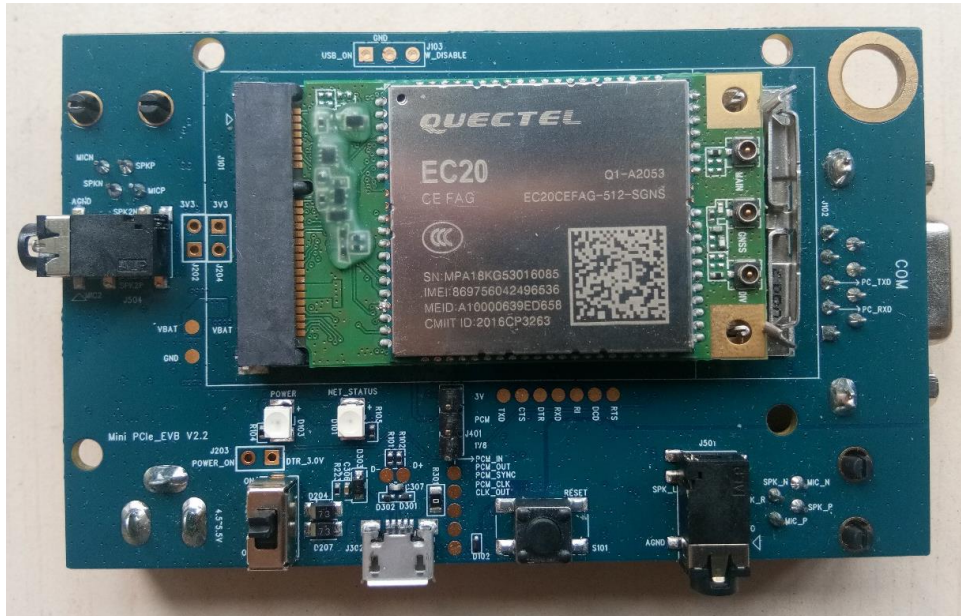


Figure 3: EVB Top View

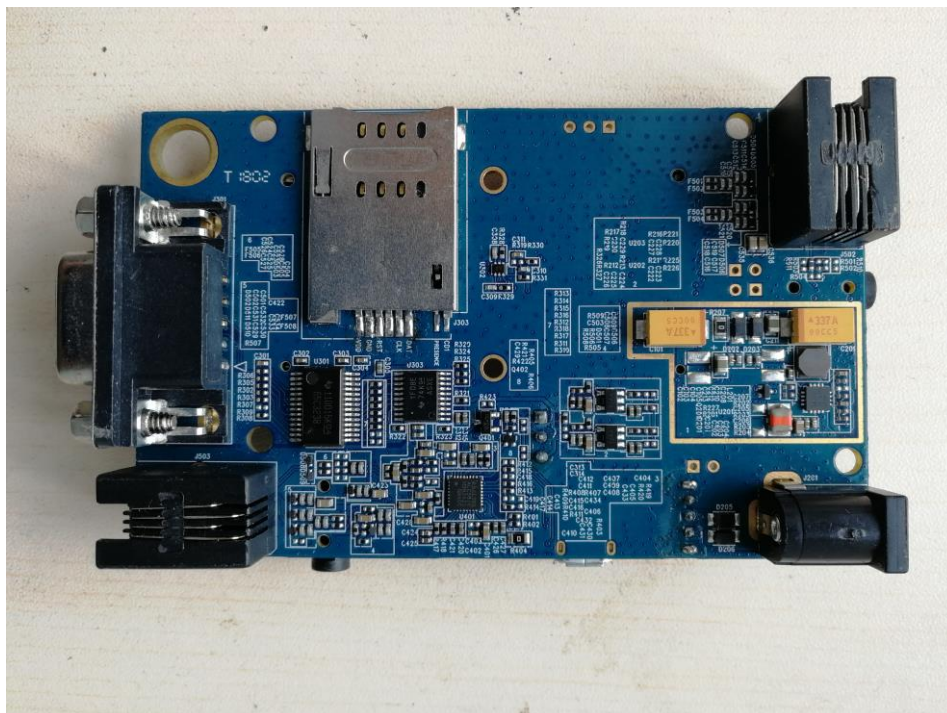


Figure 4: EVB Bottom View

2.4. EVB Kit Accessories

All accessories of the EVB kit are listed below.



Figure 5: EVB Kit Accessories

Table 3: List of Accessories

Items	Description	Quantity
Cables	USB to RS-232 converter cable	1
	USB cable	1
	RF cables	3
Antennas	Main antennas	2

	GNSS antenna (passive)	1
Audio	Earphone	1
Disk	USB 2.0 to RS-232 driver	1
USB Flash Disk	Including Mini PCIe module's related documents, tools, drivers, etc.	1
Others	Bolts and nuts for assembling EVB	4
Instruction Sheet	A sheet of paper giving instructions for EVB connection, details of EVB accessories, etc.	1

NOTE

The main antennas can also be used for diversity reception.

The following figure shows the assembly of Mini PCIe EVB and its accessories.



Figure 6: Mini PCIe EVB and Accessories Assembly

4 EVB Interface Application

This chapter describes the following Mini PCIe EVB components application:

- Power supply
- USB interface
- Audio interfaces
- (U)SIM interface
- UART interface

It also provides information about the switch, button, status indicators LEDs, jumper, and test points to facilitate the use of the EVB.

4.1. Power Supply (J201/J302)

The Mini PCIe EVB can be powered by an external power adapter through connecting with the power jack (J201) or USB connector (J302) on the EVB. The power adapter is designed to be connected to a step-down converter (U201), which can convert the supplied voltage into proper voltage (VBAT) for the Mini PCIe module.

The following two figures show the simplified power supply block diagram and the EVB power supply interface.

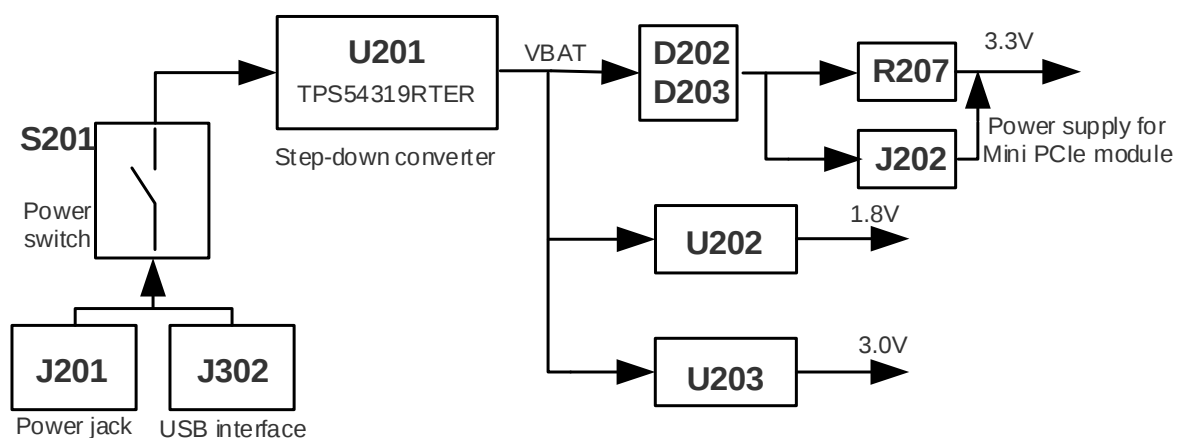


Figure 7: EVB Power Supply Block Diagram

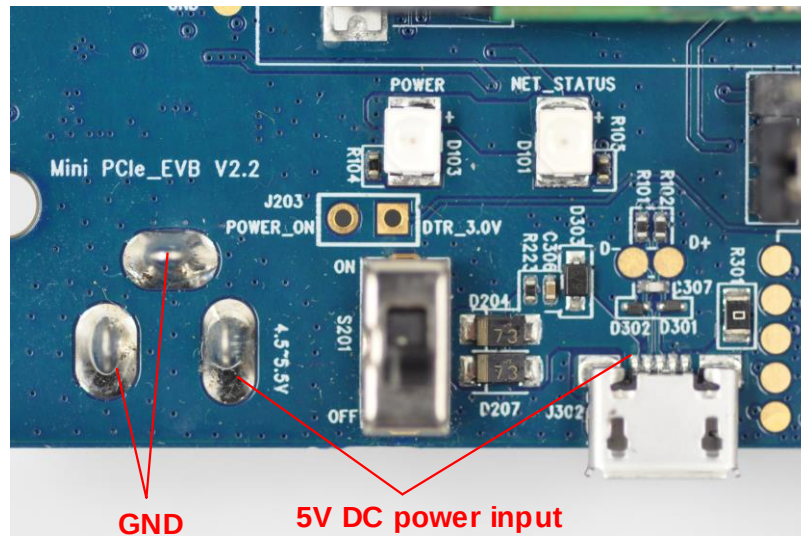


Figure 8: EVB Power Supply Interface

If the power jack is used for power supply, the power plug design of the adapter is shown as below.

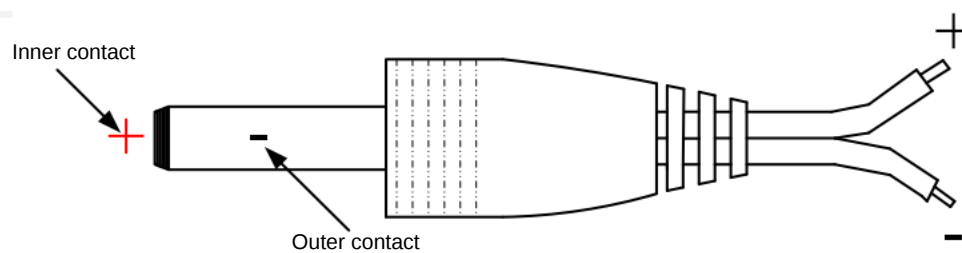


Figure 9: Power Plug Design

4.2. USB Interface (J302)

Quectel Mini PCIe module provides a USB interface which complies with USB 2.0 standard and supports high-speed (480Mbps) mode. The interface is used for AT command communication, data transmission, firmware upgrade and GNSS NMEA output.

The Mini PCIe EVB provides a micro-USB interface J302 for connection with a host device. The USB data lines USB_DP and USB_DM are connected directly to the Mini PCIe module. The USB_VBUS line can be used for USB connection detection and EVB power supply.

The following figure is a reference circuit design of USB interface.

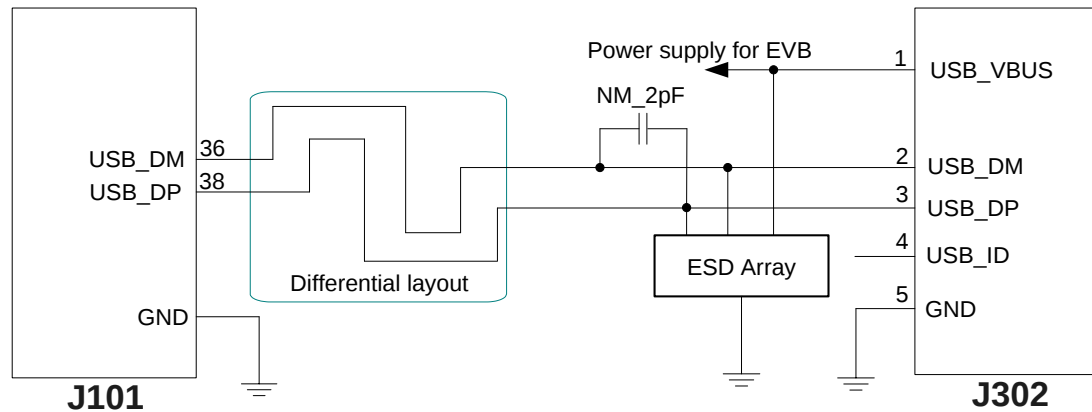


Figure 10: Reference Circuit Design of USB Interface

Table 4: Pin Definition of J302

Pin No.	Pin Name	Function
1	USB_VBUS	Used for EVB power supply
2	USB_DM	USB serial differential bus (-)
3	USB_DP	USB serial differential bus (+)
4	USB_ID	Not connected
5	GND	GND for USB interface

4.3. Analog Audio Interfaces Connected to Codec for PCM Function

Testing (J501/J504/J502/J503)

Quectel Mini PCIe module provides one digital audio interface (PCM) and UC15 Mini PCIe provides two analog audio interfaces in addition to the digital audio interface. Mini PCIe EVB is equipped with an external audio codec named ALC5616, and the following figure shows the reference circuit design of the audio codec.

The Mini PCIe EVB provides four audio interfaces J501, J503, J502 and J504. J501 and J503 are used to test the PCM function of the module by connecting to codec ALC5616. J502 and J504 are used for UC15 Mini PCIe analog audio function only. The following sub-chapters give detailed introduction on these audio interfaces.



4.3.2. Earphone Interface (J501)

The schematic diagram illustrates the ALC5616 audio codec circuit. The codec is connected to an audio jack (J501) and includes several decoupling capacitors and ESD protection diodes. The differential layout is highlighted in a red box. The circuit includes a 4.7uF capacitor connected to AGND, and two 33pF capacitors connected to GND. The audio jack is connected to pins 1, 2, 3, 4, and 5. The codec pins are labeled IN2N, IN2P, HPO_R, HPO_L, and AGND. The audio jack is labeled J501. The codec is labeled ALC5616. The differential layout is highlighted in a red box. The circuit includes a 4.7uF capacitor connected to AGND, and two 33pF capacitors connected to GND. The audio jack is connected to pins 1, 2, 3, 4, and 5. The codec pins are labeled IN2N, IN2P, HPO_R, HPO_L, and AGND. The audio jack is labeled J501.

Figure 12: Reference Circuit Design for Earphone Interface J501

The figure and table below illustrate the pin assignment and pin definition of the earphone interface J501.

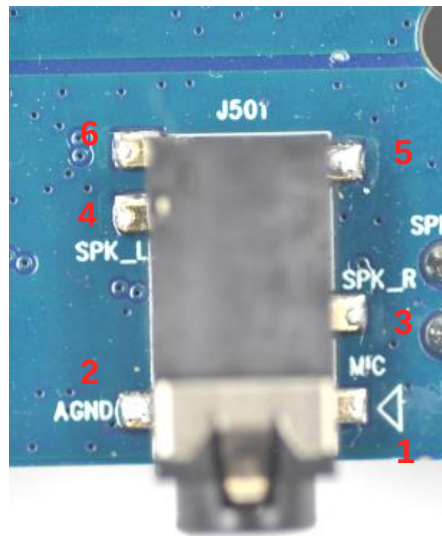


Figure 13: Pin Assignments of Earphone Interface J501

Table 5: Pin Definition of J501

Pin No.	Pin Name	Function
1	MIC	Microphone input
2	AGND	Dedicated GND for audio
3	SPK_R	Right channel of stereo audio output
4	SPK_L	Left channel of stereo audio output
5, 6	NC	/

4.3.3. Handset Interface (J503)

The audio interface J503 is designed for handset. Its reference circuit design is shown in the following figure.

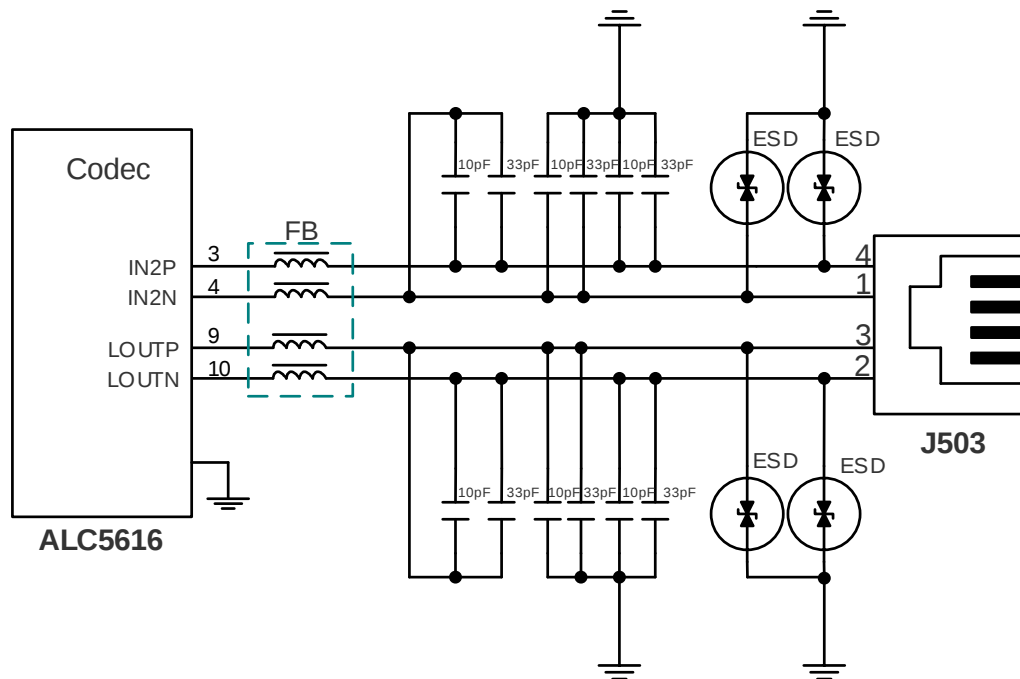


Figure 14: Reference Circuit Design for Handset Interface J503

The figure and table below illustrate the pin assignment and pin definition of the handset interface J503.



Figure 15: Pin Assignments of Handset Interface J503

Table 6: Pin Definition of J503

Pin No.	Pin Name	Function
1	MICN	Negative microphone input
2	SPKN	Negative speaker output
3	SPKP	Positive speaker output
4	MICP	Positive microphone input

4.3.4. Analog Audio Interfaces for UC15 Mini PCIe (J502/J504)

4.3.5. Handset Interface (J502)

The audio interface J502 is designed for handset. Its reference circuit design is shown as below.

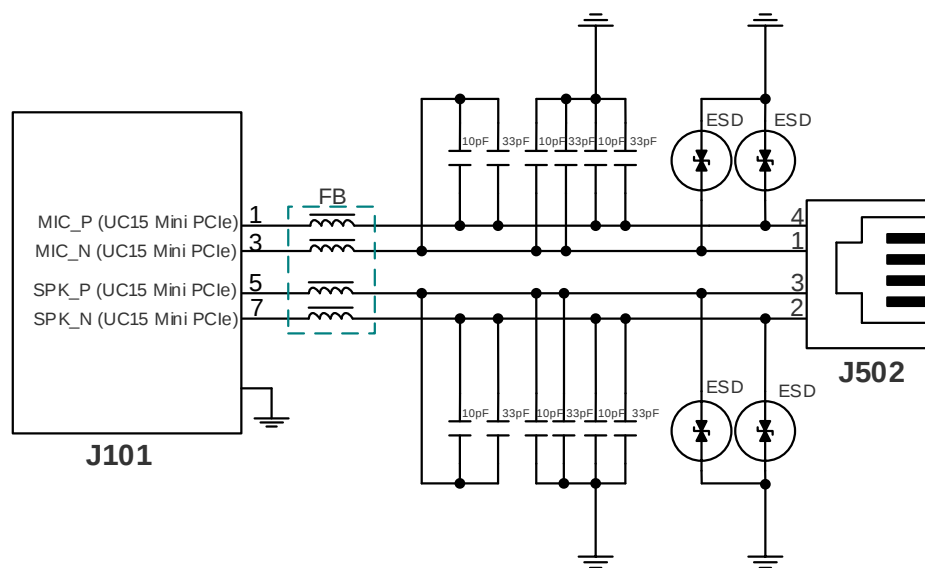


Figure 16: Reference Circuit Design for Handset Interface J502

The figure and table below illustrate the pin assignment and pin definition of the handset interface J502.

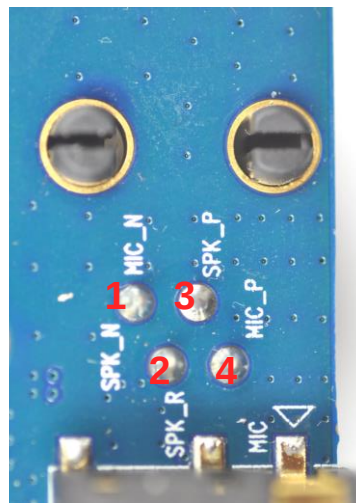


Figure 17: Pin Assignments of Handset Interface J502

Table 7: Pin Definition of J502

Pin No.	Pin Name	Function
1	MICN	Negative microphone input
2	SPKN	Negative speaker output
3	SPKP	Positive speaker output
4	MICP	Positive microphone input

4.3.6. Earphone Interface (J504)

The analog audio interface J504 is designed for CTIA earphone. Its reference circuit design is shown as below.

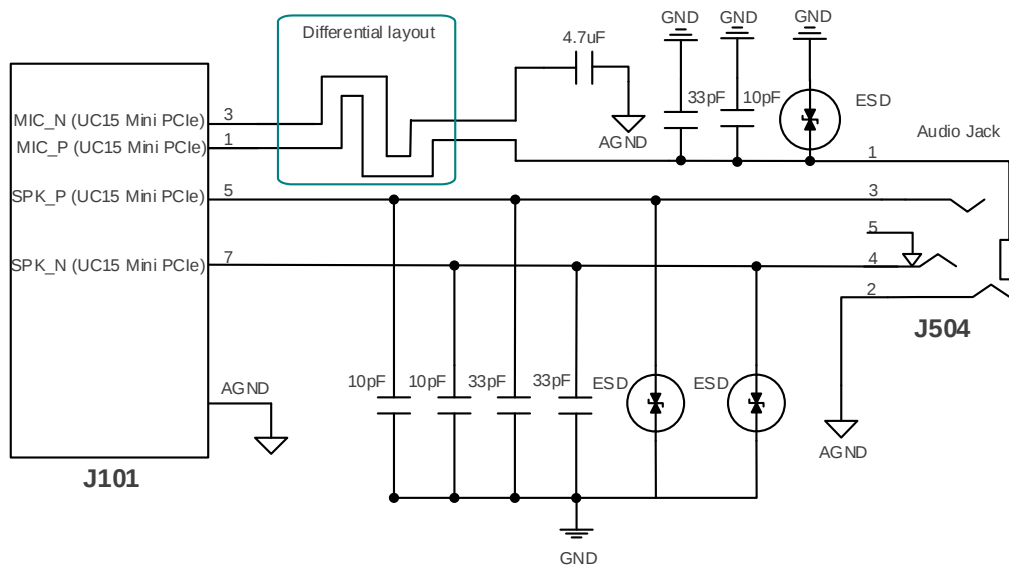


Figure 18: Reference Circuit Design for Earphone Interface J504

The figure and table below illustrate the pin assignment and pin definition of the earphone interface J504.

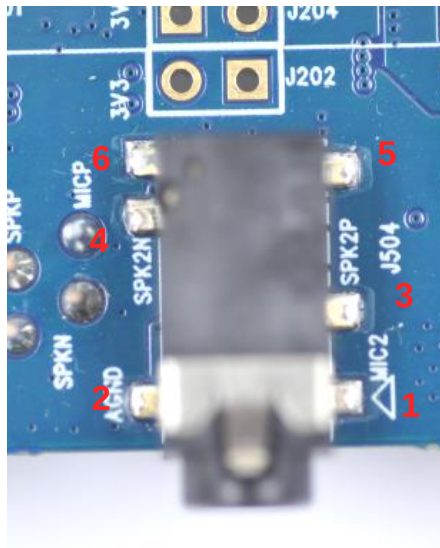


Figure 19: Pin Assignments of Earphone Interface J504

Table 8: Pin Definition of J504

Pin No.	Pin Name	Function
1	MIC	Microphone input
2	AGND	Dedicated GND for audio
3	SPK_R	Right channel of stereo audio output
4	SPK_L	Left channel of stereo audio output
5, 6	NC	/

The following figure shows the sketch design of the CTIA audio plug which suits the audio jack on Mini PCIe EVB.

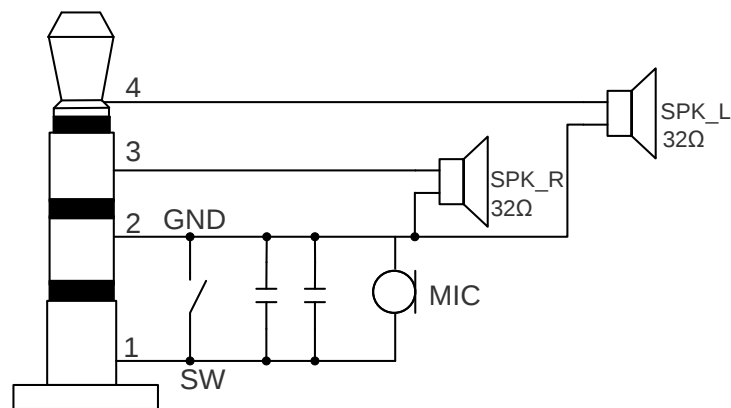


Figure 20: Sketch Design of CTIA Audio Plug

4.4. (U)SIM Interface (J303)

The Mini PCIe EVB provides a 6-pin push-push type (U)SIM interface J303 which supports 1.8V/3.0V (U)SIM card. Its reference circuit design is shown as below.

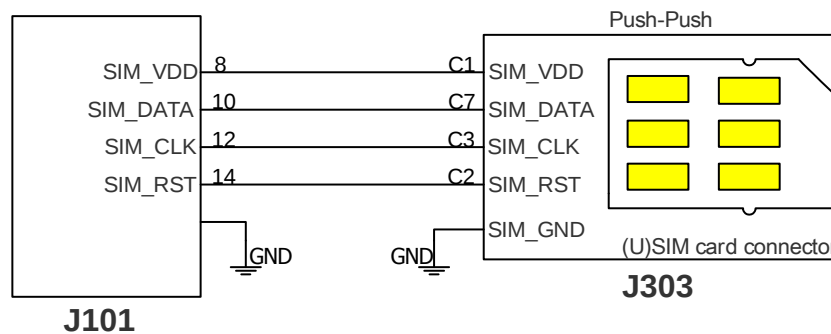


Figure 21: Reference Circuit Design for (U)SIM Interface J303

The figure and table below illustrate the pin assignment and pin definition of the (U)SIM interface J303.

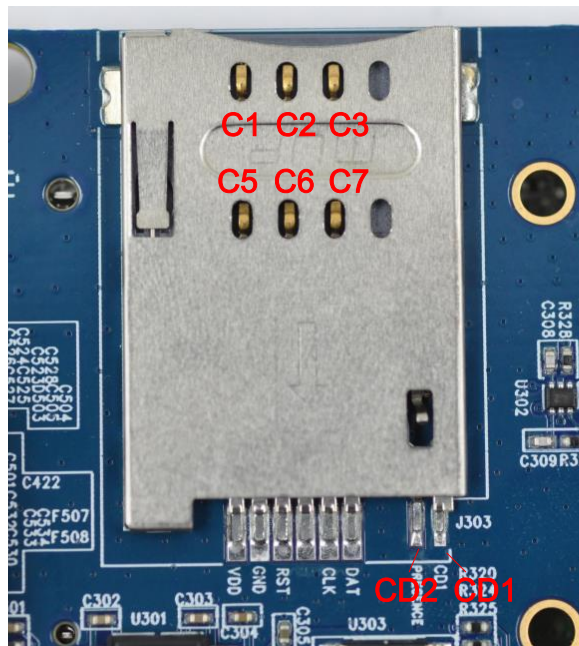


Figure 22: Pin Assignments of (U)SIM Interface J303

Table 9: Pin Definition of J303

Pin No.	Signal Name	I/O (Module Direction)	Function
C1	SIM_VDD	O	(U)SIM card power supply, which is provided by Mini PCIe module.
C2	SIM_RST	O	(U)SIM card reset signal
C3	SIM_CLK	O	(U)SIM card clock signal
C5	GND	/	Ground
C6	VPP	/	Not connected
C7	SIM_DATA	I/O	Data line. Bidirectional.
CD1		/	Not connected
CD2		/	Not connected

4.5. UART Interface (J301)

The UART interface of the Mini PCIe EVB is intended for the communication between the module and the host application. It can be used for data transmission and AT command communication.

The following figure shows the block diagram of the UART interfaces on Mini PCIe EVB.

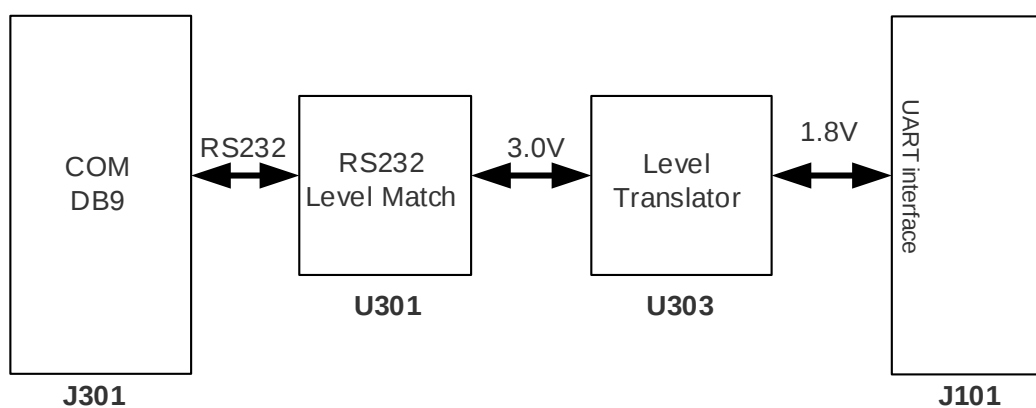


Figure 23: Block Diagram of UART Interfaces

The figure and table below illustrate the pin assignment and pin definition of UART interface J301.

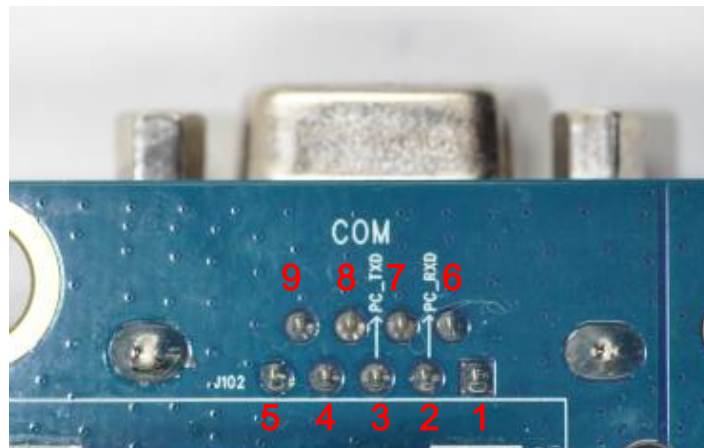


Figure 24: Pin Assignments of UART Interface J301

Table 10: Pin Definition of J301

Pin No.	Signal Name	I/O (Module Direction)	Description
1	RS232_DCD	DO	Data carrier detection
2	RS232_RXD	DO	Receive data
3	RS232_TXD	DI	Transmit data
4	RS232_DTR	DI	Data terminal ready
5	RS232_GND	/	GND
6	NC	/	Not connected
7	RS232_RTS	I	Request to send
8	RS232_CTS	O	Clear to send
9	RS232_RI	O	Ring indicator

4.6. Switch and Button (S201/S101)

The Mini PCIe EVB provides a switch S201 and a button S101, which are shown as the following figure.

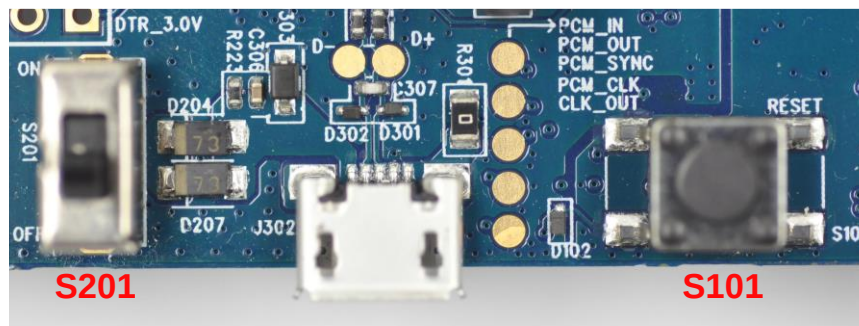


Figure 25: Switch S201 and Button S101

Table 11: Description of S201 and S101

Reference No.	Description
S201	VBAT ON/OFF control
S101	It is used to reset the Mini PCIe module. The reset operation of the Mini PCIe modules are as below: - For UC15 Mini PCIe, drive the button to low level for 50ms~200ms and then release. - For UC20 Mini PCIe, drive the button to low level for more than 150ms. - For EC21/EC25/EC20 R2.0/EC20 R2.1/EG25-G/EG21-G/BG96 Mini PCIe, drive the button to low level for time between 150ms and 460ms, and the module will be reset again if the time exceeds 460ms. - For BG95 Mini PCIe, drive the button to low level for time between 2000ms and 3800ms, and the module will be reset if the time exceeds 3800ms.

4.7. Status Indicators (D103/D101)

The Mini PCIe EVB provides two status indicators D103 and D101. The following figure shows the location of the two LED indicators.

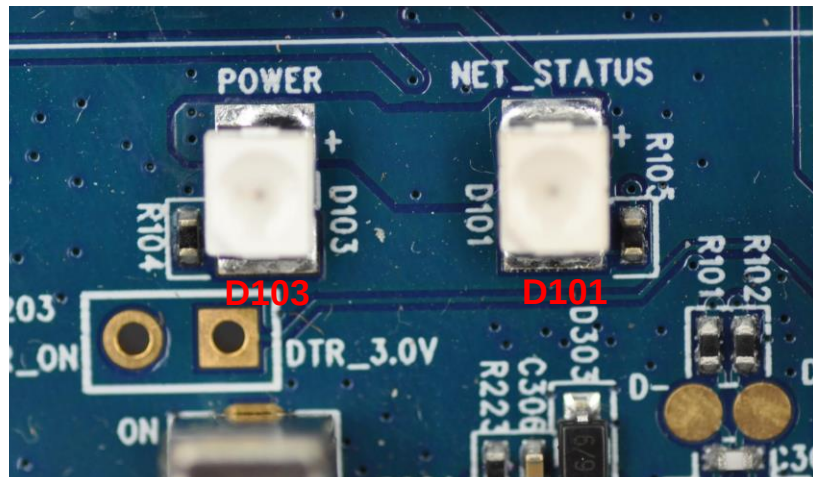


Figure 26: Status Indicators

Table 12: Description of D103 and D101

Reference No.	Description
D103	VBAT ON/OFF indicator indicating whether the power supply for Mini PCIe modules is ready. ● Bright: VBAT ON ● Extinct: VBAT OFF
D101	Network status indicator indicating the network status of Mini PCIe modules. Bright: Register the network. ● Slow flashing (200ms low/1800ms high): Searching for network ● Slow flashing (1800ms low/200ms high): Standby mode ● Fast flashing (125ms low/125ms high): Data transmission mode Extinct: ● No network coverage or not registered. ● W_DISABLE# signal is at a low level. ● AT+CFUN=0 or AT+CFUN=4. ● Module enters sleep mode. (for UC15 Mini PCIe only)

4.8. Jumper (J401/J103¹⁾/J203¹⁾)

The Mini PCIe EVB provides three jumpers J401, J103 and J203. J401 is used to match the PCM signal level between the Mini PCIe module and the codec on the EVB. The following table shows the operation of jumper J401.

If the airplane mode needs to be enabled, please connect the pin W_DISABLE# to GND with the reserved jumper J103.

If the power requires to be controlled through UART's DTR, please connect the pin POWER_ON and DTR_3.0V with the reserved jumper J203. Then the power can be turned off when DTR_3.0V is at a high level.

Table 13: Operation of J401

Module PCM Signal Level	Jumper J401
3.0V (UC15 Mini PCIe)	Connect the PCM signal of codec to 3.0V
1.8V (Other applicable modules)	Connect the PCM signal of codec to 1.8V

NOTE

¹⁾ Jumper J103 and J203 are reserved.

4.9. Test Points

The Mini PCIe EVB provides a series of test points, which can facilitate to obtain the corresponding waveform of some signals. The following figure shows the test points.

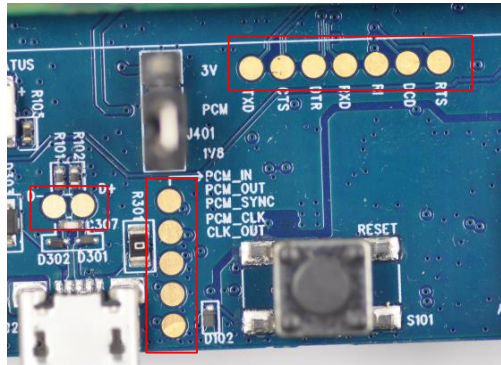


Figure 27: Test Points

Table 14: Pin Definition of Test Points

Pin Name	Description
TXD	Connected directly to Mini PCIe UART's TXD
CTS	Connected directly to Mini PCIe UART's RTS
DTR	Connected directly to Mini PCIe UART's DTR
RXD	Connected directly to Mini PCIe UART's RXD
RTS	Connected directly to Mini PCIe UART's CTS
DCD	Connected directly to Mini PCIe UART's DCD
RI	Connected directly to Mini PCIe UART's RI
PCM_CLK	Connected directly to Mini PCIe PCM's PCM_CLK
PCM_SYNC	Connected directly to Mini PCIe PCM's PCM_SYNC
PCM_OUT	Connected directly to Mini PCIe PCM's PCM_OUT
PCM_IN	Connected directly to Mini PCIe PCM's PCM_IN
CLK_OUT	Provide the main clock to codec
D-	Connected directly to Mini PCIe USB's USB_DM
D+	Connected directly to Mini PCIe USB's USB_DP
GND	Ground
VBAT	Connected directly to the output of U201

5 Operation Procedures Illustration

This chapter introduces how to use the Mini PCIe EVB for testing and evaluation of Quectel Mini PCIe modules.

5.1. Turn on the Mini PCIe Module

1. Connect the Mini PCIe module to the EVB via connector J101, and supply power for the EVB with USB cable or +5V power adapter.
2. Insert a (U)SIM card into J303 ((U)SIM card connector) on EVB.
3. Switch S201 (power switch) to **ON** state, then D103 (VBAT ON/OFF indicator) will light up and indicates power supply for EVB is ready. The module will be powered on automatically and D101 (NET_STATUS) will light up after the module registers on the network successfully.

5.2. Communication via USB or UART Interface

5.2.1. Communication via USB Interface

1. Turn on the module according to the procedure mentioned in **Chapter 5.1**.
2. Connect the EVB and the PC with USB cable through USB connector J302, and then run the driver disk on PC to install the USB driver. For details about USB driver installation, please refer to **document [2]** stored in USB flash disk. The USB port numbers can be viewed through the PC Device Manager. The port numbers are shown below.



Figure 28: USB Ports for the Modules

3. Install and then use the QCOM tool provided by Quectel to realize the communication between the EVB and the PC.

The following figure shows the COM Port Setting field on QCOM: select correct “**COM port**” (USB AT Port which is shown in the above figure) and set correct “**Baudrate**” (such as 115200bps). For more details about QCOM tool usage and configuration, please refer to **document [3]**.

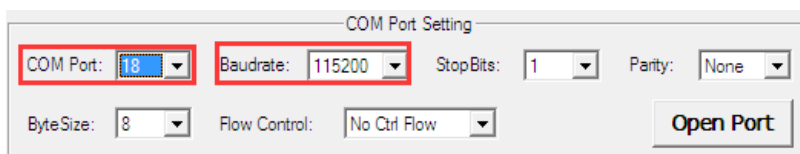


Figure 29: COM Port Setting Field on QCOM (USB AT Port Connection)

5.2.2. Communication via UART Interface

1. Run the driver disk on PC to install the USB to RS-232 driver.
2. Connect the main UART connector of module to PC with the USB-to-UART converter cable (USB-to-RS232 cable), and the USB serial port number can be viewed through the PC Device Manager, as shown below.



Figure 30: USB Serial Port

3. Install and then use the QCOM tool provided by Quectel to realize the communication between the EVB and the PC. The following figure shows the COM Port Setting field on QCOM: select correct “**COM port**” (USB Serial Port) and set correct “**Baudrate**” (such as 115200bps). For more details about QCOM tool usage and configuration, please refer to **document [3]**.

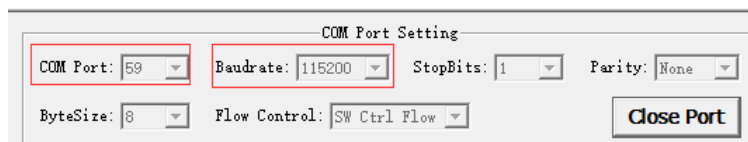


Figure 31: COM Port Setting Field on QCOM (USB Serial Port Connection)

5.3. Firmware Upgrade

Quectel Mini PCIe module upgrades firmware via USB port by default. Please follow the procedures below to upgrade firmware.

1. Install and open the firmware upgrade tool QFlash on PC and then power on the module according to the procedures mentioned in **Chapter 5.1**.
2. Click the “**COM Port**” dropdown list and select the USB DM port.
3. Click the “**Load FW Files**” button to choose the firmware package.
4. Click the “**Start**” button to upgrade the firmware.

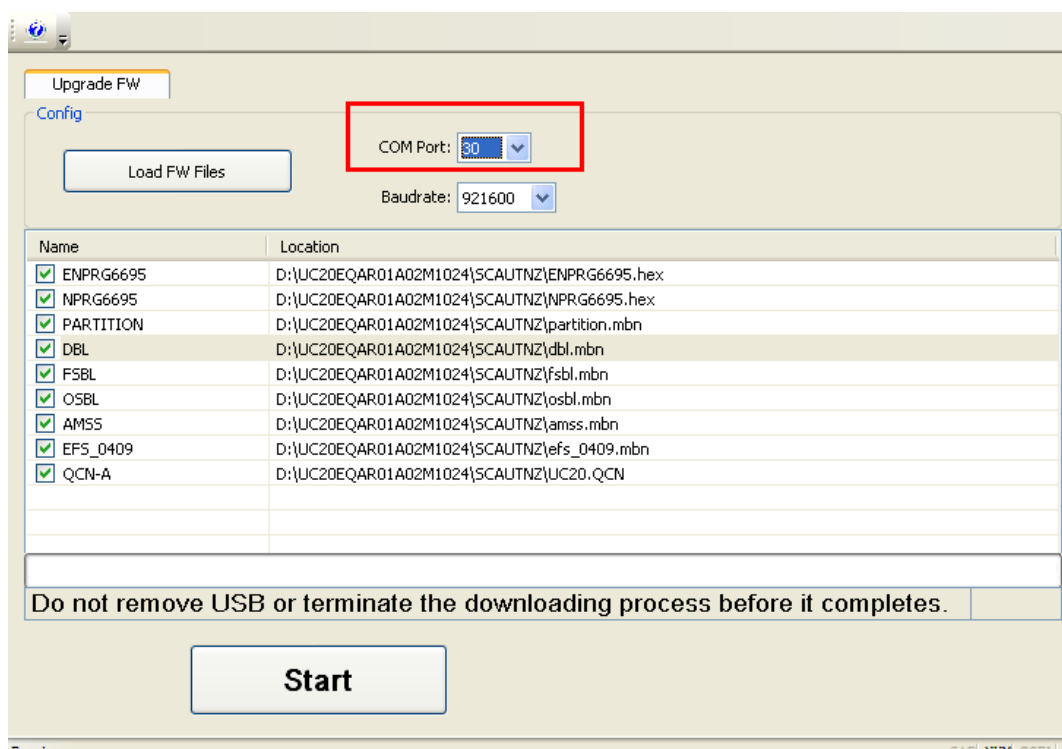


Figure 32: Configurations for Firmware Upgrade

5.4. Reset the Mini PCIe Module

The reset option is only used in case of emergency. For example, the software does not respond for more than 5s due to some serious problems.

The module can be reset by pressing the button S101 for more than 300ms and then releasing. (For BG95 Mini PCIe, drive the button to low level for time between 2000ms and 3800ms, and the module will be reset if the time exceeds 3800ms.) However, this operation may cause the loss of information stored in the memory since the system has been initialized after reset.

5.5. Turn off the Mini PCIe Module

There are two ways to turn off the Mini PCIe module.

- Execute **AT+QPOWD** via PC. This is the best and the safest way. The module will log off from the network and save data before the shutdown, but it will be turned on again after shutdown. Please refer to *document [4]* for details of **AT+QPOWD** command.
- Switch S201 (power switch) to OFF state directly.

6 Appendix A References

Table 15: Related Documents

SN	Document Name	Remark
[1]	Quectel_XX_Mini_PcIe_Hardware_Design	Hardware design for UC15, UC20, EC20 R2.0, EC20 R2.1, EC21, EC25, EG25-G, EG21-G, BG95 and BG96 Mini PCIe modules
[2]	Quectel_XX_Windows_USB_Driver_Installation_Guide	Windows USB driver installation guide for UC15, UC20, LTE&5G modules
[3]	Quectel_QCOM_User_Guide	User guide for QCOM tool
[4]	Quectel_XX_AT_Commands_Manual	AT commands manual for UC15, UC20, EC20 R2.0, EC20 R2.1, EC21, EC25, EG21-G, EG25-G, BG95 and BG96 modules

Table 16: Terms and Abbreviations

Abbreviation	Description
AGND	Analogue Ground
COM	Cluster Communication Port
CTIA	American Association for Wireless Communications and the Internet
DC	Direct Current
DI	Digital Input
DO	Digital Output
GND	Ground
GNSS	Global Navigation Satellite System
I/O	Input/Output
LED	Light Emitting Diode

MIC	Microphone
NC	Not Connected
PCM	Pulse-code Modulation
PO	Power Output
RF	Radio Frequency
UART	Universal Asynchronous Receiver & Transmitter
(U)SIM	(Universal) Mobile Telecommunication System
VBAT	Voltage of Battery

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