UC200T-GL Mini PCIe

Hardware Design

UMTS/HSPA+ Standard Module Series

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About the Document

History

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1 Introduction

This document defines UC200T-GL Mini PCIe module, and describes its air interfaces and hardware interfaces which are connected with customers' applications.

This document helps customers quickly understand module interface specifications, electrical characteristics, mechanical specifications and other related information of the module. To facilitate application designs, it also includes some reference designs for customers' reference. The document, coupled with application notes and user guides, makes it easy to design and set up wireless applications with UC200T-GL Mini PCIe.

FCC Certification Requirements.

According to the definition of mobile and fixed device is described in Part 2.1091(b), this device is a mobile device.

And the following conditions must be met:

1. This Modular Approval is limited to OEM installation for mobile and fixed applications only. The antenna installation and operating configurations of this transmitter, including any applicable source-based time-averaging duty factor, antenna gain and cable loss must satisfy MPE categorical Exclusion Requirements of 2.1091.

2. The EUT is a mobile device; maintain at least a 20 cm separation between the EUT and the user's body and must not transmit simultaneously with any other antenna or transmitter.

3.A label with the following statements must be attached to the host end product: This device contains FCC ID: XMR202007UC200TGL.

4.To comply with FCC regulations limiting both maximum RF output power and human exposure to RF radiation, maximum antenna gain (including cable loss) must not exceed:

❒ GSM850: <7.636dBi
❒ GSM1900: <9.360dBi
❒ WCDMA B2: <8.000dBi
❒ WCDMA B5: <9.416dBi

5. This module must not transmit simultaneously with any other antenna or transmitter

6. The host end product must include a user manual that clearly defines operating requirements and conditions that must be observed to ensure compliance with current FCC RF exposure guidelines.

For portable devices, in addition to the conditions 3 through 6 described above, a separate approval is required to satisfy the SAR requirements of FCC Part 2.1093

If the device is used for other equipment that separate approval is required for all other operating configurations, including portable configurations with respect to 2.1093 and different antenna configurations.

For this device, OEM integrators must be provided with labeling instructions of finished products. Please refer to KDB784748 D01 v07, section 8. Page 6/7 last two paragraphs:

A certified modular has the option to use a permanently affixed label, or an electronic label. For a permanently affixed label, the module must be labeled with an FCC ID - Section 2.926 (see 2.2 Certification (labeling requirements) above). The OEM manual must provide clear instructions explaining to the OEM the labeling requirements, options and OEM user manual instructions that are required (see next paragraph).

For a host using a certified modular with a standard fixed label, if (1) the module's FCC ID is not visible when installed in the host, or (2) if the host is marketed so that end users do not have straightforward commonly used methods for access to remove the module so that the FCC ID of the module is visible; then an additional permanent label referring to the enclosed module:"Contains Transmitter Module FCC ID: XMR202007UC200TGL" or "Contains FCC ID: XMR202007UC200TGL" must be used. The host OEM user manual must also contain clear instructions on how end users can find and/or access the module and the FCC ID.

The final host / module combination may also need to be evaluated against the FCC Part 15B criteria for unintentional radiators in order to be properly authorized for operation as a Part 15 digital device.

The user's manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. In cases where the manual is provided only in a form other than paper, such as on a computer disk or over the Internet, the information required by this section may be included in the manual in that alternative form, provided the user can reasonably be expected to have the capability to access information in that form.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.

To ensure compliance with all non-transmitter functions the host manufacturer is responsible for ensuring compliance with the module(s) installed and fully operational. For example, if a host was previously authorized as an unintentional radiator under the Declaration of Conformity procedure without a transmitter certified module and a module is added, the host manufacturer is responsible for ensuring that the after the module is installed and operational the host continues to be compliant with the Part 15B unintentional radiator requirements.

1.1. 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 UC200T-GL Mini PCIe module. 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.
	Cellular terminals or mobiles operating over radio signals and cellular network cannot be guaranteed to connect in all possible conditions (for example, with unpaid bills or with an invalid (U)SIM card). When emergent help is needed in such conditions, please remember using emergency call. In order to make or receive a call, the cellular terminal or mobile must be switched on in a service area with adequate cellular signal strength.

	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 Product Concept

2.1. General Description

UC200T-GL Mini PCIe module provides data connectivity on DC-HSDPA, HSPA+, HSDPA, HSUPA, WCDMA, TD-SCDMA, EVDO, CDMA, EDGE and GPRS networks with PCI Express Mini Card 1.2 standard interface. It provides audio and high-speed data transmission for customers' applications.

UC200T-GL Mini PCIe module can be applied in the following fields:

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

Table 1: Supported Bands of UC200T-GL Mini PCIe

Module	Description
UC200T-GL Mini PCIe	WCDMA: B1/B8 TD-SCDMA: B34/B39 EVDO/CDMA: BC0 GSM: 900/1800MHz Support digital audio [3)]

2.2. Key Features

The following table describes the detailed features of UC200T-GL Mini PCIe module.

Table 2: Key Features of UC200T-GL Mini PCIe

Features	Description

Function Interface	PCI Express Mini Card 1.2 Standard Interface
Power Supply	Supply voltage: 3.0V~3.6V Typical supply voltage: 3.3V
Transmitting Power	Class 4 (33dBm±2dB) for EGSM900MHz Class 1 (30dBm±2dB) for DCS1800MHz Class E2 (27dBm±3dB) for EGSM900 8-PSK Class E2 (26dBm±3dB) for DCS1800 8-PSK Class 3 (24dBm+2/-1dB) for EVDO/CDMA BC0 Class 3 (24dBm+1/-3dB) for WCDMA bands Class 2 (24dBm+1/-3dB) for TD-SCDMA bands
UMTS Features	Support 3GPP R8 DC-HSDPA, HSPA+, HSDPA, HSUPA and WCDMA Support QPSK,16-QAM and 64-QAM modulation DC-HSDPA: Max 42Mbps (DL) HSUPA: Max 5.76Mbps (UL) WCDMA: Max 384Kbps (UL), 384Kbps (DL)
TD-SCDMA Features	Support CCSA Release 3 TD-SCDMA Max 4.2Mbps (DL)/Max 2.2Mbps (UL)
CDMA2000 Features	Support 3GPP2 CDMA2000 1X Advanced and 1xEV-DO Rev.A EVDO: Max 3.1Mbps (DL)/Max 1.8Mbps (UL) 1X Advanced: Max 307.2Kbps (DL)/Max 307.2Kbps (UL)
GSM Features	**GPRS:** Support GPRS multi-slot class 33 (33 by default) Coding scheme: CS-1, CS-2, CS-3 and CS-4 Max 107Kbps (DL)/Max 85.6Kbps (UL) **EDGE:** Support EDGE multi-slot class 33 (33 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 Max 296Kbps (DL)/Max 236.8Kbps (UL)
Internet Protocol Features	Support protocols TCP/UDP/PPP/FTP/HTTP/NTP/PING/QMI/NITZ/CMUX*/HTTPS*/SMTP*/MMS*/FTPS*/SMTPS*/SSL*/FILE* protocols Support protocols PAP (Password Authentication Protocol) and CHAP (Challenge Handshake Authentication Protocol) which are usually used for PPP connection
SMS	Text and PDU modes Point-to-point MO and MT SMS cell broadcast SMS storage: ME by default
(U)SIM Interface	Support USIM/SIM card: 1.8V, 3.0V

UART Interfaces	**Main UART**: Support RTS and CTS hardware flow control Baud rate can reach up to 230400bps; 115200bps by default Used for AT command communication and data transmission
Audio Features	Support one digital audio interface: PCM interface GSM: HR/FR/EFR/AMR/AMR-WB WCDMA: AMR/AMR-WB Support echo cancellation and noise suppression
PCM Interface	Support 16-bit linear data format Support long frame synchronization and short frame synchronization Support master and slave modes, but must be the master in long frame synchronization
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, firmware upgrade, software debugging, GNSS NMEA output and voice over USB Support USB serial driver for: Windows 7/8/8.1/10, Linux 2.6/3.x/4.1~4.15, Android 4.x/5.x/6.x/7.x/8.x/9.x, etc.
Antenna Connectors	Main antenna
AT Commands	Compliant with 3GPP TS 27.007, 27.005 and Quectel enhanced AT commands
Physical Characteristics	Size: (51.0±0.15)mm × (30.0±0.15)mm × (4.9±0.2)mm Weight: approx. 10.6g
Temperature Range	Operation temperature range: -35°C ~ +75°C [1)] Extended temperature range: -40°C ~ +80°C [2)] Storage temperature range: -40°C ~ +90°C
Firmware Upgrade	Upgrade via USB interface or DFOTA*
RoHS	All hardware components are fully compliant with EU RoHS directive

NOTES

1. [1)] Within operation temperature range, the module is 3GPP compliant.
2. [2)] Within extended temperature range, the module remains the ability to establish and maintain a voice, SMS, data transmission, emergency call*, etc. There is no unrecoverable malfunction. There are also no effects on radio spectrum and no harm to radio network. Only one or more parameters like P_{out} might reduce in their value and exceed the specified tolerances. When the temperature returns to normal operation temperature levels, the module will meet 3GPP specifications again.
3. "*" means under development.

2.3. Functional Diagram

The following figure shows the block diagram of UC200T-GL Mini PCIe.

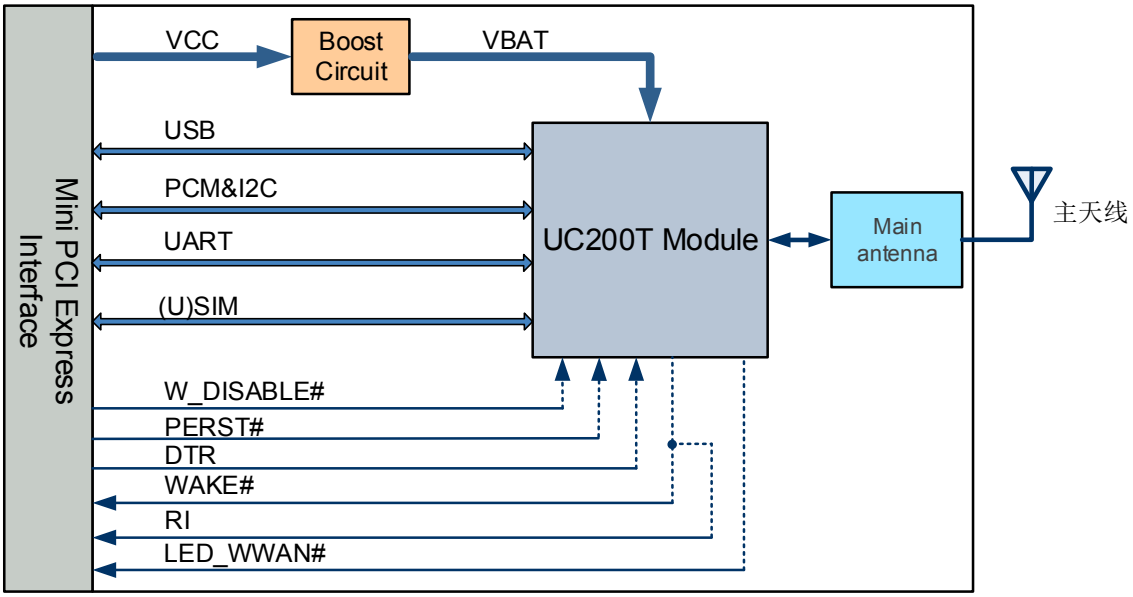


Figure 1: Functional Diagram

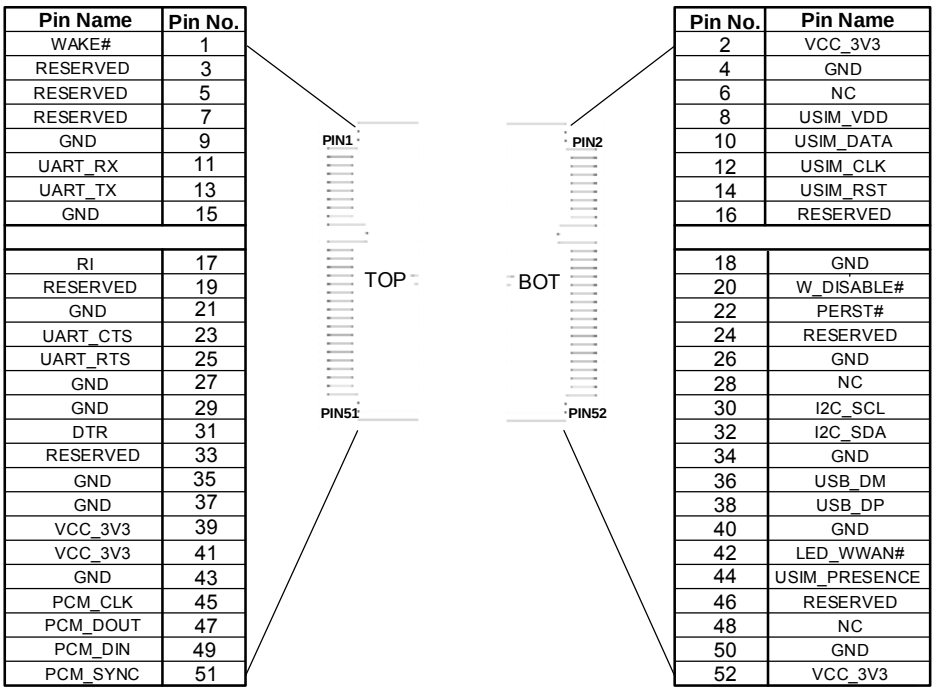
3 Application Interfaces

The physical connections and signal levels of UC200T-GL Mini PCIe comply with PCI Express Mini Card Electromechanical Specification. This chapter mainly describes the definition and application of the following interfaces for UC200T-GL Mini PCIe:

- Power supply
- UART interfaces
- USB interface
- (U)SIM interfaces
- PCM and I2C interfaces
- Control and Indication signals

3.1. Pin Assignment

The following figure shows the pin assignment of UC200T-GL Mini PCIe module. The top side contains UC200T-GL 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
RI	17
RESERVED	19
GND	21
UART_CTS	23
UART_RTS	25
GND	27
GND	29
DTR	31
RESERVED	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	USIM_PRESENCE
46	RESERVED
48	NC
50	GND
52	VCC_3V3

Figure 2: UC200T-GL Mini PCIe Pin Assignment

3.2. Pin Description

The following tables show the pin definition and description of the 52 pins on UC200T-GL Mini PCIe.

Table 3: I/O Parameters Definition

Type	Description
DI	Digital Input
DO	Digital Output
IO	Bidirectional
OC	Open Collector
PI	Power Input
PO	Power Output

Table 4: Pin Description

Pin No.	Mini PCI Express Standard Name	UC200T-GL Mini PCIe Pin Name	I/O	Description	Comment
1	WAKE#	WAKE#	OC	Output signal used to wake up the host.	
2	3.3Vaux	VCC_3V3	PI	3.0V~3.6V, typically 3.3V DC supply	
3	RESERVED	RESERVED		Reserved	
4	GND	GND		Mini card ground	
5	RESERVED	RESERVED		Reserved	
6	1.5V	NC		Not connected	
7	CLKREQ#	RESERVED		Reserved	
8	UIM_PWR	USIM_VDD	PO	Power supply for the (U)SIM card	
9	GND	GND		Mini card ground	
10	UIM_DATA	USIM_DATA	IO	Data signal of (U)SIM card	

11	REFCLK-	UART_RX	DI	UART receive data	Connect to DTE's TX.
12	UIM_CLK	USIM_CLK	DO	Clock signal of (U)SIM card	
13	REFCLK+	UART_TX	DO	UART transmit data	Connect to DTE's RX.
14	UIM_RESET	USIM_RST	DO	Reset signal of (U)SIM card	
15	GND	GND		Mini card ground	
16	UIM_VPP	RESERVED		Reserved	
17	RESERVED	RI	DO	Ring indication	
18	GND	GND		Mini card ground	
19	RESERVED	RESERVED		Reserved	
20	W_DISABLE#	W_DISABLE#	DI	Airplane mode control	Active low.
21	GND	GND		Mini card ground	
22	PERST#	PERST#	DI	Fundamental reset signal	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		Not connected	
29	GND	GND		Mini card ground	
30	SMB_CLK	I2C_SCL	DO	I2C serial clock	Require external pull-up to 1.8V.
31	PETn0	DTR	DI	Sleep mode control	
32	SMB_DATA	I2C_SDA	IO	I2C serial data	Require external pull-up to 1.8V.

33	PETp0	UART_DCD	DO	Data carrier detection	
34	GND	GND		Mini card ground	
35	GND	GND		Mini card ground	
36	USB_D-	USB_DM	IO	USB differential data (-)	Require differential impedance of 90Ω.
37	GND	GND		Mini card ground	
38	USB_D+	USB_DP	IO	USB differential data (+)	Require differential impedance of 90Ω.
39	3.3Vaux	VCC_3V3	PI	3.0V~3.6V, typically 3.3V DC supply	
40	GND	GND		Mini card ground	
41	3.3Vaux	VCC_3V3	PI	3.0V~3.6V, typically 3.3V DC supply	
42	LED_WWAN#	LED_WWAN#	OC	LED signal for indicating the network status of the module	
43	GND	GND		Mini card ground	
44	LED_WLAN#	USIM_PRESENCE	DI	(U)SIM card insertion detection	
45	RESERVED	PCM_CLK	IO	PCM clock	
46	LED_WPAN#	RESERVED		Reserved	
47	RESERVED	PCM_DOUT	DO	PCM data output	
48	1.5V	NC		Not connected	
49	RESERVED	PCM_DIN	DI	PCM data input	
50	GND	GND		Mini card ground	
51	RESERVED	PCM_SYNC [2)]	IO	PCM frame synchronization	
52	3.3Vaux	VCC_3V3	PI	3.0V~3.6V, typically 3.3V DC supply	

NOTES

1. Keep all NC, reserved and unused pins unconnected.

3.3. Operating Modes

The following table briefly outlines the operating modes to be mentioned in the following chapters.

Table 5: Overview of Operating Modes

Mode	Details	
Normal Operation	Idle	Software is active. The module has registered on the network, and it is ready to send and receive data.
	Talk/Data	Network connection is ongoing. In this mode, the power consumption is decided by network setting and data transfer rate.
Minimum Functionality Mode	**AT+CFUN=0**command can set the module to a minimum functionality mode without removing the power supply. In this case, both RF function and (U)SIM card will be invalid.	
Airplane Mode	**AT+CFUN=4**command or W_DISABLE# pin can set the module to airplane mode. In this case, RF function will be invalid.	
Sleep Mode	In this mode, the current consumption of the module will be reduced to the minimal level. In this mode, the module can still receive paging message, SMS, voice call and TCP/UDP data from the network normally.	

3.4. Power Saving

3.4.1. Sleep Mode

UC200T-GL Mini PCIe is able to reduce its current consumption to a minimum value in sleep mode. There are three preconditions must be met to make the module enter sleep mode.

- Execute **AT+QSCLK=1**; to enable sleep mode.
- Ensure the DTR is kept at high level or be kept open.
- The host's USB bus, which is connected with the module's USB interface, enters suspend state.

3.4.2. Airplane Mode

When the module enters airplane mode, the RF function will be disabled, and all AT commands related to it will be inaccessible. For more details, please refer to ***Chapter 3.10.3***.

3.5. Power Supply

The following table shows pin definition of power supply interface.

Table 6: Definition of Power Supply Interface

Pin Name	Pin No.	I/O	Power Domain	Description
VCC_3V3	2, 39, 41, 52	PI	3.0V~3.6V	Typically 3.3V DC supply
GND	4, 9, 15, 18, 21, 26, 27, 29, 34, 35, 37, 40, 43, 50			Mini card ground

The typical supply voltage of UC200T-GL Mini PCIe is 3.3V. In the 2G network, the input peak current may reach 2.7A during the transmitting time. Therefore, the power supply must be able to provide a rated output current of 2.7A at least, and a bypass capacitor of no less than 470μF with low-ESR should be used to prevent the voltage from dropping.

The following figure shows a reference design of power supply where R2 and R3 are 1% tolerance resistors and C3 is a low-ESR capacitor.

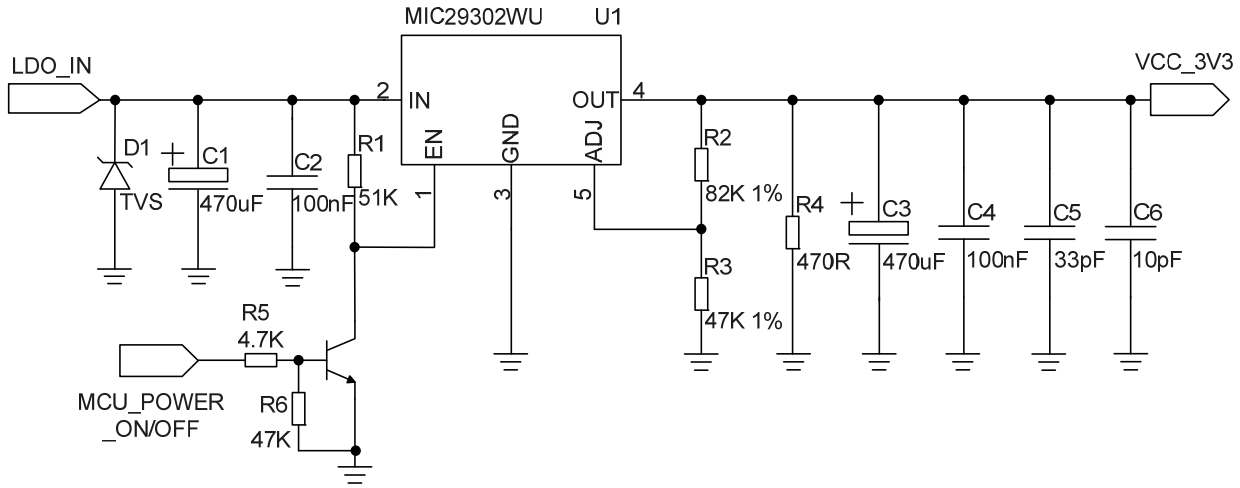


Figure 3: Reference Circuit of Power Supply

3.6. UART Interfaces

UC200T-GL Mini PCIe provides one main UART interface.

3.6.1. Main UART Interface

The main UART interface supports 9600bps, 19200bps, 38400bps, 57600bps, 115200bps and 230400bps baud rates, and the default is 115200bps. This interface supports RTS and CTS hardware flow control, and can be used for AT command communication and data transmission.

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

Table 7: Pin Definition of Main UART Interface

Pin Name	Pin No.	I/O	Power Domain	Description
UART_RX	11	DI	3.3V	UART receive data
UART_TX	13	DO	3.3V	UART transmit data
UART_CTS	23	DI	3.3V	UART clear to send
UART_RTS	25	DO	3.3V	UART request to send

The signal level of main UART interface is 3.3V. When connecting to the peripheral MCU/RAM, customers need to pay attention to the signal direction. The reference circuit is as follows:

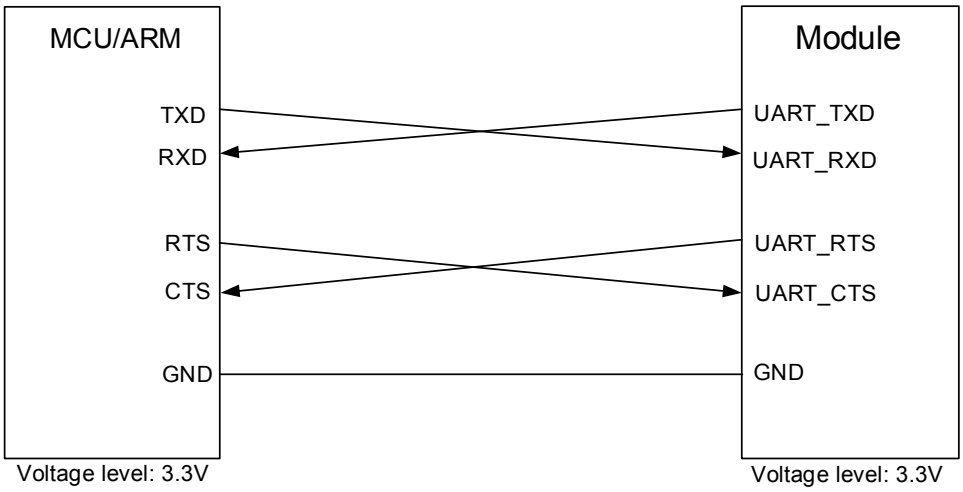


Figure 4: Reference Circuit of Power Supply

3.7. USB Interface

UC200T-GL Mini PCIe provides one integrated Universal Serial Bus (USB) interface which complies with USB 2.0 specification. It can only be used as a slave device. Meanwhile, it supports high speed (480Mbps) mode and full speed (12Mbps) mode. The USB interface is used for AT command communication, data

transmission, software debugging, firmware upgrade and voice over USB.

The following table shows the pin definition of USB interface.

Table 8: Pin Definition of USB Interface

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

The following figure shows a reference circuit of USB interface.

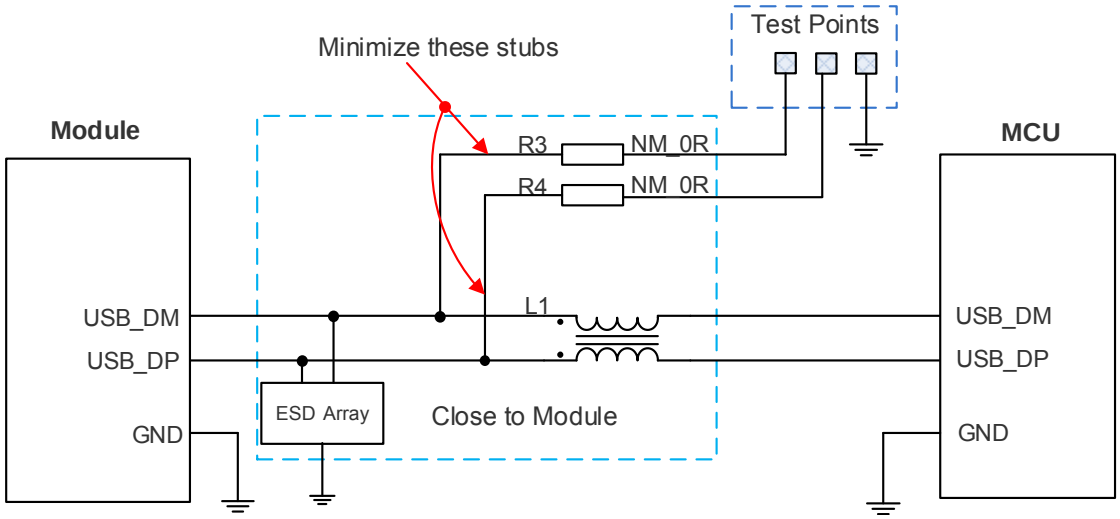


Figure 5: Reference Circuit of USB Interface

A common mode choke L1 is recommended to be added in series between the module and customer's MCU in order to suppress EMI spurious transmission. Meanwhile, the 0Ω resistors (R3 and R4) should be added in series between the module and the test points so as to facilitate debugging, and the resistors are not mounted by default. In order to ensure the integrity of USB data line signal, L1/R3/R4 components must be placed close to the module, and also R3 and R4 should be placed close to each other. The extra stubs of trace must be as short as possible.

Please follow the requirements below during USB interface design so as to meet USB 2.0 specification.

- It is important to route the USB signal traces as differential pairs with total grounding. The impedance of USB differential trace is 90Ω.
- Do not route signal traces under crystals, oscillators, magnetic devices or RF signal traces. It is important to route the USB differential traces in inner-layer with ground shielding on not only upper and lower layers but also right and left sides.

- Special attention should be paid to the selection of ESD device on the USB data line. Its parasitic capacitance should not exceed 2pF and should be placed as close as possible to the USB interface.

3.8. (U)SIM Interface

UC200T-GL Mini PCIe's (U)SIM interface circuitry meets ETSI and IMT-2000 requirements. Both 1.8V and 3.0V (U)SIM cards are supported. The following table shows the pin definition of the (U)SIM interface.

Table 9: Pin Definition of (U)SIM Interface

Pin Name	Pin No.	I/O	Power Domain	Description
USIM_VDD	8	PO	1.8V/3.0V	Power supply for (U)SIM card
USIM_DATA	10	IO	1.8V/3.0V	Data signal of (U)SIM card
USIM_CLK	12	DO	1.8V/3.0V	Clock signal of (U)SIM card
USIM_RST	14	DO	1.8V/3.0V	Reset signal of (U)SIM card
USIM_PRESENCE	44	DI	1.8V	(U)SIM card insertion detection

UC200T-GL Mini PCIe supports (U)SIM card hot-plug via the USIM_PRESENCE pin. The function supports low level and high level detections. By default, It is disabled, and can be configured via **AT+QSIMDET** command. Please refer to ***document [2]*** for details about the command.

The following figure shows a reference design for (U)SIM interface with an 8-pin (U)SIM card connector.

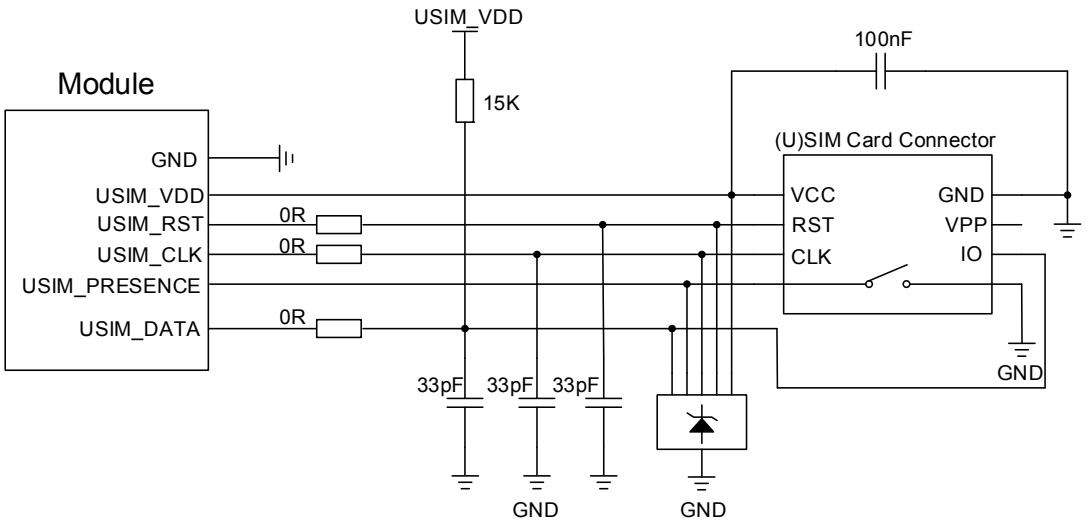


Figure 6: Reference Circuit of (U)SIM Interface with an 8-pin (U)SIM Card Connector

If (U)SIM card detection function is not needed, please keep USIM_PRESENCE unconnected. A reference circuit for (U)SIM interface with a 6-pin (U)SIM card connector is illustrated in the following figure.

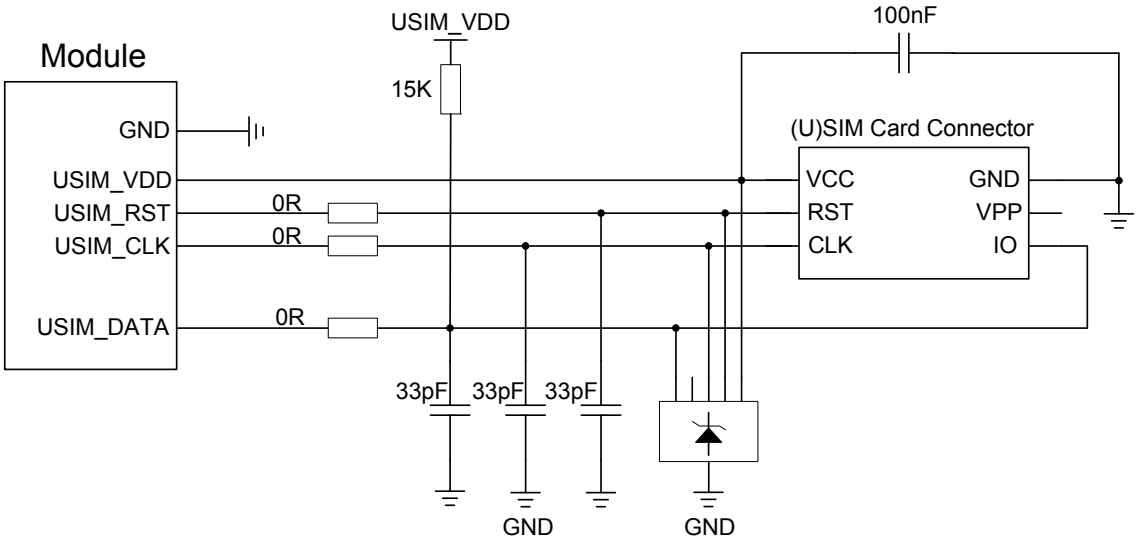


Figure 7: R Reference Circuit of (U)SIM Interface with a 6-pin (U)SIM Card Connector

In order to enhance the reliability and availability of the (U)SIM card in customers' applications, please follow the criteria below in (U)SIM circuit design:

- Keep placement of (U)SIM card connector to the module as close as possible. Keep the trace length as less than 200mm as possible.
- Keep (U)SIM card signals away from RF and power supply traces.
- To avoid cross-talk between USIM_DATA and USIM_CLK, keep them away from each other and shield them with surrounded ground.
- In order to offer good ESD protection, it is recommended to add a TVS diode with parasitic capacitance not exceeding 15pF.
- The 0Ω resistors should be added in series between the module and the (U)SIM card connector so as to facilitate debugging. The 33pF capacitors are used for filtering interference of EGSM900. Please note that the (U)SIM peripheral circuit should be close to the (U)SIM card connector.
- The pull-up resistor on USIM_DATA line can improve anti-jamming capability when long layout trace and sensitive occasion are applied and should be placed close to the (U)SIM card connector.

3.9. PCM and I2C Interfaces

UC200T-GL Mini PCIe provides one Pulse Code Modulation (PCM) digital interface and one I2C interface.

The following table shows the pin definition of PCM and I2C interfaces that can be applied in audio codec design.

Table 10: Pin Definition of PCM and I2C Interfaces

Pin Name	Pin No.	I/O	Power Domain	Description
PCM_CLK	45	IO	1.8V	PCM clock
PCM_DOUT	47	DO	1.8V	PCM data output
PCM_DIN	49	DI	1.8V	PCM data input
PCM_SYNC	51	IO	1.8V	PCM frame synchronization
I2C_SCL	30	DO	1.8V	I2C serial clock. Require external pull-up to 1.8V.
I2C_SDA	32	IO	1.8V	I2C serial data. Require external pull-up to 1.8V.

UC200T-GL Mini PCIe provides one PCM digital interface, which supports 16-bit linear data format and the following modes:

- Primary mode (short frame synchronization, works as either master or slave)
- Auxiliary mode (long frame synchronization, 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, the PCM interface supports 256kHz, 512kHz, 1024kHz or 2048kHz PCM_CLK at 8kHz PCM_SYNC, and also supports 4096kHz PCM_CLK at 16kHz PCM_SYNC. The following figure shows the timing relationship in primary mode with 8kHz PCM_SYNC and 2048kHz PCM_CLK.

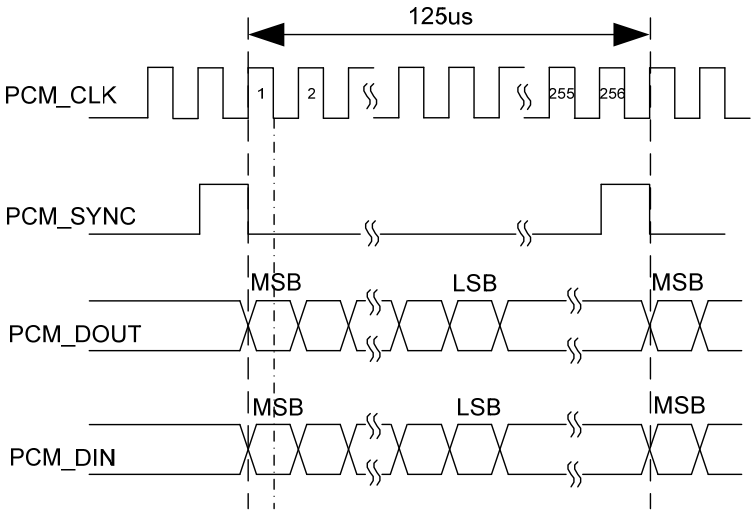


Figure 8: Timing in Primary Mode

In auxiliary mode, the data is sampled on the falling edge of the PCM_CLK and transmitted on the rising edge. The PCM_SYNC rising edge represents the MSB. In this mode, the PCM interface operates with a 256kHz, 512kHz, 1024kHz or 2048kHz PCM_CLK and an 8kHz, 50% duty cycle PCM_SYNC. The following figure shows the timing relationship in auxiliary mode with 8kHz PCM_SYNC and 256kHz PCM_CLK.

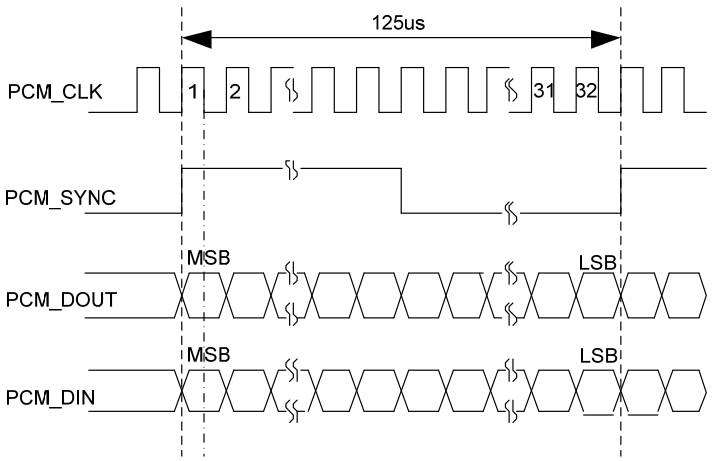


Figure 9: Timing in Auxiliary Mode

Clock and mode can be configured by AT command, and the default configuration is master mode using short frame synchronization format with 2048kHz PCM_CLK and 8kHz PCM_SYNC. In addition, UC200T-GL Mini PCIe's firmware has integrated the configuration on some PCM codec's application with I2C interface. Please refer to ***document [2]*** for details about **AT+QDAI** command.

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

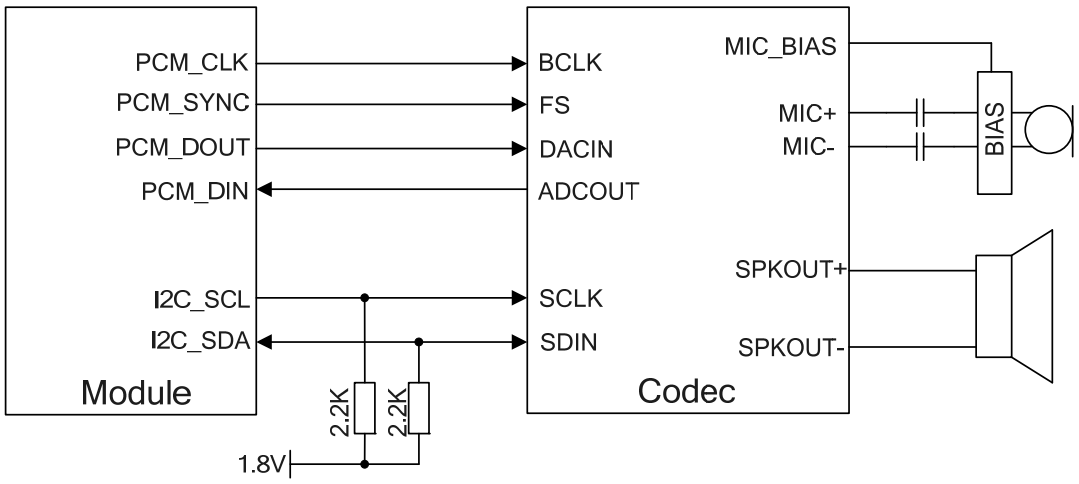


Figure 10: Reference Circuit of PCM Application with Audio Codec

3.10. Control and Indication Signals

The following table shows the pin definition of control and indication signals.

Table 11: Pin Definition of Control and Indication Signals

Pin Name	Pin No.	I/O	Power Domain	Description
RI	17	DO	3.3V	Output signal used to wake up the host.
DTR	31	DI	3.3V	Sleep mode control.
DCD	33	DO	3.3V	Data carrier detection
W_DISABLE#	20	DI	3.3V	Airplane mode control. Pulled up by default. Active low.
PERST#	22	DI	3.3V	Fundamental reset signal. Active low.
LED_WWAN#	42	OC		LED signal for indicating the network status of the module.
WAKE#	1	OC		Output signal used to wake up the host.

3.10.1. RI Signal

The RI signal can be used to wake up the host. When a URC returns, there will be the following behaviors on the RI pin after executing **AT+QCFG="risignaltype","physical"**.

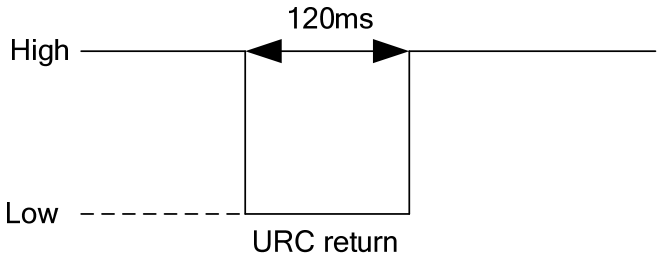


Figure 11: RI Behaviors

3.10.2. DTR Signal

The DTR signal is used for sleep mode control. It is pulled up by default. When module is in sleep mode, driving it to low level can wake up the module. For more details about the preconditions for module to enter sleep mode, please refer to ***Chapter 3.4.1***.

3.10.3. W_DISABLE# Signal

UC200T-GL Mini PCIe provides a W_DISABLE# signal to disable or enable the RF function (GNSS not included). The W_DISABLE# pin is pulled up by default. Its control function for airplane mode is disabled by default, and **AT+QCFG="airplanecontrol",1** can be used to enable the function. Driving it to low level can make the module enter airplane mode.

Table 12: Airplane Mode Controlled by Hardware Method

W_DISABLE#	RF Function Status	Module Operation Mode
High level	RF enabled	Normal mode
Low level	RF disabled	Airplane mode

Software method can be controlled by **AT+CFUN**, and has the same effect with W_DISABLE# signal function, the details are as follows.

Table 13: Airplane Mode Controlled by Software Method

AT+CFUN=?	RF Function Status	Module Operation Mode
0	RF and (U)SIM disabled	Minimum functionality mode
1	RF enabled	Normal mode

4	RF disabled	Airplane mode

3.10.4. PERST# Signal

The PERST# signal can be used to force a hardware reset on the card. Customers can reset the module by driving PERST# signal low for more 300ms and then releasing it. The reset scenario is illustrated in the following figure.

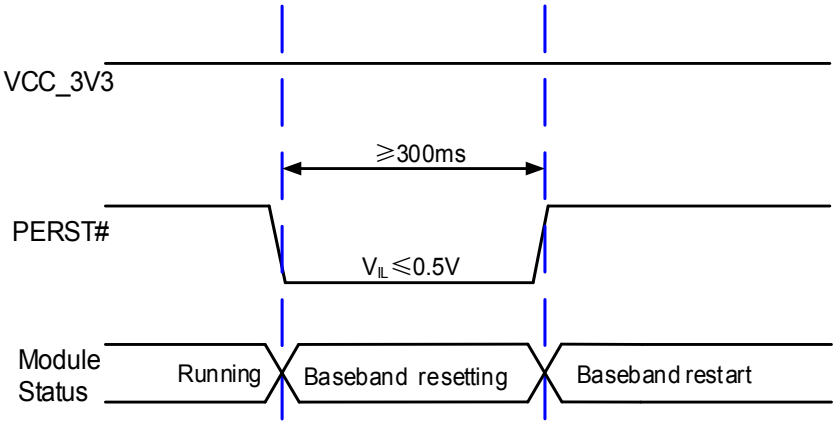


Figure 12: Timing of Resetting Module

3.10.5. LED_WWAN# Signal

The LED_WWAN# signal of UC200T-GL Mini PCIe is used to indicate the network status of the module, and can absorb a 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 low.

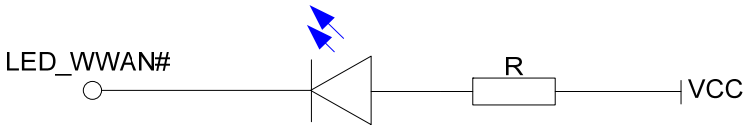


Figure 13: LED_WWAN# Signal Reference Circuit Diagram

There are two indication modes for LED_WWAN# signal to indicate network status, which can be switched through following AT commands:

- **AT+QCFG="ledmode",0** (Default setting)
- **AT+QCFG="ledmode",2**

The following tables show the detailed network status indications of the LED_WWAN# signal.

Table 14: Indications of Network Status (AT+QCFG="ledmode",0, Default Setting)

Pin Status	Description
Flicker slowly (200ms Low/1800ms High)	Network searching
Flicker slowly (1800ms Low/200ms High)	Idle
Flicker quickly (125ms Low/125ms High)	Data transfer is ongoing
Always Low	Voice calling

Table 15: Indications of Network Status (AT+QCFG="ledmode",2)

Pin Status	Description
Low Level (Light ON)	Registered on network successfully
High Impedance (Light OFF)	● No network coverage or not registered ● W_DISABLE# signal is at low level. (Disable RF) ● **AT+CFUN=0**, **AT+CFUN=4**

3.10.6. WAKE# Signal

The WAKE# signal is an open collector signal which is similar to RI signal, but a host pull-up resistor and **AT+QCFG="risignaltype","physical"** command are required. When a URC returns, a 120ms low level pulse will be outputted. The state of WAKE# signal is shown as below.

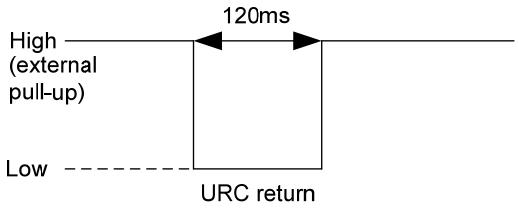


Figure 14: WAKE# Behavior

4 Antenna Connection

4.1. Antenna Connectors

UC200T-GL Mini PCIe is mounted with a main antenna connector. The impedance of the antenna connectors is 50Ω.

4.1.1. Operating Frequency

Table 16: Operating Frequencies

3GPP Band	Transmit	Receive	Unit
EGSM900	880~915	925~960	MHz
DCS1800	1710~1785	1805~1880	MHz
EVDO/CDMA BC0	824~849	869~894	MHz
WCDMA B1	1920~1980	2110~2170	MHz
WCDMA B8	880~915	925~960	MHz
TD-SCDMA B34	2010~2025	2010~2025	MHz
TD-SCDMA B39	1880~1920	1880~1920	MHz

4.2. Antenna Requirements

The following table shows the requirements on main antenna

Table 17: Antenna Requirements

Type	Requirements

GSM/EVDO/CDMA/UMTS/ TD-SCDMA/LTE	VSWR: ≤ 2 Efficiency: > 30% Max input power: 50W Input impedance: 50Ω Cable insertion loss: < 1dB (EGSM900, WCDMA B8, LTE-FDD B5/B8, EVDO/CDMA BC0) Cable insertion loss: < 1.5dB (DCS1800, WCDMA B1, LTE-FDD B1/B3, LTE-TDD B34/B39, TD-SCDMA B34/B39) Cable insertion loss: < 2dB

4.3. Recommended Mating Plugs for Antenna Connection

UC200T-GL Mini PCIe is mounted with RF connectors (receptacles) for convenient antenna connection. The dimensions of the antenna connectors are shown as below.

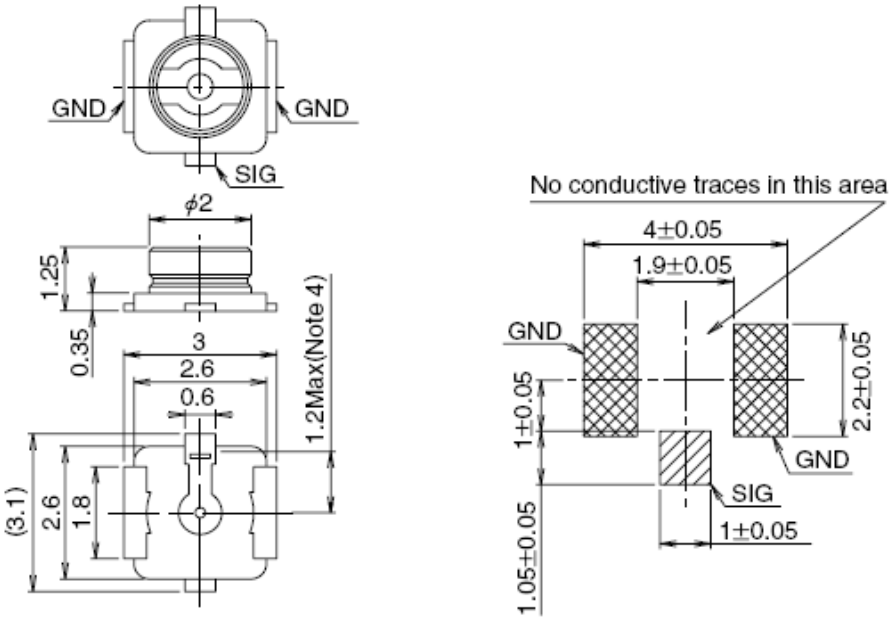


Figure 15: Dimensions of the Receptacle RF Connectors (Unit: mm)

U.FL-LP mating plugs listed in the following figure can be used to match the receptacles.

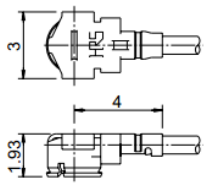
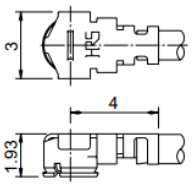
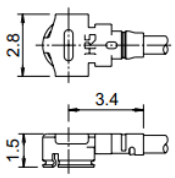
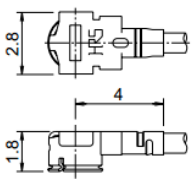
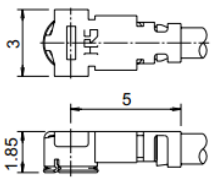
Part No.	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
					
Mated Height	2.5mm Max. (2.4mm Nom.)	2.5mm Max. (2.4mm Nom.)	2.0mm Max. (1.9mm Nom.)	2.4mm Max. (2.3mm Nom.)	2.4mm Max. (2.3mm Nom.)
Applicable cable	Dia. 0.81mm Coaxial cable	Dia. 1.13mm and Dia. 1.32mm Coaxial cable	Dia. 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 U.FL-LP Mating Plugs

The following figure describes the space factor of mating plugs.

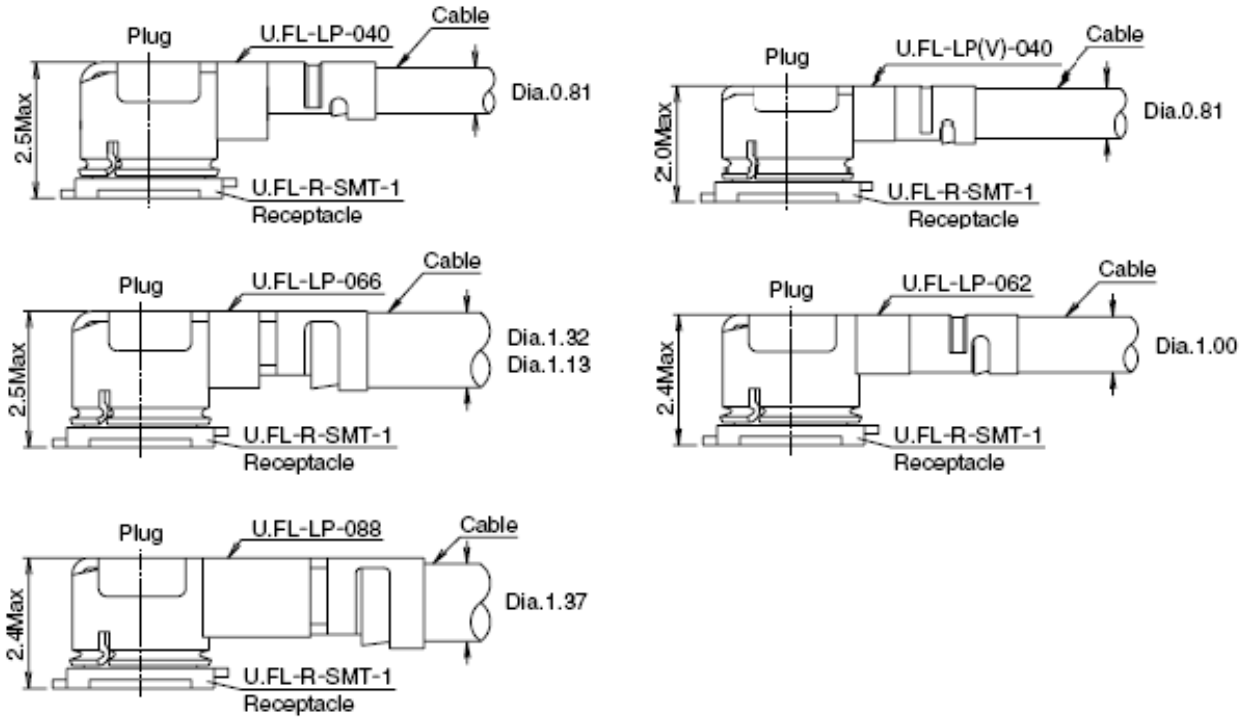


Figure 17: Space Factor of Mating Plugs (Unit: mm)

For more details of the recommended mating plugs, please visit http://www.hirose.com.

5 Electrical, Reliability and Radio Characteristics

5.1. General Description

This chapter mainly describes the following electrical and radio characteristics of UC200T-GL Mini PCIe:

- Power supply requirements
- I/O requirements
- RF characteristics
- ESD characteristics
- Thermal consideration
- Current consumption

5.2. Power Supply Requirements

The input voltage of UC200T-GL Mini PCIe is 3.0V~3.6V. The following table shows the power supply requirements of UC200T-GL Mini PCIe.

Table 18: Power Supply Requirements

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

5.3. I/O Requirements

The following table shows the I/O requirements of UC200T-GL Mini PCIe.

Table 19: I/O Requirements

Parameter	Description	Min.	Max.	Unit
V_{IH}	Input High Voltage	0.7 × VCC_3V3	VCC_3V3 + 0.3	V
V_{IL}	Input Low Voltage	-0.3	0.3 × VCC_3V3	V
V_{OH}	Output High Voltage	VCC_3V3 - 0.5	VCC_3V3	V
V_{OL}	Output Low Voltage	0	0.4	V

NOTES

1. The PCM and I2C interfaces belong to 1.8V power domain and other I/O interfaces belong to VCC_3V3 power domain.
2. The maximum voltage value of V_{IL} for PERST# signal and W_DISABLE# signal is 0.5V.

5.4. RF Characteristics

The following tables show the conducted RF output power and receiving sensitivity of UC200T-GL Mini PCIe module.

Table 20: UC200T-GL Mini PCIe Conducted RF Output Power

Frequency	Max.	Min.
EGSM900	33dBm±2dB	5dBm±5dB
DCS1800	30dBm±2dB	0dBm±5dB
EGSM900 (8-PSK)	27dBm±3dB	5dBm±5dB
DCS1800 (8-PSK)	26dBm±3dB	0dBm±5dB
WCDMA B1/B8	24dBm+1/-3dB	< -49dBm
TD-SCDMA B34/B39	24dBm+1/-3dB	< -49dBm

CDMA BC0	24dBm+2/-1dB	< -49dBm

Table 21: UC200T-GL Mini PCIe Conducted RF Receiving Sensitivity

Frequency	Primary	Diversity	SIMO	3GPP (SIMO)
EGSM900	-109dBm	NA	NA	-102dBm
DCS1800	-109dBm	NA	NA	-102dBm
CDMA BC0	-108dBm	NA	NA	-104dBm
TD-SCDMA B34	-110dBm	NA	NA	-108dBm
TD-SCDMA B39	-110dBm	NA	NA	-108dBm
WCDMA B1	-110dBm	-109.5dBm	-112dBm	-106.7dBm
WCDMA B8	-110dBm	-109.5dBm	-112dBm	-103.7dBm

5.5. ESD Characteristics

The following table shows the ESD characteristics of UC200T-GL Mini PCIe.

Table 22: ESD Characteristics of UC200T-GL Mini PCIe

Tested Interfaces	Contact Discharge	Air Discharge	Unit
Power Supply and GND			kV
Antenna Interfaces			kV
USB Interface			kV
(U)SIM Interface			kV
Others			kV

5.6. Current Consumption

Table 23: Current Consumption of UC200T-GL Mini PCIe

Parameter	Description	Conditions	Typ.	Unit
I_{VBAT}	Sleep state	**AT+CFUN=0** (USB disconnected)		mA
		EGSM @DRX=2 (USB disconnected)		mA
		EGSM @DRX=5 (USB disconnected)		mA
		EGSM @DRX=5 (USB suspend)		mA
		EGSM @DRX=9 (USB disconnected)		mA
		DCS @DRX=2 (USB disconnected)		mA
		DCS @DRX=5 (USB disconnected)		mA
		DCS @DRX=5 (USB suspend)		mA
		DCS @DRX=9 (USB disconnected)		mA
		TD-SCDMA Band A @PF=64 (USB disconnected)		mA
		TD-SCDMA Band A @PF=128 (USB disconnected)		mA
		TD-SCDMA Band A @PF=256 (USB disconnected)		mA
		TD-SCDMA Band A @PF=512 (USB disconnected)		mA
		BC0 @SCI=1 (USB disconnected)		mA
		BC0 @SCI=1 (USB suspend)		mA
		WCDMA @PF=64 (USB suspend)		mA
		WCDMA @PF=128 (USB disconnected)		mA
		WCDMA @PF=256 (USB disconnected)		mA
		WCDMA @ PF=512 (USB disconnected)		mA
	Idle state	EGSM DRX=5 (USB disconnected)		mA

		EGSM DRX=5 (USB connected)	mA
		BC0 @SCI=1 (USB disconnected)	mA
		BC0 @SCI=1 (USB connected)	mA
		TD-SCDMA Band A @PF=64 (USB disconnected)	mA
		TD-SCDMA Band A @PF=64 (USB connected)	mA
		WCDMA @PF=64 (USB disconnected)	mA
		WCDMA @PF=64 (USB connected)	mA
	GPRS data transfer (GNSS OFF)	EGSM900 4DL/1UL @32.71dBm	mA
		EGSM900 3DL/2UL @32.50dBm	mA
		EGSM900 2DL/3UL @30.83dBm	mA
		EGSM900 1DL/4UL @29.68dBm	mA
		DCS1800 4DL/1UL @29.60dBm	mA
		DCS1800 3DL/2UL @29.48dBm	mA
		DCS1800 2DL/3UL @29.81dBm	mA
		DCS1800 1DL/4UL @29.73dBm	mA
	EDGE data transfer (GNSS OFF)	EGSM900 4DL/1UL @27.50dBm	mA
		EGSM900 3DL/2UL @27.50dBm	mA
		EGSM900 2DL/3UL @27.60dBm	mA
		EGSM900 1DL/4UL @27.42dBm	mA
		DCS1800 4DL/1UL @26.20dBm	mA
		DCS1800 3DL/2UL @26.10dBm	mA
		DCS1800 2DL/3UL @27.67dBm	mA
		DCS1800 1DL/4UL @27.55dBm	mA
	CDMA/TD-SCDMA data transfer (GNSS OFF)	BC0 @23.55dBm	mA
		TD-SCDMA Band A @23.18dBm	mA

		TD-SCDMA Band F @23.42dBm	mA
	WCDMA data transfer (GNSS OFF)	WCDMA B1 HSDPA @22.03dBm	mA
		WCDMA B1 HSUPA @22.02dBm	mA
		WCDMA B8 HSDPA @21.68dBm	mA
		WCDMA B8 HSUPA @21.75dBm	mA
	GSM voice call	EGSM900 PCL=5 @32.47dBm	mA
		EGSM900 PCL=12 @19.40dBm	mA
		EGSM900 PCL=19 @5.58dBm	mA
		DCS1800 PCL=0 @29.49dBm	mA
		DCS1800 PCL=7 @16.47dBm	mA
		DCS1800 PCL=15 @0.24dBm	mA
	CDMA voice call	BC0 @23.87dBm	mA
		BC0 @-60.67dBm	mA
	WCDMA voice call	WCDMA B1 @23.05dBm	mA
		WCDMA B8 @23.1dBm	mA

Table 24: GNSS Current Consumption of UC200T-GL Mini PCIe

Parameter	Description	Conditions	Typ.	Unit
I_{VBAT} (GNSS)	Searching (**AT+CFUN=0**)	Cold start @Passive Antenna		mA
		Lost state @Passive Antenna		mA
	Tracking (**AT+CFUN=0**)	Instrument Environment		mA
		Open Sky @Passive Antenna		mA
		Open Sky @Active Antenna		mA

6 Dimensions and Packaging

6.1. General Description

This chapter mainly describes mechanical dimensions as well as packaging specification of UC200T-GL Mini PCIe module. All dimensions are measured in millimeter (mm), and the dimensional tolerances are ±0.05mm unless otherwise specified.

6.2. Mechanical Dimensions of UC200T-GL Mini PCIe

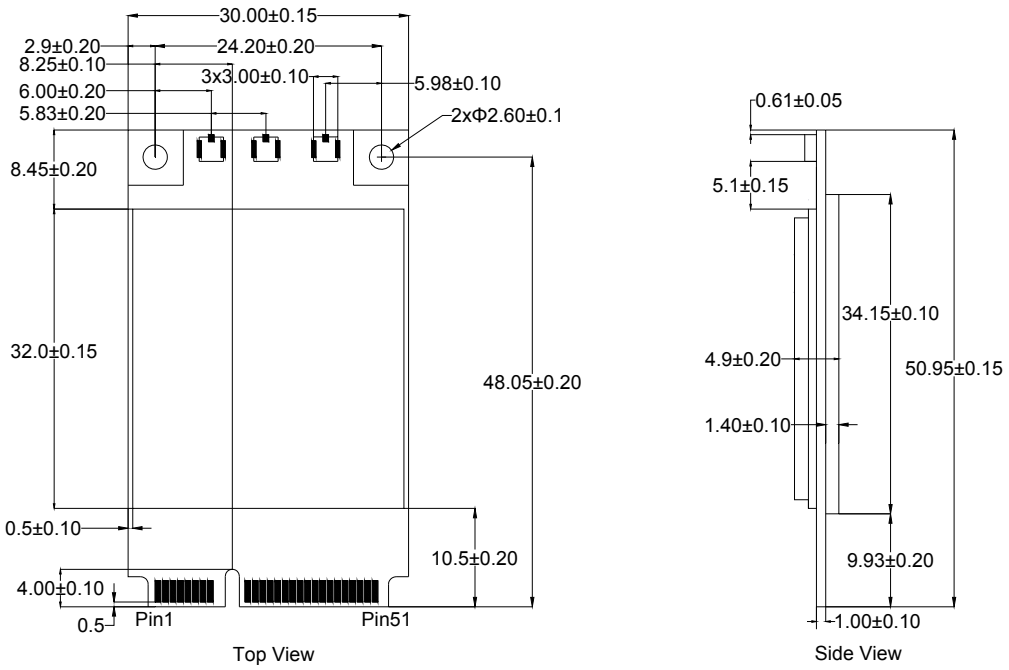


Figure 18: Mechanical Dimensions of UC200T-GL Mini PCIe

6.3. 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 Detail B.

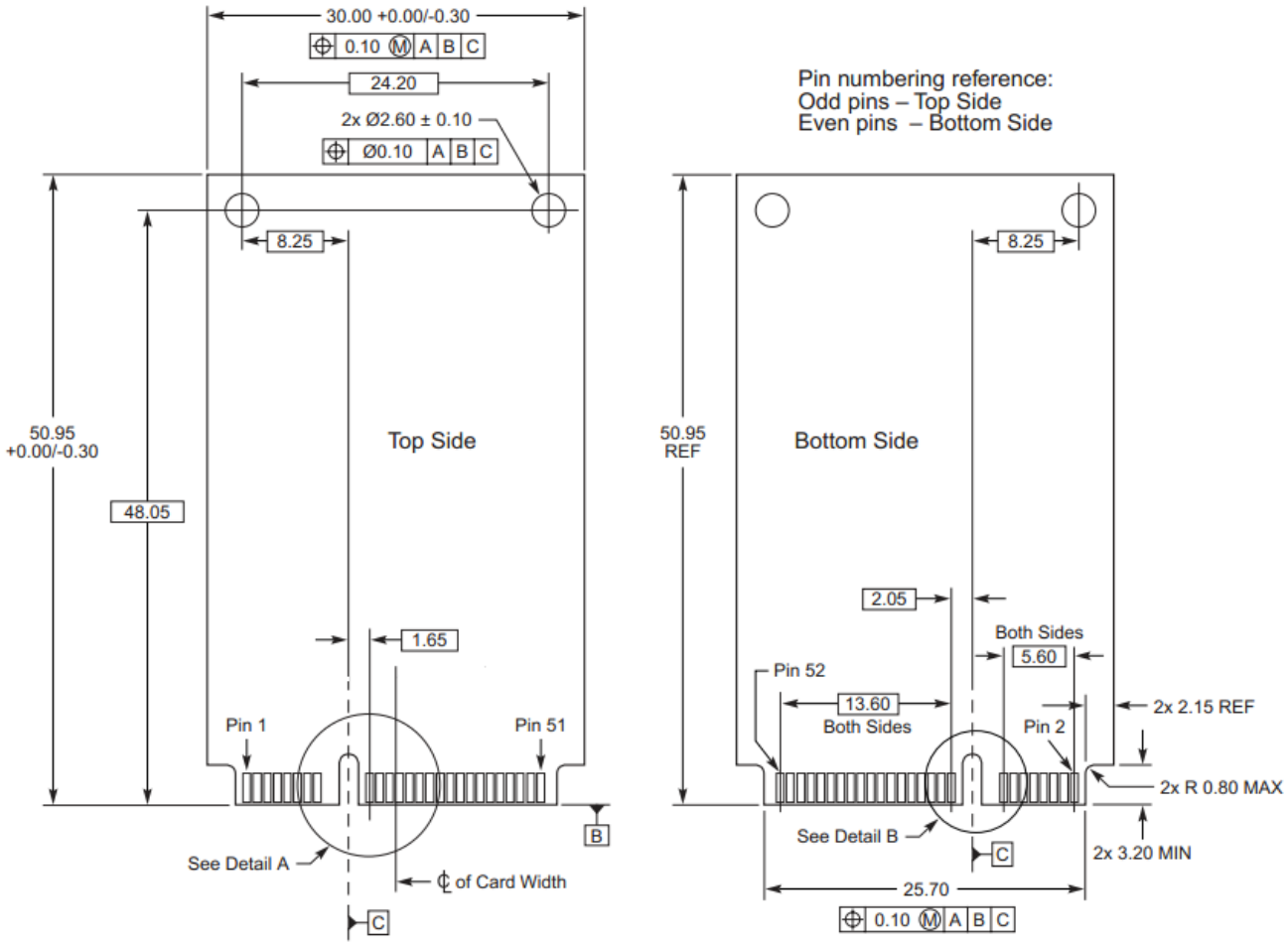


Figure 19: Standard Dimensions of Mini PCI Express

UC200T-GL Mini PCIe adopts a standard Mini PCI Express connector which compiles with the directives and standards listed in ***document [1]***. The following figure takes the Molex 679100002 as an example.

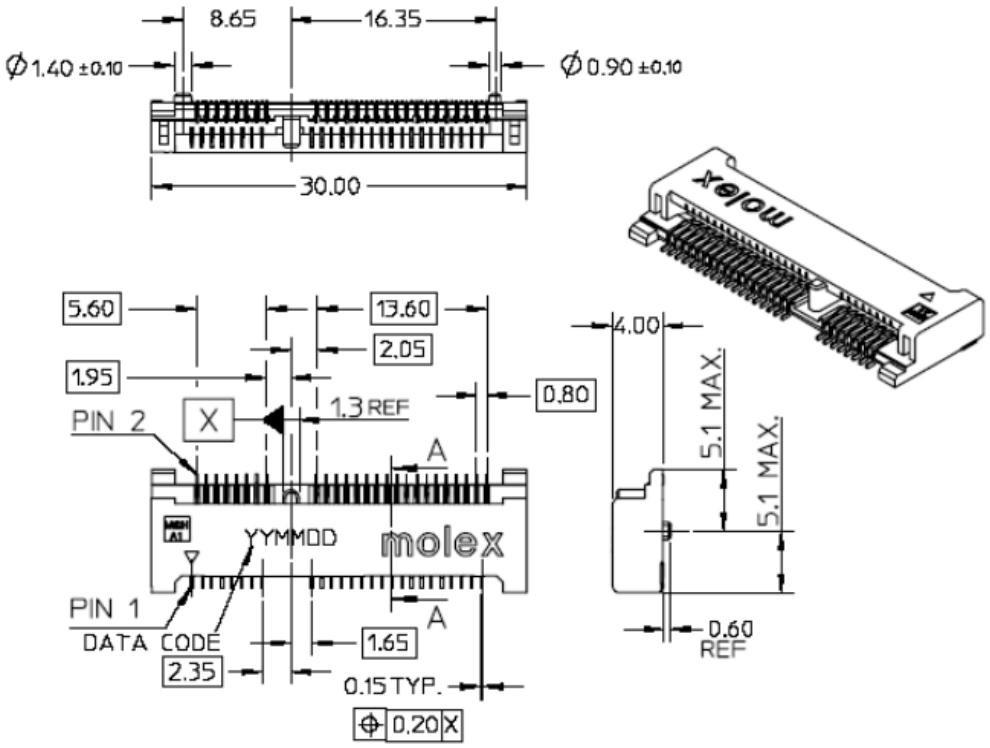


Figure 20: Dimensions of the Mini PCI Express Connector (Molex 679100002)

6.4. Packaging Specifications

UC200T-GL Mini PCIe modules are packaged in a tray. Each tray contains 10 modules. The smallest package of UC200T-GL Mini PCIe contains 100 modules.

7 Appendix A References

Table 25: Related Documents

SN	Document Name	Remark
[1]	PCI Express Mini Card Electromechanical Specification Revision 1.2	PCI Express Mini Card Electromechanical Specification
[2]	Quectel_UC200T-GL_AT_Commands_Manual	UC200T-GL AT commands manual
[3]	Quectel_LTE_Standard_GNSS_AT_ Commands_Manual	GNSS AT commands manual for LTE Standard modules

Table 26: Terms and Abbreviations

Abbreviation	Description
AMR	Adaptive Multi-rate
bps	Bits Per Second
CS	Coding Scheme
CTS	Clear to Send
DC-HSPA+	Dual-carrier High Speed Packet Access
DFOTA	Delta Firmware Upgrade Over The Air
DL	Down Link
DTE	Data Terminal Equipment
DTR	Data Terminal Ready
EFR	Enhanced Full Rate
EMI	Electro Magnetic Interference
ESD	Electrostatic Discharge

ESR	Equivalent Series Resistance
FDD	Frequency Division Duplexing
FR	Full Rate
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
HR	Half Rate
kbps	Kilo Bits Per Second
LED	Light Emitting Diode
LTE	Long-Term Evolution
Mbps	Million Bits Per Second
MCU	Micro Control Unit
ME	Mobile Equipment
MIMO	Multiple-Input Multiple-Output
MMS	Multimedia Messaging Service
MO	Mobile Originated
MT	Mobile Terminated
NMEA	National Marine Electronics Association
PCM	Pulse Code Modulation
PDA	Personal Digital Assistant
PDU	Protocol Data Unit
POS	Point of Sale
PPP	Point-to-Point Protocol

RF	Radio Frequency
RTS	Ready To Send
Rx	Receive Direction
SIMO	Single Input Multiple Output
SMS	Short Message Service
TX	Transmitting Direction
TVS	Transient Voltage Suppressor
UART	Universal Asynchronous Receiver & Transmitter
UL	Up Link
URC	Unsolicited Result Code
USB	Universal Serial Bus
(U)SIM	(Universal) Subscriber Identification Module
WCDMA	Wideband Code Division Multiple Access
WLAN	Wireless Local Area Networks