EC200N-CN Mini PCIe-C (Audio) Hardware Design

LTE Standard Module Series

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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 the module. Manufacturers of the cellular terminal should notify users and operating personnel of the following safety information by incorporating these guidelines into all manuals of the product. Otherwise, Quectel assumes no liability for customers' failure to comply with these precautions.

Full attention must be paid 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 there is an Airplane Mode, it should be enabled prior to boarding an aircraft. Please consult the airline staff for more restrictions on the use of wireless devices on an 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 signal and cellular network cannot be guaranteed to connect in certain conditions, such as when the mobile bill is unpaid or the (U)SIM card is invalid. When emergency help is needed in such conditions, use emergency call if the device supports it. 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. In an emergency, the device with emergency call function cannot be used as the only contact method considering network connection cannot be guaranteed under all circumstances.

The cellular terminal or mobile contains a transceiver. When it is ON, it receives and transmits radio frequency signals. RF interference can occur if it is used close to TV sets, radios, computers or other electric equipment.

In locations with explosive or potentially explosive atmospheres, obey all posted signs and turn off wireless devices such as mobile phone or other cellular terminals. Areas with explosive or potentially explosive atmospheres include fuelling areas, below decks on boats, fuel or chemical transfer or storage facilities, and areas where the air contains chemicals or particles such as grain, dust or metal powders.

About the Document

Revision History

Version	Date	Author	Description
-	2021-07-28	Demon ZHANG/ Kwen XIA	Creation of the document
1.0	2021-08-19	Demon ZHANG/ Kwen XIA	First official release

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1 Introduction

This document defines the EC200N-CN Mini PCIe-C module supporting audio function, and describes its air interfaces and hardware interfaces which are connected with your applications.

This document helps you 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 your reference. The document, coupled with application notes and user guides, makes it easy to design and set up wireless applications with EC200N-CN Mini PCIe-C.

2 Product Concept

2.1. General Description

EC200N-CN Mini PCIe-C module provides data connectivity on LTE-FDD and LTE-TDD networks with PCI Express Mini Card 1.2 standard interface. It supports embedded operating systems such as Linux, Android, etc.

EC200N-CN Mini PCIe-C module can be applied in the following fields:

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

Table 1: Frequency Bands of EC200N-CN Mini PCIe-C

Mode	Frequency Bands
LTE-FDD	B1/B3/B5/B8
LTE-TDD	B34/B38/B39/B40/B41

2.2. Key Features

The following table describes the detailed features of EC200N-CN Mini PCIe-C module.

Table 2: Key Features of EC200N-CN Mini PCIe-C

Features	Details
Mini PCIe Interface	● PCI Express Mini Card 1.2 Standard Interface
Power Supply	● Supply voltage range: 3.4–4.5 V ● Typical supply voltage: 3.8 V
Transmitting Power	● Class 3 (23 dBm ±2 dB) for LTE-FDD bands ● Class 3 (23 dBm ±2 dB) for LTE-TDD bands
LTE Features	● Supports up to Cat 1 FDD and TDD ● Supports 1.4/3/5/10/15/20 MHz RF bandwidth ● LTE-FDD: Max. 10 Mbps (DL)/Max. 5 Mbps (UL) ● LTE-TDD: Max. 7.5 Mbps (DL)/Max. 1 Mbps (UL)
Internet Protocol Features	● Supports TCP/UDP/PPP/FTP/HTTP/NTP/PING/NITZ/CMUX/HTTPS/ SMTP/MMS/FTPS/SMTPS/SSL/FILE protocols ● Supports PAP and CHAP protocols for PPP connections
SMS	● Text and PDU modes ● Point-to-point MO and MT ● SMS cell broadcast ● SMS storage: (U)SIM and ME, ME by default
(U)SIM Interface	● Supports USIM/SIM cards: 1.8/3.0 V
UART Interface	● Supports RTS and CTS hardware flow control ● Baud rate can reach up to 230400 bps, the default is 115200 bps ● Used for AT command communication and data transmission
Analog Audio Interfaces	● Supports one differential input and one differential output
USB Interface	● Compliant with USB 2.0 specification (slave only); the data transfer rate can reach up to 480 Mbps ● Used for AT command communication, data transmission, firmware upgrade and software debugging ● Supports USB serial driver: Windows 7/8/8.1/10, Linux 2.6–5.12, Android 4.x–11.x
AT Commands	● Compliant with 3GPP TS 27.007, 27.005 and Quectel enhanced AT commands
Antenna Interface	● One main antenna connector ● 50 Ω impedance

Physical Characteristics	● Size: (51.0 ±0.15) mm × (30.0 ±0.15) mm × (3.4 ±0.2) mm ● Weight: approx. 11.4 g
Operating Temperature	● Operating temperature range: -35°C to +75 °C [1] ● Extended temperature range: -40°C to +85 °C [2] ● Storage temperature range: -40°C to +90 °C
Firmware Upgrade	● Upgrade via USB interface or DFOTA
RoHS	● All hardware components are fully compliant with EU RoHS directive

2.3. Functional Diagram

The following figure shows the block diagram of EC200N-CN Mini PCIe-C.

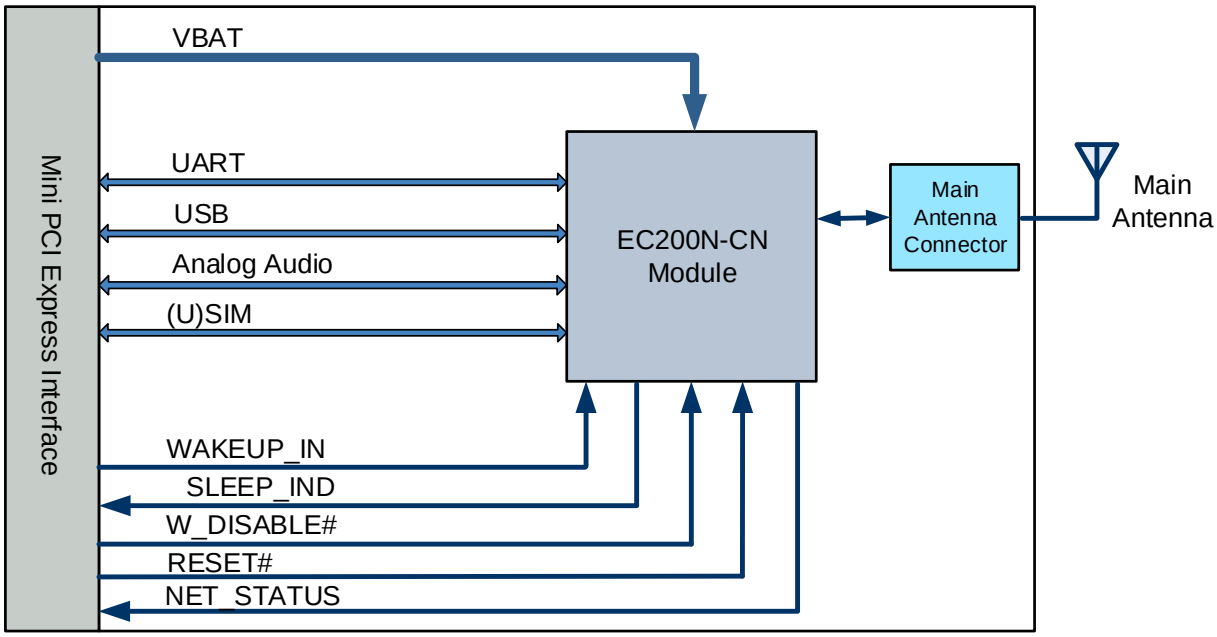


Figure 1: Functional Diagram

[1] Within the operating temperature range, the module meets 3GPP specifications.
[2] Within the extended temperature range, the module remains the ability to establish and maintain functions such as voice, SMS, data transmission, etc., without any unrecoverable malfunction. Radio spectrum and radio network are not influenced, while one or more specifications, such as P_{out}, may exceed the specified tolerances of 3GPP. When the temperature returns to the operating temperature range, the module meets 3GPP specifications again.

3 Application Interfaces

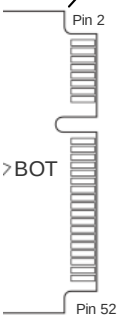
This chapter mainly describes the definition and application of the following interfaces for EC200N-CN Mini PCIe-C:

- Power supply
- UART interface
- USB interface
- (U)SIM interface
- Analog audio interfaces
- Control and indication Interfaces

3.1. Pin Assignment

The following figure shows the pin assignment of EC200N-CN Mini PCIe-C module. The EC200N-CN module and antenna connector are attached to the TOP side, and the reverse side is the BOT side.

Pin Name	Pin No.
MIC_P	1
MIC_N	3
SPK_P	5
SPK_N	7
AGND	9
VDD_EXT	11
RESERVED	13
GND	15
RESERVED	17
WAKEUP_IN	19
GND	21
UART_RXD	23
UART_RTS	25
GND	27
GND	29
UART_TXD	31
RESET#	33
GND	35
GND	37
VBAT	39
VBAT	41
GND	43
RESERVED	45
RESERVED	47
RESERVED	49
RESERVED	51



Pin No.	Pin Name
2	VBAT
4	GND
6	NC
8	USIM_VDD
10	USIM_DATA
12	USIM_CLK
14	USIM_RST
16	RESERVED
18	GND
20	W_DISABLE#
22	RESET#
24	VBAT
26	GND
28	UART_CTS
30	UART_DCD
32	SLEEP_IND
34	GND
36	USB_DM
38	USB_DP
40	GND
42	NET_STATUS
44	USIM_DET
46	UART_DTR
48	NC
50	GND
52	VBAT

Figure 2: EC200N-CN Mini PCIe-C Pin Assignment

3.2. Pin Description

The following tables show the pin definition and description of EC200N-CN Mini PCIe-C on the 52-pin application.

Table 3: I/O Parameters Definition

Type	Description
AI	Analog Input
AO	Analog Output
AIO	Analog Input/Output
DI	Digital Input
DO	Digital Output
DIO	Digital Input/Output
OD	Open Drain
PI	Power Input
PO	Power Output

Table 4: Pin Description

Pin No.	Pin Name	I/O	Description	Comment
1	MIC_P	AI	Microphone analog input (+)	If unused, keep it open.
2	VBAT	PI	Power supply for the module	3.4–4.5 V, typ. 3.8 V.
3	MIC_N	AI	Microphone analog input (-)	If unused, keep it open.
4	GND		Ground	
5	SPK_P	AO	Analog audio differential output (+)	If unused, keep it open.
6	NC		Not connected	
7	SPK_N	AO	Analog audio differential output (-)	If unused, keep it open.
8	USIM_VDD	PO	(U)SIM card power supply	The module automatically recognizes 1.8 V or 3.0 V (U)SIM card.

9	AGND		Analog audio ground	
10	USIM_DATA	DIO	(U)SIM card data	
11	VDD_EXT	PO	Provide 1.8 V for external circuit	Iomax = 50 mA
12	USIM_CLK	DO	(U)SIM card clock	
13	RESERVED		Reserved	.
14	USIM_RST	DO	(U)SIM card reset	
15	GND		Ground	
16	RESERVED		Reserved	
17	RESERVED		Reserved	
18	GND		Ground	
19	WAKEUP_IN	DI	Wake up the module	1.8 V power domain. Active high.
20	W_DISABLE#	DI	Airplane mode control	1.8 V power domain. Active low.
21	GND		Ground	
22	RESET#	DI	Reset the module	1.8 V power domain. Active low.
23	UART_RXD	DI	UART receive	
24	VBAT	PI	Power supply for the module	3.4–4.5 V, typ. 3.8 V.
25	UART_RTS	DO	DCE request to send signal to DTE	
26	GND		Ground	
27	GND		Ground	
28	UART_CTS	DI	DCE clear to send signal from DTE	
29	GND		Ground	
30	UART_DCD	DO	UART data carrier detect	
31	UART_TXD	DO	UART transmit	
32	SLEEP_IND	DO	Indicate the module's sleep mode	1.8 V power domain. Active low.
33	RESET#	DI	Reset the module	1.8 V power domain. Active low.

34	GND		Ground	
35	GND		Ground	
36	USB_DM	AIO	USB differential data (-)	Require differential impedance of 90 Ω.
37	GND		Ground	
38	USB_DP	AIO	USB differential data (+)	Require differential impedance of 90 Ω.
39	VBAT	PI	Power supply for the module	3.4–4.5 V, typ. 3.8 V.
40	GND		Ground	
41	VBAT	PI	Power supply for the module	3.4–4.5 V, typ. 3.8 V.
42	NET_STATUS	OD	Indicate the module's network activity status	
43	GND		Ground	
44	USIM_DET	DI	(U)SIM card hot-plug detect	1.8 V power domain. If unused, keep it open.
45	RESERVED		Reserved	
46	UART_DTR	DI	UART data terminal ready	1.8 V power domain. Can be used to wake up the module; active low.
47	RESERVED		Reserved	
48	NC		Not connected	
49	RESERVED		Reserved	
50	GND		Ground	
51	RESERVED		Reserved	
52	VBAT	PI	Power supply for the module	3.4–4.5 V, typ. 3.8 V.

NOTE

1. The power domain for all digital interfaces is 1.8 V except for the (U)SIM interfaces. The (U)SIM interface voltage can support both 1.8 V and 3.0 V.
2. 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

Modes	Details	
Normal Operation	Talk/Data	Network connection is ongoing. In this mode, the power consumption is decided by network setting and data transfer rate.
	Idle	Software is active. The module has registered on the network, and it is ready to send and receive data.
Airplane Mode	**AT+CFUN=4** or W_DISABLE# pin can set the module to airplane mode. In this case, RF function will be disabled.	
Minimum Functionality Mode	**AT+CFUN=0** 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.	
Sleep Mode	In this mode, the current consumption of the module will be reduced to the minimal level and the module can still receive paging message, SMS, voice call and TCP/UDP data from the network normally.	

3.4. 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	Description
VBAT	2, 24, 39, 41, 52	PI	3.4–4.5 V, typ. 3.8 V.
GND	4, 9, 15, 18, 21, 26, 27, 29, 34, 35, 37, 40, 43, 50		Ground

EC200N-CN Mini PCIe-C is powered by VBAT. Therefore, the power supply must be able to provide a rated output current of 2.0 A at least, and a bypass tantalum capacitor or electrolytic capacity of no less than 470 µF with low ESR should be used to prevent the voltage from dropping. If a switching power supply is used to power the module, the power components and power traces of the switching power supply should be kept away from the antenna as much as possible to prevent EMI interference.

The following figure shows a reference design of power supply where R2 and R3 are 1 % tolerance resistors and C3 is a low-ESR 470 µF filter capacitor.

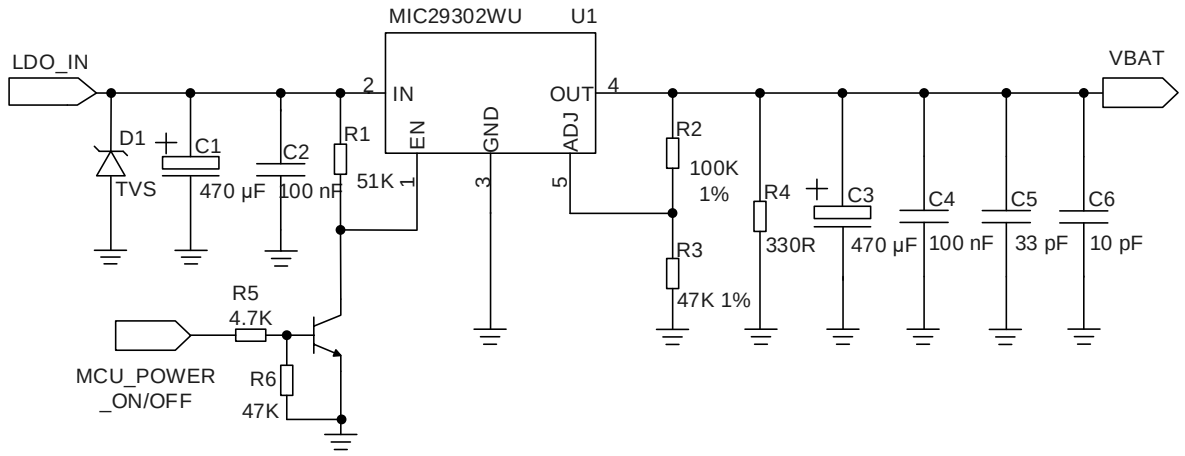


Figure 3: Reference Circuit of Power Supply

3.5. UART Interface

EC200N-CN Mini PCIe-C supports one UART with RTS/CTS hardware flow control function. The UART interface supports 9600 bps, 19200 bps, 38400 bps, 57600 bps, 115200 bps and 230400 bps baud rates. The default is 115200 bps.

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_RXD	23	DI	1.8 V	UART receive.
UART_TXD	31	DO	1.8 V	UART transmit.
UART_CTS	28	DI	1.8 V	DCE clear to send signal from DTE.
UART_RTS	25	DO	1.8 V	DCE request to send signal to DTE.
UART_DTR	46	DI	1.8 V	UART data terminal ready.
UART_DCD	30	DO	1.8 V	UART data carrier detect.

A level translator should be used if your application is equipped with a 3.3 V UART interface. For the design of circuits in dotted lines, see that of circuits in solid lines, but pay attention to the direction of connection.

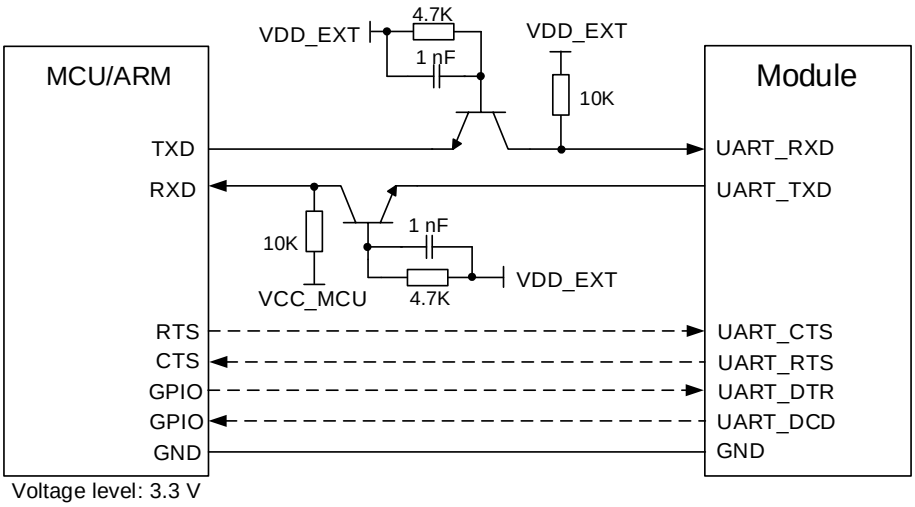


Figure 4: Reference Circuit of 3.3 V Level-shift

NOTE

1. The hardware flow control function is disabled by default, and can be enabled by via **AT+IFC=2,2** and disabled via **AT+IFC=0,0**. For more details, see ***document [1]***.
2. The baud rate of the serial port can be changed via **AT+IPR**. For more related configuration information, see ***document [1]***.

3.6. USB Interface

EC200N-CN Mini PCIe-C 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 (480 Mbps) mode and full speed (12 Mbps) mode. The USB interface is used for AT command communication, data transmission, software debugging and firmware upgrade.
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	AIO	USB differential data (-)	Require differential impedance of 90 Ω.
USB_DP	38	AIO	USB differential data (+)	Require differential impedance of 90 Ω.

The following figure shows a reference circuit of USB interface.

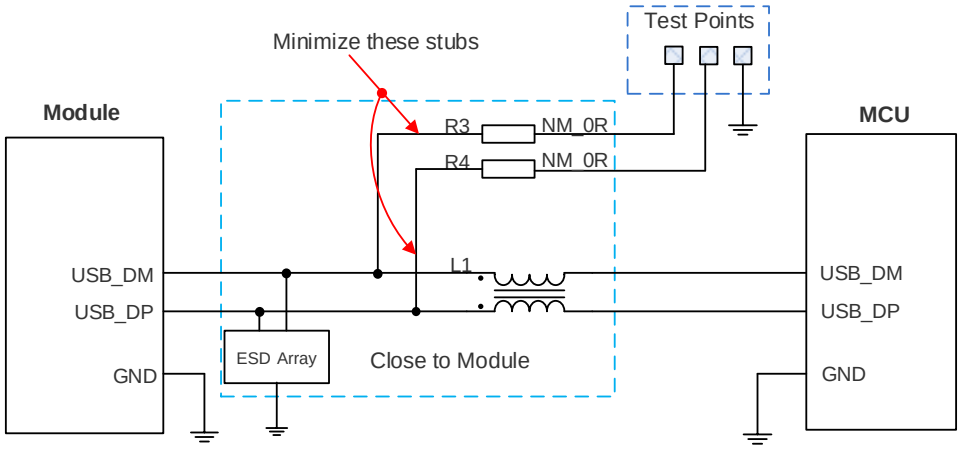


Figure 5: Reference Circuit of USB Interface

A common mode choke L1 is recommended to be added in series between the module and MCU in order to suppress EMI spurious transmission. Meanwhile, the 0 Ω 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 and 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.

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 a differential pair with total grounding. The impedance of USB differential trace is 90 Ω.
- 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, and surround the traces with ground on that layer and with ground planes above and below.
- Special attention should be paid to the selection of ESD device on the USB data line. Its parasitic capacitance should not exceed 2 pF and should be placed as close as possible to the USB interface.

3.7. (U)SIM Interface

EC200N-CN Mini PCIe-C's (U)SIM interface circuitry meets ETSI and IMT-2000 requirements. Both 1.8 V and 3.0 V (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	Description	Comment
USIM_VDD	8	PO	(U)SIM card power supply	The module automatically recognizes 1.8 V or 3.0 V (U) SIM card.
USIM_DATA	10	DIO	(U)SIM card data	
USIM_CLK	12	DO	(U)SIM card clock	
USIM_RST	14	DO	(U)SIM card reset	
USIM_ DET	44	DI	(U)SIM card hot-plug detect	1.8V voltage domain. If unused, keep it open.

EC200N-CN Mini PCIe-C supports (U)SIM card hot-plug via the USIM_DET pin. The function supports low level and high level detections. The function is disabled by default and can be configured via **AT+QSIMDET** command. See ***document [1]*** for details about the command.

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

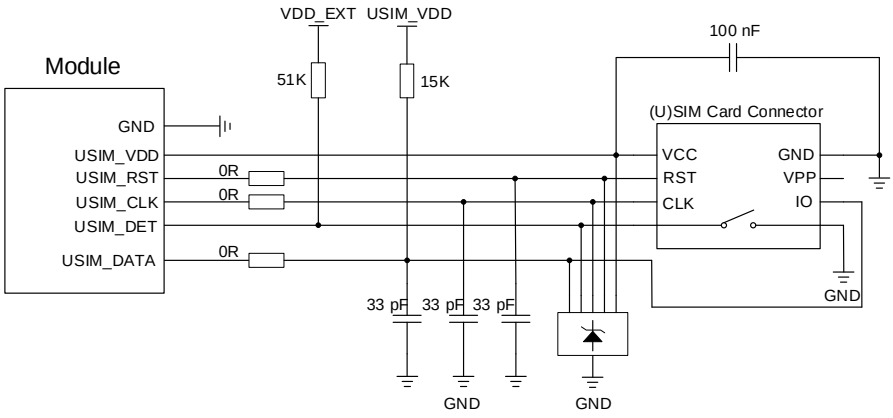


Figure 6: Reference Circuit of (U)SIM Interface with an 8-pin (U)SIM Card Connector

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

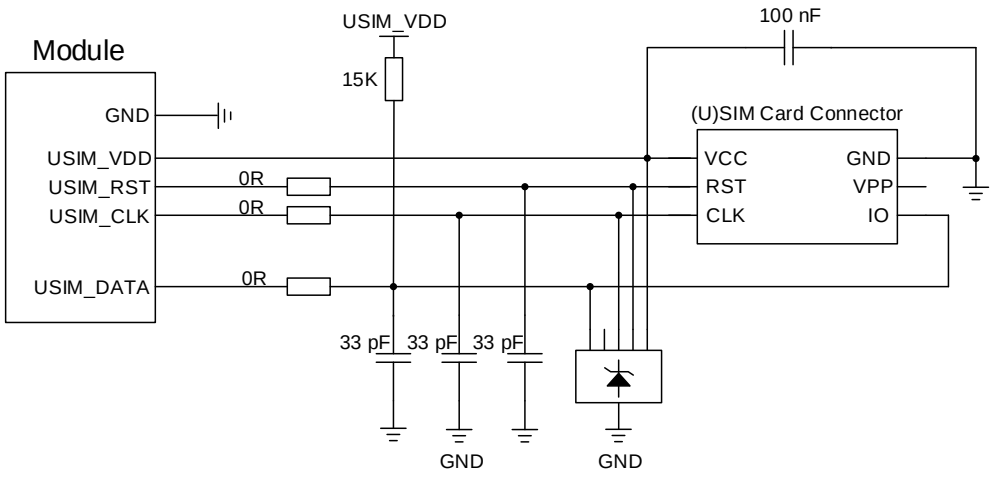


Figure 7: Reference Circuit of (U)SIM Interface with a 6-pin (U)SIM Card Connector

In order to enhance the reliability and availability of the (U)SIM card in your applications, 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 200 mm as possible.
- Keep (U)SIM card signals away from RF and power supply traces.
- The wiring between the ground of the (U)SIM card holder and the USIM_GND of the module should be short and thick. In order to ensure the same potential, ensure that the width of the USIM_VDD and USIM_GND wiring is not less than 0.5 mm; If your PCB GND is complete, USIM_GND can also be directly connected to the GND of the PCB.
- To avoid cross-talk between USIM_DATA and USIM_CLK, keep them away from each other and shield them with surrounded ground.
- The 0 Ω resistors should be added in series between the module and the (U)SIM card so as to facilitate debugging. The 33 pF capacitors are used for filtering interference of Radio Frequency. 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.

3.8. Analog Audio Interfaces

EC200N-CN Mini PCIe-C provides one analog audio input channel and one analog output channel. The following table shows the pin definition of analog audio interfaces.

Table 10: Pin Definition of Analog Audio Interfaces

Interface	Pin Name	Pin No.	I/O	Description
AIN	MIC_P	1	AI	Microphone analog input (+).
	MIC_N	3	AI	Microphone analog input (-).
AOUT	SPK_P	5	AO	Analog audio differential output (+).
	SPK_N	7	AO	Analog audio differential output (-).
AGND	AGND	9		Analog audio ground.

- MIC_P and MIC_N channels are used for microphone differential input. Electret microphones are usually used in microphones.
- SPK_P and SPK_N channels are used for differential output of the receiver or loudspeaker (requiring external audio power amplifier).

AT+QMIC can be used for adjusting the microphone input gain. **AT+CLVL** can be used for adjusting the volume gain between output and receiver. **AT+QSIDET** can be used for setting the side volume gain. See ***document [2]*** for details.

3.8.1. Audio Interfaces Design Considerations

It is recommended to use the electret microphone with dual built-in capacitors (e.g., 10 pF and 33 pF) for filtering out RF interference, which will greatly improve the coupled TDD noise. It should be noted that since the resonance point of a capacitor largely depends on the capacitor material and manufacturing process, when choosing a capacitor, you need to consult the capacitor supplier to select the most suitable capacitor value to filter out high-frequency noise during RF operation.

The severity of high-frequency interference during radio frequency transmission mainly depends on the your application design. Therefore, according to the test results, suitable filter capacitors can be selected for the frequency band with severe interference. The filter capacitor on the PCB board should be placed as close as possible to the audio device or audio interface, and the trace should be as short as possible, and the filter capacitor must be passed through the filter capacitor and then to other connection points.

In order to decrease radio or other signal interference, RF antennas should be placed away from audio interfaces and audio traces. Power traces cannot be parallel with and also should be far away from the audio traces.

The differential audio traces must be routed according to the differential signal layout rule.

3.8.2. Microphone Interface Circuit

MIC_P and MIC_N channel provides electret microphone bias voltage in EC200N-CN Mini PCIe-C without additional bias circuit outside. The microphone channel reference circuit is shown in the following figure:

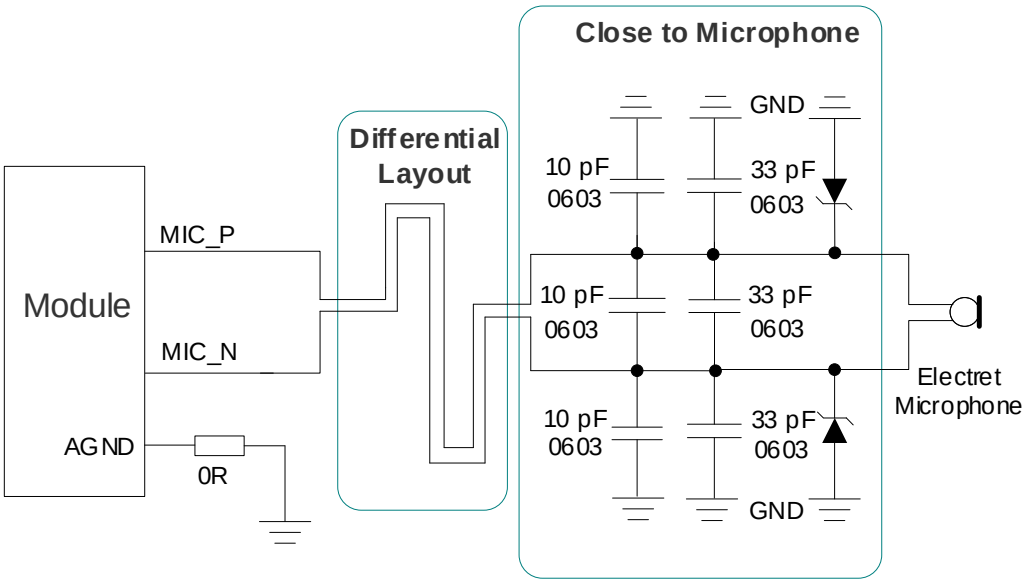


Figure 8: Reference Circuit of Microphone Interface

3.8.3. Receiver Interface Circuit

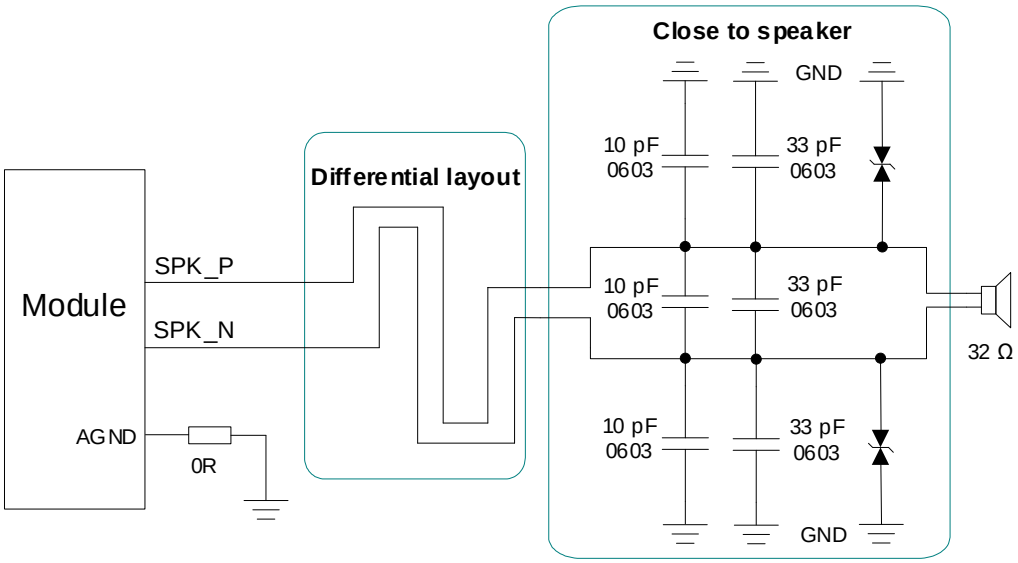


Figure 9: Reference Circuit of Speaker Output

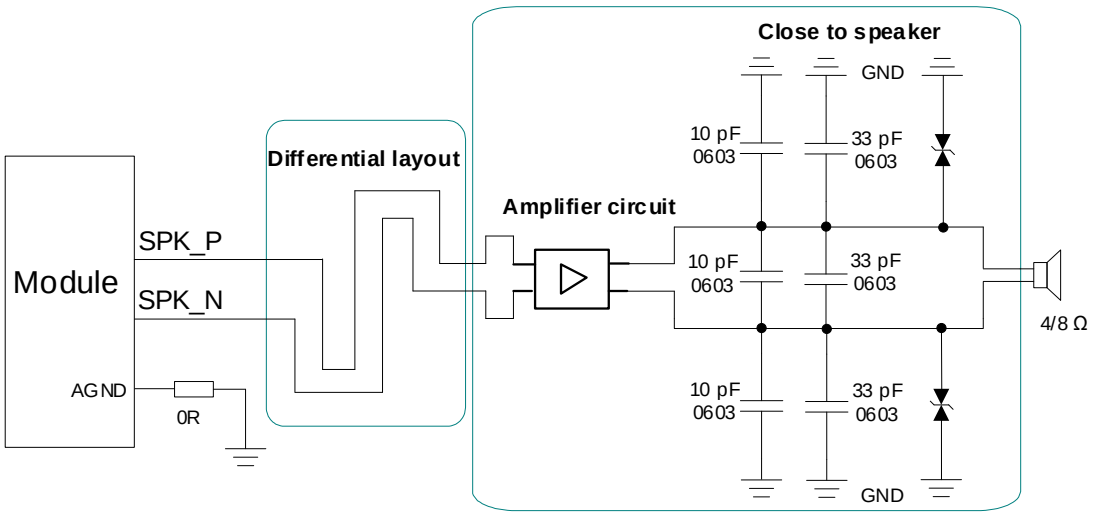


Figure 10: Reference Circuit of Speaker Output with Audio Amplifier

NOTE

It is recommended to connect the analog ground of the peripheral audio circuit to the AGND of the module, and then to the ground through the 0 Ω resistor.

3.8.4. Audio Electrical Characteristics

Table 11: Audio Interface Electrical Performance Parameters

Parameter			Min.	Typ.	Max.	Unit
Audio output (AOUT)	Differential output	load	16	32	-	Ω
		Common mode voltage	-	0.9	-	V
		Differential voltage	0	-	1.4	Vpp
		Output power	-	20	37	mW
Audio input (AIN)	Differential input	Differential voltage	-	-	1.4	Vpp
		Common mode voltage	-	0.9	-	V

3.9. Control and Indication Interfaces

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

Table 12: Pin Definition of Control and Indication Interfaces

Pin Name	Pin No.	I/O	Description	Comment
UART_DTR	46	DI	UART data terminal ready	1.8 V power domain. Can be used to wake up the module; active low.
W_DISABLE#	20	DI	Airplane mode control	1.8 V power domain. Active low.
RESET#	22, 33	DI	Reset the module	1.8 V power domain. Active low.
NET_STATUS	42	OD	Indicate the module's network activity status	
WAKEUP_IN	19	DI	Wake up the module	1.8 V power domain. Active high.
SLEEP_IND	32	DO	Indicate the module's sleep mode	1.8 V power domain. Active low.

3.9.1. Sleep Mode Control and State Indication

EC200N-CN Mini PCIe-C has two pins (UART_DTR and WAKEUP_IN) for sleep mode control and one pin (SLEEP_IND) for sleep state indication. There are four preconditions for enabling EC200N-CN Mini PCIe-C to enter the sleep mode:

- Execute **AT+QSCLK=1** to enable the Sleep mode. See ***document [1]*** for details.
- WAKEUP_IN pin should be kept at low level or open.
- UART_DTR pin should be kept at high level or open.
- USB on Mini PCIe-C must be connected to a USB host and guarantee the USB host is in suspend state.

3.9.1.1. UART_DTR

UART_DTR can be used for sleep mode control. It is pulled up internally by default. When the module is in sleep mode, driving it to low level can wake up the module.

NOTE

When using UART_DTR for wakeup function, WAKEUP_IN should be kept open or at low level.

3.9.1.2. WAKEUP_IN and SLEEP_IND

EC200N-CN Mini PCIe-C module provides WAKEUP_IN for sleep mode control and SLEEP_IND for sleep state indication.

Table 13: Pin Definition of WAKEUP_IN and SLEEP_IND

Pin Name	Comment
WAKEUP_IN	High level: DTE wakes up the module. Low level: DTE makes the module enter sleep mode.
SLEEP_IND	High level: The module is in wake-up mode, and USB and UART can be used. Low level: The module is in sleep mode, and USB and UART cannot be used.

3.9.2. W_DISABLE#

EC200N-CN Mini PCIe-C provides a W_DISABLE# signal to disable or enable the RF function. 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 14: Airplane Mode Controlled by Hardware Method

W_DISABLE#	RF Function Status	Module Operation Modes
High Level	RF enabled	Full functionality mode
Low Level	RF disabled	Airplane mode

The RF function can also be enabled or disabled through AT commands **AT+CFUN**, and the details are as follows.

Table 15: Airplane Mode Controlled by Software Method

AT+CFUN=?	RF Function Status	Module Operation Modes
0	RF and (U)SIM disabled	Minimum functionality mode
1	RF enabled	Full functionality mode
4	RF disabled	Airplane mode

3.9.3. RESET#

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

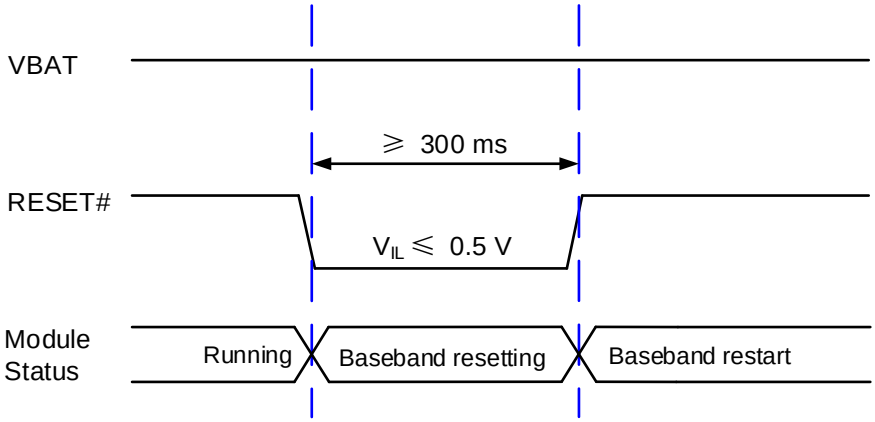


Figure 11: Timing of Resetting the Module

NOTE

1. Ensure that the load capacitance does not exceed 10 nF on RESET# pin.
2. PEREST# only resets the internal baseband chip of the module and does not reset the power management chip.

3.9.4. NET_STATUS

The NET_STATUS signal of EC200N-CN Mini PCIe-C is used to indicate the network status of the module, and can absorb a current up to 40 mA. When an external LED is connected, a current-limiting resistor needs to be connected in series, and the resistance can be adjusted according to the brightness of the LED.

The LED is emitting light when the NET_STATUS output signal is low. The following figure shows the status indicator reference circuit.

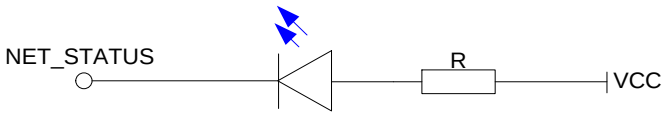


Figure 12: NET_STATUS Signal Reference Circuit

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

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

The following tables show the detailed network status indications of the NET_STATUS.

Table 16: Indications of Network Status (AT+QCFG="ledmode",0, Default Setting)

Pin Status	Indicated network status
Flicker slowly (200 ms low level/1800 ms high impedance)	Network searching
Flicker slowly (1800 ms low level/200 ms high impedance)	Idle
Flicker quickly (125 ms low level/125 ms high impedance)	Data transfer is ongoing
Low Level	Voice calling

Table 17: Indications of Network Status (AT+QCFG="ledmode",2)

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

4 Antenna Connection

4.1. Antenna Connector

EC200N-CN Mini PCIe-C is mounted with a main antenna connector. The impedance of the antenna connector is 50 Ω.

4.1.1. Operating Frequency

Table 18: Operating Frequencies

3GPP Bands	Transmit	Receive	Unit
LTE-FDD B1	1920–1980	2110–2170	MHz
LTE-FDD B3	1710–1785	1805–1880	MHz
LTE-FDD B5	824–849	869–894	MHz
LTE-FDD B8	880–915	925–960	MHz
LTE-TDD B34	2010–2025	2010–2025	MHz
LTE-TDD B38	2570–2620	2570–2620	MHz
LTE-TDD B39	1880–1920	1880–1920	MHz
LTE-TDD B40	2300–2400	2300–2400	MHz
LTE-TDD B41	2535–2675	2535–2675	MHz

4.2. Antenna Requirements

The following table shows the requirements on main antenna.

Table 19: Antenna Requirements

Type	Requirements
LTE	VSWR: ≤ 2 Efficiency: > 30% Max. input power: 50 W Input impedance: 50 Ω Cable insertion loss: < 1 dB (LTE-FDD B5/B8) Cable insertion loss: < 1.5 dB (LTE B1/B3/B34/B39) Cable insertion loss: < 2 dB (LTE-TDD B38/B40/B41)

4.3. Recommended Mating Plugs for Antenna Connection

EC200N-CN Mini PCIe-C is mounted with RF connectors (receptacles) for convenient antenna connection. The dimensions of the antenna connectors are shown as below.

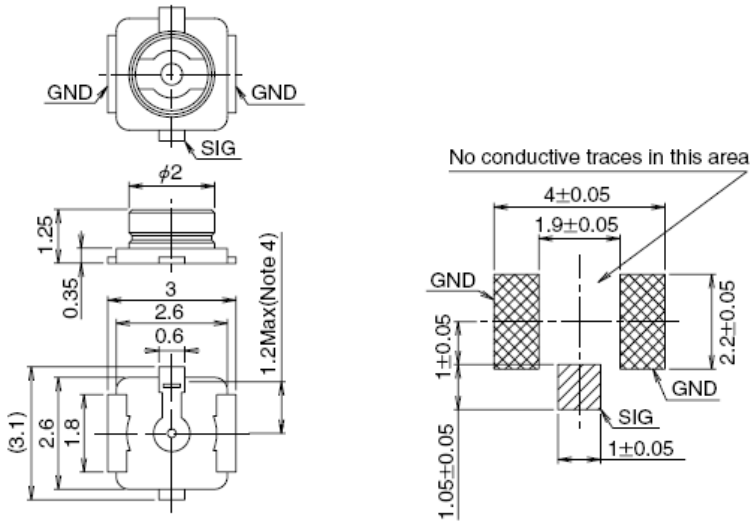


Figure 13: Dimensions of the Receptacle RF Connectors (Unit: mm)

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

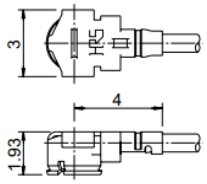
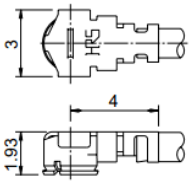
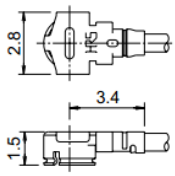
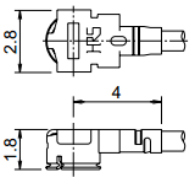
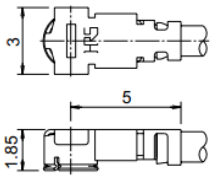
Part No.	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
					
Mated Height	2.5mm Max. (2.4mm Nom.)	2.5mm Max. (2.4mm Nom.)	2.0mm Max. (1.9mm Nom.)	2.4mm Max. (2.3mm Nom.)	2.4mm Max. (2.3mm Nom.)
Applicable cable	Dia. 0.81mm Coaxial cable	Dia. 1.13mm and Dia. 1.32mm Coaxial cable	Dia. 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 14: Mechanicals of U.FL-LP Mating Plugs

The following figure describes the space factor of mating plugs.

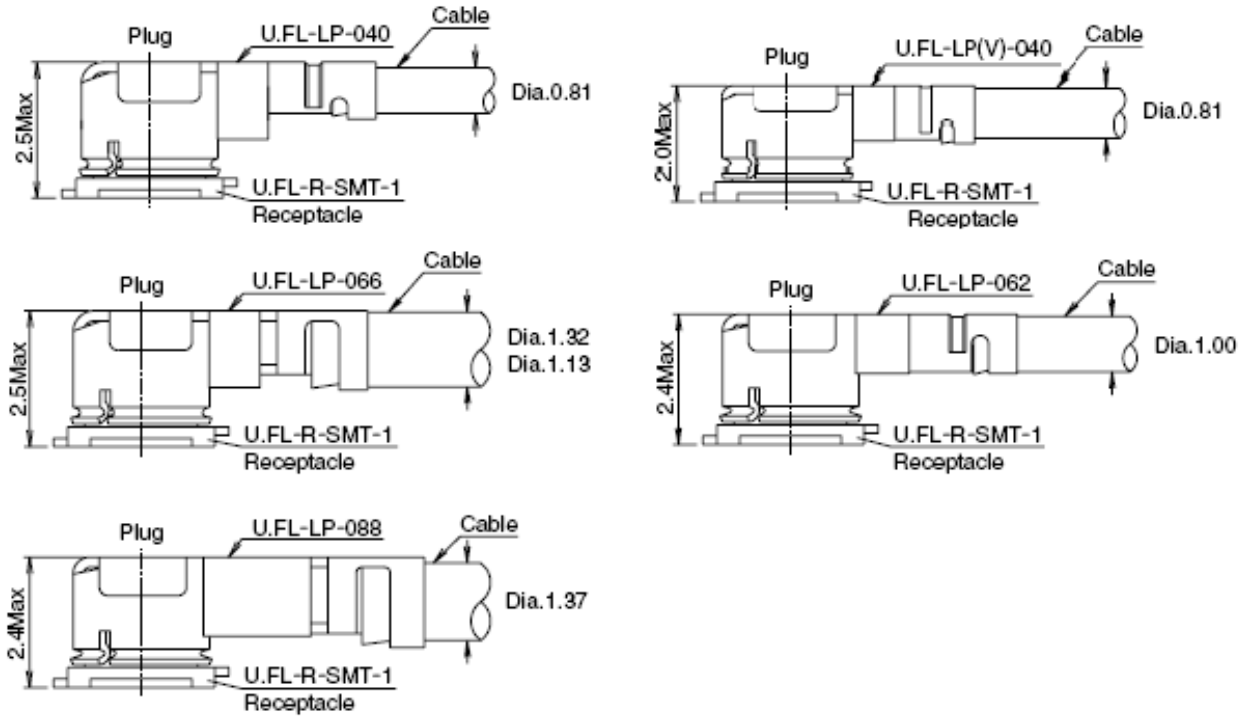


Figure 15: Space Factor of Mating Plugs (Unit: mm)

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

5 Reliability, Radio and Electrical Characteristics

5.1. General Description

This chapter mainly describes the following electrical and radio characteristics of EC200N-CN Mini PCIe-C:

- Power supply characteristics
- I/O characteristics
- RF characteristics
- ESD characteristics
- Current consumption

5.2. Power Supply Characteristics

The input voltage of EC200N-CN Mini PCIe-C is 3.4–4.5 V and the typical value is 3.8 V. It should satisfy at least 2.0 A supply capacity. The following table shows the power supply characteristics of EC200N-CN Mini PCIe-C.

Table 20: Power Supply Characteristics

Parameter	Description	Min.	Max.	Typ.	Unit
VBAT	Power Supply	3.4	4.5	3.8	V

5.3. I/O Characteristics

The following table shows the I/O characteristics of EC200N-CN Mini PCIe-C.

Table 21: I/O Characteristics

Parameter	Description	Min.	Max.	Unit
V_{IH}	Input High Voltage	0.7 × VDDIO [3]	VDDIO [3] + 0.3	V
V_{IL}	Input Low Voltage	-0.3	0.3 × VDDIO [3]	V
V_{OH}	Output High Voltage	VDDIO [3] - 0.5	VDDIO [3]	V
V_{OL}	Output Low Voltage	0	0.4	V

NOTE

The maximum voltage value of V_{IL} for RESET# signal and W_DISABLE# signal is 0.5 V.

Table 22: (U)SIM 1.8 V I/O Characteristics

Parameter	Description	Min.	Max.	Unit
USIM_VDD	Power supply	1.65	1.95	V
V_{IH}	Input High Voltage	0.7 × USIM_VDD	USIM_VDD + 0.3	V
V_{IL}	Input Low Voltage	-0.3	0.2 × USIM_VDD	V
V_{OH}	Output High Voltage	0.8 × USIM_VDD	USIM_VDD	V
V_{OL}	Output Low Voltage	0	0.4	V

[3] VDDIO is the IO voltage of chipset and equals to 1.8 V.

Table 23: (U)SIM 3.0 V I/O Characteristics

Parameter	Description	Min.	Max.	Unit
USIM_VDD	Power supply	2.7	3.05	V
V_{IH}	Input high voltage	0.7 × USIM_VDD	USIM_VDD + 0.3	V
V_{IL}	Input low voltage	-0.3	0.2 × USIM_VDD	V
V_{OH}	Output high voltage	0.8 × USIM_VDD	USIM_VDD	V
V_{OL}	Output low voltage	0	0.4	V

5.4. RF Characteristics

The following tables show the conducted RF output power and receiving sensitivity of EC200N-CN Mini PCIe-C module.

Table 24: EC200N-CN Mini PCIe-C Conducted RF Output Power

Frequency Bands	Max. RF Output Power	Min. RF Output Power
LTE-FDD B1/B3/B5/B8	23 dBm ±2 dB	< -39 dBm
LTE-TDD B34/B38/B39/B40/B41	23 dBm ±2 dB	< -39 dBm

Table 25: EC200N-CN Mini PCIe-C Conducted RF Receiving Sensitivity

Frequency Bands	Receiving Sensitivity			3GPP (SIMO)
	Primary	Diversity	SIMO	
LTE-FDD B1 (10 MHz)	-98.0 dBm	-	-	-96.3 dBm
LTE-FDD B3 (10 MHz)	-97.5 dBm	-	-	-93.3 dBm
LTE-FDD B5 (10 MHz)	-98.5 dBm	-	-	-94.3 dBm
LTE-FDD B8 (10 MHz)	-98.5 dBm	-	-	-93.3 dBm
LTE-TDD B34 (10 MHz)	-98.5 dBm	-	-	-96.3 dBm

LTE-TDD B38 (10 MHz)	-98.5 dBm	-	-	-96.3 dBm
LTE-TDD B39 (10 MHz)	-98.5 dBm	-	-	-96.3 dBm
LTE-TDD B40 (10 MHz)	-98.5 dBm	-	-	-96.3 dBm
LTE-TDD B41 (10 MHz)	-98.5 dBm	-	-	-94.3 dBm

5.5. ESD Characteristics

The following table shows the ESD characteristics of EC200N-CN Mini PCIe-C.

Table 26: ESD Characteristics of EC200N-CN Mini PCIe-C

Tested Interfaces	Contact Discharge	Air Discharge	Unit
Power Supply and GND	±5	±10	kV
Antenna Interface	±4	±8	kV
Others	±0.5	±1	kV

5.6. Current Consumption

Table 27: EC200N-CN Mini PCIe-C Current Consumption

Description	Conditions	Typ.	Unit
Sleep state	**AT+CFUN=0** (USB disconnected)	4.774	mA
	LTE-FDD @ PF = 32 (USB disconnected)	5.915	mA
	LTE-FDD @ PF = 64 (USB disconnected)	5.475	mA
	LTE-FDD @ PF = 64 (USB suspend)	2.685	mA
	LTE-FDD @ PF = 128 (USB disconnected)	5.244	mA
	LTE-FDD @ PF = 256 (USB disconnected)	5.126	mA
	LTE-TDD @ PF = 32 (USB disconnected)	5.948	mA

	LTE-TDD @ PF = 64 (USB disconnected)	5.49	mA
	LTE-TDD @ PF = 64 (USB suspend)	2.696	mA
	LTE-TDD @ PF = 128 (USB disconnected)	5.258	mA
	LTE-TDD @ PF = 256 (USB disconnected)	5.142	mA
Idle state	LTE-FDD @ PF = 64 (USB disconnected)	23.29	mA
	LTE-FDD @ PF = 64 (USB connected)	30.38	mA
	LTE-TDD @ PF = 64 (USB disconnected)	23.31	mA
	LTE-TDD @ PF = 64 (USB connected)	30.41	mA
LTE data transfer	LTE-FDD B1 @ 22.0 dBm	555.5	mA
	LTE-FDD B3 @ 22.0 dBm	494.1	mA
	LTE-FDD B5 @ 22.2 dBm	517.3	mA
	LTE-FDD B8 @ 22.6 dBm	526.5	mA
	LTE-TDD B34 @ 22.9 dBm	280.1	mA
	LTE-TDD B38 @ 22.0 dBm	297.0	mA
	LTE-TDD B39 @ 22.6 dBm	265.0	mA
	LTE-TDD B40 @ 22.3 dBm	291.5	mA
	LTE-TDD B41 @ 22.4 dBm	307.4	mA

5.7. Notification

Follow the principles below in module application.

5.7.1. Coating

If a conformal coating is necessary for the module, do NOT use any coating material that may chemically react with the PCB or shielding cover, and prevent the coating material from flowing into the module.

5.7.2. Cleaning

Avoid using ultrasonic technology for module cleaning since it can damage crystals inside the module.

6 Dimensions and Packaging

This chapter mainly describes mechanical dimensions as well as packaging specification of EC200N-CN Mini PCIe-C module. All dimensions are measured in millimeter (mm), and the dimensional tolerances are ±0.2 mm unless otherwise specified.

6.1. Mechanical Dimensions of EC200N-CN Mini PCIe-C

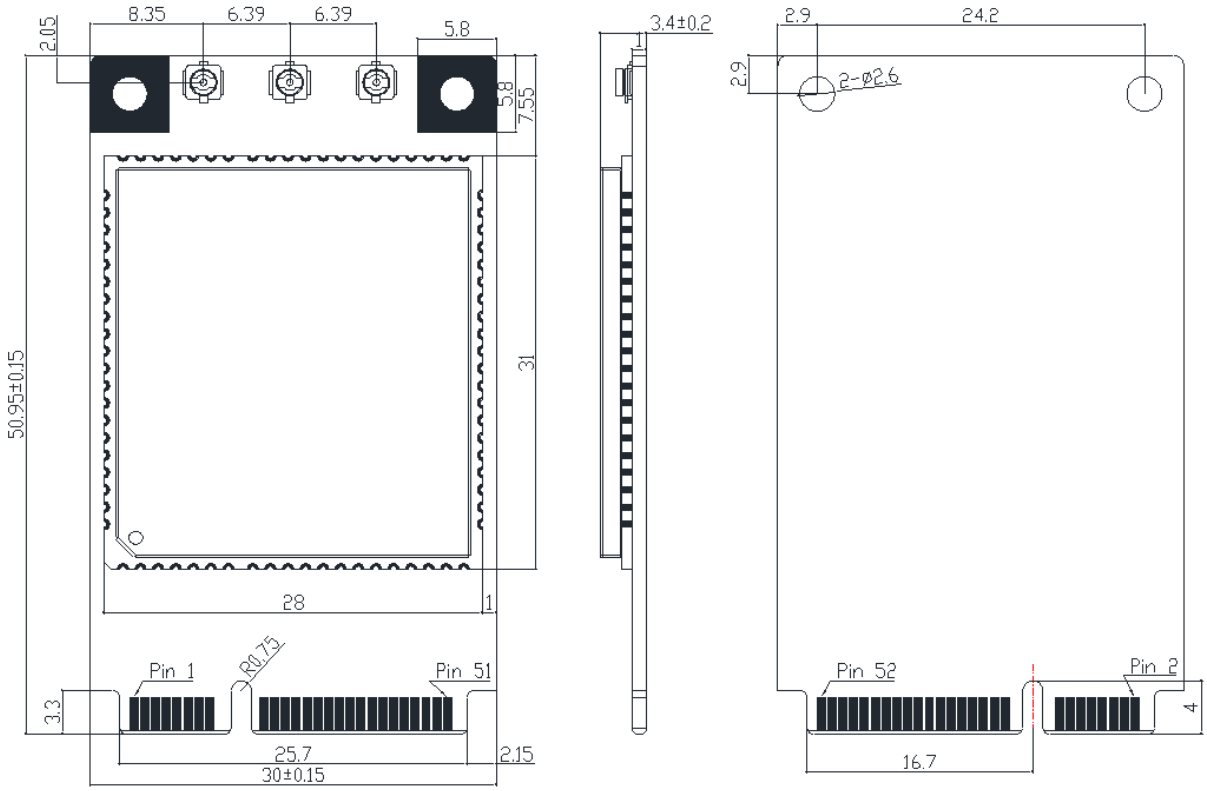


Figure 16: Mechanical Dimensions of EC200N-CN Mini PCIe-C

6.2. Standard Dimensions of Mini PCI Express

The following figure shows the standard dimensions of Mini PCI Express. See *PCI Express Mini Card Electromechanical Specification Revision 1.2* for Detail A and Detail B.

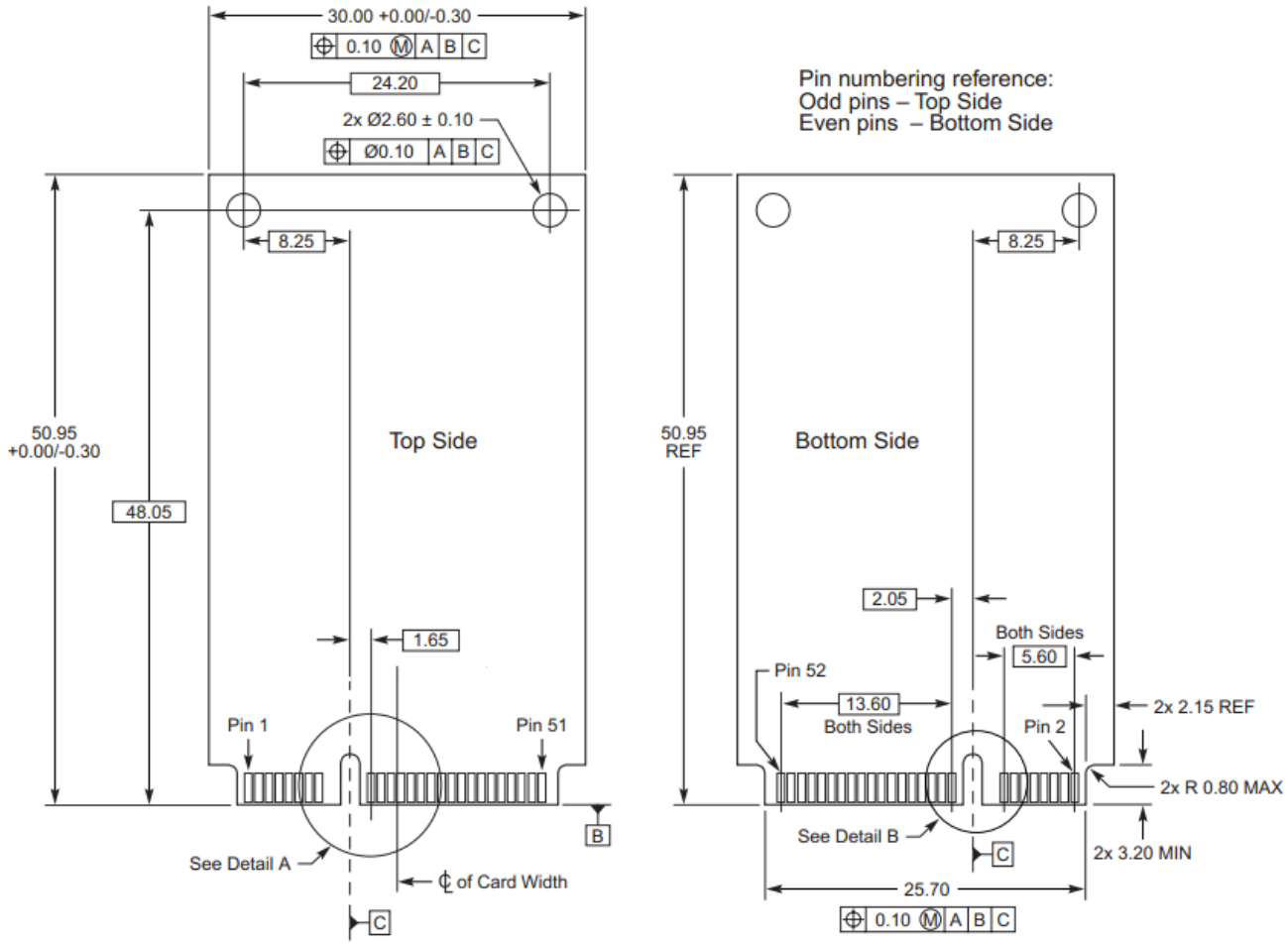


Figure 17: Standard Dimensions of Mini PCI Express Card

EC200N-CN Mini PCIe-C adopts a standard Mini PCI Express Card connector which compiles with the directives and standards listed in the *PCI Express Mini Card Electromechanical Specification Revision 1.2*. The following figure takes the Molex 679105700 as an example.

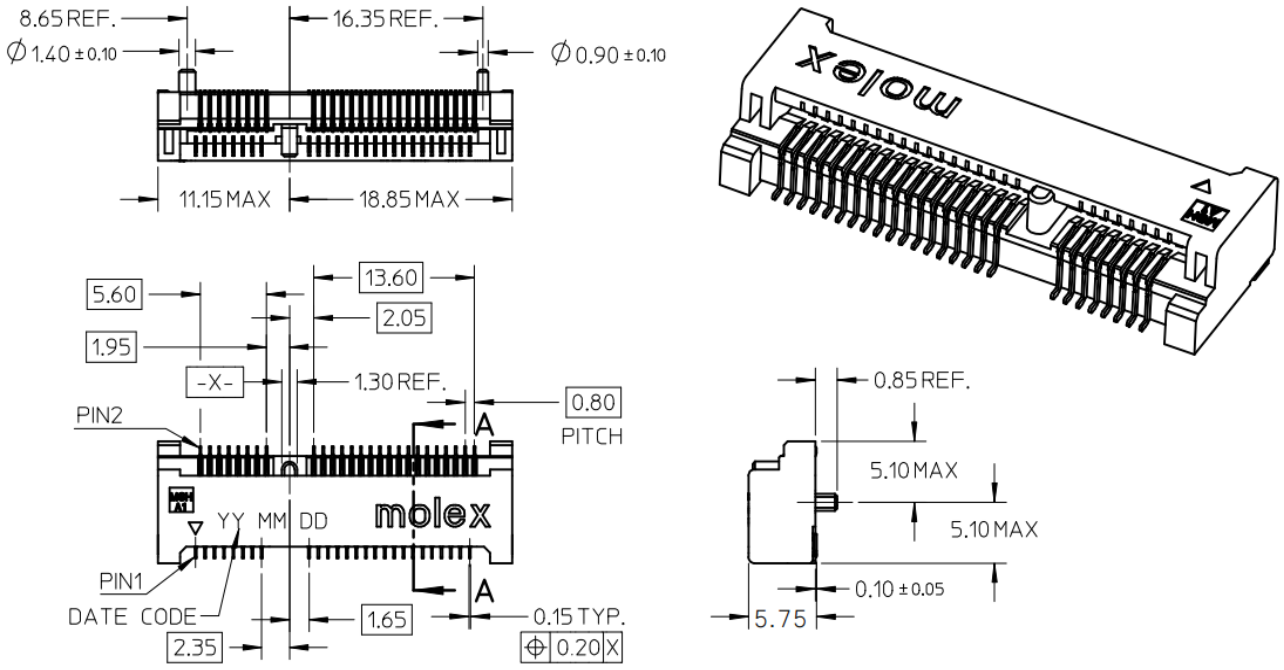


Figure 18: Dimensions of the Mini PCI Express Connector (Molex 679105700)

6.3. Packaging

EC200N-CN Mini PCIe-C modules are packaged in a tray. Each tray contains 10 modules. The smallest package of EC200N-CN Mini PCIe-C contains 100 modules.

The module adopts blister tray packaging and details are as follow:

6.3.1. Blister Tray

Dimension details are as follow:

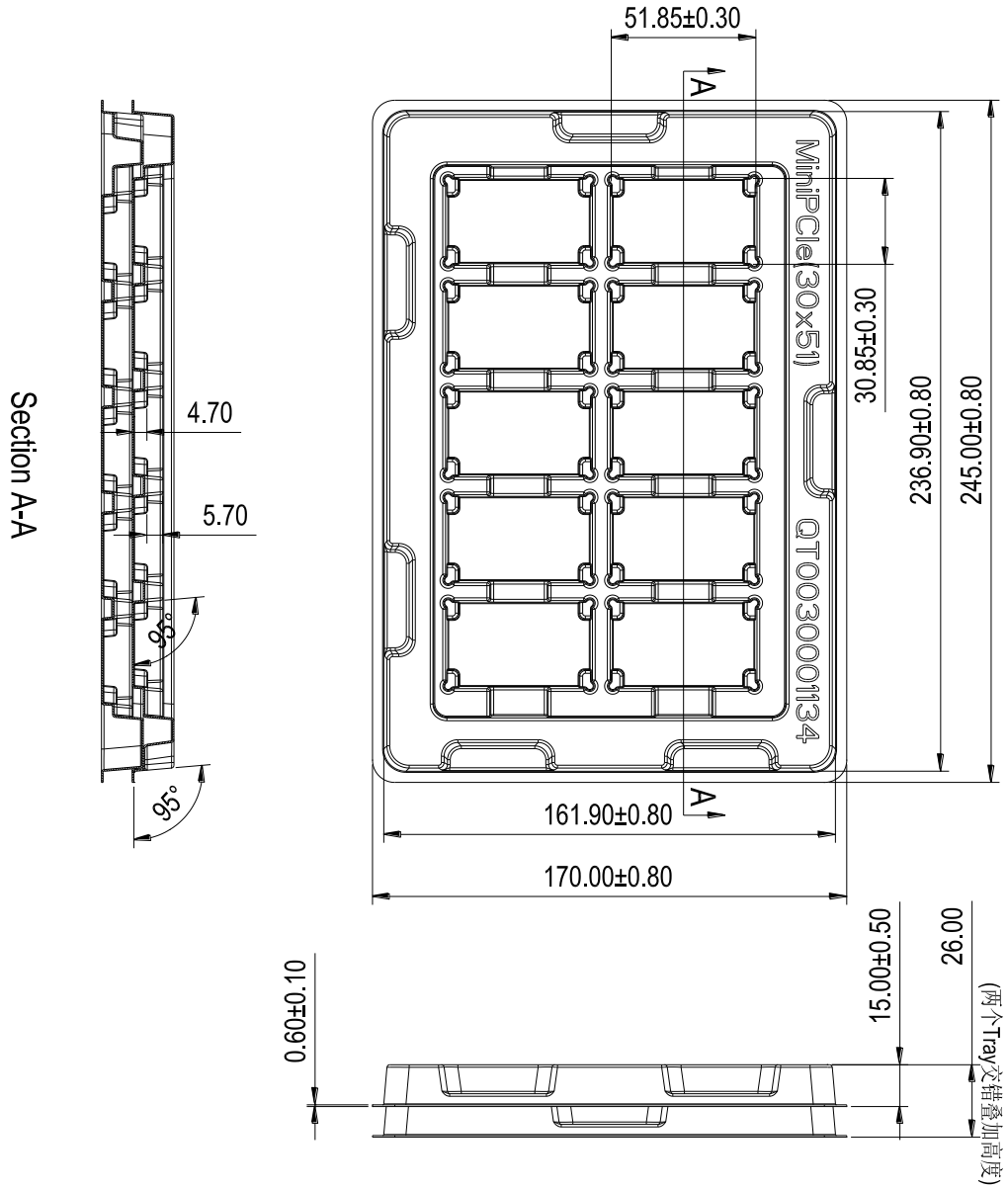
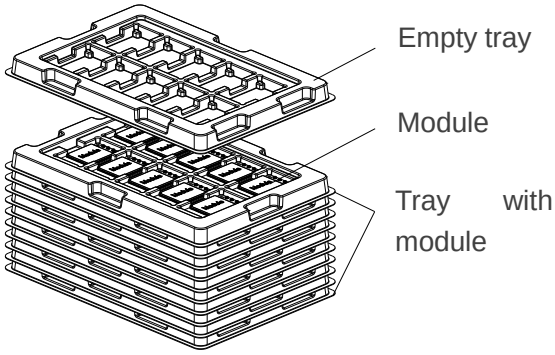
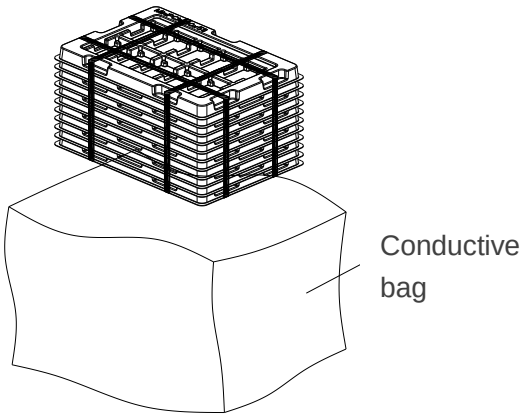


Figure 19: Blister Tray Dimension Drawing

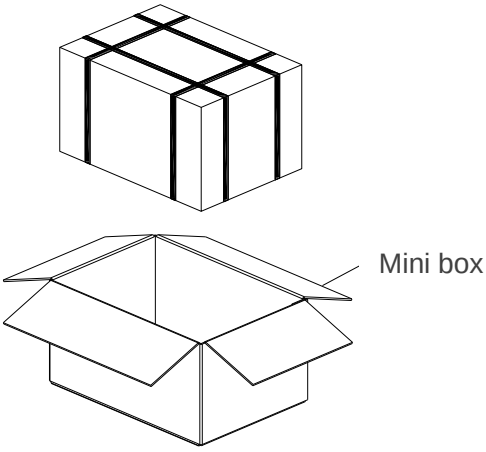
6.3.2. Packaging Process



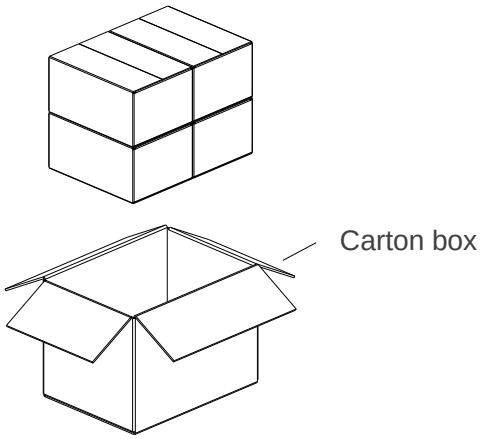
Each blister tray packs 10 modules. Stack 10 blister trays with modules together, and put 1 empty blister tray on the top.



Packing 11 blister trays together and then put blister trays into conductive bag, seal and pack the conductive bag.



Put the seal-packed blister trays into the mini box. 1 mini box can pack 100 modules.



Put 4 packaged mini boxes into 1 carton box and then seal it. 1 carton box can pack 400 modules.

Figure 20: Packaging Process

7 Appendix References

Table 28: Related Documents

Document
[1] Quectel_EC200x&EG912Y_Series_AT_Commands_Manual
[2] Quectel_WCDMA&LTE_Audio_Design_Note

Table 29: Terms and Abbreviations

Abbreviation	Description
3GPP	3rd Generation Partnership Project
bps	Bits Per Second
CHAP	Challenge-Handshake Authentication Protocol
CTS	Clear To Send
DCE	Data Communications Equipment
DFOTA	Delta Firmware Upgrade Over-The-Air
DTE	Data Terminal Equipment
DTR	Data Terminal Ready
ESD	Electrostatic Discharge
ESR	Equivalent Series Resistance
ETSI	European Telecommunications Standards Institute
FDD	Frequency Division Duplexing
FTP	File Transfer Protocol
FTPS	FTP-SSL: FTP over SSL / FTP Secure

HTTP	Hyper Text Transfer Protocol
HTTPS	Hyper Text Transfer Protocol over Secure Socket Layer
IMT-2000	International Mobile Telecommunications 2000
I/O	Input/Output
LED	Light Emitting Diode
LTE	Long Term Evolution
Mbps	Million Bits Per Second
ME	Mobile Equipment
MMS	Multimedia Messaging Service
NITZ	Network Identity and Time Zone / Network Informed Time Zone.
NTP	Network Time Protocol
PAP	Password Authentication Protocol
PCB	Printed Circuit Board
PCI	Physical Cell Identity
PDU	Protocol Data Unit
PING	Packet Internet Groper
PPP	Point-to-Point Protocol
RF	Radio Frequency
ROHS	Restriction of Hazardous Substances
RTS	Ready To Send/Request to Send
SIM	Subscriber Identity Module
SMTP	Simple Mail Transfer Protocol
SMTPS	Simple Mail Transfer Protocol Secure
SSL	Secure Sockets Layer
TCP	Transmission Control Protocol

TDD	Time Division Duplexing
UART	Universal Asynchronous Receiver & Transmitter
UDP	User Datagram Protocol
UL	Uplink
UMTS	Universal Mobile Telecommunications System
(U)SIM	(Universal) Subscriber Identity Module