EC20 R2.1 Mini PCIe-C Hardware Design

LTE Standard Module Series

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About the Document

History

Revision	Date	Author	Description
1.0	2019-09-10	Woody WU/ Niko WU	Initial

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1 Introduction

This document defines the EC20 R2.1 Mini PCIe-C module supporting audio function, 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 EC20 R2.1 Mini PCIe-C.

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 EC20 R2.1 Mini PCIe-C 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

EC20 R2.1 Mini PCIe-C module provides data connectivity on LTE-FDD, LTE-TDD, DC-HSDPA, HSPA+, HSDPA, HSUPA, WCDMA, TD-SCDMA, EVDO, CDMA, EDGE and GPRS networks with PCI Express Mini Card 1.2 standard interface. It supports embedded operating systems such as Linux, Android, etc.

EC20 R2.1 Mini PCIe-C 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 EC20 R2.1 Mini PCIe-C

Module	Description
EC20-CE R2.1 Mini PCIe-C	LTE-FDD (with receive diversity) 1): B1/B3/B5/B8 LTE-TDD (with receive diversity) 1): B34/B38/B39/B40/B41 WCDMA (with receive diversity) 1): B1/B8 TD-SCDMA: B34/B39 EVDO/CDMA: BC0 GSM: 900/1800MHz GNSS: GPS, GLONASS, BeiDou/Compass, Galileo, QZSS 2) Support analog audio 3)

NOTES

1. EC20 R2.1 Mini PCIe-C contains **Telematics** version and **Data-only** version. **Telematics** version supports voice and data functions, while **Data-only** version only supports data function.
2. 1) Rx-diversity function is optional.

3. [2] GNSS function is optional.
4. [3] Analog audio function is only supported on **Telematics** version.

2.2. Key Features

The following table describes the detailed features of EC20 R2.1 Mini PCIe-C module.

Table 2: Key Features of EC20 R2.1 Mini PCIe-C

Features	Description
Function Interface	PCI Express Mini Card 1.2 Standard Interface
Power Supply	Supply voltage: 3.3V~3.6V
Transmitting Power	Class 4 (33dBm±2dB) for EGSM900 Class 1 (30dBm±2dB) for DCS1800 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 Class 3 (23dBm±2dB) for LTE FDD bands Class 3 (23dBm±2dB) for LTE TDD bands
LTE Features	Support up to 3GPP R8 non-CA Cat 4 FDD and TDD Support 1.4/3/5/10/15/20MHz RF bandwidth Support MIMO in DL direction FDD: Max 150Mbps (DL), Max 50Mbps (UL) TDD: Max 130Mbps (DL), Max 30Mbps (UL)
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), Max 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, MCS 1-9 Uplink coding schemes: CS 1-4, 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* Support the protocols PAP (Password Authentication Protocol) and CHAP (Challenge Handshake Authentication Protocol) which are usually used for PPP connection
SMS	Text and PDU mode 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 Interface	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
Analog Audio Interfaces	Support one differential input Support one differential output
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, and GNSS NMEA output 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.
AT Commands	Compliant with 3GPP TS 27.007, 27.005 and Quectel enhanced AT commands
Antenna Connectors	Include main antenna, diversity antenna and GNSS antenna receptacle connectors
GNSS Features	Gen8C Lite of Qualcomm Protocol: NMEA 0183 Data update rate: 10Hz by default
Physical Characteristics	Size: (51.0±0.15)mm × (30.0±0.15)mm × (4.9±0.2)mm Weight: approx. 11.4g
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 operating 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 operating 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 EC20 R2.1 Mini PCIe-C.

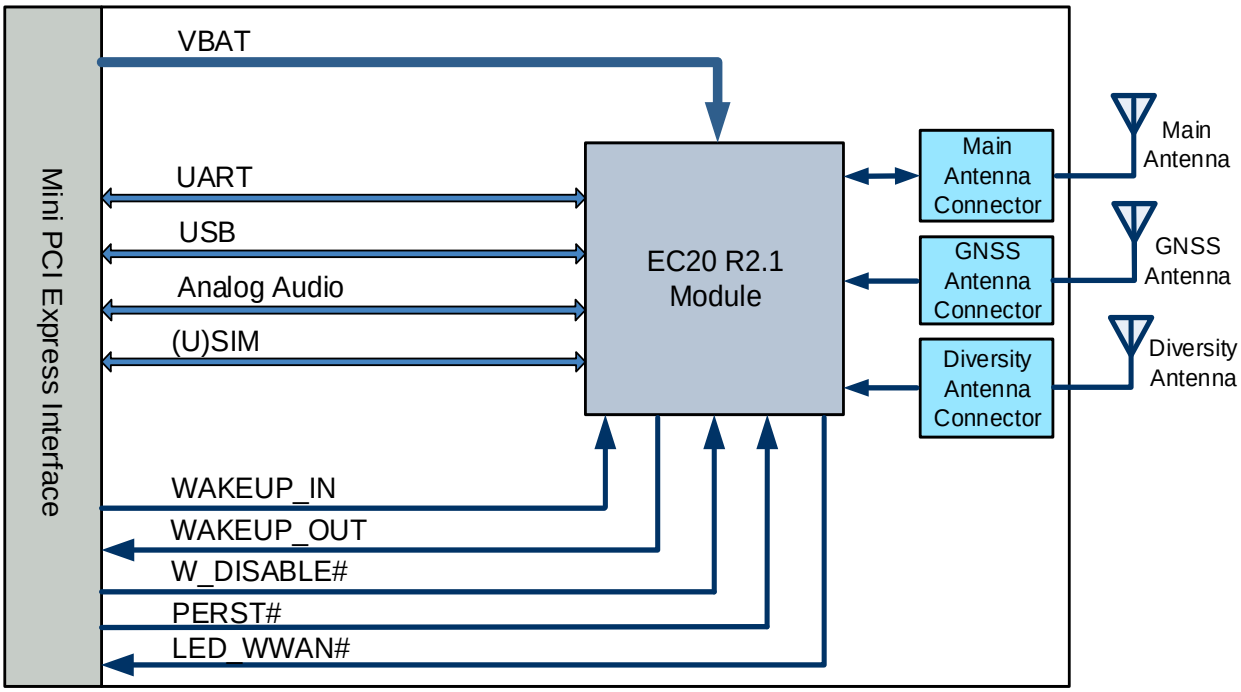


Figure 1: Functional Diagram

3 Application Interfaces

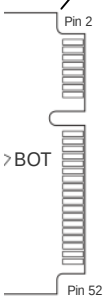
This chapter mainly describes the definition and application of the following interfaces for EC20 R2.1 Mini PCIe-C:

- Power supply
- UART interface
- USB interface
- (U)SIM interface
- Analog audio interfaces
- Control signals

3.1. Pin Assignment

The following figure shows the pin assignment of EC20 R2.1 Mini PCIe-C module. The top side contains EC20 R2.1-C module and antenna connectors.

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
PERST#	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	PERST#
24	VBAT
26	GND
28	UART_CTS
30	UART_DCD
32	WAKEUP_OUT
34	GND
36	USB_DM
38	USB_DP
40	GND
42	LED_WWAN#
44	USIM_PRESENCE
46	UART_DTR
48	NC
50	GND
52	VBAT

Figure 2: Pin Assignment

3.2. Pin Description

The following tables show the pin definition and description of EC20 R2.1 Mini PCIe-C on the 52-pin application.

Table 3: I/O Parameters Definition

Type	Description
AI	Analog input
AO	Analog output
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	EC20 R2.1 Mini PCIe-C Pin Name	I/O	Description	Comment
1	WAKE#	MIC_P [1)]	AI	Analog audio input (+)	If unused, keep it open.
2	3.3Vaux	VBAT	PI	3.3V~3.6V DC supply	
3	COEX1	MIC_N [1)]	AI	Analog audio input (-)	If unused, keep it open.
4	GND	GND		Mini card ground	
5	COEX2	SPK_P [1)]	AO	Analog audio output (+)	If unused, keep it open.
6	1.5V	NC			
7	CLKREQ#	SPK_N [1)]	AO	Analog audio output (-)	

8	UIM_PWR	USIM_VDD	PO	Power supply for the (U)SIM card	
9	GND	AGND		Analog audio ground	
10	UIM_DATA	USIM_DATA	IO	Data signal of (U)SIM card	
11	REFCLK-	VDD_EXT	PO	Provide 1.8V for external circuit	Iomax = 50mA
12	UIM_CLK	USIM_CLK	DO	Clock signal of (U)SIM card	
13	REFCLK+	RESERVED		Reserved	.
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	RESERVED		Reserved	
18	GND	GND		Mini card ground	
19	RESERVED	WAKEUP_IN	DI	Sleep mode control	Low level makes the module enter sleep mode.
20	W_DISABLE#	W_DISABLE#	DI	Airplane mode control	Active low.
21	GND	GND		Mini card ground	
22	PERST#	PERST#	DI	Reset the module	Active low.
23	PERn0	UART_RXD	DI	UART receive data	
24	3.3Vaux	VBAT	PI	3.3V~3.6V DC supply	
25	PERp0	UART_RTS	DO	UART request to send	
26	GND	GND		Mini card ground	
27	GND	GND		Mini card ground	
28	1.5V	UART_CTS	DI	UART clear to send	
29	GND	GND		Mini card ground	
30	SMB_CLK	UART_DCD	DO	UART data carrier detection	
31	PETn0	UART_TXD	DO	UART transmit data	

32	SMB_DATA	WAKEUP_OUT	DO	Module sleep indication	
33	PETp0	PERST#	DI	Reset the module	Active low.
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	VBAT	PI	3.3V~3.6V DC supply	
40	GND	GND		Mini card ground	
41	3.3Vaux	VBAT	PI	3.3V~3.6V 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	RESERVED		Reserved	
46	LED_WPAN#	UART_DTR	DI	Data terminal ready, sleep mode control	
47	RESERVED	RESERVED		Reserved	
48	1.5V	NC		Not connected	
49	RESERVED	RESERVED		Reserved	
50	GND	GND		Mini card ground	
51	RESERVED	RESERVED		Reserved	
52	3.3Vaux	VBAT	PI	3.3V~3.6V DC supply	

NOTES

1. [1)] Analog audio function is only supported on **Telematics** version.
2. All the digital interface power domain is 1.8V except for the (U)SIM interface. The (U)SIM interface voltage can support both 1.8V and 3.0V.
3. 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** 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** 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 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	3.3V~3.6V DC supply

GND	4, 9, 15, 18, 21, 26, 27, 29, 34, 35, 37, 40, 43, 50	Mini card ground

EC20 R2.1 Mini PCIe-C is powered by VBAT. In the 2G network, the input peak current may reach 2.0A during the transmitting time. Therefore, the power supply must be able to provide a rated output current of 2.0A 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.

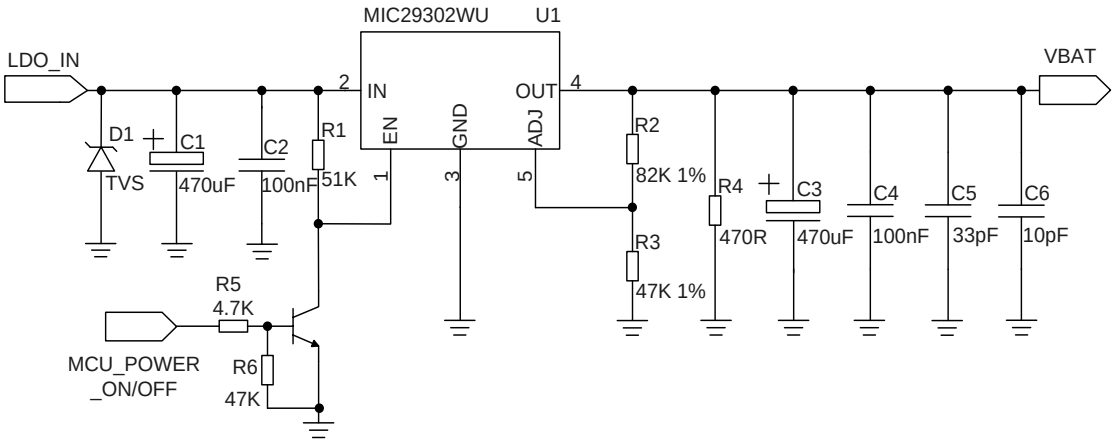


Figure 3: Reference Circuit of Power Supply

3.5. UART Interface

EC20 R2.1 Mini PCIe-C supports one UART with RTS/CTS hardware flow control function. The UART interface supports 9600bps, 19200bps, 38400bps, 57600bps, 115200bps and 230400bps baud rates. The default is 115200bps.

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	1.8V	UART receive data
UART_TXD	31	DO	1.8V	UART transmit data

UART_CTS	28	DI	1.8V	UART clear to send
UART_RTS	25	DO	1.8V	UART request to send
UART_DTR	46	DI	1.8V	Data terminal ready, sleep mode control
UART_DCD	30	DO	1.8V	UART data carrier detection

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

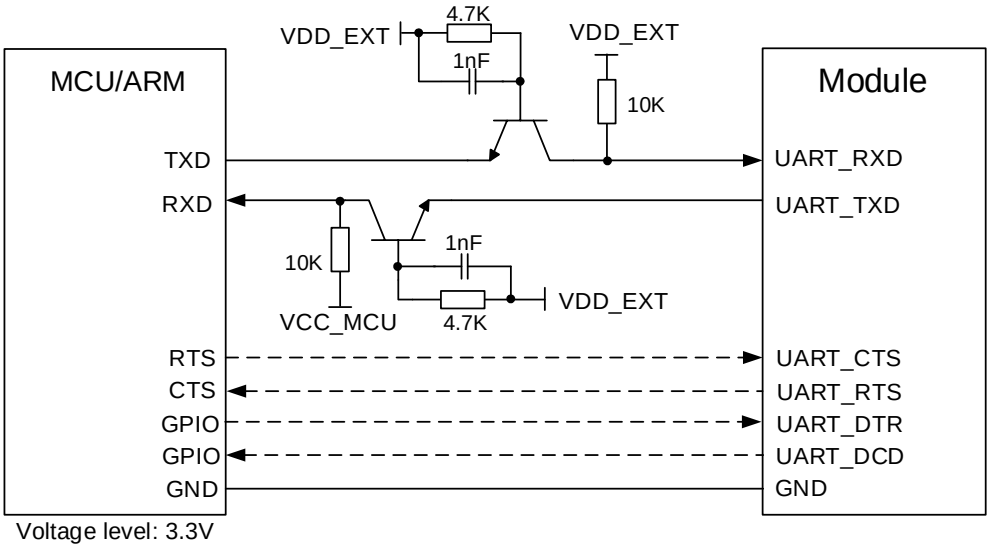


Figure 4: Reference Circuit of 3.3V Level-shift

NOTES

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, please refer to ***document [2]***.
2. The baud rate of the serial port can be changed via **AT+IPR**. For more related configuration information, please refer to ***document [2]***.

3.6. USB Interface

EC20 R2.1 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 (480Mbps) mode and full speed (12Mbps) mode. The USB interface is used for AT command communication, data transmission, GNSS NMEA output, 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	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.

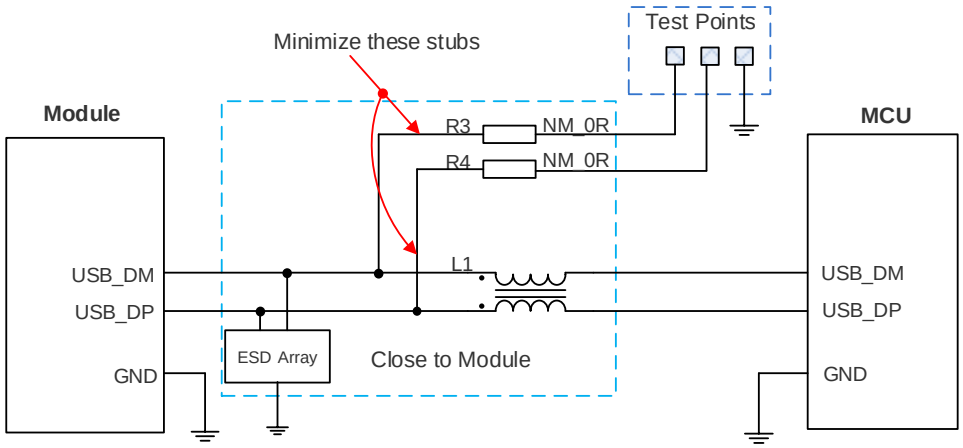


Figure 5: Reference Circuit of USB Interface

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.

3.7. (U)SIM Interface

EC20 R2.1 Mini PCIe-C'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

EC20 R2.1 Mini PCIe-C 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.

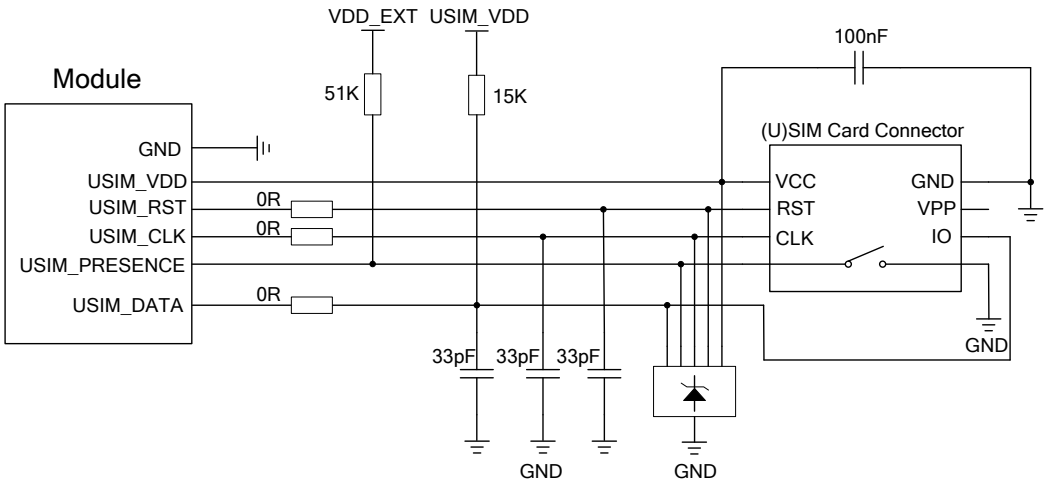


Figure 6: Reference Circuit with an 8-pin (U)SIM Card Connector

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.

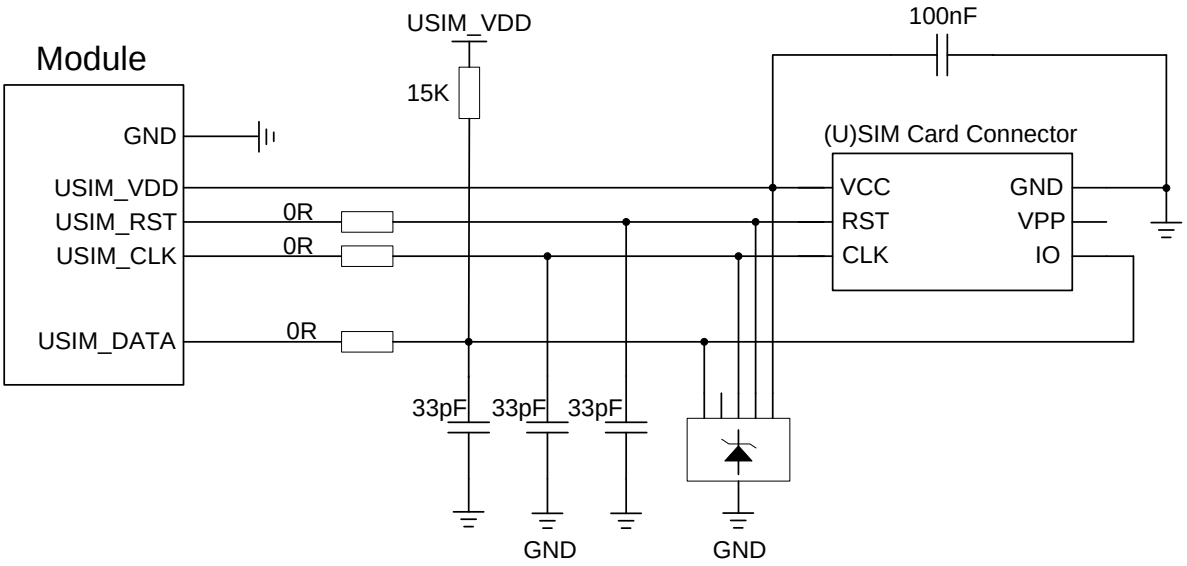


Figure 7: Reference Circuit with a 6-pin (U)SIM Card Connector

In order to enhance the reliability and availability of the (U)SIM card in 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 array with parasitic capacitance not exceeding 15pF.
- The 0Ω resistors should be added in series between the module and the (U)SIM card 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.

3.8. Analog Audio Interfaces

EC20 R2.1 Mini PCIe-C provides two analog audio input channels and two analog output channels. The following table shows the pin definition of analog audio interfaces.

Table 10: Pin Definition of Analog Audio Interface

Pin Name	Pin No.	I/O	Description	Comment
MIC_P	1	AI	Analog audio input (+)	If unused, keep it open.
MIC_N	3	AI	Analog audio input (-)	If unused, keep it open.
SPK_P	5	AO	Analog audio output (+)	If unused, keep it open.
SPK_N	7	AO	Analog audio input (-)	If unused, keep it open.

MIC_P and MIN_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. Please refer to ***document [2]*** or ***[5]*** for details.

NOTE

Analog audio function is only supported on **Telematics** version.

3.8.1. Audio Interfaces Design Considerations

It is recommended to use the electret microphone with dual built-in capacitors (e.g. 10pF and 33pF) for filtering out RF interference, thus reducing TDD noise. The 33pF capacitor is applied for filtering out RF interference when the module is transmitting at EGSM900. Without placing this capacitor, TDD noise could be heard. The 10pF capacitor here is used for filtering out RF interference at DCS1800. Please note that the resonant frequency point of a capacitor largely depends on the material and production technique. Therefore, customers would have to discuss with their capacitor vendors to choose the most suitable capacitor for filtering out high-frequency noises.

The severity degree of the RF interference in the voice channel during GSM transmitting largely depends on the application design. In some cases, EGSM900 TDD noise is more severe; while in other cases, DCS1800 TDD noise is more obvious. Therefore, a suitable capacitor can be selected based on the test results. Sometimes, even no RF filtering capacitor is required.

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/MIC_N channel provides electret microphone bias voltage in EC20 R2.1 Mini PCIe-C without additional bias circuit outside. The microphone channel reference circuit is shown in the following figure:

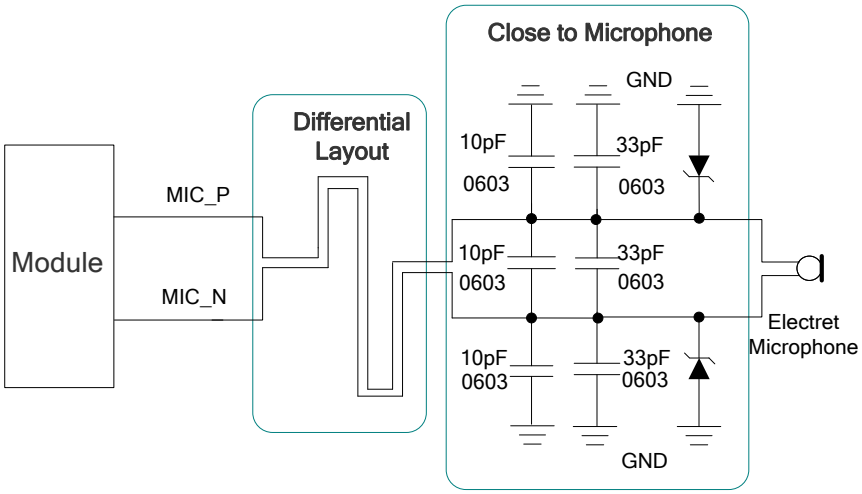


Figure 8: Reference Circuit of Microphone Interface

3.8.3. Receiver Interface Circuit

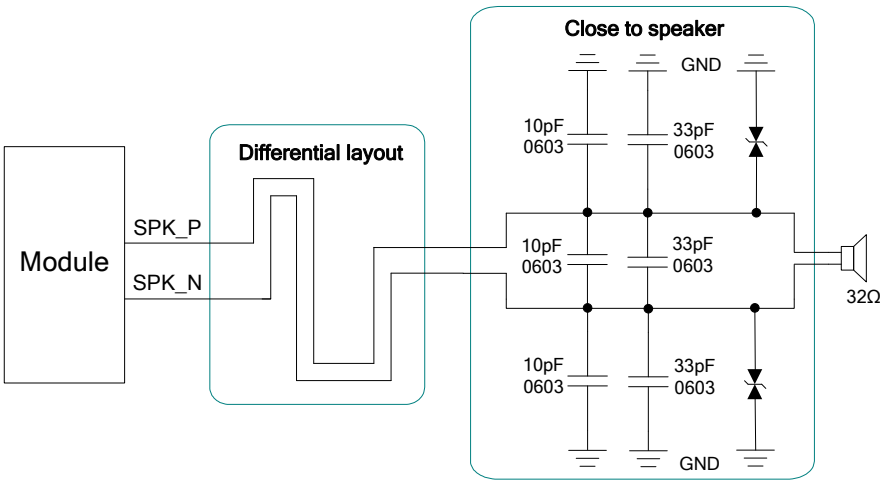


Figure 9: Reference Circuit of SPK Output

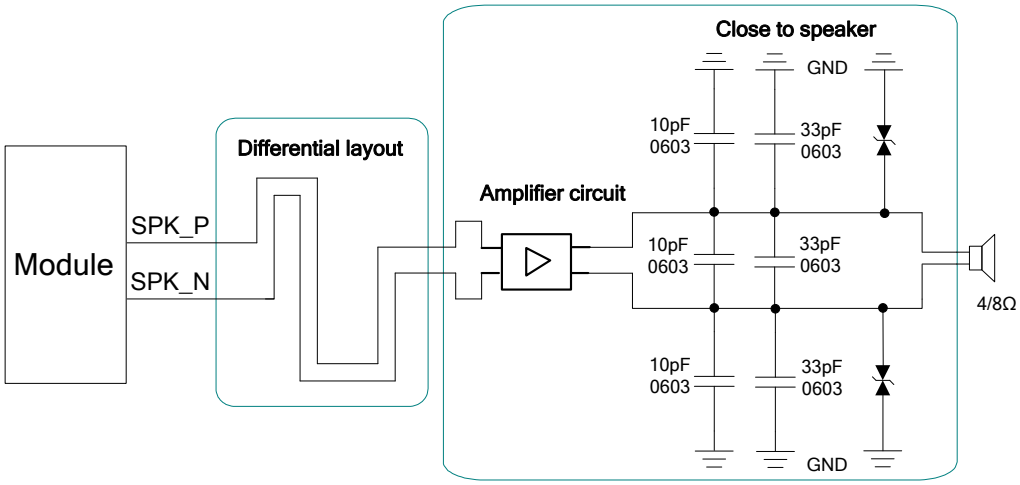


Figure 10: Reference Circuit of SPK Output with Audio Amplifier

3.9. 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
UART_DTR	46	DI	1.8V	Data terminal ready, sleep mode control
W_DISABLE#	20	DI	1.8V	Airplane mode control. Active low.
PERST#	22, 33	DI	1.8V	Reset the module. Active low.
LED_WWAN#	42	OC		LED signal for indicating the network status of the module.
WAKEUP_IN	19	DI	1.8V	Sleep mode control. Active low.
WAKEUP_OUT	32	DO	1.8V	Module sleep indication. Active low.

3.9.1. Sleep Mode Control and State Indication Signals

EC20 R2.1 Mini PCIe-C has two pins including UART_DTR and WAKEUP_IN for sleep mode control and one pin WAKEUP_OUT for sleep state indication. There are four preconditions when enabling EC20 R2.1 Mini PCIe-C to enter the sleep mode:

- Execute **AT+QSCLK=1** to enable the sleep mode. Please refer to ***document [2]*** 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 please guarantee the USB host is in suspend state.

3.9.1.1. UART_DTR Signal

UART_DTR can 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.

NOTE

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

3.9.1.2. WAKEUP_IN and WAKEUP_OUT Signals

EC20 R2.1 Mini PCIe-C module provides WAKEUP_IN for sleep mode control and WAKEUP_OUT for sleep state indication.

Table 12: Pin Definition of WAKEUP_IN and WAKEUP_OUT Signals

Pin Name	Description
WAKEUP_IN	High level: DTE wakes up the module Low level: DTE makes the module enter sleep mode
WAKEUP_OUT	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# Signal

EC20 R2.1 Mini PCIe-C 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 13: 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**, which has the same effect with W_DISABLE# signal function, the details is as follows.

Table 14: 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

3.9.3. 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 150ms~460 and then releasing it. The reset scenario is illustrated in the following figure.

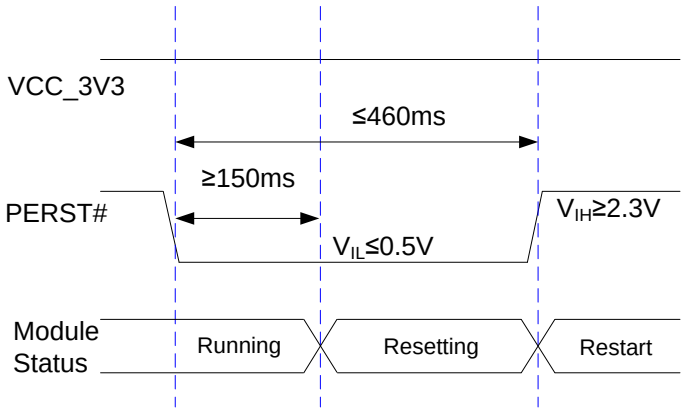


Figure 11: Timing of Resetting Module

3.9.4. LED_WWAN# Signal

The LED_WWAN# signal of EC20 R2.1 Mini PCIe-C 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.

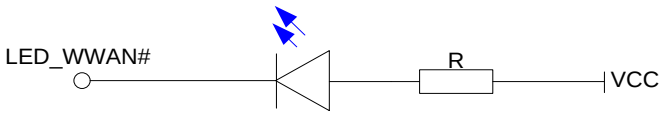


Figure 12: LED_WWAN# Signal Reference Circuit Diagram

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 15: 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 16: 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**

4 GNSS Receiver

4.1. General Description

EC20 R2.1 Mini PCIe-C includes a fully integrated global navigation satellite system solution that supports Qualcomm Gen8C Lite (GPS, GLONASS, BeiDou/Compass, Galileo and QZSS). Additionally, it supports standard NMEA-0183 protocol, and outputs NMEA messages at 1Hz data update rate via USB interface by default.

By default, EC20 R2.1 Mini PCIe-C GNSS engine is switched off. It has to be switched on via AT command. For more details about GNSS engine technology and configurations, please refer to ***document [3]***.

4.2. GNSS Performance

Table 17: GNSS Performance

Parameter	Description	Conditions	Typ.	Unit
Sensitivity (GNSS)	Cold start	Autonomous	-146	dBm
	Reacquisition	Autonomous	-157	dBm
	Tracking	Autonomous	-157	dBm
TTFF (GNSS)	Cold start @open sky	Autonomous	35	s
		XTRA enabled	18	s
	Warm start @open sky	Autonomous	26	s
		XTRA enabled	2.2	s
	Hot start @open sky	Autonomous	2.5	s
		XTRA enabled	1.8	s

Accuracy (GNSS)	CEP-50	Autonomous @open sky	<2.5	m

NOTES

1. Tracking sensitivity: the minimum GNSS signal power at which the module can maintain lock (keep positioning for at least 3 minutes continuously).
2. Reacquisition sensitivity: the minimum GNSS signal power required for the module to maintain lock within 3 minutes after loss of lock.
3. Cold start sensitivity: the minimum GNSS signal power at which the module can fix position successfully within 3 minutes after executing cold start command.

4.3. GNSS Frequency

Table 18: GNSS Frequency

Type	Frequency	Unit
GPS	1575.42±1.023	MHz
GLONASS	1597.5~1605.8	MHz
Galileo	1575.42±2.046	MHz
BeiDou/Compass	1561.098±2.046	MHz
QZSS	1575.42	MHz

5 Antenna Connection

5.1. Antenna Connectors

EC20 R2.1 Mini PCIe-C antenna interfaces include a main antenna interface, an Rx-diversity antenna interface and a GNSS antenna interface. And Rx-diversity function is enabled by default. The impedance of the antenna connectors is 50Ω.

5.1.1. Operating Frequency

Table 19: 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
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	2555~2655	2555~2655	MHz

5.2. Antenna Requirements

The following table shows the requirements on main antenna, Rx-diversity antenna and GNSS antenna.

Table 20: Antenna Requirements

Type	Requirements
GNSS	Frequency range: 1559MHz~1609MHz Polarization: RHCP or linear VSWR: < 2 (Typ.) Passive antenna gain: > 0dBi Active antenna noise figure: < 1.5dB Active antenna gain: > 0dBi Active antenna embedded LNA gain: < 17dB
GSM/WCDMA/TD-SCDMA/ EVDO/CDMA/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, TD-SCDMAB34/B39, LTE B1/B3/B34/B39) Cable insertion loss: < 2dB (LTE-TDD B38/B40/B41)

NOTE

Since the GNSS port has a 2.85V voltage output, a passive antenna that causes shorting to GND, such as PIFA antenna is not recommended.

5.3. Recommended Mating Plugs for Antenna Connection

EC20 R2.1 Mini PCIe-C is mounted with RF connectors (receptacles) for convenient antenna connection. The dimensions of the antenna connectors are shown as below.

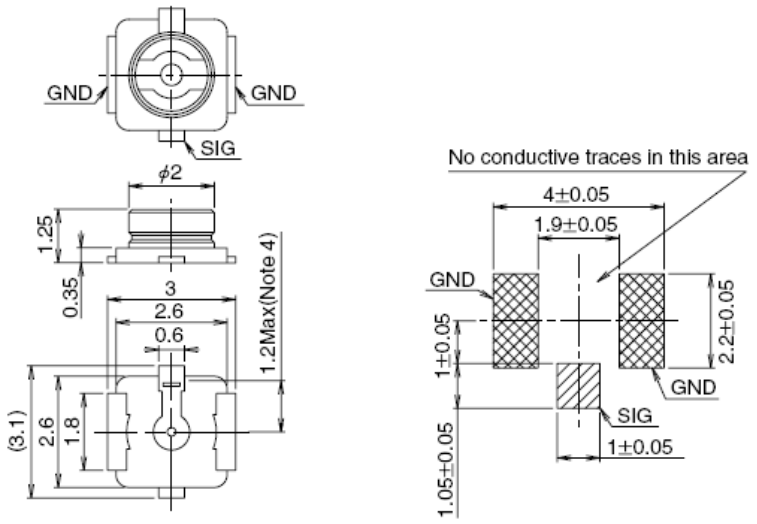


Figure 13: Dimensions of the Receptacle RF Connectors (Unit: mm)

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

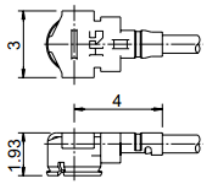
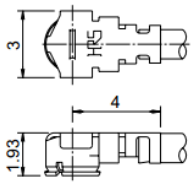
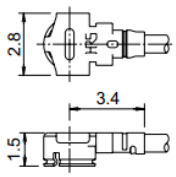
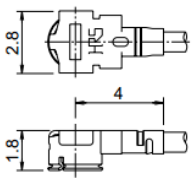
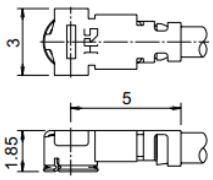
Part No.	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
					
Mated Height	2.5mm Max. (2.4mm Nom.)	2.5mm Max. (2.4mm Nom.)	2.0mm Max. (1.9mm Nom.)	2.4mm Max. (2.3mm Nom.)	2.4mm Max. (2.3mm Nom.)
Applicable cable	Dia. 0.81mm Coaxial cable	Dia. 1.13mm and Dia. 1.32mm Coaxial cable	Dia.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

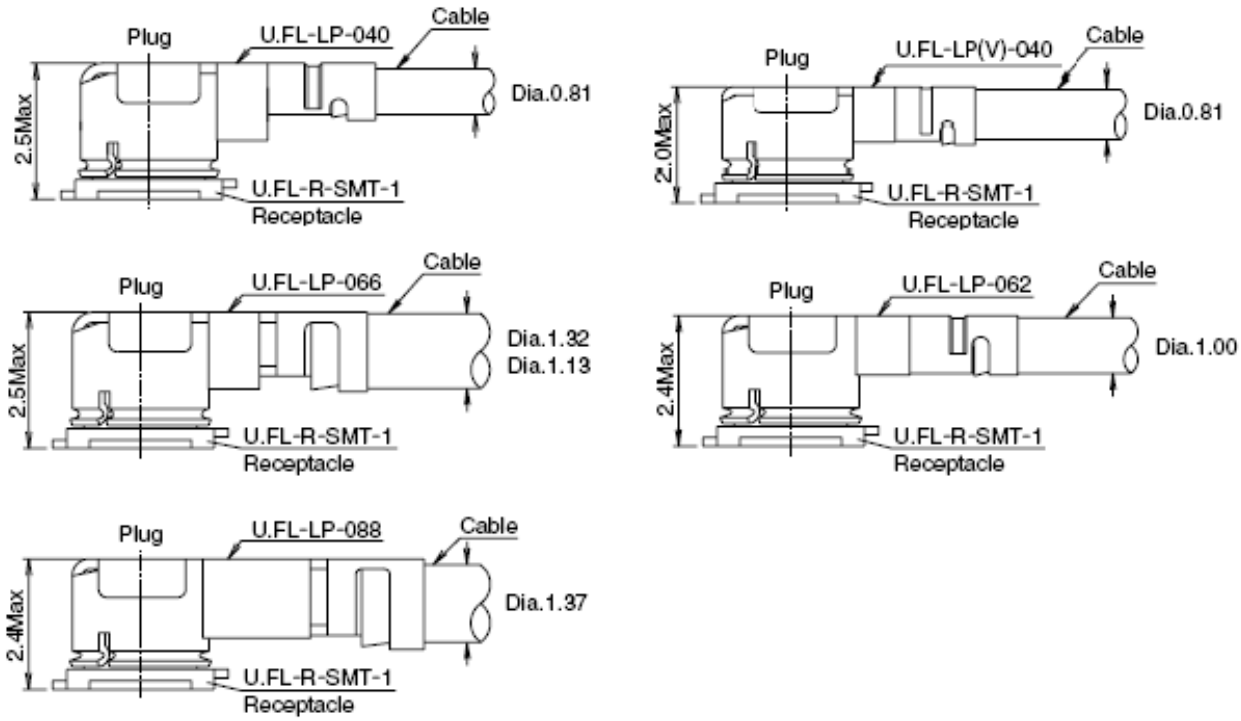


Figure 15: Space Factor of Mating Plugs (Unit: mm)

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

6 Electrical, Reliability and Radio Characteristics

6.1. General Description

This chapter mainly describes the following electrical and radio characteristics of EC20 R2.1 Mini PCIe-C:

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

6.2. Power Supply Requirements

The input voltage of EC20 R2.1 Mini PCIe-C is 3.3V~3.6V, and should satisfy at least 2.0A supply capacity. The following table shows the power supply requirements of EC20 R2.1 Mini PCIe-C.

Table 21: Power Supply Requirements

Parameter	Description	Min.	Max.	Unit
VBAT	Power Supply	3.3	3.6	V

6.3. I/O Requirements

The following table shows the I/O requirements of EC20 R2.1 Mini PCIe-C.

Table 22: I/O Requirements

Parameter	Description	Min.	Max.	Unit
V_{IH}	Input High Voltage	0.7 × VDDIO [1)]	VDDIO [1)] + 0.3	V
V_{IL}	Input Low Voltage	-0.3	0.3 x VDDIO [1)]	V
V_{OH}	Output High Voltage	VDDIO [1)] - 0.5	VDDIO [1)]	V
V_{OL}	Output Low Voltage	0	0.4	V

NOTES

1. The maximum voltage value of V_{IL} for PERST# signal and W_DISABLE# signal is 0.5V.
2. [1)] VDDIO is the IO voltage of chipset and equals to 1.8V.

6.4. RF Characteristics

The following tables show the conducted RF output power and receiving sensitivity of EC20 R2.1 Mini PCIe-C module.

Table 23: EC20 R2.1 Mini PCIe-C 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

EVDO/CDMA BC0	24dBm+2/-1dB	< -49dBm
LTE-FDD B1/B3/B5/B8	23dBm±2dB	< -39dBm
LTE-TDD B34/B38/B39/B40/B41	23dBm±2dB	< -39dBm

Table 24: EC20 R2.1 Mini PCIe-C Conducted RF Receiving Sensitivity

Frequency	Primary	Diversity	SIMO	3GPP (SIMO)
EGSM900	-109dBm	NA	NA	-102dBm
DCS1800	-109dBm	NA	NA	-102dBm
EVDO/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
LTE-FDD B1 (10MHz)	-99dBm	-99.3dBm	-101.6dBm	-96.3dBm
LTE-FDD B3 (10MHz)	-98dBm	-98.9dBm	-101.9dBm	-93.3dBm
LTE-FDD B5 (10MHz)	-98dBm	-99.8dBm	-102dBm	-94.3dBm
LTE-FDD B8 (10MHz)	-99dBm	-99.6dBm	-102.1dBm	-93.3dBm
LTE-TDD B34 (10MHz)	-98dBm	-99dBm	-101dBm	-96.3dBm
LTE-TDD B38 (10MHz)	-99dBm	-98.5dBm	-101.3dBm	-96.3dBm
LTE-TDD B39 (10MHz)	-98dBm	-99.5dBm	-101.2dBm	-96.3dBm
LTE-TDD B40 (10MHz)	-99dBm	-99.0dBm	-101.4dBm	-96.3dBm
LTE-TDD B41 (10MHz)	-98dBm	-98.1dBm	-101.4dBm	-94.3dBm

6.5. ESD Characteristics

The following table shows the ESD characteristics of EC20 R2.1 Mini PCIe-C.

Table 25: ESD Characteristics of EC20 R2.1 Mini PCIe-C

Tested Interfaces	Contact Discharge	Air Discharge	Unit
Power Supply and GND	+/-5	+/-10	kV
Antenna Interface	+/-4	+/-8	kV
USB Interface	+/-4	+/-8	kV
(U)SIM Interface	+/-4	+/-8	kV
Others	+/-0.5	+/-1	kV

6.6. Current Consumption

Table 26: Current Consumption of EC20 R2.1 Mini PCIe-C

Parameter	Description	Conditions	Typ.	Unit
I_{VBAT}	Sleep state	**AT+CFUN=0** (USB disconnected)	2.81	mA
		EGSM @DRX=2 (USB disconnected)	4.09	mA
		EGSM @DRX=5 (USB disconnected)	3.49	mA
		EGSM @DRX=5 (USB suspend)	3.68	mA
		EGSM @DRX=9 (USB disconnected)	3.35	mA
		DCS @DRX=2 (USB disconnected)	4.11	mA
		DCS @DRX=5 (USB disconnected)	3.54	mA
		DCS @DRX=5 (USB suspend)	3.69	mA
		DCS @DRX=9 (USB disconnected)	3.44	mA
		TD-SCDMA Band A @PF=64 (USB disconnected)	3.52	mA

		TD-SCDMA Band A @PF=128 (USB disconnected)	3.21	mA
		TD-SCDMA Band A @PF=256 (USB disconnected)	3.01	mA
		TD-SCDMA Band A @PF=512 (USB disconnected)	2.92	mA
		BC0 @SCI=1 (USB disconnected)	5.12	mA
		BC0 @SCI=1 (USB suspend)	5.11	mA
		WCDMA @PF=64 (USB suspend)	3.90	mA
		WCDMA @PF=128 (USB disconnected)	3.35	mA
		WCDMA @PF=256 (USB disconnected)	3.15	mA
		WCDMA @ PF=512 (USB disconnected)	3.10	mA
		LTE-FDD @PF=32 (USB disconnected)	5.21	mA
		LTE-FDD @PF=64 (USB disconnected)	4.19	mA
		LTE-FDD @PF=64 (USB suspend)	4.38	mA
		LTE-FDD @PF=128 (USB disconnected)	3.70	mA
		LTE-FDD @PF=256 (USB disconnected)	3.30	mA
		LTE-TDD @PF=32 (USB disconnected)	5.56	mA
		LTE-TDD @PF=64 (USB disconnected)	4.24	mA
		LTE-TDD @PF=64 (USB suspend)	4.48	mA
		LTE-TDD @PF=128 (USB disconnected)	3.67	mA
		LTE-TDD @PF=256 (USB disconnected)	3.22	mA
	Idle state	EGSM DRX=5 (USB disconnected)	21.07	mA
		EGSM DRX=5 (USB connected)	32.05	mA
		BC0 @SCI=1 (USB disconnected)	23.87	mA
		BC0 @SCI=1 (USB connected)	36.44	mA

		TD-SCDMA Band A @PF=64 (USB disconnected)	20.95	mA
		TD-SCDMA Band A @PF=64 (USB connected)	32.08	mA
		WCDMA @PF=64 (USB disconnected)	21.03	mA
		WCDMA @PF=64 (USB connected)	33.11	mA
		LTE-FDD @PF=64 (USB disconnected)	21.7	mA
		LTE-FDD @PF=64 (USB connected)	32.95	mA
		LTE-TDD @ PF=64 (USB disconnected)	21.96	mA
		LTE-TDD @ PF=64 (USB connected)	33.24	mA
	GPRS data transfer (GNSS OFF)	GSM900 4DL/1UL @32.71dBm	259.7	mA
		GSM900 3DL/2UL @32.50dBm	436.0	mA
		GSM900 2DL/3UL @30.83dBm	535.8	mA
		GSM900 1DL/4UL @29.68dBm	625.4	mA
		DCS1800 4DL/1UL @29.60dBm	191.3	mA
		DCS1800 3DL/2UL @29.48dBm	320.3	mA
		DCS1800 2DL/3UL @29.81dBm	442.3	mA
		DCS1800 1DL/4UL @29.73dBm	563.8	mA
	EDGE data transfer (GNSS OFF)	GSM900 4DL/1UL @27.50dBm	170.8	mA
		GSM900 3DL/2UL @27.50dBm	277.4	mA
		GSM900 2DL/3UL @27.60dBm	380.1	mA
		GSM900 1DL/4UL @27.42dBm	485.4	mA
		DCS1800 4DL/1UL @26.20dBm	149.6	mA
		DCS1800 3DL/2UL @26.10dBm	240.7	mA
		DCS1800 2DL/3UL @27.67dBm	341.5	mA
		DCS1800 1DL/4UL @27.55dBm	438.6	mA
	CDMA/TD-SCDMA	BC0 @23.55dBm	648.8	mA

	data transfer (GNSS OFF)	TD-SCDMA Band A @23.18dBm	140.6	mA
		TD-SCDMA Band F @23.42dBm	144.4	mA
	WCDMA data transfer (GNSS OFF)	WCDMA B1 HSDPA @22.03dBm	637.5	mA
		WCDMA B1 HSUPA @22.02dBm	636.1	mA
		WCDMA B8 HSDPA @21.68dBm	540.2	mA
		WCDMA B8 HSUPA @21.75dBm	537.8	mA
	LTE data transfer (GNSS OFF)	LTE-FDD B1 @23.08dBm	892.9	mA
		LTE-FDD B3 @22.6dBm	822.0	mA
		LTE-FDD B5 @22.67dBm	782.0	mA
		LTE-FDD B8 @22.81dBm	756.7	mA
		LTE-TDD B34 @23.86dBm	387.6	
		LTE-TDD B38 @23.28dBm	490.7	mA
		LTE-TDD B39 @23.8dBm	387.6	mA
		LTE-TDD B40 @23.1dBm	415.6	mA
		LTE-TDD B41 @23.47dBm	500.4	mA
	GSM voice call	GSM900PCL=5 @32.47dBm	260.6	mA
		GSM900PCL=12 @19.40dBm	124.4	mA
		GSM900PCL=19 @5.58dBm	93.7	mA
		DCS1800 PCL=0 @29.49dBm	184.9	mA
		DCS1800 PCL=7 @16.47dBm	133.2	mA
		DCS1800 PCL=15 @0.24dBm	114.7	mA
	CDMA voice call	BC0 @23.87dBm	751.8	mA
		BC0 @-60.67dBm	177.9	mA
	WCDMA voice call	WCDMA B1 @23.05dBm	728.3	mA
		WCDMA B8 @23.1dBm	616.9	mA

Table 27: GNSS Current Consumption of EC20 R2.1 Mini PCIe-C

Parameter	Description	Conditions	Typ.	Unit
I_{VBAT} (GNSS)	Searching (**AT+CFUN=0**)	Cold start @Passive Antenna	63.1	mA
		Lost state @Passive Antenna	62.5	mA
	Tracking (**AT+CFUN=0**)	Instrument Environment	33.7	mA
		Open Sky @Passive Antenna	37.6	mA
		Open Sky @Active Antenna	37.5	mA

6.7. Thermal Consideration

In order to achieve better performance of the module, it is recommended to comply with the following principles for thermal consideration:

- On customers' PCB design, please keep placement of the PCI Express Mini Card away from heating sources.
- Do not place components on the PCB area where the module is mounted, in order to facilitate adding of heatsink.
- Do not apply solder mask on the PCB area where the module is mounted, so as to ensure better heat dissipation performance.
- The reference ground of the area where the module is mounted should be complete, and add ground vias as many as possible for better heat dissipation.
- Add a heatsink on the top of the module and the heatsink should be designed with as many fins as possible to increase heat dissipation area. Meanwhile, a thermal pad with high thermal conductivity should be used between the heatsink and module.
- Add a thermal pad with appropriate thickness at the bottom of the module to conduct the heat to PCB.

The following figure shows the referenced heatsink design.

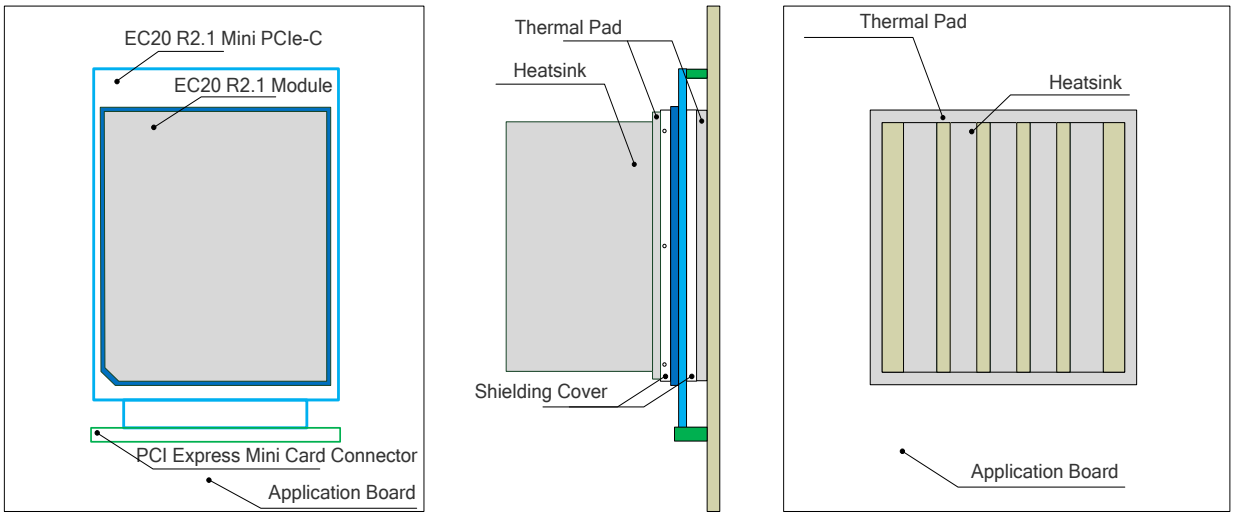


Figure 16: Referenced Heatsink Design

NOTES

1. The module offers the best performance when the internal BB chip stays below 105°C. When the maximum temperature of the BB chip reaches or exceeds 105°C, the module works normal but provides reduced performance (such as RF output power, data rate, etc.). When the maximum BB chip temperature reaches or exceeds 115°C, the module will disconnect from the network, and it will recover to network connected state after the maximum temperature falls below 115°C. Therefore, the thermal design should be maximally optimized to make sure the maximum BB chip temperature always maintains below 105°C. Customers can execute **AT+QTEMP** command and get the maximum BB chip temperature from the first returned value.
2. For more detailed guidelines on thermal design, please refer to ***document [4]***.

7 Dimensions and Packaging

7.1. General Description

This chapter mainly describes mechanical dimensions as well as packaging specification of EC20 R2.1 Mini PCIe-C module. All dimensions are measured in millimeter (mm), and the dimensional tolerances are ±0.05mm unless otherwise specified.

7.2. Mechanical Dimensions of EC20 R2.1 Mini PCIe-C

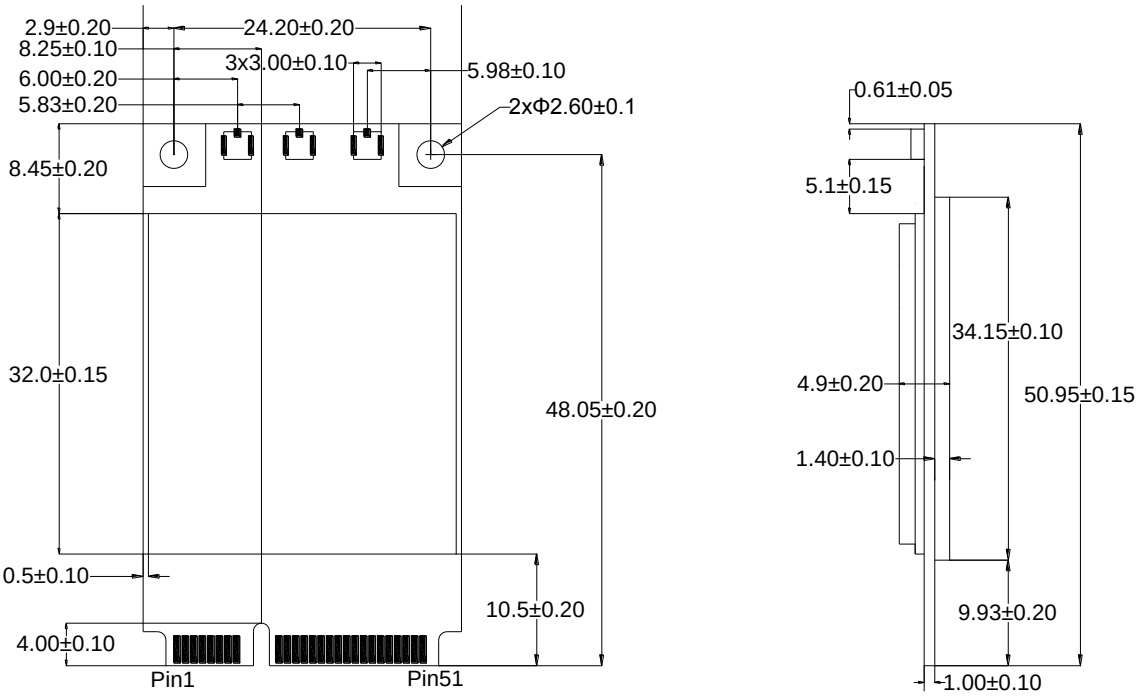


Figure 17: Mechanical Dimensions of EC20 R2.1 Mini PCIe-C

7.3. 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.

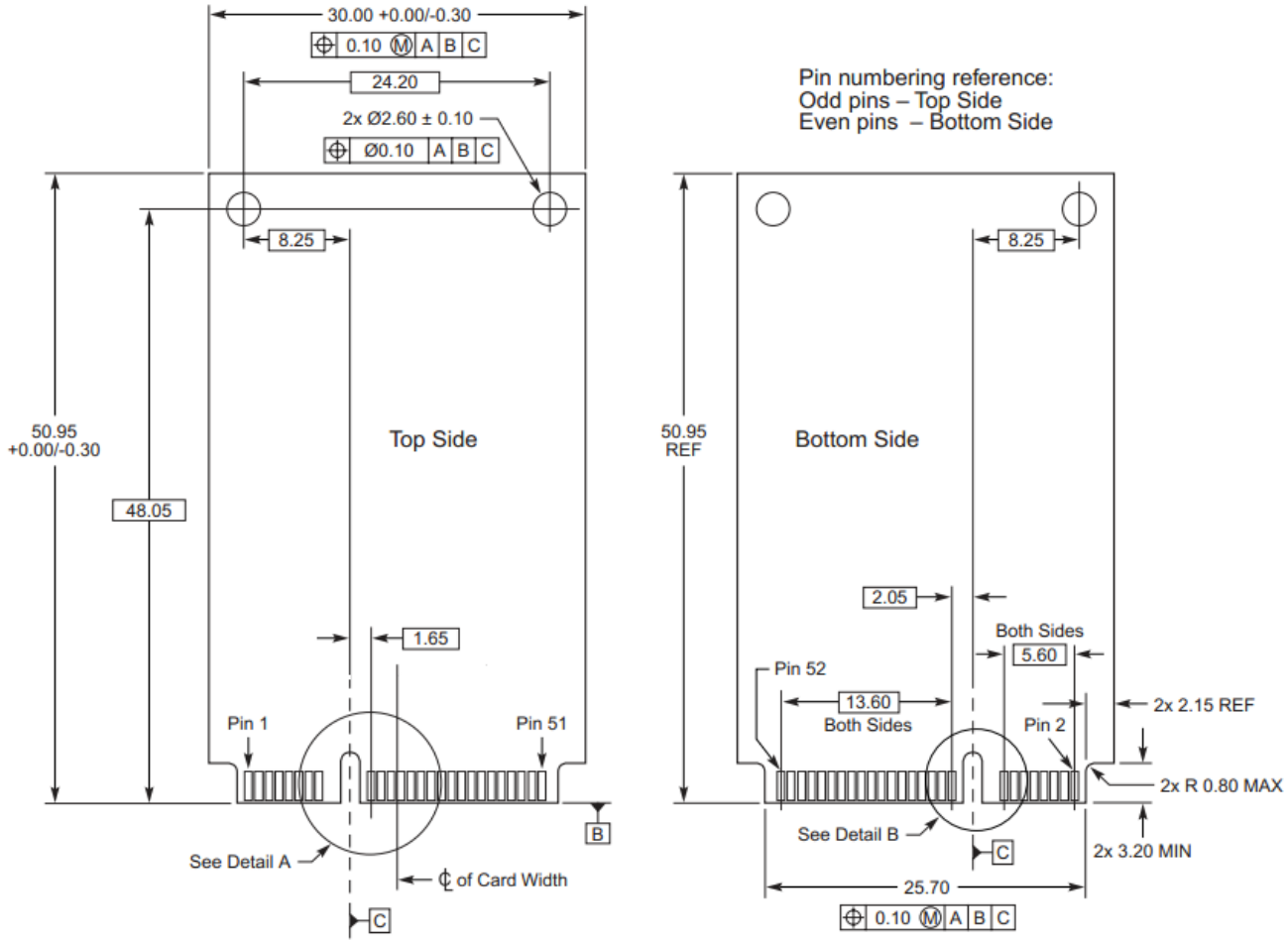


Figure 18: Standard Dimensions of Mini PCI Express

EC20 R2.1 Mini PCIe-C adopts a standard Mini PCI Express connector which compiles with the directives and standards listed in the ***document [1]***. The following figure takes the Molex 679100002 as an example.

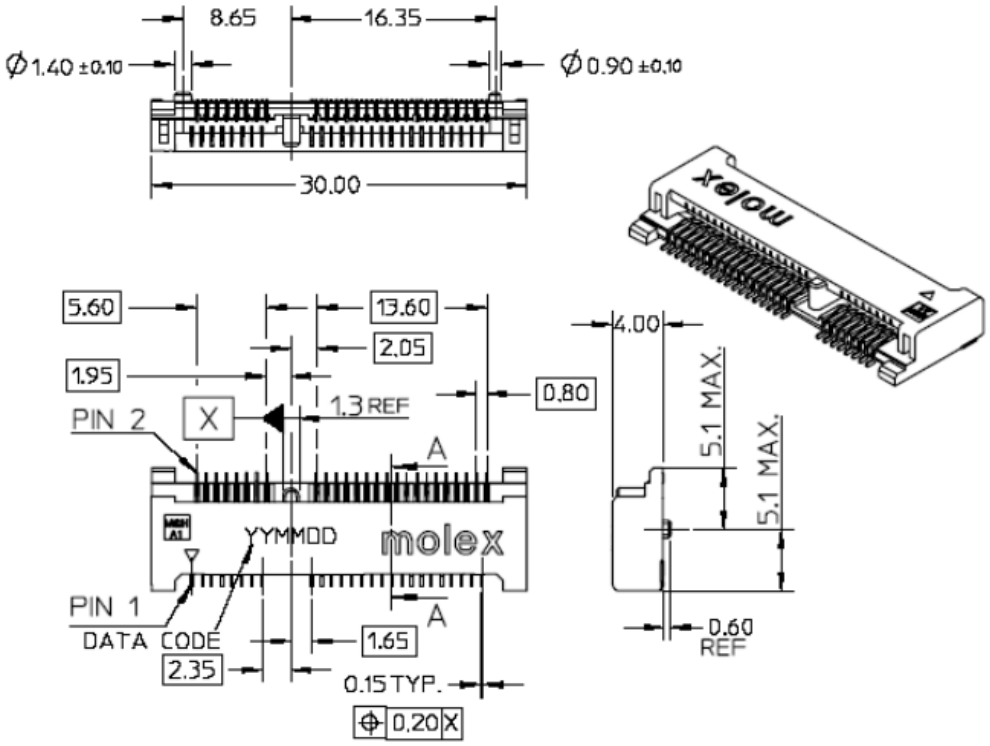


Figure 19: Dimensions of the Mini PCI Express Connector (Molex 679100002)

7.4. Packaging Specifications

EC20 R2.1 Mini PCIe-C modules are packaged in a tray. Each tray contains 10 modules. The smallest package of EC20 R2.1 Mini PCIe-C contains 100 modules.

8 Appendix A References

Table 28: Related Documents

SN	Document Name	Remark
[1]	PCI Express Mini Card Electromechanical Specification Revision 1.2	PCI Express Mini Card Electromechanical Specification
[2]	Quectel_EC20_R2.1_AT_Commands_Manual	EC20 R2.1 AT commands manual
[3]	Quectel_LTE_Standard_GNSS_AT_Commands_Manual	GNSS AT commands manual for LTE Standard modules
[4]	Quectel_LTE_Module_Thermal_Design_Guide	Thermal design guide for LTE standard, LTE-A and Automotive modules
[5]	Quectel_WCDMA&LTE_Audio_Design_Note	Audio design note for UMTS/HSPA(+) and LTE Standard modules

Table 29: Terms and Abbreviations

Abbreviation	Description
8-PSK	8-Phase Shift Keying
bps	Bits Per Second
CS	Coding Scheme
CTS	Clear To Send
DCE	Data Communications Equipment
DL	Downlink
DTE	Data Terminal Equipment
DTR	Data Terminal Ready
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge

ESR	Equivalent Series Resistance
FDD	Frequency Division Duplexing
GLONASS	GLObalnayaNAvigatsionnayaSputnikovaya 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
HSDPA	High Speed Down Link Packet Access
HSPA	High Speed Packet Access
HTTP	Hyper Text Transfer Protocol
HTTPS	Hyper Text Transfer Protocol over Secure Socket Layer
I/O	Input/Output
kbps	Kilobit Per Second
LED	Light Emitting Diode
LTE	Long Term Evolution
Mbps	Million Bits Per Second
MCS	Modulation and Coding Scheme
ME	Mobile Equipment
MMS	Multimedia Messaging Service
MO	Mobile Originated
MS	Mobile Station (GSM engine)
MT	Mobile Terminated
PAP	Password Authentication Protocol
PCB	Printed Circuit Board
PDU	Protocol Data Unit

PPP	Point-to-Point Protocol
RF	Radio Frequency
RX	Receive Direction
SMS	Short Message Service
TDD	Time Division Duplexing
TD-SCDMA	Time Division-Synchronous Code Division Multiple Access
TE	Terminal Equipment
TTFF	Time to First Fix
TX	Transmitting Direction
UART	Universal Asynchronous Receiver & Transmitter
UL	Uplink
UMTS	Universal Mobile Telecommunications System
URC	Unsolicited Result Code
(U)SIM	(Universal) Subscriber Identity Module
USSD	Unstructured Supplementary Service Data
WCDMA	Wideband Code Division Multiple Access