



Re-imagining Cellular IoT Solutions

Cavli C16QS Mini PCIe Card LTE CAT 1.bis

Hardware Manual
External Release Version 1.6

Connect to our website and feel free to contact our technical support team for any assistance.

Cavli Inc

99 South Almaden Blvd., Suite 600, San Jose, CA 95113

Web: www.cavliwireless.com

IoT Connectivity Platform: www.cavlihubble.io

Support Center

<https://www.cavliwireless.com/support-center.html>

e-Mail: support@cavliwireless.com

For sales enquiries

<https://www.cavliwireless.com/contact-us.html>

e-Mail: sales@cavliwireless.com

More IoT Modules

<https://www.cavliwireless.com/iot-modules/cellular-modules.html>

COPYRIGHT

THE INFORMATION CONTAINED HERE IS PROPRIETARY TECHNICAL INFORMATION OF CAVLI WIRELESS INC. TRANSMITTING, REPRODUCTION, DISSEMINATION AND EDITING OF THIS DOCUMENT AS WELL AS UTILIZATION OF THE CONTENT ARE FORBIDDEN WITHOUT PERMISSION. OFFENDERS WILL BE HELD LIABLE FOR PAYMENT OF DAMAGES. ALL RIGHTS ARE RESERVED IN THE EVENT OF A PATENT GRANT OR REGISTRATION OF A UTILITY MODEL OR DESIGN. EVERY EFFORT HAS BEEN MADE IN PREPARATION OF THIS DOCUMENT TO ENSURE ACCURACY OF THE CONTENTS. BUT ALL STATEMENTS, INFORMATION, AND RECOMMENDATIONS IN THIS DOCUMENT DO NOT CONSTITUTE A WARRANTY OF ANY KIND, EXPRESS OR IMPLIED. THE INFORMATION IN THIS DOCUMENT IS SUBJECT TO CHANGE WITHOUT NOTICE DUE TO PRODUCT VERSION UPDATE OR OTHER REASONS. FOR MOST RECENT DOCUMENTS, ALWAYS REFER THE PRODUCT PORTFOLIO SECTION AT WWW.CAVLIWIRELESS.COM.

Copyright © Cavli Inc. All rights reserved



VERSION HISTORY

Version	Edit	Date (DD/MM/YYYY)
1.0	<ul style="list-style-type: none"> Initial Version 	06/12/2022
1.1	<ul style="list-style-type: none"> Updated contents based on latest schematic Updated ordering information 	28/07/2023
1.2	<ul style="list-style-type: none"> Updated dimensions of Mini PCIe 	22/08/2023
1.3	<ul style="list-style-type: none"> Updated entire document as per the new updated design. 	18/12/2023
1.4	<ul style="list-style-type: none"> Updated the Block Diagram Updated the USB and USIM reference circuit Diagram 	09/01/2024
1.5	<ul style="list-style-type: none"> Updated the entire Interface list as per the new Design Updated the GNSS Constellation data 	17/01/1024
1.6	<ul style="list-style-type: none"> Updated the ordering information Updated the temperature information Updated the pin interfacing list 	21/02/2024



Table of Contents

1 Introduction	7
2 Module Overview	8
2.1 Module introduction	8
2.2 Module characteristics	9
2.3 Functional Block Diagram	10
3 Interface Application description.....	11
3.1 Chapter overview.....	11
4 mPCIe Interface Application Description	12
4.1 C16QS Mini PCIe Card Pin Layout.....	12
4.2 C16QS Pin Interface Definition	13
4.2.1 Absolute maximum ratings.....	13
4.2.2 Operating Conditions	14
4.2.3 C16QS Pin Interface Listing.....	14
4.4 Power Supply	17
4.5 USIM Card interface	17
4.6 USB interface	19
4.7 UART Interface	20
4.8 I2C interface	21
4.9 Control and indicator signals	21
4.9.1 RI Signal.....	22
4.9.2 W_DISABLE# Signal	22
4.9.3 PERST# Signal	22
4.9.4 LED_WWAN# Signal	22
5 80 Pin Connector*	24



5.1 UART Interface	27
5.2 Control and indicator signals	27
5.2.1 STATUS.....	27
5.2.2 NETLIGHT	27
5.3 SPI Interface	28
6 Antenna Interface.....	29
6.1 Antenna interface.....	29
7 Overall technical indicators	30
7.1 Chapter overview	30
7.2 Power Supply Requirements	30
7.3 IO Requirements.....	30
7.4 ESD Characteristics	31
7.5 GNSS reception performance	31
7.6 Antenna Requirements.....	32
8 Dimensions and Packaging	38
8.1 Mechanical Dimensions of C16QS Mini PCIe.....	38
9 Ordering Information.....	40
10 Appendix.....	41
10.1 Chapter overview.....	41
10.2 Abbreviations	41
10.3 Safety and precautions.....	43



Table of Figures

Table 1 Key Features	9
Table 2 Pin Description	13
Table 3 Absolute Maximum ratings	13
Table 4 Operating Condition	14
Table 5 Pin name	14
Table 6 VCC and GND Pin Definition	17
Table 7 USIM Pin Definition	17
Table 8 USB Pin Definition	19
Table 9 Pin Definition of the UART Interface	20
Table 10 I2C Pin Definition	21
Table 11 Control Signal Pin Definition	21
Table 12 Radio Operational States	22
Table 13 Pin description	24
Table 14 Pin Definition of the UART Interface in the 80-pin connector	27
Table 15 Control signal pin definition of 80-pin connector	27
Table 16 SPI interface pin definition in the 80-pin connector	28
Table 17 Antenna Definition	29
Table 18 Power Supply Requirements	30
Table 19 IO Requirements	30
Table 20 ESD Characteristics	31
Table 21 GNSS performance parameters	31
Table 22 Antenna indicator requirements	32
Table 23 Abbreviations	41



1 Introduction

This document is the **Hardware Manual** of the Cavli Wireless solution product C16QS Mini PCIe, which describes:

- ✓ The hardware composition and functional characteristics of the module
- ✓ Application interface definition and use instructions
- ✓ The electrical performance and mechanical characteristics of the module

Combined with this and other application documents, users can quickly use this module to design wireless products.



2 Module Overview

2.1 Module introduction

The C16QS mini PCIe is a wireless communication module that integrates network standard **LTE CAT 1.bis** and RF transceiver with PCI Express Mini Card 1.2 standard interface. It supports a maximum downlink rate of 10 Mbps and a maximum uplink rate of 5 Mbps. The module is based on Cortex M3 processor. It has built-in multiple network protocols (HTTP, HTTPS, MQTT, MQTTS, TCP) and supports Windows 7 and higher, embedded operating system such as Android 4.0 or higher.

The C16QS module can be used in the following applications:

- ✓ Health monitoring
- ✓ Fleet management and asset tracking
- ✓ Fixed CPE-Type applications
- ✓ LTE mobile router
- ✓ Other wireless terminals, etc.



2.2 Module characteristics

Table 1 Key Features

Characteristics	Description
Physical properties	50.9mm*30.0mm*3.78mm
Working voltage	2.5V–5.5V, Typical voltage 3.3V
Application interface	<ul style="list-style-type: none"> ✓ USIM interface ✓ Hardware reset interface ✓ UART serial interface ✓ I2C Interface ✓ Power interface ✓ Network status indication interface ✓ GPIO interface ✓ SPI ✓ SWD
Operating frequency band	<p>LTE BANDS:</p> <ul style="list-style-type: none"> ▪ E.A: - 1/ 3/ 5/ 8/ 20 ▪ N.A: - 2/ 4/ 5/ 12/ 13/ 66 ▪ A.N: - 1/ 3/ 5/ 8/ 18/ 19/ 26/ 28 ▪ L.A: - 2/ 3/ 4/ 7/ 8/ 28 ▪ W.W: - 1/ 2/ 3/ 4/ 5/ 7/ 8/ 12/ 18/ 19/ 20/ 25/ 26/ 28/ 40/ 41/66 ▪ E.U: - 1/ 3/ 5/ 7/ 8/ 20/ 28
Data service	<ul style="list-style-type: none"> ✓ FDD/TDD LTE CAT 1.bis ✓ Peak DL 10Mbps/ UL 5Mbps (CAT 1.bis)
Antenna Interface	<ul style="list-style-type: none"> ✓ Main x 1 ✓ GNSS x 1 ✓ Characteristic impedance 50 Ω
GNSS	<ul style="list-style-type: none"> ✓ GPS ✓ BeiDou
Virtual Network Card	Support USB virtual network card



Humidity	RH5% ~ RH95%
Operating temperature	<ul style="list-style-type: none"> ✓ Normal working temperature -30°C to +85°C ✓ Storage temperature -45°C to +90°C
Network Protocol	<p>TCP(S)/HTTP(S)/MQTT(S)/FTP(S)/PPP</p> <p>TLS versions supported as well</p>
AT command	<ul style="list-style-type: none"> ✓ Supports standard AT Commands ✓ Specific AT query C16QS AT command set

2.3 Functional Block Diagram

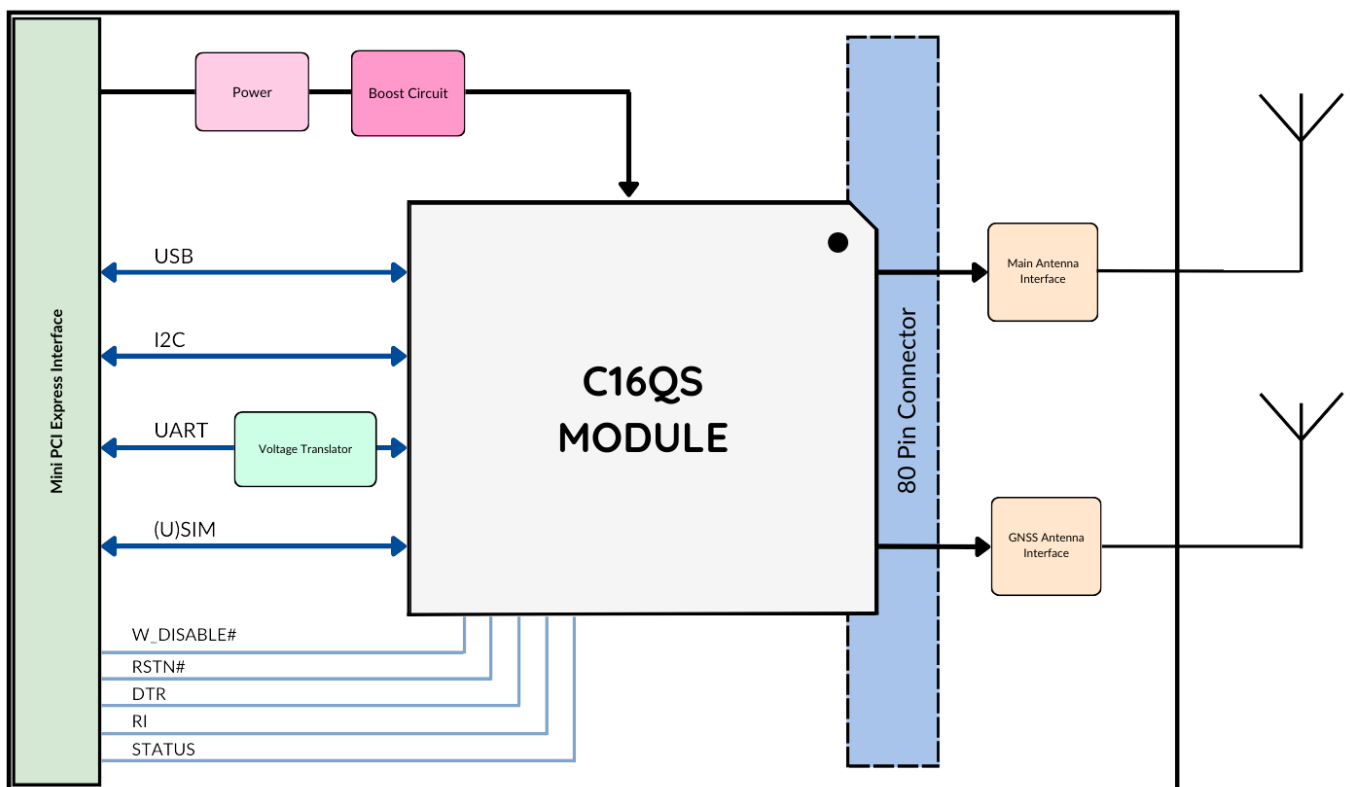


Figure 1 Functional block diagram



3 Interface Application description

3.1 Chapter overview

This chapter mainly describes the interface definition and application of this module. It contains the following sections:

- ✓ Module interface
- ✓ Power supply
- ✓ USIM Card interface
- ✓ USB interface
- ✓ UART interface
- ✓ Audio and I2C interface
- ✓ Control signals
- ✓ ADC Interface
- ✓ GPIO Interface
- ✓ Antenna interface
- ✓ SDIO Interface
- ✓ SPI
- ✓ GNSS Interface



4 mPCIe Interface Application Description

4.1 C16QS Mini PCIe Card Pin Layout

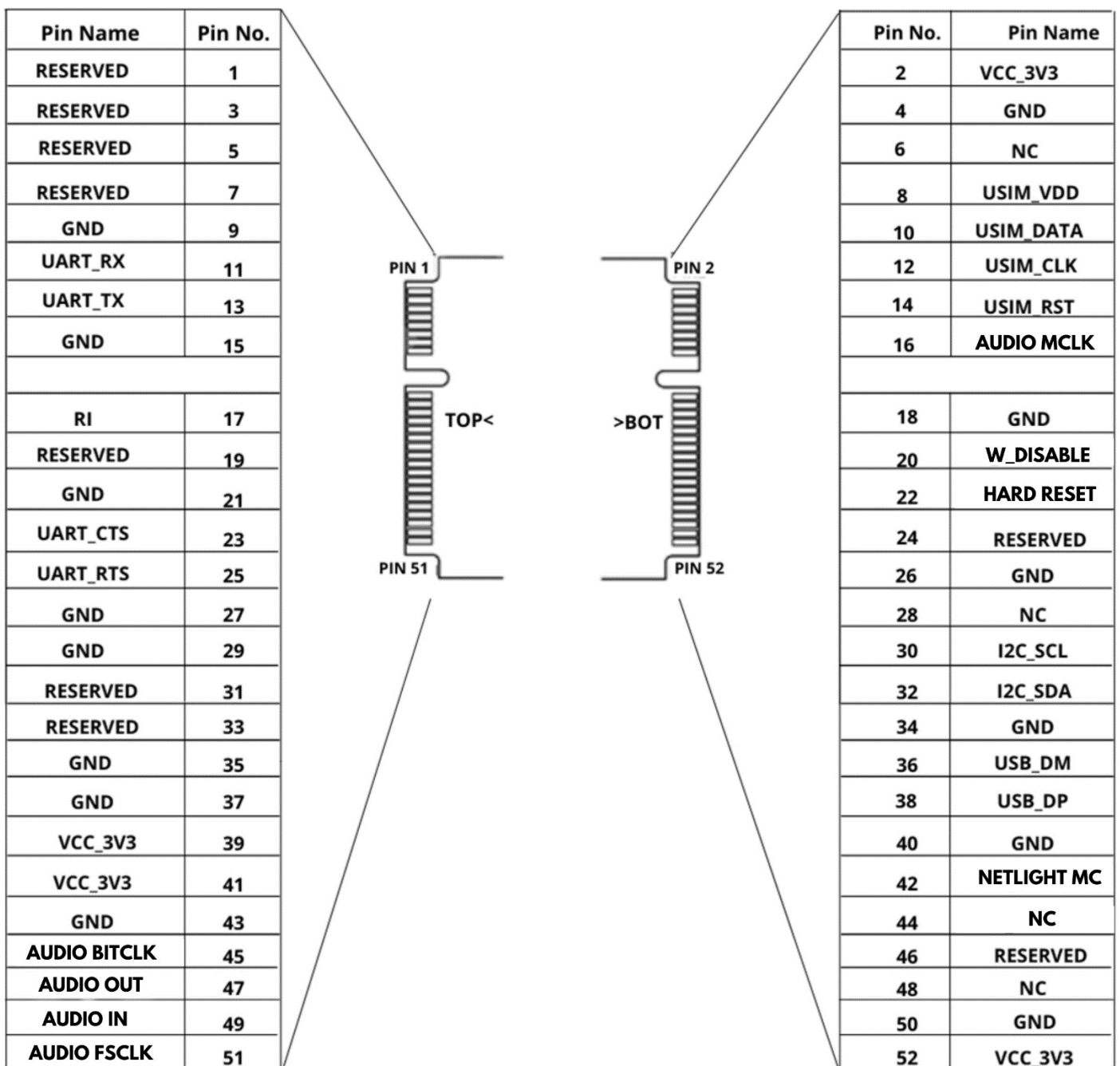


Figure 2 C16QS Mini PCIe Card Pin layout



4.2 C16QS Pin Interface Definition

The module interface definition is shown in the following table:

Table 2 Pin Description

Symbol	Description
PAD ATTRIBUTE	
AI	Analog Input
AO	Analog Output
AIO	Analog input output
B	Bidirectional digital with CMOS input
DI	Digital Input (CMOS)
DO	Digital Output (CMOS)
DIO	Digital Input/Output
H	High voltage tolerant
PI	Power Input
PO	Power Output
GNDC	Common ground

4.2.1 Absolute maximum ratings

The absolute maximum ratings table reflects the stress levels that, if exceeded, may cause permanent damage to the device. No functionality is guaranteed outside the operating specifications. Functionality and reliability are only guaranteed within the operating conditions described in Operating conditions.

Table 3 Absolute Maximum ratings

Pin Type	V_min	V_max
VB	2.5	5.5
P2	0.3	2



P3	0.3	3.6
P5	0.3	4.2
P6	0.3	3.6

4.2.2 Operating Conditions

The operating voltages are listed below.

Table 4 Operating Condition

Pin Type	V_min (if applicable)	V_typical	V_max (if applicable)
VB	2.5	3.3	5.5
P2	1.75	1.8	1.85
P3	0	-	3.4
P5	1.75/2.95	1.8/3	1.85/3.05
P6	-	3.3	-

4.2.3 C16QS Pin Interface Listing

The C116QS Mini PCIe module has the LCC interface. The module interface definition is shown in the following table:

Table 5 Pin name

Pin No	Mini PCI Express Standard Name	C16QS Mini PCIe Pin Name	Voltage Definition	IO Type	Functional description	Remarks
1	WAKE#	RESERVED	-	-	RESERVED	
2	VCC_3V3	VCC_3V3	VB	PI	DC supply	
3	COEX_UART_RX	RESERVED	P2	DI	RESERVED	
4	GND	GND	-	GND	Ground Pin	



5	COEX_UART_TX	RESERVED	P2	DO	RESERVED	
6	NC	NC	-	-	Not connected	
7	RESERVED	RESERVED	-	-	RESERVED	
8	USIM_VDD	USIM_VDD	P5	PO	Power source for the USIM/SIM card	
9	GND	GND	-	GND	Ground Pin	
10	USIM_DATA	USIM_DATA	P5	DIO	USIM/SIM data signal	
11	UART_RX	UART0_RX	P2	DI	UART receive data	
12	USIM_CLK	USIM_CLK	-	DIO	USIM/SIM clock signal	
13	UART_TX	UART0_TX	P2	DO	UART transmit data	
14	USIM_RST	USIM_RST	-	DIO	USIM/SIM reset signal	
15	GND	GND	-	GND	Ground Pin	
16	AUD_MCLK	AUD_MCLK	-	-	RESERVED	
17	RI	RI	-	DO	Output signal can be used to wake up the host.	
18	GND	GND	-	GND	Ground Pin	
19	RESERVED	RESERVED	-	-	RESERVED	
20	W_DISABLE#	W_DISABLE#	-	DI	Disable wireless communications	Pull-up, Active low
21	GND	GND	-	GND	Ground Pin	
22	PERST#	HARD RESET	-	DI	Functional reset to the card	Active low
23	UART_CTS	UART0_CTS	P2	DO	RESERVED	
24	RESERVED	RESERVED	-	-	RESERVED	
25	UART_RTS	UART0_RTS	P2	DI	RESERVED	
26	GND	GND	-	GND	Ground Pin	
27	GND	GND	-	GND	Ground Pin	



28	NC	NC	-	-	Not connected	
29	GND	GND	-	GND	Ground Pin	
30	I2C_SCL	I2C_SCL	P2	DIO	I2C serial clock	
31	DTR	RESERVED	-	-	RESERVED	
32	I2C_SDA	I2C_SDA	P2	DIO	I2C serial data	Require external pull-up to 1.8V
33	RESERVED	RESERVED	-	-	RESERVED	
34	GND	GND	-	GND	Ground pin	
35	GND	GND	-	GND	Ground pin	
36	USB_DM	USB_DM	P6	AIO	USB differential data (-)	
37	GND	GND	-	GND	Ground Pin	
38	USB_DP	USB_DP	P6	AIO	USB differential data (+)	
39	VCC_3V3	VCC_3V3	VB	PI	3.3 DC supply	
40	GND	GND	-	GND	Ground Pin	
41	VCC_3V3	VCC_3V3	VB	PI	DC supply	
42	LED_WWAN#	NETLIGHT MC	P2	DO	Active-low LED signal for indicating the state of the card	
43	GND	GND	-	GND	Ground Pin	
44	USIM_PRESENCE	NC	-	DI	Sim card detection	
45	AUD_CLK	AUDIO BITCLK	-	IO	RESERVED	
46	RESERVED	NC	-	-	RESERVED	
47	AUD_DOUT	AUDIO OUT	-	DO	RESERVED	
48	NC	NC	-	-	Not connected	
49	AUD_DIN	AUDIO IN	-	DI	Reserved	



50	GND	GND	-	GND	Ground Pin	
51	AUD_SYNC	AUDIO FSCLK	-	IO	Reserved	
52	VCC_3V3	VCC_3V3	VB	PI	3.3 DC supply	

4.4 Power Supply

The following table shows the pin definition of VCC pins and ground pins.

Table 6 VCC and GND Pin Definition

Pin No.	Pin Name	IO	Power Domain	Description
2, 39, 41, 52	VCC	PI	2.5V - 5.5V	3.3V DC supply
4, 9, 15, 18, 21, 26, 27, 29, 34, 35, 37, 40, 43, 50	GND	GND	-	Ground Pins

The typical supply voltage of C16QS Mini PCIe is 3.3V. Therefore, the power supply must be able to provide enough current, and a bypass capacitor of no less than 470µF with low ESR should be used to prevent the voltage from dropping.

4.5 USIM Card interface

The (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 (U)SIM interface.

Table 7 USIM Pin Definition

Pin No.	Pin Name	IO	Power Domain		Description
8	USIM_VDD	PO	1.8V	V _{max} =1.85V V _{min} =1.75V	Power source for the USIM/SIM card
			3.0V	V _{max} =3.05V V _{min} =2.95V I _{Omax} =50mA	
10	USIM_DATA	DIO	1.8V	V _{ILmax} =0.6V V _{IHmin} =1.2V V _{OLmax} =0.45V V _{OHmin} =1.35V	USIM/SIM data signal



			3.0V	VILmax=1.0V VIHmin=1.95V VOLmax=0.45V VOHmin=2.55V	
12	USIM_CLK	DIO	1.8V	VOLmax=0.45V VOHmin=1.35V	USIM/SIM clock signal
			3.0V	VOLmax=0.45V VOHmin=2.55V	
14	USIM_RST	DIO	1.8V	VOLmax=0.45V VOHmin=1.35V	USIM/SIM reset signal
			3.0V	VOLmax=0.45V VOHmin=2.55V	

C16QS Mini PCIe supports 1.8V and 3.0V USIM cards. The following figure shows a reference design for a 6-pin USIM connector.

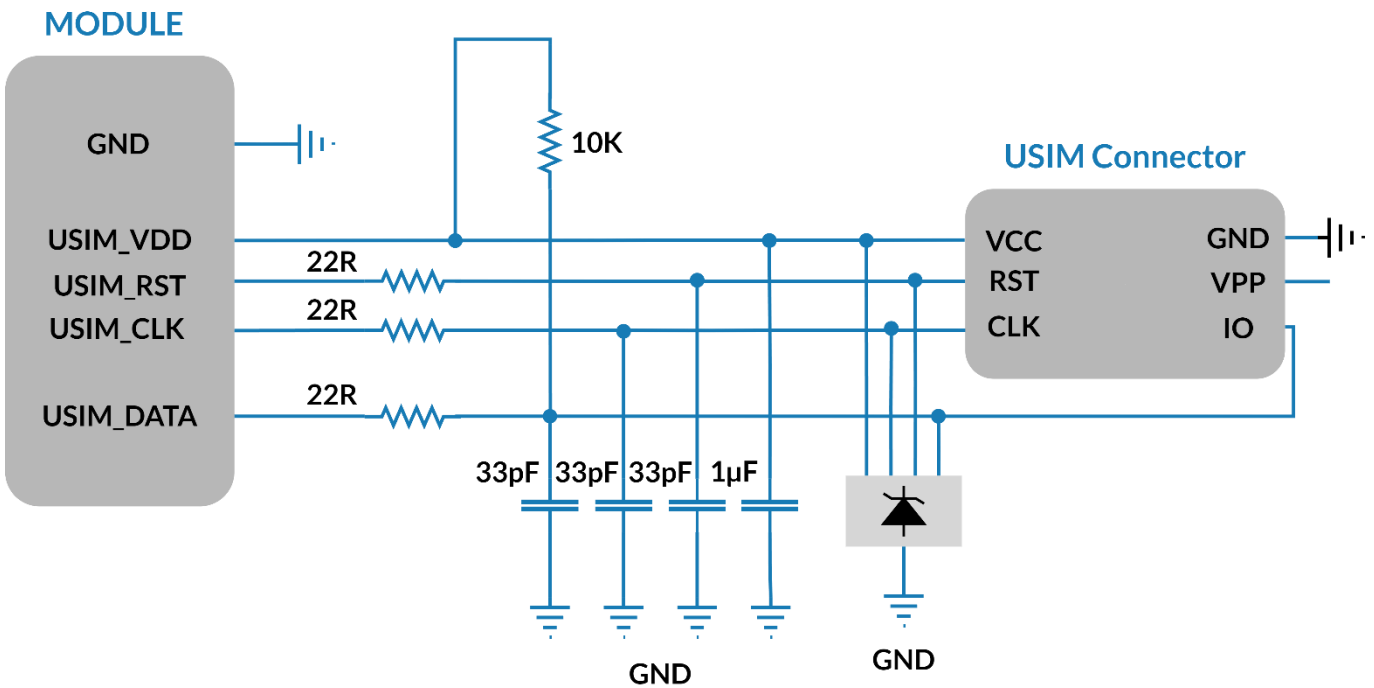


Figure 3 USIM connector reference circuit

In order to enhance the reliability and availability of the USIM card in your application, please follow the criteria below in the USIM circuit design:

- ✓ Keep the layout of USIM cards as close to the module as possible.
- ✓ Keep USIM card signal away from RF and power supply alignment.
- ✓ To avoid transient voltage overload, the USIM interface requires a 1.8V (use an external power source) through a 22R resistor in series with each other on the signal line path.



In order to offer good ESD protection, it is recommended to add a TVS whose parasitic capacitance should be no more than 50pF. The 22ohm resistors should be added in series between the module and the USIM card so as to suppress the EMI spurious transmission and enhance the ESD protection. The 33pF capacitors are used for filtering interference of high frequency signals. Please note that the USIM peripheral circuit should be close to the USIM 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 connector.

4.6 USB interface

The following table shows the pin definition of USB interface.

Table 8 USB Pin Definition

Pin No.	Pin Name	I/O	Description	Comment
36	USB_DM	AIO	USB differential data (-): Compliant with USB 2.0 standard specification.	Require differential impedance of 90Ω
38	USB_DP	AIO	USB differential data (+): Compliant with USB 2.0 standard specification.	Require differential impedance of 90Ω

C16QS Mini PCIe is compliant with USB 2.0 specification. It can only be used as a slave device. Meanwhile, it supports high speed (480Mbps) mode and full speed (12Mbps) mode. The USB interface is used for AT command communication, data transmission, software debugging and firmware upgrade. The following figure shows a reference circuit of the USB interface.

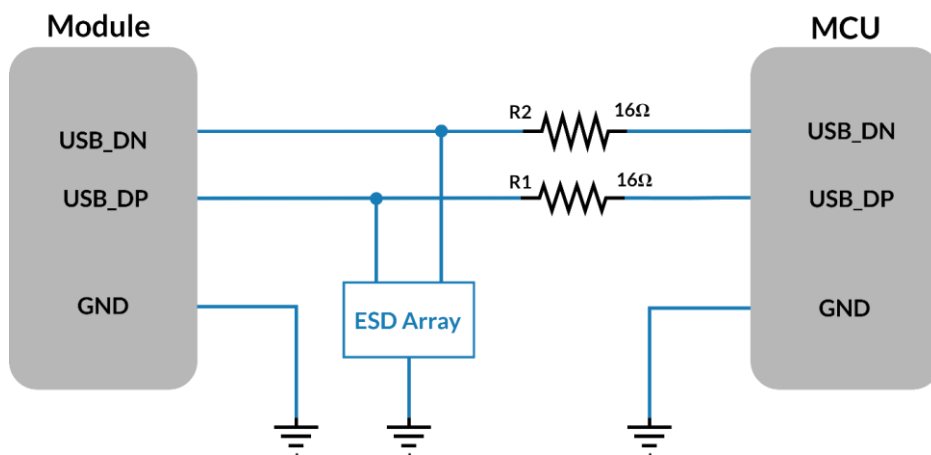


Figure 4 USB connection design circuit diagram



The components R1, R2, R3 and R4 must be placed close to the module, and then these resistors should be placed close to each other. The extra stubs of trace must be as short as possible.

- ✓ In order to ensure the USB interface design corresponding with the USB 2.0 specification, please comply with the following principles:
- ✓ It is important to route the USB signal traces as differential pairs with total grounding. The impedance of the USB differential trace is 90ohm.
- ✓ Do not route signal traces under crystals, oscillators, magnetic devices or RF signal traces. It is important to route the USB differential traces in the inner layer with ground shielding, and not only upper and lower layer but also right and left side should be shielded.
- ✓ If you use the USB connector, you should keep the ESD components as close to the USB connector as possible. Pay attention to the influence of junction capacitance of ESD components on USB data lines. Typically, the capacitance value should be less than 2pF.
- ✓ Keep USB data test points traces short to avoid noise coupled on USB data lines. If possible, reserve 0R resistor on these two lines.
- ✓ The USB interface bus supply voltage is provided internally by the module and does not need to be externally supplied. At the same time, since the USB interface of the module does not provide USB bus power, the module can only be used as a slave device of the USB bus device.

4.7 UART Interface

The following table shows the pin definition of the UART interface in the Mini PCIe card:

Table 9 Pin Definition of the UART Interface

Pin No.	C16QS Mini PCIe Pin Name	I/O	Power Domain		Description
11	UART_RX	DI	3.3V	VILmin=-0.3V VILmax=0.6V VIHmin=1.2V VIHmax=2.0V	UART receive data
13	UART_TX	DO	3.3V	VOLmax=0.45V VOHmin=1.3V	UART transmit data
23	UART_CTS	DO	3.3V	VOLmax=0.45V VOHmin=1.3V	UART clear to send
25	UART_RTS	DI	3.3V	VILmin=-0.3V VILmax=0.6V VIHmin=1.2V VIHmax=2.0V	UART request to send



The UART interface supports baud rates 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600, 1152000, 3000000 bps. The default is 115200bps. This interface can be used for AT command communication.

4.8 I2C interface

The following table shows the pin definition of I2C interface.

Table 10 I2C Pin Definition

Pin No.	C16QS Mini PCIe Pin Name	Standard Mini PCIe Pin Name	I/O	Power Domain	Description
30	I2C_SCL	I2C_SCL	DIO	1.8V	I2C serial clock, require external pull-up to 1.8V
32	I2C_SDA	I2C_SDA	DIO	1.8V	I2C serial data, require external pull-up to 1.8V

4.9 Control and indicator signals

The following table shows the pin definition of control signals.

Table 11 Control Signal Pin Definition

Pin No.	C16QS Mini PCIe Pin Name	I/O	Power Domain		Description
17	RI	DO	1.8V	VOLmax=0.45V VOHmin=1.35V	Output signal can be used to wake up the host.
20	W_DISABLE#	DI	1.8V		Disable wireless communications. pull-up by default, active low.
22	PERST#	DI	1.8V		Functional reset to the card; active low.
42	LED_WWAN#	DO	1.8V		Active-low LED signal for indicating the state of the module.



4.9.1 RI Signal

The C16QS module supports the serial sleep wake-up function, and the RI pin can be used as an interrupt to wake up the host.

RI: The RI pin can be used as an interrupt to wake up the host.

4.9.2 W_DISABLE# Signal

C16QS Mini PCIe provides W_DISABLE# signal to enable and disable wireless communications through hardware operation. The following table shows the radio operational states of the module

Table 12 Radio Operational States

W_DISABLE#	Radio Operation	Module operation mode
High Level	Enabled	Normal mode
Low Level	Disabled	Airplane mode

4.9.3 PERST# Signal

The PERST# signal can be used to force a hardware reset on the card. You can reset the module by driving the PERST# to a low-level voltage with the time frame of 150~460ms and then releasing it.

4.9.4 LED_WWAN# Signal

The LED_WWAN# signal of C16QS Mini PCIe is used to indicate the network status of the module, which can absorb the current up to 40mA. According to the following circuit, in order to reduce the current of the LED, a resistor must be placed in series with the LED. The LED is emitting light when the LED_WWAN# output signal is active low.

LED network indicator light reference design chart is as follows:



Figure 5 Circuit diagram of network indicator



The following table shows the indications of network status of the LED_WWAN# signal.

LED_WWAN#	Description
Low Level (Light on)	Registered on network
High impedance (Light off)	No network coverage or not registered W_DISABLE# signal is at a low level. (Disable the RF) AT+CFUN=0, AT+CFUN=4



5 80 Pin Connector*

*Optional

The Mini PCIe card contains an optional 80-pin male connector. The following table shows the pin description of the connector:

Table 13 Pin description

Pin No.	80 Pin connector Pin Name	C16QS module Pin Name	IO	Description
1	GND	GND	-	Ground
2	GND	GND	-	Ground
3	M_ANT	NC	-	Not Connected
4	M-ANT	NC	-	Not Connected
5	GND	GND	-	Ground
6	GND	GND	-	Ground
7	G_ANT	NC	-	Not Connected
8	G_ANT	NC	-	Not Connected
9	GND	GND	-	Ground
10	GND	GND	-	Ground
11	D_ANT	NC	-	Not Connected
12	D_ANT	NC	-	Not Connected
13	GND	GND	-	Ground
14	GND	GND	-	Ground
15	CAN_CTRL0	Reserved	-	Reserved
16	CAN_CTRL1	Reserved	-	Reserved
17	CAN_RX	Reserved	-	Reserved
18	CAN_TX	Reserved	-	Reserved
19	JTAG_TCK	Reserved	-	Reserved
20	JTAG_TDO	Reserved	-	Reserved



21	JTAG_TMS	Reserved	-	Reserved
22	JTAG_TDI	Reserved	-	Reserved
23	MDC	NC	-	Not Connected
24	MDIO	NC	-	Not Connected
25	TXD3	NC	-	Not Connected
26	TXD2	NC	-	Not Connected
27	TXD1	NC	-	Not Connected
28	TXD0	NC	-	Not Connected
29	TX_EN	NC	-	Not Connected
30	RX_DIV	NC	-	Not Connected
31	RXD_0	NC	-	Not Connected
32	RXD_1	NC	-	Not Connected
33	RXD_2	NC	-	Not Connected
34	RXD_3	NC	-	Not Connected
35	GTX_CLK	NC	-	Not Connected
36	RX_CLK	NC	-	Not Connected
37	USB_BOOT	USB_BOOT/N ETLIGHT	-	NETLIGHT
38	SECURE_DIS	SECURE_DIS	-	SECURE_DIS
39	GNSS_VRTC	GNSS_VRTC	PI	Backup voltage for GNSS
40	GND	GND		Ground
41	VDD_EXT	VDD_EXT	PO	Module output
42	USB_VBUS	USB_VBUS	PI	USB insertion detection, high level effective
43	W_DISABLE	W_DISABLE	DI	Flight mode
44	NETLIGHT	NETLIGHT	DO	Network status indication
45	PWRKEY	PWRKEY	PI	Low level boot
46	GNSS_1PPS	GNSS_1PPS	DO	One pulse per second
47	STATUS	STATUS	DO	Module status indication
48	PSM_IND	NC	-	Not Connected
49	NC	NC	-	Not Connected
50	NC	NC	-	Not Connected



51	NC	NC	-	Not Connected
52	SPI_CLK	SPI_CLK	DO	Clock
53	SPI_CS_N	SPI_CS_N	DO	Slave select
54	SPI_MISO	SPI_MISO	DI	Master Input Slave Output
55	SPI_MOSI	SPI_MOSI	DO	Master Output Slave Input
56	UART2_TXD	UART2_TXD	DO	Data transmission
57	UART2_RXD	UART2_RXD	DI	Data reception
58	VDD_SDIO	NC	-	Not Connected
59	SDC2 D0	SDC2 D0	-	Not Connected
60	SDC2_CMD	SDC2_CMD	-	Not Connected
61	SDC2_CLK	SDC2_CLK	-	Not Connected
62	SDC_D1	SDC_D1	-	Not Connected
63	SDC_D2	SDC_D2	-	Not Connected
64	SDC_D3	SDC_D3	-	Not Connected
65	SD_CARD_DET	NC	-	Not Connected
66	UART1_TXD	UART1_TXD	DO	Data transmission
67	UART1_RXD	UART1_RXD	DI	Data reception
68	NC	NC	-	Not Connected
69	ADC1	ADC1	-	Not Connected
70	ADC2	ADC2	-	Not Connected
71	GPIO9	NC	-	Not Connected
72	GPIO8	NC	-	Not Connected
73	GPIO7	AGPIO7	IO	General input/Output port (AGPIO 7)
74	GPIO6	GPIO7	IO	General input/Output port (GPIO 7)
75	GPIO5	AGPIO5	IO	General input/Output port (AGPIO 5)
76	GPIO4	NC	-	Not Connected
77	GPIO3	NC	-	Not Connected
78	GPIO2	NC	-	Not Connected
79	GPIO1	GPIO1	IO	General input/Output port (GPIO 1)
80	GND	GND	-	Ground



5.1 UART Interface

The following table shows the pin definition of the UART interface in the 80-pin male connector:

Table 14 Pin Definition of the UART Interface in the 80-pin connector

Pin No.	80-Pin connector Pin Name	I/O	Description
67	UART1_RXD	DI	UART1 receive data (DM Port)
66	UART1_TXD	DO	UART1 transmit data (DM Port)
57	UART2_RXD	DI	UART2 receive data
56	UART2_TXD	DO	UART2 transmit data

5.2 Control and indicator signals

The following table shows the pin definition of control signals

Table 15 Control signal pin definition of 80-pin connector

Pin No.	80-Pin connector Pin name	I/O	Description
47	STATUS	DO	Module status Indication
44	NETLIGHT	DO	Network status indication

5.2.1 STATUS

C16QS Mini PCIe provides STATUS signal to indicate the state of the module. It is the 47th pin in the 80-pin male connector.

5.2.2 NETLIGHT

C16QS Mini PCIe provides NETLIGHT signal to indicate the network status of the module. It is the 44th in the 80-pin male connector.



5.3 SPI Interface

Table 16 SPI interface pin definition in the 80-pin connector

Pin No	Signal name in the 80-pin connector	I/O	Description
53	SPI_CS_N	DO	Slave select
52	SPI_CLK	DO	Clock
55	SPI_MOSI	DO	Master output slave input
54	SPI_MISO	DI	Master input slave output



6 Antenna Interface

6.1 Antenna interface

C16QS Mini PCIe antenna interfaces include a main antenna interface and a GNSS antenna interface. GNSS function is enabled by default. Both main antenna and GNSS antenna are connected to a U.FL connector.

Table 17 Antenna Definition

U.FL Connector	Antenna	Network Type
U.FL 1	LTE	<ul style="list-style-type: none"> Cellular
U.FL 2	GNSS	<ul style="list-style-type: none"> GPS BeiDou



7 Overall technical indicators

7.1 Chapter overview

The C16QS mini PCIe RF overall specifications include the following sections:

- Power supply requirements
- IO requirements
- ESD Characteristics
- GNSS requirements
- Antenna requirements

7.2 Power Supply Requirements

The input voltage of C16QS Mini PCIe is 3.3 specified by PCI Express Mini CEM Specifications.

The following table shows the power supply requirements of C16QS Mini PCIe:

Table 18 Power Supply Requirements

Parameter	Description	Min.	Typ.	Max.	Unit
VCC	Power Supply	2.5	3.3	5.5	V

7.3 IO Requirements

The following table shows the IO requirements of C16QS Mini PCIe.

Table 19 IO Requirements

Parameter	Description	Typical	Unit
VIO	Input Output Voltage	1.8V	V



7.4 ESD Characteristics

The following table shows the ESD characteristics of C16QS Mini PCIe:

Table 20 ESD Characteristics

Parameter	Contact Discharge	Air Discharge	Unit
Power Supply and GND	+/-5	+/-10	kV
Antenna Interface	+/-4	+/-8	kV
USB Interface	+/-4	+/-8	kV
USIM Interface	+/-4	+/-8	kV
Others	+/-0.5	+/-1	kV

7.5 GNSS reception performance

C16QS Module GNSS performance parameters:

Table 21 GNSS performance parameters

Features	Description
Receiving Bands	<ul style="list-style-type: none"> GPS L1 C/A: 1575.42 Mhz BD2 B1 C/A: 1561.098 MHz
Horizontal Position Accuracy:	<ul style="list-style-type: none"> < 2.0 m CEP50
Velocity Accuracy:	<ul style="list-style-type: none"> Without Aid: < 0.01 m/s
Vertical Positioning accuracy	<ul style="list-style-type: none"> < 3.0 m CEP50
Timing Accuracy:	<ul style="list-style-type: none"> 1PPS: 3.9 ns
Reacquisition Time:	<ul style="list-style-type: none"> < 1.5 s
TTFB@-130dBm	<ul style="list-style-type: none"> Cold Start < 28s



	<ul style="list-style-type: none"> • Hot Start $\leq 1s$ • Reacquisition $\leq 1s$
Sensitivity:	<ul style="list-style-type: none"> • Cold Start: -147 dBm • Tracking: -160 dBm • Hot Start: -155 dBm • Reacquisition: -158 dBm

7.6 Antenna Requirements

C16QS Mini PCIe antenna interfaces include a main antenna interface and a GNSS antenna interface. GNSS function is enabled by default. Both main antenna and GNSS antenna are connected to a U.FL connector.

The following table shows the requirement on the main antenna and GNSS antenna:

Table 22 Antenna indicator requirements

Frequency band	Standing wave ratio	Antenna gain	Effectiveness	TRP	TIS
B1 FDD	<2:1	> -2.5dbi	> 40%	>16.5	<-88
B2 FDD	<2:1	> -2.5dbi	> 40%	>16.5	<-88
B3 FDD	<2:1	> -2.5dbi	> 40%	>16.5	<-88
B4 FDD	<2:1	> -2.5dbi	> 40%	>16.5	<-88
B5 FDD	<2:1	> -2.5dbi	> 40%	>16.5	<-88
B7 FDD	<2:1	> -2.5dbi	> 40%	>16.5	<-88
B8 FDD	<2:1	> -2.5dbi	> 40%	>16.5	<-88
B12 FDD	<2:1	> -2.5dbi	> 40%	>16.5	<-88
B13 FDD	<2:1	> -2.5dbi	> 40%	>16.5	<-88



B18 FDD	<2:1	> -2.5dbi	> 40%	>16.5	<-88
B19 FDD	<2:1	> -2.5dbi	> 40%	>16.5	<-88
B20 FDD	<2:1	> -2.5dbi	> 40%	>16.5	<-88
B26 FDD	<2:1	> -2.5dbi	> 40%	>16.5	<-88
B28 FDD	<2:1	> -2.5dbi	> 40%	>16.5	<-88
B66 FDD	<2:1	> -2.5dbi	> 40%	>16.5	<-88



8 Interface Electrical Characteristics

8.1 Chapter Overview

- Working storage temperature
- Power supply
- Power consumption characteristics

8.2 Working Storage Temperature

Table 23 C16QS Mini PCIe working storage temperature

Parameter	Minimum	Maximum
Normal operating temperature	-30°C	85°C
Storage temperature	-45°C	90°C

8.3 Power Supply

The C16QS Mini PCIe input power requirements are as follows:

Table 24 C16QS Mini PCIe Operating Voltage

Parameter	Minimum value	Typical value	Maximum value
Input Voltage	2.5V	3.3V	5.5V



8.4 Power Consumption Characteristics

Table 24 Power Consumption Characteristics

Mode	Type/band	Rx CINR @ 80dBm (dB)	Sensitivity (dBm)	Current consumption @ 23dBm and @3.7 V		
				Typical	Tx Idle	Unit
CAT 1.bis E.A. Bands (GNSS off)	Band1	15	-97.97	640	16	mA
	Band 3	11	-95.47	678	16	mA
	Band 5	15	-96.22	600	16	mA
	Band 7	TBD	TBD	TBD	TBD	mA
	Band 8	15	-95.97	534	16	mA
	Band 20	14	-94.47	544	16	mA
CAT 1.bis N.A. Bands (GNSS off)	Band 2	TBD	TBD	TBD	TBD	mA
	Band 4	TBD	TBD	TBD	TBD	mA
	Band 5	TBD	TBD	TBD	TBD	mA
	Band 12	TBD	TBD	TBD	TBD	mA
	Band 13	TBD	TBD	TBD	TBD	mA
	Band 66	TBD	TBD	TBD	TBD	mA
CAT 1.bis A.N. Bands (GNSS off)	Band 1	TBD	TBD	TBD	TBD	mA
	Band 3	TBD	TBD	TBD	TBD	mA
	Band 5	TBD	TBD	TBD	TBD	mA
	Band 8	TBD	TBD	TBD	TBD	mA
	Band 18	TBD	TBD	TBD	TBD	mA
	Band 19	TBD	TBD	TBD	TBD	mA
	Band 26	TBD	TBD	TBD	TBD	mA



	Band 28	TBD	TBD	TBD	TBD	mA
CAT 1.bis L.A. Bands (GNSS off)	Band 2	TBD	TBD	TBD	TBD	mA
	Band 3	TBD	TBD	TBD	TBD	mA
	Band 4	TBD	TBD	TBD	TBD	mA
	Band 7	TBD	TBD	TBD	TBD	mA
	Band 8	TBD	TBD	TBD	TBD	mA
CAT 1.bis W.W. Bands (GNSS off)	Band 1	TBD	TBD	TBD	TBD	mA
	Band 2	TBD	TBD	TBD	TBD	mA
	Band 3	TBD	TBD	TBD	TBD	mA
	Band 4	TBD	TBD	TBD	TBD	mA
	Band 5	TBD	TBD	TBD	TBD	mA
	Band 7	TBD	TBD	TBD	TBD	mA
	Band 8	TBD	TBD	TBD	TBD	mA
	Band 12	TBD	TBD	TBD	TBD	mA
	Band 18	TBD	TBD	TBD	TBD	mA
	Band 19	TBD	TBD	TBD	TBD	mA
	Band 20	TBD	TBD	TBD	TBD	mA
	Band 25	TBD	TBD	TBD	TBD	mA
	Band 26	TBD	TBD	TBD	TBD	mA
	Band 28	TBD	TBD	TBD	TBD	mA
Band 40	TBD	TBD	TBD	TBD	mA	
Band 41	TBD	TBD	TBD	TBD	mA	
Band 66	TBD	TBD	TBD	TBD	mA	
CAT 1.bis	Band 1	mA	TBD	TBD	TBD	mA



E.U. Bands (GNSS off)	Band 3	mA	TBD	TBD	TBD	mA
	Band 5	mA	TBD	TBD	TBD	mA
	Band 7	mA	TBD	TBD	TBD	mA
	Band 8	mA	TBD	TBD	TBD	mA
	Band 20	mA	TBD	TBD	TBD	mA
	Band 28	mA	TBD	TBD	TBD	mA
GNSS	Powering			TBD		mA
	Tracking			TBD		mA
	Fix			TBD		mA
GNSS off & CFUN=0				TBD		mA
Idle Sleep (DRX)				TBD		mA
Sleep 1				TBD		mA
Sleep 2				TBD		mA
Hibernate				TBD		mA



9 Dimensions and Packaging

9.1 Mechanical Dimensions of C16QS Mini PCIe

The following figure shows the standard dimensions (top and bottom view) of MiniPCI Express.

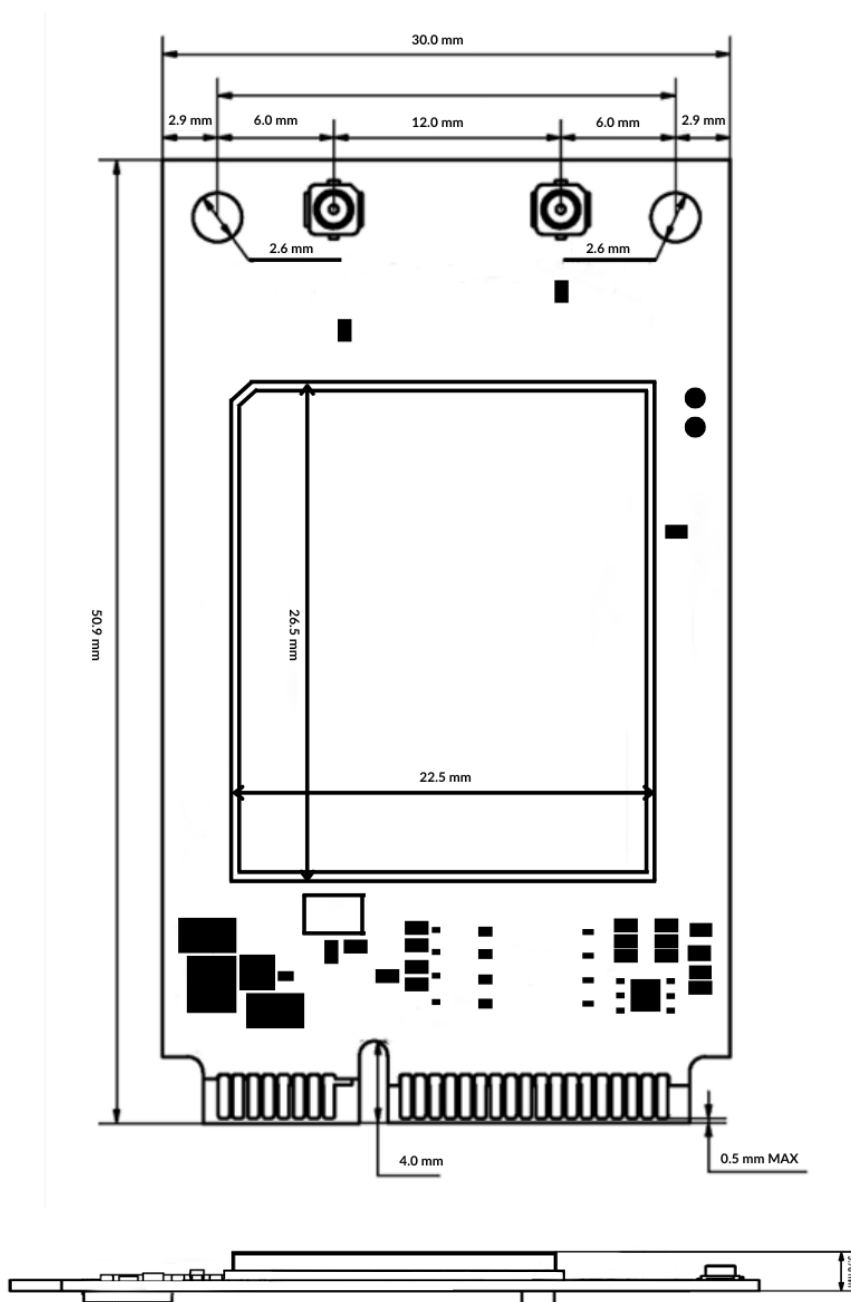


Figure 6 Standard dimensions of Mini PCIe



C16QS Mini PCIe adopts a standard Mini PCI Express connector. The following figure takes the Molex 679100002 as an example:

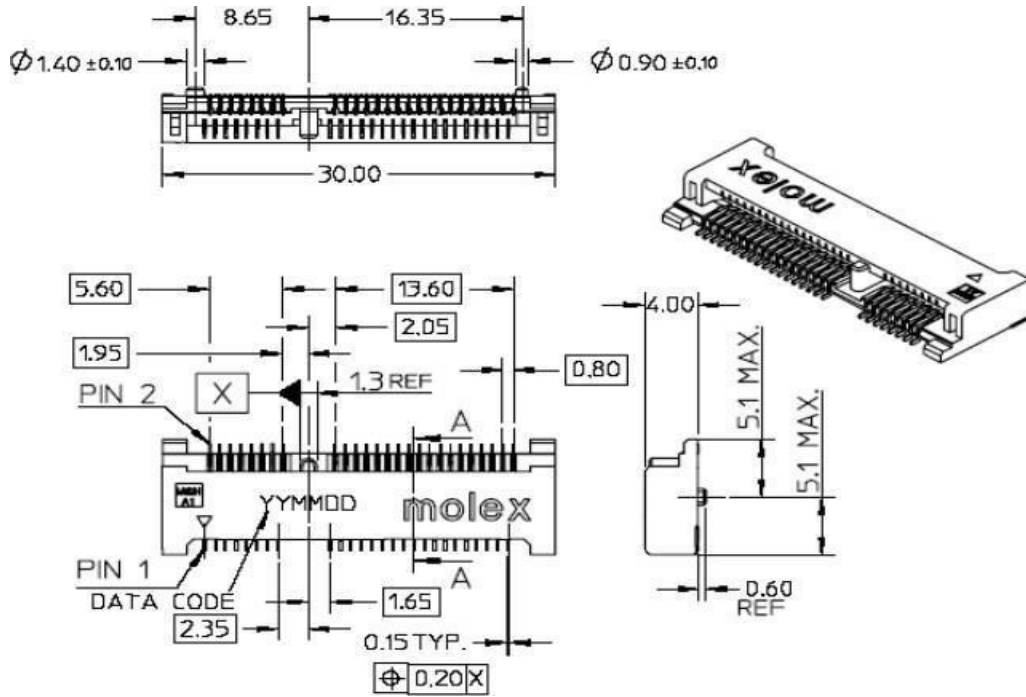


Figure 7 Molex 679100002 example figure



11 Appendix

11.1 Chapter overview

- Abbreviations
- Safety and precautions

11.2 Abbreviations

Table 25 Abbreviations

Abbreviations	Full name
3GPP	Third Generation Partnership Project
AP	Access Point
AMR	Adaptive Multi-rate
BER	Bit Error Rate
CCC	China Compulsory Certification
CDMA	Code Division Multiple Access
CE	European Conformity
CSD	Circuit Switched Data
CTS	Clear to Send
DC	Direct Current
DTR	Data Terminal Ready
DL	Down Link
DTE	Data Terminal Equipment
DRX	Discontinuous Reception
EDGE	Enhanced Data Rate for GSM Evolution
EU	European Union
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge



FCC	Federal Communications Commission
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communication
HSDPA	High-Speed Downlink Packet Access
HSPA	Enhanced High Speed Packet Access
HSUPA	High Speed Up-link Packet Access
IMEI	International Mobile Equipment Identity
LED	Light-Emitting Diode
LTE	Long Term Evolution
NC	Not Connected
PCB	Printed Circuit Board
PCM	Pulse Code Modulation
PDU	Protocol Data Unit
PMU	Power Management Unit
PPP	Point-to-point protocol
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
RoHS	Restriction of the Use of Certain Hazardous Substances
SMS	Short Message Service
TIS	Total Isotropic Sensitivity
TVS	Transient Voltage Suppressor
TX	Transmitting Direction
UART	Universal Asynchronous Receiver-Transmitter
UMTS	Universal Mobile Telecommunications System
USIM	Universal Subscriber Identity Module
USSD	Unstructured Supplementary Service Data
VSWR	Voltage Standing Wave Ratio
WWAN	Wireless Wide Area Network



11.3 Safety and precautions

In order to use the wireless device safely, the terminal device informs the user of the relevant safety information:

- ✓ **Interference:** When the use of wireless devices is prohibited or the use of the device may cause interference and security of the electronic device, turn off the wireless device. Because the terminal will send and receive RF signals when it is powered on. It can interfere with TV, radio, computer or other electrical equipment.
- ✓ **Medical equipment:** In medical and health care facilities where the use of wireless devices is prohibited in the express text, please follow the regulations of the site and turn off the device. Some wireless devices may interfere with the medical device, causing the medical device to malfunction or cause errors. If interference occurs, turn off the wireless device and consult a physician.
- ✓ **Flammable and explosive areas:** In flammable and explosive areas, please turn off your wireless device and follow the relevant label instructions to avoid an explosion or fire. For example; gas stations, fuel zones, chemical products areas, chemical transportation and storage facilities, areas with explosion hazard signs, areas with “turn off radio equipment” signs, etc.
- ✓ **Traffic Safety:** Please comply with local laws or regulations in your country or region regarding the use of wireless devices when driving a vehicle.
- ✓ **Aviation Safety:** When flying, please follow the airline's regulations and regulations regarding the use of wireless devices. Before taking off, turn off the wireless device to prevent wireless signals from interfering with aircraft control signals.
- ✓ **Environmental Protection:** Please comply with local laws regarding the handling of equipment packaging materials, equipment or accessories, and support recycling operations.
- ✓ **Emergency call:** This device uses wireless signals for propagation. Therefore, there is no guarantee that the network can be connected in all situations.

