HUAWEI MC509 CDMA Mini PCIe Module

Hardware Guide

Issue 03

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About This Document

Revision History

Document Version	Date	Chapter	Descriptions
01	2014-11-11		Creation
02	2014-12-05	2.2	Updated the table 2-1: features
		5.3	Updated the table 5-2: operating and storage temperatures for the MC509 Mini PCIe module
03	2014-12-26	All	Updated the description of LED_WWAN# pin

Contents

1 Introduction

This document describes the hardware application interfaces and air interfaces provided by HUAWEI MC509 CDMA Mini PCIe Module (hereinafter referred to as the MC509 Mini PCIe module).

This document helps hardware engineer to understand the interface specifications, electrical features and related product information of the MC509 Mini PCIe module.

2 Overall Description

2.1 About This Chapter

This chapter gives a general description of the MC509 Mini PCIe module and provides:

- Function Overview
- Circuit Block Diagram

2.2 Function Overview

Table 2-1 Features

Feature	Description
Physical Dimensions	• Dimensions (L × W × H): 51 mm × 30.4 mm × 3.4 mm • Weight: about 12 g
Operating Bands	• CDMA 2000 1x, EV-DO Rev.0, EV-DO Rev.A • Support BC0 (800 MHz), BC1 (1900 MHz) • GPS: 1574.42 MHz–1576.42 MHz
Operating Temperature	Normal operating temperature: –20°C to +60°C Extended operating temperature[1]: –30°C to +70°C
Storage Temperature	–40°C to +85°C
Power Voltage	DC 3.0 V–3.6 V (typical value is 3.3 V)
AT Commands	See the *HUAWEI MC509 Series CDMA LGA Module AT Command Interface Specification*.
Application Interface (52-pin Mini	One standard RUIM card (3 V or 1.8 V)
	Audio interface: PCM interface

Feature	Description
PCIe interface	USB 2.0 (High Speed)
	RESIN_N: Reset module
	WAKE#: Wake up signal
	W_DISABLE#: Disable wireless communications
	LED_WWAN#: Active-low LED signal indicating the state of the module
Antenna Connector	WWAN MAIN antenna connector x1 WWAN AUX antenna connector x1 GPS antenna connector x1
Data Services	CDMA2000 1X: UL 153.6 kbit/s; DL 153.6 kbit/s
	CDMA2000 1X/EVDO Rev.0: UL 153.6 kbit/s; DL 2.4 Mbit/s
	CDMA2000 1X/EVDO Rev.A: UL 1.8 Mbit/s; DL 3.1 Mbit/s

NOTE

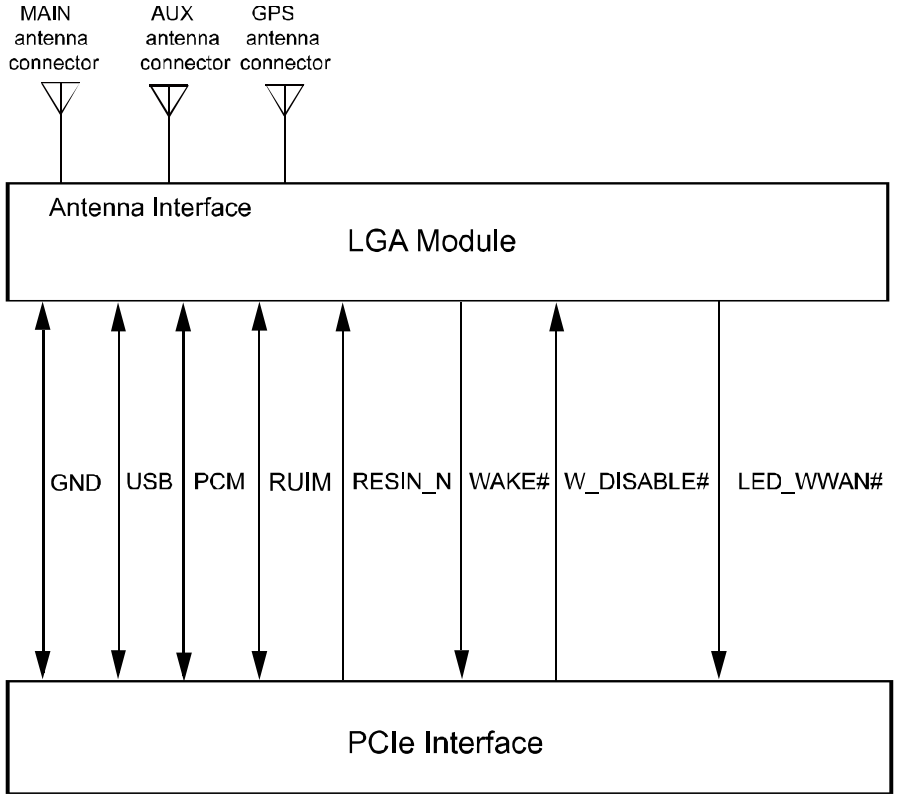
- [1]: When the MC509 Mini PCIe module works in the range of –30°C to –20°C or +60°C to +70°C, **NOT** all its RF performances comply with 3GPP2 specifications.
- The thermal design must be implemented according to the chapter 6.8 . If not, the overheat protection mechanism will be triggered due to overheated Mini PCIe and the network connection will be terminated.

2.3 Circuit Block Diagram

Figure 2-1 shows the circuit block diagram of the MC509 Mini PCIe module. The major functional unit of the Mini PCIe module contains the following parts:

- LGA Module
- Control Signals
- Antenna Connectors

Figure 2-1 Circuit block diagram of the MC509 Mini PCIe module



3 Description of the Application Interfaces

3.1 About This Chapter

This chapter mainly describes the external application interfaces of the MC509 Mini PCIe module, including:

- Mini PCIe Interface
- Power Interface
- Signal Control Interface
- USB Interface
- RUIM Card Interface
- Audio Interface
- Reserved Pins
- NC Pins

3.2 Mini PCIe Interface

The MC509 module uses a Mini PCIe interface as its external interface. For details about the module and dimensions, see 6.2 Dimensions and Interfaces.

Figure 3-1 shows the sequence of pins on the interface of the Mini PCIe Adapter.

Figure 3-1 Sequence of Mini PCIe interface

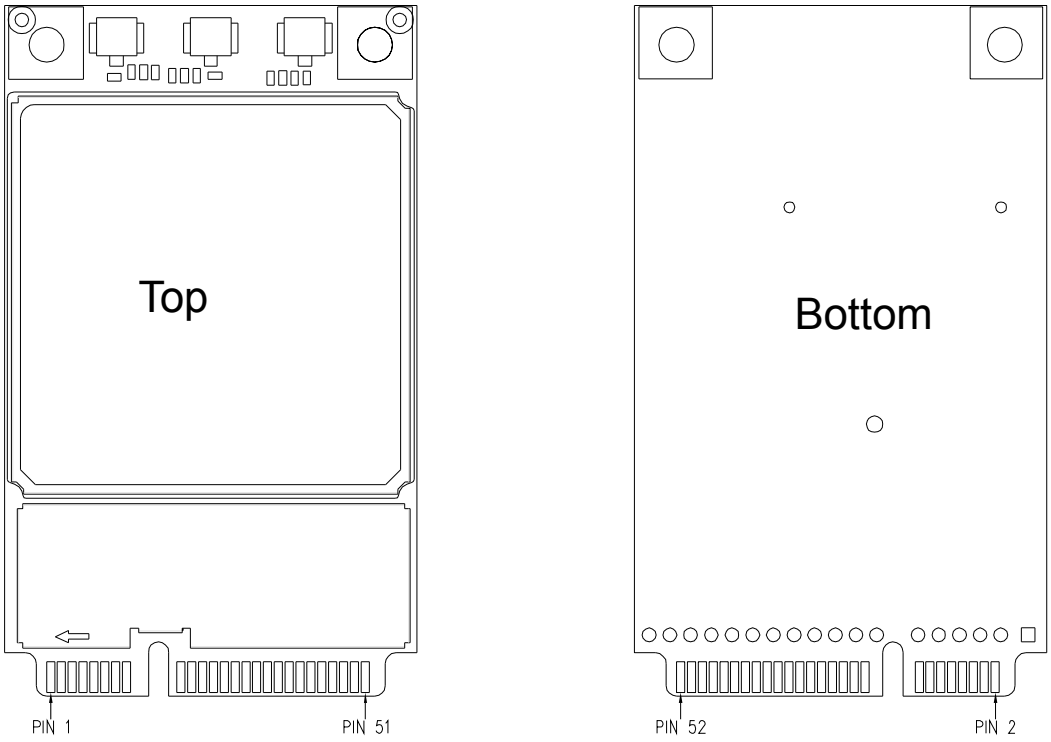


Table 3-1 shows the pin definitions of the Mini PCIe interface.

Table 3-1 Pin definitions of the Mini PCIe interface

Pin No.	Pin Name		Pad Type	Description	Parameter	Min. (V)	Typ. (V)	Max. (V)
	Mini PCI Express Standard Description	HUAWEI Pin Description						
1	WAKE#	WAKE#	O	Open collector active low signal. This signal is used to wake up the host.	-	–0.3	-	0.45
2	3.3Vaux	VCC_3V3	PI	3.3 V DC supply input.	-	3.0	3.3	3.6
3	COEX1	Reserved	-	Reserved	-	-	-	-
4	GND	GND	-	Ground	-	-	-	-
5	COEX2	Reserved	-	Reserved	-	-	-	-
6	1.5 V	NC	-	Not connected	-	-	-	-

Pin No.	Pin Name		Pad Type	Description	Parameter	Min. (V)	Typ. (V)	Max. (V)
	Mini PCI Express Standard Description	HUAWEI Pin Description						
7	CLKREQ#	NC	-	Not connected	-	-	-	-
8	UIM_PWR	RUIM_PWR	PO	Power source for the external RUIM card	Class C	–0.3	1.8	1.98
					Class B	–0.3	2.85	3.3
9	GND	GND	-	Ground	-	-	-	-
10	UIM_DATA	RUIM_DATA	I/O	External RUIM data signal	-	-	1.8/2.85	-
11	REFCLK-	NC	-	Not connected	-	-	-	-
12	UIM_CLK	RUIM_CLK	O	External RUIM clock signal	-	-	1.8/2.85	-
13	REFCLK+	NC	-	Not connected	-	-	-	-
14	UIM_RESET	RUIM_RESET	O	External RUIM reset signal	-	-	1.8/2.85	-
15	GND	GND	-	Ground	-	-	-	-
16	UIM_Vpp	NC	-	Not connected	-	-	-	-
17	Reserved	Reserved	-	Reserved	-	-	-	-
18	GND	GND	-	Ground	-	-	-	-
19	Reserved	Reserved	-	Reserved	-	-	-	-
20	W_DISABLE#	W_DISABLE#	I	Disable radio operation Active-low	V_{IL}	–0.3	0	0.3
					V_{IH}	1.17	1.8	2.1
21	GND	GND	-	Ground	-	-	-	-
22	PERST#	RESIN_N	I	Reset module Active-low	V_{IL}	–0.3	0	0.3
					V_{IH}	1.17	1.8	2.1
23	PERn0	NC	-	Not connected	-	-	-	-
24	3.3Vaux	VCC_3V3	PI	3.3 V DC supply input.	-	3.0	3.3	3.6
25	PERp0	NC	-	Not connected	-	-	-	-
26	GND	GND	-	Ground	-	-	-	-
27	GND	GND	-	Ground	-	-	-	-
28	1.5 V	NC	-	Not connected	-	-	-	-

Pin No.	Pin Name		Pad Type	Description	Parameter	Min. (V)	Typ. (V)	Max. (V)
	Mini PCI Express Standard Description	HUAWEI Pin Description						
29	GND	GND	-	Ground	-	-	-	-
30	SMB_CLK	NC	-	Not connected	-	-	-	-
31	PETn0	NC	-	Not connected	-	-	-	-
32	SMB_DATA	NC	-	Not connected	-	-	-	-
33	PETp0	NC	-	Not connected	-	-	-	-
34	GND	GND	-	Ground	-	-	-	-
35	GND	GND	-	Ground	-	-	-	-
36	USB_D-	USB_DM	I/O	USB signal D-	-	-	-	-
37	GND	GND	-	Ground	-	-	-	-
38	USB_D+	USB_DP	I/O	USB signal D+	-	-	-	-
39	3.3Vaux	VCC_3V3	PI	3.3 V DC supply input.	-	3.0	3.3	3.6
40	GND	GND	-	Ground	-	-	-	-
41	3.3Vaux	VCC_3V3	PI	3.3 V DC supply input.	-	3.0	3.3	3.6
42	LED_WWAN#	LED_WWAN#	O	LED signal indicating the state of the card. Active-low. The firmware function is in planning.	-	–0.3	-	0.45
43	GND	GND	-	Ground	-	-	-	-
44	LED_WLAN#	NC	-	Not connected	-	-	-	-
45	Reserved	PCM_CLK	O	PCM interface clock	V_{OL}	0	-	0.45
					V_{OH}	-	2.6	-
46	LED_WPAN#	NC	-	Not connected	-	-	-	-
47	Reserved	PCM_DOUT	O	PCM I/F data out	V_{OL}	0	-	0.45
					V_{OH}	-	2.6	-
48	1.5 V	NC	-	Not connected	-	-	-	-

Pin No.	Pin Name		Pad Type	Description	Parameter	Min. (V)	Typ. (V)	Max. (V)
	Mini PCI Express Standard Description	HUAWEI Pin Description						
49	Reserved	PCM_DIN	I	PCM I/F data in	V_{IL}	–0.3	-	0.91
					V_{IH}	1.69	-	2.9
50	GND	GND	-	Ground	-	-	-	-
51	Reserved	PCM_SYNC	O	PCM interface sync	V_{OL}	–0.3	-	0.91
					V_{OH}	1.69	-	2.9
52	3.3Vaux	VCC_3V3	PI	3.3 V DC supply input.	-	3.0	3.3	3.6

NOTE

- **P** indicates power pins; **I** indicates pins for digital signal input; **O** indicates pins for digital signal output. **PI** indicates power input pins; **PO** indicates power output pins**.**
- V_{IL} indicates Low-level input voltage; V_{IH} indicates High-level input voltage; V_{OL} indicates Low-level output voltage; V_{OH} indicates High-level output voltage.
- The **Reserved** pins are internally connected to the module. Therefore, these pins should not be used, otherwise they may cause problems. Please contact with us for more details about this information.
- The **NC** pins are not connected, therefore, before you deal with these pins, please refer to the corresponding hardware guide.

3.3 Power Interface

3.3.1 Power Sources and Grounds

For the Mini PCIe Adapter, +3.3Vaux is the only voltage supply that is available. The input voltage is 3.3 V±9%, as specified by *PCI Express Mini CEM Specifications 2.0.*

Table 3-2 Power and ground specifications

Pin No.	Pin Name	Pad Type	Description	Parameter	Min.(V)	Typ.(V)	Max.(V)
2, 24, 39, 41 and 52	VCC_3V3	PI	3.3 V DC supply input.	-	3.0 V	3.3 V	3.6 V
4, 9, 15, 18, 21, 26, 27, 29, 34, 35, 37, 40, 43, and 50	GND	-	Ground	-	-	-	-

NOTE

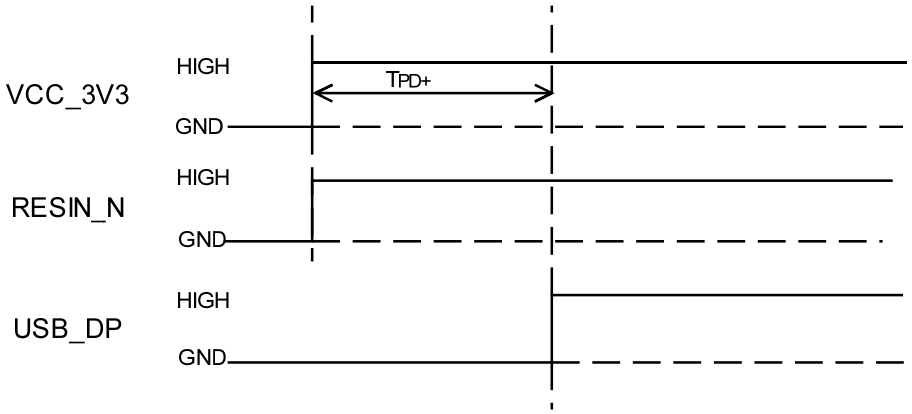
To minimize the RF radiation through the power lines, it is suggested to add ceramic capacitors of 10 pF and 100 nF in the power lines beside the Mini PCIe connector on the host side.

3.3.2 Power Supply Time Sequence

Power on Sequence

Do not toggle RESIN_N pin during the power on sequence. Pulling RESIN_N pin low will extend time for module startup.

Figure 3-2 Power on timing sequence

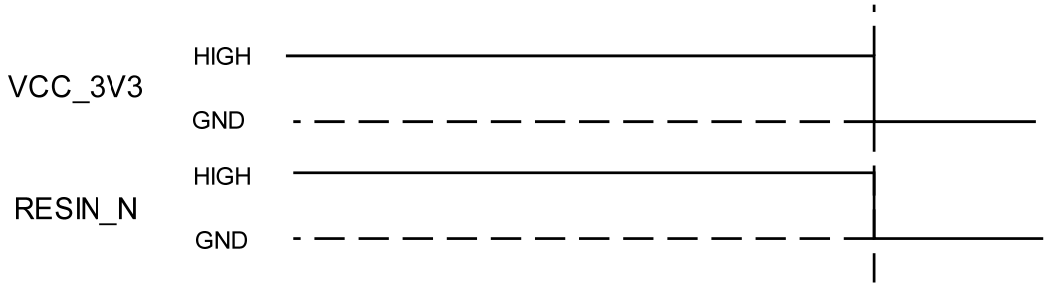


Parameter	Remarks	Time (Nominal value)	Unit
T_{PD+}	Power valid to USB D+ high	4	s

Power off Sequence

Cutting off VCC_3V3 will power off the module.

Figure 3-3 Power off timing sequence



3.4 Signal Control Interface

3.4.1 Overview

The signal control part of the interface in the MC509 Mini PCIe module consists of the following:

- WAKE# Signal
- RESIN_N Signal
- W_DISABLE# Signal
- LED_WWAN# Signal

Table 3-3 lists the pins on the signal control interface.

Table 3-3 Definitions of the pins on the signal control interface

Pin No.	Pin Name	Pad Type	Description	Parameter	Min. (V)	Typ. (V)	Max. (V)
1	WAKE#	O	Open collector active low signal. This signal is used to wake up the host.	-	–0.3	-	0.45
22	RESIN_N	I	Reset module Active-low	V_{IL}	–0.3	0	0.3
				V_{IH}	1.17	1.8	2.1
20	W_DISABLE#	I	Disable radio operation Active-low	V_{IL}	–0.3	0	0.3
				V_{IH}	1.17	1.8	2.1
42	LED_WWAN#	O	LED signal indicating the state of the card. Active-low The firmware function is in planning.	-	–0.3	-	0.45

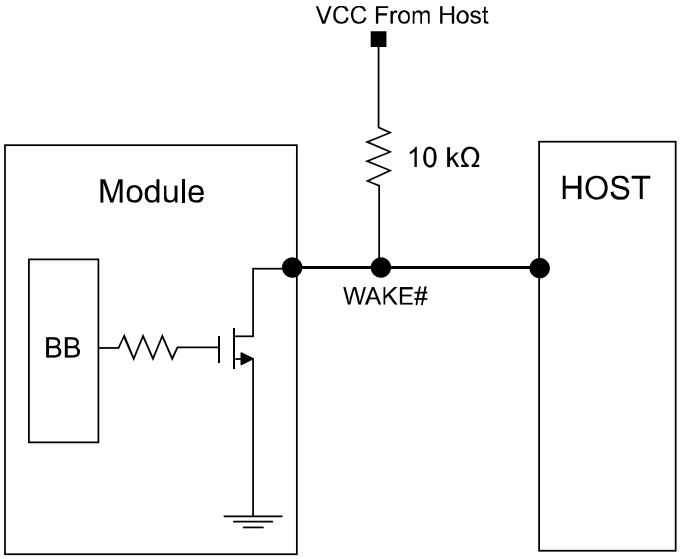
3.4.2 WAKE# Signal

WAKE# pin (the signal that the module uses to wake up the PC) supports software control.

This signal is used for module to wake up the host. It is designed as an OC (Open Collector) gate, so it should be pulled up by the host and it is active-low.

When the module wakes up the host, the WAKE# pin will output low-level voltage.

Figure 3-4 Connections of the WAKE# pin

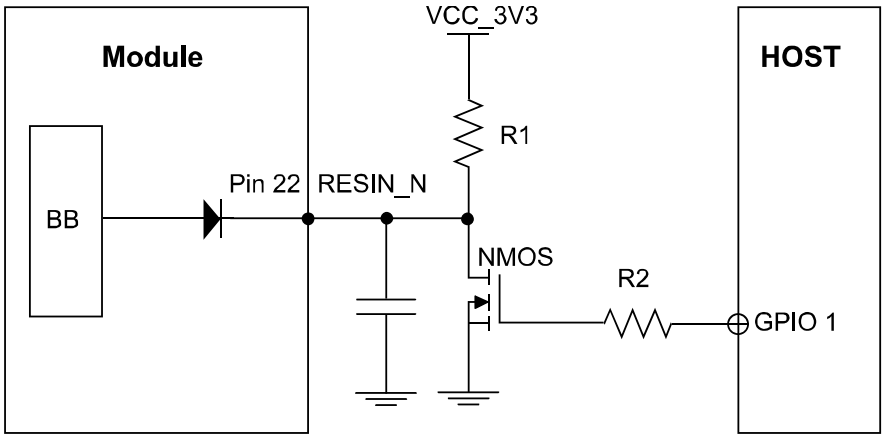


3.4.3 RESIN_N Signal

The RESIN_N pin is used to reset the module's system. When the module software stops responding, the RESIN_N pin can be pulled down to reset the module hardware.

The RESIN_N signal is internally pulled up to 1.8 V, which is automatically on when 3.3 V is applied and it is active-low.

Figure 3-5 Connections of the RESIN_N pin

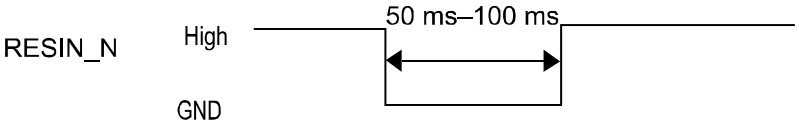


CAUTION

- As the RESIN_N signal is relatively sensitive, it is recommended that you install a 10 nF to 0.1 μF capacitor near the RESIN_N pin of the interface for filtering. In addition, when you design a circuit on the PCB of the interface board, it is recommended that the circuit length should not exceed 20 mm and that the circuit should be kept at a distance of 2.54 mm (100 mil) at least from the PCB edge. Furthermore, you need to wrap the area adjacent to the signal wire with a ground wire. Otherwise, the module may be reset due to interference.
- The maximum Forward Voltage Drop of the diode used in the module is 0.6 V. So when the host wants to reset the module, the low-level voltage in the RESIN_N pin should be below 50 mV.

The MC509 Mini PCIe module supports hardware reset function. If the software of the MC509 Mini PCIe module stops responding, you can reset the hardware through the RESIN_N signal as shown in Figure 3-6 . When a low-level pulse is supplied through the RESIN_N pin, the hardware will be reset. After the hardware is reset, the software starts powering on the module and reports relevant information according to the actual settings.

Figure 3-6 Reset pulse timing



NOTE

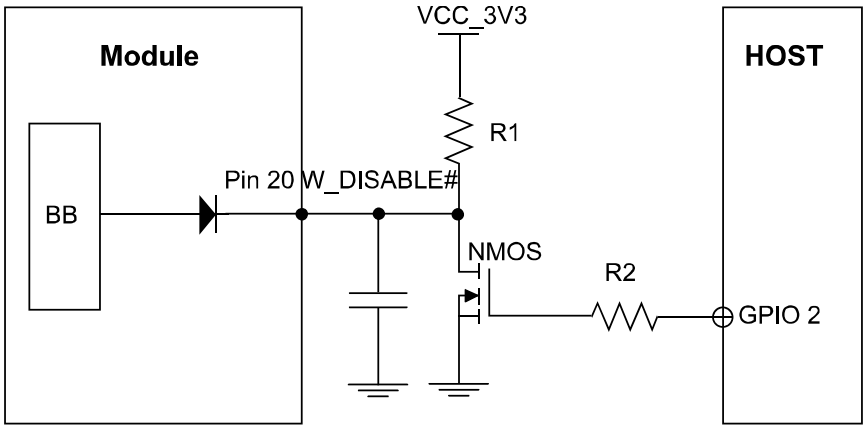
- The RESIN_N pin must not be pulled down for more than 1s.
- The RESIN_N pin is optional, which can be connected or not.
- The maximum Forward Voltage Drop of the diode used in the module is 0.6 V.

3.4.4 W_DISABLE# Signal

The W_DISABLE# signal is provided to allow users to disable wireless communications of the module.

The W_DISABLE# signal is internally pulled up, which is automatically on when 3.3 V is applied and it is active-low.

Figure 3-7 Connections of the W_DISABLE# pin



NOTE

- As the W_DISABLE# signal is relatively sensitive, it is recommended that you install a 10 nF to 0.1 μF capacitor near the W_DISABLE# pin of the interface for filtering.
- The maximum Forward Voltage Drop of the diode used in the module is 0.6 V. So when the host wants to reset the module, the low-level-voltage in the W_DISABLE# pin should be below 50 mV.

3.4.5 LED_WWAN# Signal

NOTE

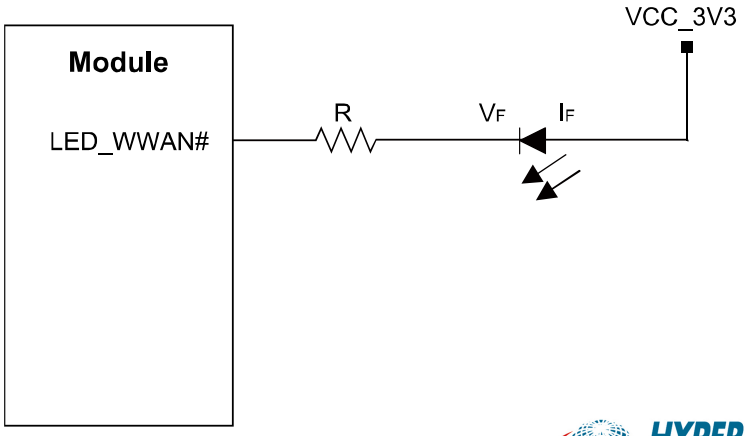
The firmware function is in planning.

MC509 provides an LED_WWAN# signal to indicate the RF status.

The pulse signal output through this pin controls the status LED on the user interface board to display the network status. The LEDs are controlled by a current sink. The high voltage is the voltage of VCC (with the typical value of 3.3 V). The planning drive strength is 10 mA.

Figure 3-8 shows the recommended circuits of the LED_WWAN# pin. According to LED feature, you can adjust the LED brightness by adjusting the resistance of resistor R.

Figure 3-8 Driving circuit



3.5 USB Interface

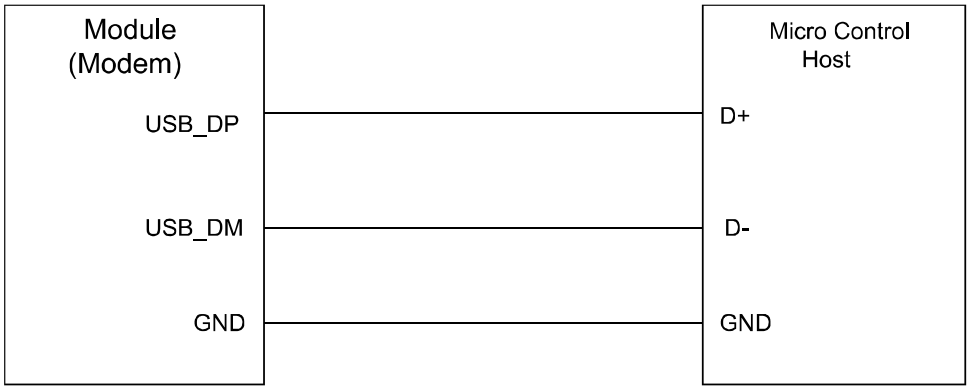
The MC509 Mini PCIe module is compliant with USB 2.0 protocol. The USB interface is powered directly from the VBAT supply. The USB input/output lines are compatible with the USB 2.0 signal specifications. Figure 3-9 shows the circuit of the USB interface.

Table 3-4 Definition of the USB interface

Pin No.	Pin Name	Pad Type	Description	Parameter	Min.(V)	Typ.(V)	Max.(V)
36	USB_DM	I/O	USB signal D-	-	-	-	-
38	USB_DP	I/O	USB signal D+	-	-	-	-

According to USB protocol, for bus timing or electrical characteristics of MC509 Mini PCIe USB signal, please refer to the chapter 7.3.2 of *Universal Serial Bus Specification 2.0.*

Figure 3-9 Recommended circuit of USB interface



3.6 RUIM Card Interface

3.6.1 Overview

The MC509 Mini PCIe module provides an RUIM card interface complying with the C.S0023 standard and supports automatic detection of a 3.0 V or 1.8 V RUIM card.

Table 3-5 RUIM card interface signals

Pin No.	Pin Name	Pad Type	Description	Parameter	Min.(V)	Typ.(V)	Max. (V)
14	RUIM_RESET	O	External RUIM reset signal.	-	-	1.8/2.85	-

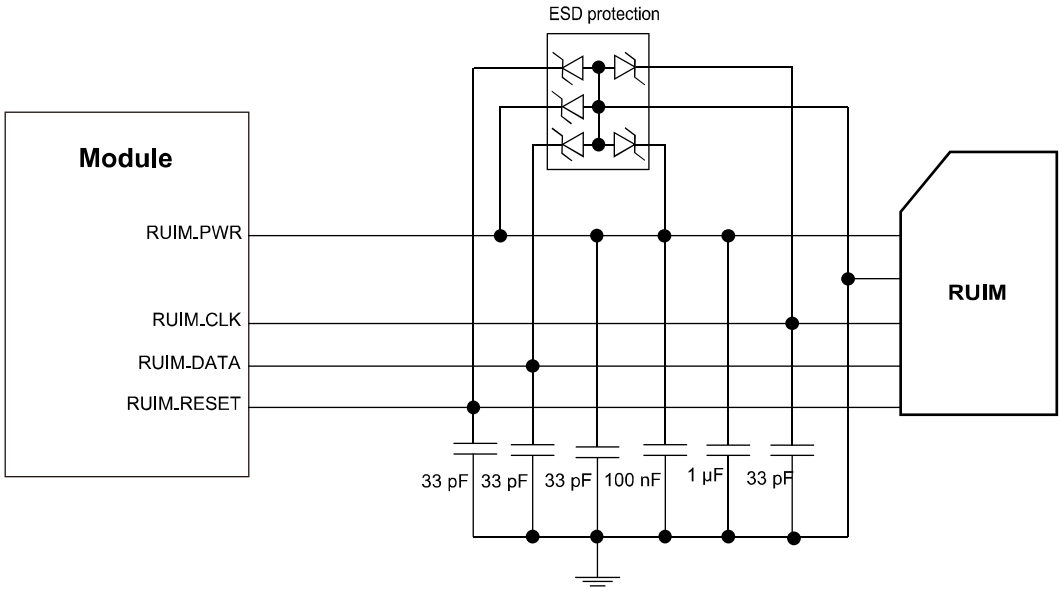
Pin No.	Pin Name	Pad Type	Description	Parameter	Min.(V)	Typ.(V)	Max. (V)
12	RUIM_CLK	O	External RUIM clock signal	-	-	1.8/2.85	-
10	RUIM_DATA	I/O	External RUIM data signal	-	-	1.8/2.85	-
8	RUIM_PWR	PO	Power source for the external RUIM card	Class C	–0.3	1.8	1.98
				Class B	–0.3	2.85	3.3

3.6.2 Circuit Recommended for the RUIM Card Interface

As the Mini PCIe Adapter is not equipped with an RUIM socket, you need to place an RUIM socket on the user interface board.

Figure 3-10 shows the circuit of the RUIM card interface.

Figure 3-10 Circuit of the RUIM card interface



CAUTION

- To meet the requirements of 3GPP TS 11.11 protocols and electromagnetic compatibility (EMC) authentication, the RUIM socket should be placed near the Mini PCIe interface (it is recommended that the PCB circuit connects the Mini PCIe interface and the RUIM socket does not exceed 100 mm), because a long circuit may lead to wave distortion, thus affecting signal quality.
- It is recommended that you wrap the area adjacent to the RUIM_CLK and RUIM_DATA signal wires with ground. The Ground pin of the RUIM socket and the Ground pin of the RUIM card must be well connected to the power Ground pin supplying power to the Mini PCIe Adapter.
- A 100 nF capacitor and 1 μF capacitor are placed between the RUIM_PWR and GND pins in a parallel manner (If RUIM_PWR circuit is too long, that the larger capacitance such as 4.7 μF can be employed if necessary). Three 33 pF capacitors are placed between the RUIM_DATA and Ground pins, the RUIM_RESET and Ground pins, and the RUIM_CLK and Ground pins in parallel to filter interference from RF signals.
- It is recommended to take electrostatic discharge (ESD) protection measures near the RUIM card socket. The TVS diode with Vrwm of 5 V and junction capacitance less than 10 pF must be placed as close as possible to the RUIM socket, and the Ground pin of the ESD protection component is well connected to the power Ground pin that supplies power to the Mini PCIe Adapter.
- It is not recommended that pull the RUIM_DATA pin up during design as a 15000 Ω resistor is used to connect the RUIM_DATA pin to the RUIM_PWR.

3.7 Audio Interface

3.7.1 Overview

The MC509 Mini PCIe module provides one PCM digital audio interface. Table 3-6 lists the signals on the digital audio interface.

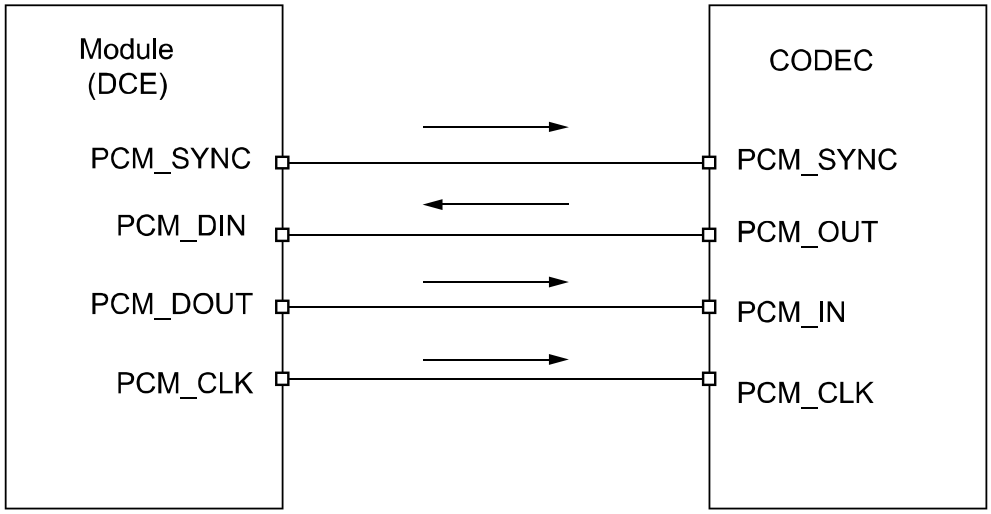
Table 3-6 Signals on the digital audio interface

Pin No.	Pin Name	Pad Type	Description	Parameter	Min.(V)	Typ.(V)	Max.(V)
45	PCM_CLK	O	PCM interface clock	V_{OL}	0	-	0.45
				V_{OH}	-	2.6	-
47	PCM_DOUT	O	PCM I/F data out	V_{OL}	0	-	0.45
				V_{OH}	-	2.6	-
49	PCM_DIN	I	PCM I/F data in	V_{IL}	–0.3	-	0.91
				V_{IH}	1.69	-	2.9
51	PCM_SYNC	O	PCM interface sync	V_{OL}	–0.3	-	0.91

Pin No.	Pin Name	Pad Type	Description	Parameter	Min.(V)	Typ.(V)	Max.(V)
				V_{OH}	1.69	-	2.9

The MC509 PCM interface enables communication with an external codec to support linear and μ-law format. The PCM_SYNC runs at 8 kHz with a 50% duty cycle.

Figure 3-11 Circuit diagram of the interface of the PCM (MC509 Mini PCIe module is used as PCM master)



NOTE

- PCM_SYNC and PCM_CLK: Output when PCM is in master mode;
- The PCM function of MC509 Mini PCIe only supports master mode;
- It is recommended that a TVS be used on the related interface, to prevent electrostatic discharge and protect integrated circuit (IC) components.

3.7.2 External Codec PCM Interface

PCM interface (2048 kHz clock)

Figure 3-12 PCM_SYNC timing

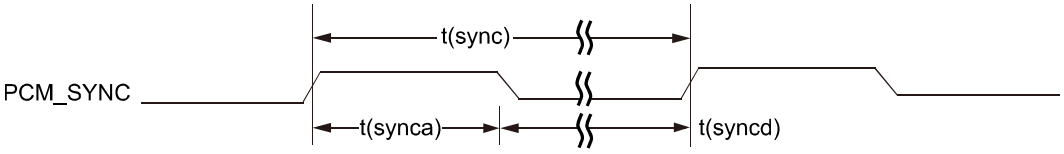


Figure 3-13 PCM_CODEC to MC509 Mini PCIe timing

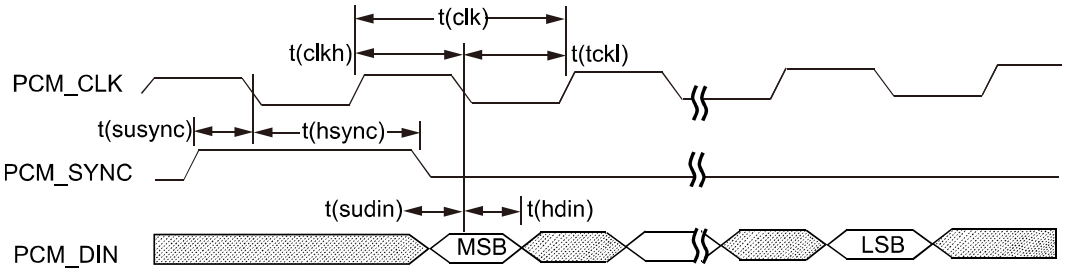


Figure 3-14 MC509 Mini PCIe to PCM_CODEC timing

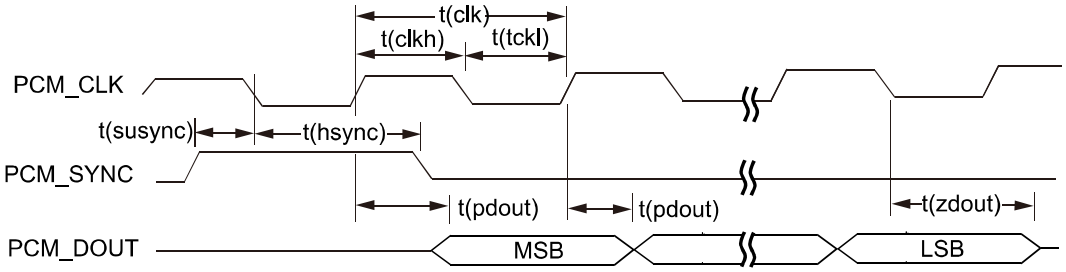


Table 3-7 PCM_CODEC timing parameters

Parameter		Min.	Typ.	Max.	Unit
t(sync)	PCM_SYNC cycle time	-	125	-	µs
t(synca)	PCM_SYNC asserted time	400	500	-	ns
t(syncd)	PCM_SYNC de-asserted time	-	124.5	-	µs
t(clk)	PCM_CLK cycle time	400	500	-	ns
t(clkh)	PCM_CLK high time	200	250	-	ns
t(clkl)	PCM_CLK low time	200	250	-	ns
t(sudin)	PCM_DIN setup time to PCM_CLK falling	50	-	-	ns
t(hdin)	PCM_DIN hold time after PCM_CLK falling	10	-	-	ns
t(pdout)	Delay from PCM_CLK rising to PCM_DOUT valid	-	-	350	ns
t(zdout)	Delay from PCM_CLK falling to PCM_DOUT HIGH-Z	-	160	-	ns

3.8 Reserved Pins

The MC509 Mini PCIe module provides some reserved pins. All of reserved pins cannot be used by the customer.

Table 3-8 Reserved pins

Pin No.	Pin Name	Pad Type	Description
3, 5, 17 and 19	Reserved	-	Reserved

3.9 NC Pins

The MC509 Mini PCIe module has some NC pins. All of NC pins should not be connected. Please keep these pins open.

Table 3-9 NC pins

Pin No.	Pin Name	Pad Type	Description
6–7, 11, 13, 16, 23, 25, 28, 30–33, 44, 46 and 48	NC	-	Not connected, please keep open.

4 RF Specifications

4.1 About This Chapter

This chapter describes the RF specifications of the MC509 Mini PCIe module, including:

- Operating Frequencies
- Conducted RF Measurement
- Conducted Rx Sensitivity and Tx Power
- Antenna Design Requirements

4.2 Operating Frequencies

Table 4-1 shows the RF bands supported by the MC509 Mini PCIe module.

Table 4-1 RF bands of MC509 Mini PCIe module

Operating Band	Tx	Rx
CDMA 800 (BC0)	824 MHz–849 MHz	869 MHz–894 MHz
CDMA 1900 (BC1)	1850 MHz–1910 MHz	1930 MHz–1990 MHz
GPS	-	1574.42 MHz–1576.42 MHz

4.3 Conducted RF Measurement

4.3.1 Test Environment

Test instrument	R&S CMU200, Agilent 8960
Power supply	Keithley 2303, Agilent 66319

RF cable for testing	L08-C014-350 of DRAKA COMTEQ or Rosenberger Cable length: 29 cm

NOTE

- The compensation for different frequency bands relates to the cable and the test environment.
- The instrument compensation needs to be set according to the actual cable conditions.

4.3.2 Test Standards

Huawei modules meet all 3GPP2 test standards. Each module passes strict tests at the factory and thus the quality of the modules is guaranteed.

4.4 Conducted Rx Sensitivity and Tx Power

4.4.1 Conducted Receive Sensitivity

The conducted receive sensitivity is a key parameter that indicates the receiver performance of MC509 Mini PCIe module. The conducted receive sensitivity refers to the weakest signal that the module at the antenna port can receive.

Table 4-2 lists the typical tested values of the MC509 Mini PCIe module.

Table 4-2 MC509 Mini PCIe module conducted Rx sensitivity

Band	Typical value (Unit: dBm)	Note
CDMA 800 Primary	–107.5	1 x (FER < 0.5%)
	–109	EVDO (PER < 0.5%)
CDMA 1900 Primary	–107	1 x (FER < 0.5%)
	–109	EVDO (PER < 0.5%)

Table 4-3 MC509 Mini PCIe module GPS main characteristics

Item	Typical Value (Unit: dBm)
Receive Sensitivity (Cold start)	–145
Receive Sensitivity (Hot start)	–157.5
Receive Sensitivity (Tracking mode)	–158

NOTE

The typical values are the average of some test samples.

4.4.2 Conducted Transmit Power

The conducted transmit power is another indicator that measures the performance of MC509 Mini PCIe module. The conducted transmit power refers to the maximum power that the module tested at the antenna connector can transmit. According to the 3GPP2 protocol, the required transmit power varies with the power class.

Table 4-4 lists the typical tested values of the MC509 Mini PCIe module.

Table 4-4 MC509 Mini PCIe module conducted Tx power

Band		Typical Value (Unit: dBm)	Note (Unit: dB)
CDMA800	1 x	24	-1/+1.5
	EVDO	24	-1/+1.5
CDMA1900	1 x	24	-1/+1.5
	EVDO	24	-1/+1.5

4.5 Antenna Design Requirements

4.5.1 Antenna Design Indicators

Antenna Efficiency

Antenna efficiency is the ratio of the input power to the radiated or received power of an antenna. The radiated power of an antenna is always lower than the input power due to the following antenna losses: return loss, material loss, and coupling loss. The efficiency of an antenna relates to its electrical dimensions. To be specific, the antenna efficiency increases with the electrical dimensions. In addition, the transmission cable from the antenna connector of Mini PCIe Adapter to the antenna is also part of the antenna. The cable loss increases with the cable length and the frequency. It is recommended that the cable loss is as low as possible, for example, U.FL-LP-088 made by HRS.

The following antenna efficiency (free space) is recommended for MC509 Mini PCIe module to ensure high radio performance of the module:

- **Efficiency of the primary antenna: ≥ 40% (below 960 MHz); ≥ 50% (over 1710 MHz)**
- **Efficiency of the diversity antenna: ≥ half of the efficiency of the primary antenna in receiving band**
- **Efficiency of the GPS antenna: ≥ 50%**

In addition, the efficiency should be tested with the transmission cable.

S11 or VSWR

S11 indicates the degree to which the input impedance of an antenna matches the reference impedance (50 Ω). S11 shows the resonance feature and impedance bandwidth of an antenna. Voltage standing wave ratio (VSWR) is another expression of S11. S11 relates to the antenna efficiency. S11 can be measured with a vector analyzer.

The following S11 value is recommended for the antenna of MC509 Mini PCIe module:

- **S11 of the primary antenna: ≤ –6 dB**
- **S11 of the diversity antenna: ≤ –6 dB**
- **S11 of the GPS antenna: ≤ –10 dB**

In addition, S11 is less important than the efficiency, and S11 has weak correlation to wireless performance.

Isolation

For a wireless device with multiple antennas, the power of different antennas is coupled with each other. Antenna isolation is used to measure the power coupling. The power radiated by an antenna might be received by an adjacent antenna, which decreases the antenna radiation efficiency and affects the running of other devices. To avoid this problem, evaluate the antenna isolation as sufficiently as possible at the early stage of antenna design.

Antenna isolation depends on the following factors:

- Distance between antennas
- Antenna type
- Antenna direction

The primary antenna must be placed as near as possible to the MC509 Mini PCIe module to minimize the cable length. The diversity antenna needs to be installed perpendicularly to the primary antenna. The diversity antenna can be placed farther away from the MC509 Mini PCIe module. Antenna isolation can be measured with a two-port vector network analyzer.

The following antenna isolation is recommended for the antennas on laptops:

- **Isolation between the primary and diversity antennas: ≤ –12 dB**
- **Isolation between the primary(diversity) antenna and the GPS antenna: ≤ –15 dB**
- **Isolation between the primary antenna and the Wi-Fi antenna: ≤ –15 dB**

Polarization

The polarization of an antenna is the orientation of the electric field vector that rotates with time in the direction of maximum radiation.

The linear polarization is recommended for the antenna of MC509 Mini PCIe module.

Radiation Pattern

The radiation pattern of an antenna reflects the radiation features of the antenna in the remote field region. The radiation pattern of an antenna commonly describes the power or field strength of the radiated electromagnetic waves in various directions from the antenna. The power or field strength varies with the angular coordinates (θ and φ), but is independent of the radial coordinates.

The radiation pattern of half wave dipole antennas is omnidirectional in the horizontal plane, and the incident waves of base stations are often in the horizontal plane. For this reason, the receiving performance is optimal.

The following radiation patterns are recommended for the antenna of MC509 Mini PCIe module.

Primary/Diversity/GPS antenna: omnidirectional

In addition, the diversity antenna's pattern should be complementary with the primary's.

Envelope Correlation Coefficient

The envelope correlation coefficient indicates the correlation between different antennas in a multi-antenna system (primary antenna, diversity antenna, and MIMO antenna). The correlation coefficient shows the similarity of radiation patterns, that is, amplitude and phase, of the antennas. The ideal correlation coefficient of a diversity antenna system or a MIMO antenna system is 0. A small value of the envelope correlation coefficient between the primary antenna and the diversity antenna indicates a high diversity gain. The envelope correlation coefficient depends on the following factors:

- Distance between antennas
- Antenna type
- Antenna direction

The antenna correlation coefficient differs from the antenna isolation. Sufficient antenna isolation does not represent a satisfactory correlation coefficient. For this reason, the two indicators need to be evaluated separately.

For the antennas on laptops, the recommended envelope correlation coefficient between the primary antenna and the diversity antenna is smaller than 0.5.

Gain and Directivity

The radiation pattern of an antenna represents the field strength of the radiated electromagnetic waves in all directions, but not the power density that the antenna radiates in the specific direction. The directivity of an antenna, however, measures the power density that the antenna radiates.

Gain, as another important parameter of antennas, correlates closely to the directivity. The gain of an antenna takes both the directivity and the efficiency of the antenna into account. The appropriate antenna gain prolongs the service life of relevant batteries.

The following antenna gain is recommended for MC509 Mini PCIe module. **Gain of the primary/diversity antenna ≤ 2.5 dBi**

NOTE

- The antenna consists of the antenna body and the relevant RF transmission cable. Take the RF transmission cable into account when measuring any of the preceding antenna indicators.
- Huawei cooperates with various famous antenna suppliers who are able to make suggestions on antenna design, for example, Amphenol, Skycross, etc.

4.5.2 Interference

Besides the antenna performance, the interference on the user board also affects the radio performance (especially the TIS) of the module. To guarantee high performance of the module, the interference sources on the user board must be properly controlled.

On the user board, there are various interference sources, such as the LCD, CPU, audio circuits, and power supply. All the interference sources emit interference signals that affect the normal operation of the module. For example, the module sensitivity can be decreased due to interference signals. Therefore, during the design, you need to consider how to reduce the effects of interference sources on the module. You can take the following measures: Use an LCD with optimized performance; shield the LCD interference signals; shield the signal cable of the board; or design filter circuits.

Huawei is able to make technical suggestions on radio performance improvement of the module.

4.5.3 Antenna Requirements

The antenna for MC509 Mini PCIe module must fulfill the following requirements:

Antenna Requirements	
Frequency range	Depending on frequency band(s) provided by the network operator, the customer must use the most suitable antenna for that/those band (s)
Bandwidth of primary antenna	70 MHz in CDMA 800 140 MHz in CDMA 1900
Bandwidth of diversity antenna	25 MHz in CDMA 800 60 MHz in CDMA 1900
Bandwidth of GPS antenna	2 MHz in GPS
Gain	≤ 2.5 dBi
Impedance	50 Ω
VSWR absolute Max.	≤ 3:1 (≤ 2:1 for GPS antenna)
VSWR recommended	≤ 2:1 (≤ 1.5:1 for GPS antenna)

5 Electrical and Reliability Features

5.1 About This Chapter

This chapter describes the electrical and reliability features of the interfaces in the MC509 Mini PCIe module, including:

- Absolute Ratings
- Operating and Storage Temperatures
- Power Supply Features
- Reliability Features
- EMC and ESD Features

5.2 Absolute Ratings

WARNING

Table 5-1 lists the absolute ratings for the MC509 Mini PCIe module. Using the module beyond these conditions may result in permanent damage to the module.

Table 5-1 Absolute ratings for the MC509 Mini PCIe module

Symbol	Specification	Min.	Max.	Unit
VCC_3V3	External power voltage	–0.3	4.0	V

5.3 Operating and Storage Temperatures

Table 5-2 lists the operating and storage temperatures for the MC509 Mini PCIe module.

Table 5-2 Operating and storage temperatures for the MC509 Mini PCIe module

Specification	Min.	Max.	Unit
Normal working temperatures	–20	+60	°C
Extended temperatures[1]	–30	+70	°C
Ambient temperature for storage	–40	+85	°C

NOTE

- [1]: When the MC509 Mini PCIe module works in the range of –30°C to –20°C or +60°C to +70°C, **NOT** all its RF performances comply with 3GPP2 specifications.
- The thermal design must be implemented according to the chapter 6.8 . If not, the overheat protection mechanism will be triggered due to overheated Mini PCIe and the network connection will be terminated.

5.4 Power Supply Features

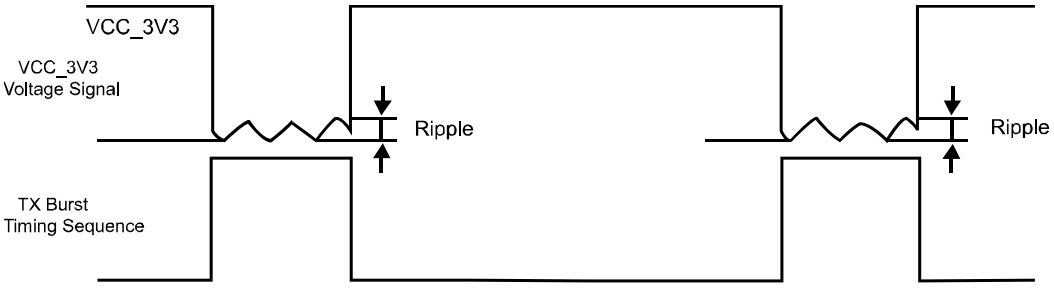
5.4.1 Input Power Supply

Table 5-3 lists the requirements for input power of the MC509 Mini PCIe module.

Table 5-3 Requirements for input power for the MC509 Mini PCIe module

Parameter	Min.	Typ.	Max.	Ripple	Unit
VCC_3V3	3.0	3.3	3.6	0.05	V

Figure 5-1 Power Supply During Burst Emission



NOTE

The VCC_3V3 minimum value must be guaranteed during the burst. So a low-dropout (LDO) regulator or switch power with current output of more than 3.5 A is strongly recommended for external power supply.

Table 5-4 Requirements for input current of the MC509 Mini PCIe module

Power	Module	Peak	Normal
VCC_3V3	MC509 Mini PCIe	< 1500 mA	< 1000 mA

5.4.2 Power Consumption

The power consumptions of MC509 Mini PCIe module in different scenarios are respectively listed in Table 5-5 and Table 5-7 .

The power consumption listed in this section are tested when the power supply of MC509 Mini PCIe module is normal voltage (3.3 V), and all of test values are measured at room temperature.

Table 5-5 Averaged standby DC power consumption of MC509 (CDMA/EVDO)

Description	Bands	Test Value (Unit: mA)	Notes/Configuration
		Typical	
Sleep	CDMA/EVDO 800 MHz	3.5	Module is powered up. SCI=2 (5.12s) Module is registered on the network. USB is in suspend.
Idle		60	Module is powered up. SCI=2 (5.12s) Module is registered on the network, and no data is transmitted. USB is in active.
Radio Off		2.9	Module is powered up. RF is disabled. USB is in suspend.
Sleep	CDMA/EVDO 1900 MHz	3.5	Module is powered up. SCI=2 (5.12s) Module is registered on the network. USB is in suspend.
Idle		70	Module is powered up. SCI=2 (5.12s) Module is registered on the network, and no data is transmitted. USB is in active.

Description	Bands	Test Value (Unit: mA)	Notes/Configuration
		Typical	
Radio Off		2.9	Module is powered up. RF is disabled. USB is in suspend.

Table 5-6 Averaged Data Transmission DC power consumption of MC509 (CDMA/EVDO)

Description	Band	Test Value (Unit: mA)	Notes/Configuration
		Typical	
CDMA	800 MHz	380	0 dBm Tx Power
		400	10 dBm Tx Power
		780	24 dBm Tx Power
EVDO		385	0 dBm Tx Power
		430	10 dBm Tx Power
		800	24 dBm Tx Power
CDMA	1900 MHz	385	0 dBm Tx Power
		415	10 dBm Tx Power
		920	24 dBm Tx Power
EVDO		390	0 dBm Tx Power
		450	10 dBm Tx Power
		930	24 dBm Tx Power

NOTE
Test condition: For max. Tx power, see 4.4.2 Conducted Transmit Power, which are listed in Table 4-4 for max. data throughput, see 2.2 Function Overview, which are listed in Table 2-1 .

Table 5-7 Averaged GPS operation DC power consumption of MC509

Description	Test Value (Unit: mA)	Notes/Configuration
	Typical	
GPS fixing	108	RF is disabled; USB is in active; The Rx power of GPS is –130 dBm.
GPS tracking	108	

5.5 Reliability Features

Table 5-8 lists the test conditions and results of the reliability of the MC509 Mini PCIe module.

Table 5-8 Test conditions and results of the reliability of the MC509 Mini PCIe module

Item		Test Condition	Standard	Sample size	Results
Stress	Low-temperature storage	• Temperature: –40ºC • Operation mode: no power, no package • Test duration: 24 h	IEC60068-2-1 Ab	3 pcs/group	Visual inspection: ok Function test: ok RF specification: ok
	High-temperature storage	• Temperature: 85ºC • Operation mode: no power, no package • Test duration: 24h	IEC60068-2-2 Bb	3 pcs/group	Visual inspection: ok Function test: ok RF specification: ok
	Low-temperature operating	• Temperature: –30ºC • Operation mode: working with service connected • Test duration: 24 h	IEC60068-2-1 Ae JESD22-A 108-C	3 pcs/group	Visual inspection: ok Function test: ok RF specification: ok
	High-temperature operating	• Temperature: 70ºC • Operation mode: working with service connected • Test duration: 24 h	IEC60068-2-2 Be JESD22-A 108-C	3 pcs/group	Visual inspection: ok Function test: ok RF specification: ok

Item		Test Condition	Standard	Sample size	Results
	Damp heat cycling	• High temperature: 55ºC • Low temperature: 25ºC • Humidity: 95% ±3% • Operation mode: working with service connected • Test duration: 6 cycles; 12 h+12 h/cycle	IEC60068-2-30 JESD22-A101-B	3 pcs/group	Visual inspection: ok Function test: ok RF specification: ok
	Temperature shock	• Low temperature: –40ºC • High temperature: 85ºC • Temperature change interval: < 20s • Operation mode: no power, no package • Test duration: 100 cycles; 15 Min+15 Min/cycle	IEC60068-2-14 JESD22-A104-C	3 pcs/group	Visual inspection: ok Function test: ok RF specification: ok
	Salty fog test	• Temperature: 35°C • Density of the NaCl solution: 5% ± 1% • Operation mode: no power, no package Test duration: • Spraying interval: 8 h • Duration of exposing the module to the temperature of 35°C: 16 h	IEC60068-2-14 JESD22-A107-B	3 pcs/group	Visual inspection: ok Function test: ok RF specification: ok
	Sine vibration	• Frequency range: 5 Hz to 200 Hz • Acceleration: 1Grms • Frequency scan rate: 0.5 oct/min • Operation mode: working with service connected • Test duration: 3 axial directions. 2 h for each axial direction.	IEC60068-2-6 JESD22-B103-B	3 pcs/group	Visual inspection: ok Function test: ok RF specification: ok

Item		Test Condition	Standard	Sample size	Results
	Shock test	• Half-sine wave shock • Peak acceleration: 30Grms • Shock duration: 11 ms • Operation mode: working with service connected • Test duration: 6 axial directions. 3 shocks for each axial direction.	IEC60068-2-27 JESD-B104-C	3 pcs/group	Visual inspection: ok Function test: ok RF specification: ok
	Drop test	• 0.8 m in height. Drop the module on the marble terrace with one surface facing downwards, Six surfaces should be tested. • Operation mode: no power, no package	IEC60068-2-32	3 pcs/group	Visual inspection: ok Function test: ok RF specification: ok
ESD	ESD with DVK (or embedded in the host)	• Contact and Air discharges: 10 positive and 10 negative applied • Contact Voltage: ±2 kV, ±4 kV • Air Voltage : ±2 kV, ±4 kV, ±8 kV • Operation mode: working with service connected	IEC61000-4-2	2 pcs	Visual inspection: ok Function test: ok RF specification: ok
NOTE Groups ≥ 2					

5.6 EMC and ESD Features

The following are the EMC design comments:

- Attention should be paid to static control in the manufacture, assembly, packaging, handling and storage process to reduce electrostatic damage to HUAWEI module.
- RSE (Radiated Spurious Emission) may exceed the limit defined by EN301489 if the antenna port is protected by TVS (Transient Voltage Suppressor), which is resolved by making some adjustment on RF match circuit.

- TVS should be added on the USB port for ESD protection, and the parasitic capacitance of TVS on D+/D- signal should be less than 2 pF. Common-mode inductor should be added in parallel on D+/D- signal.
- TVS should be added on the RUIM interface for ESD protection. The parasitic capacitance of TVS on RUIM signal should be less than 10 pF.
- Resistors in parallel and a 10 nF capacitor should be added on RESIN_N signal to avoid shaking, and the distance between the capacitor and the related pin should be less than 100 mil.
- PCB routing should be V-type rather than T-type for TVS.
- An integrated ground plane is necessary for EMC design.

The following are the requirements of ESD environment control:

- The electrostatic discharge protected area (EPA) must have an ESD floor whose surface resistance and system resistance are greater than 1×10^4 Ω while less than 1×10^9 Ω.
- The EPA must have a sound ground system without loose ground wires, and the ground resistance must be less than 4 Ω.
- The workbench for handling ESD sensitive components must be equipped with common ground points, the wrist strap jack, and ESD pad. The resistance between the jack and common ground point must be less than 4 Ω. The surface resistance and system resistance of the ESD pad must be less than 1×10^9 Ω.
- The EPA must use the ESD two-circuit wrist strap, and the wrist strap must be connected to the dedicated jack. The crocodile clip must not be connected to the ground.
- The ESD sensitive components, the processing equipment, test equipment, tools, and devices must be connected to the ground properly. The indexes are as follows:
  - Hard ground resistance < 4 Ω
  - 1×10^5 Ω ≤ Soft ground resistance < 1×10^9 Ω
  - 1×10^5 Ω ≤ ICT fixture soft ground resistance < 1×10^{11} Ω
  - The electronic screwdriver and electronic soldering iron can be easily oxidized. Their ground resistance must be less than 20 Ω.
- The parts of the equipment, devices, and tools that touch the ESD sensitive components and moving parts that are close to the ESD sensitive components must be made of ESD materials and have sound ground connection. The parts that are not made of ESD materials must be handled with ESD treatment, such as painting the ESD coating or ionization treatment (check that the friction voltage is less than 100 V).
- Key parts in the production equipment (parts that touch the ESD sensitive components or parts that are within 30 cm away from the ESD sensitive components), including the conveyor belt, conveyor chain, guide wheel, and SMT nozzle, must all be made of ESD materials and be connected to the ground properly (check that the friction voltage is less than 100 V).
- Engineers that touch IC chips, boards, modules, and other ESD sensitive components and assemblies must wear ESD wrist straps, ESD gloves, or ESD finger cots properly. Engineers that sit when handling the components must all wear ESD wrist straps.
- Noticeable ESD warning signs must be attached to the packages and placement areas of ESD sensitive components and assemblies.

- Boards and IC chips must not be stacked randomly or be placed with other ESD components.
- Effective shielding measures must be taken on the ESD sensitive materials that are transported or stored outside the EPA.

NOTE

HUAWEI MC509 Mini PCIe module does not include any protection against overvoltage.

6 Mechanical Specifications

6.1 About This Chapter

This chapter mainly describes mechanical specifications of MC509 Mini PCIe module, including:

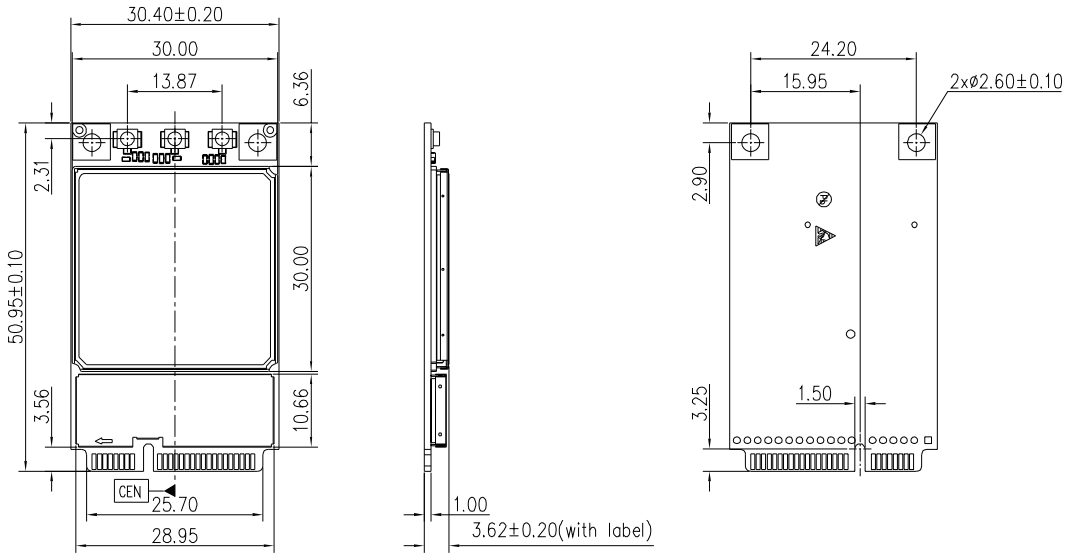
- Dimensions and Interfaces
- Dimensions of the Mini PCI Express Connector
- Packaging
- Label
- Specification Selection for Fasteners
- Antenna Plug
- Thermal Design Guide

6.2 Dimensions and Interfaces

The dimensions of the MC509 Mini PCIe module are 51 mm (length) × 30.4 mm (width) ×3.4 mm (height). Figure 6-1 shows the dimensions of MC509 Mini PCIe module in detail.

Figure 6-1 shows the appearance of the interfaces on the MC509 Mini PCIe module.

Figure 6-1 Dimensions of the MC509 Mini PCIe module (Unit: mm)

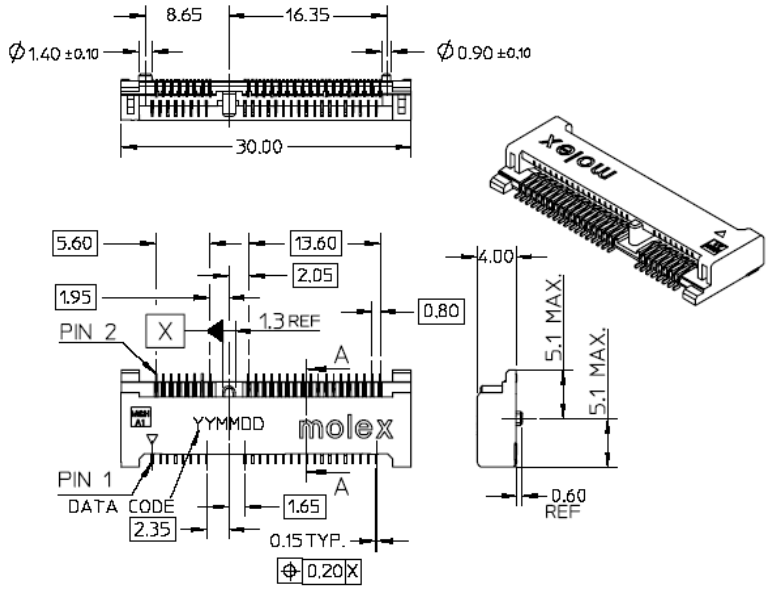


6.3 Dimensions of the Mini PCI Express Connector

The Mini PCIe Adapter adopts a standard Mini PCI Express connector that has 52 pins and complies with the *PCI Express Mini Card Electromechanical Specification Revision 2.0.*

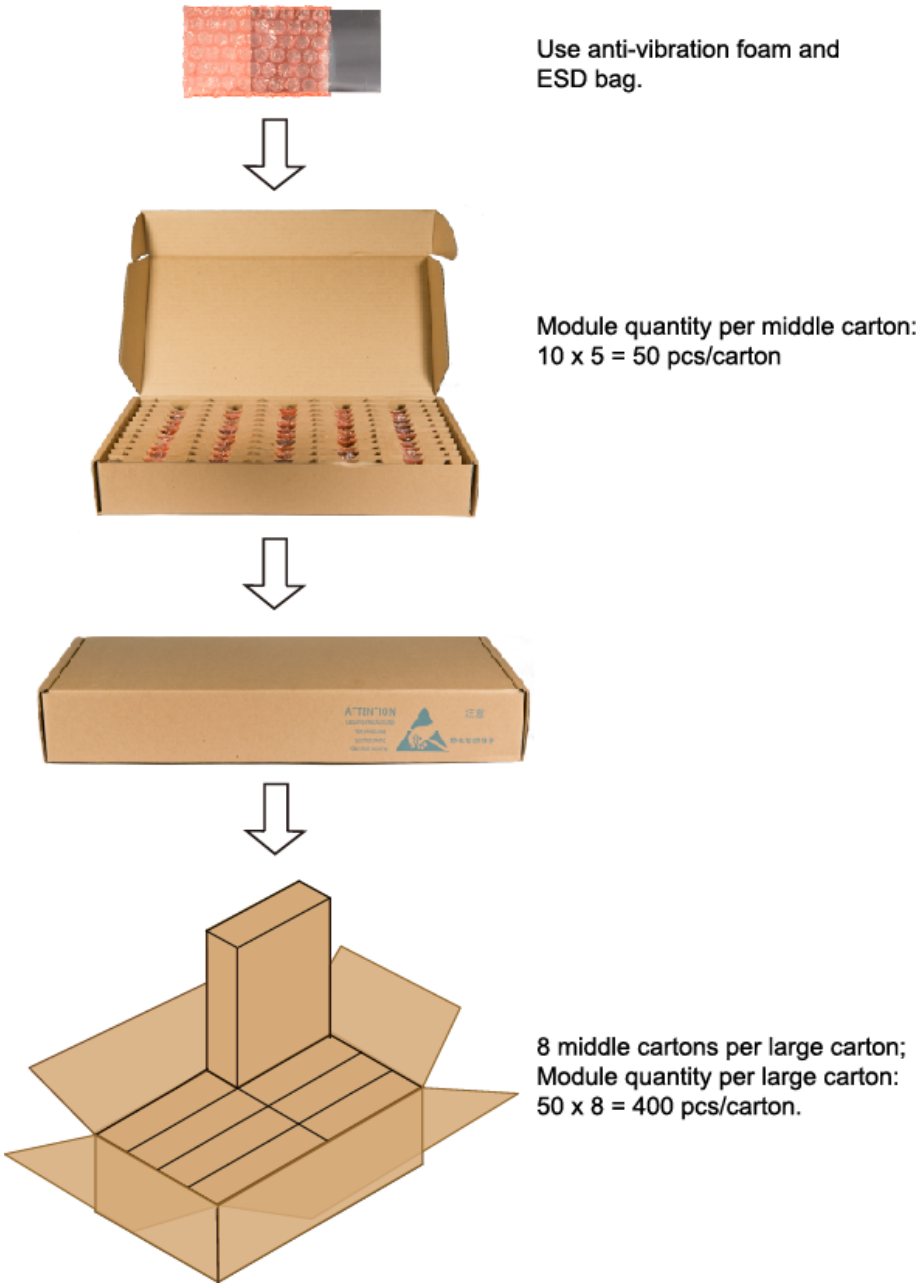
Figure 6-2 shows a 52-pin Mini PCI Express connector (take the Molex 67910002 as an example).

Figure 6-2 Dimensions of the Mini PCI Express connector (Unit: mm)



6.4 Packaging

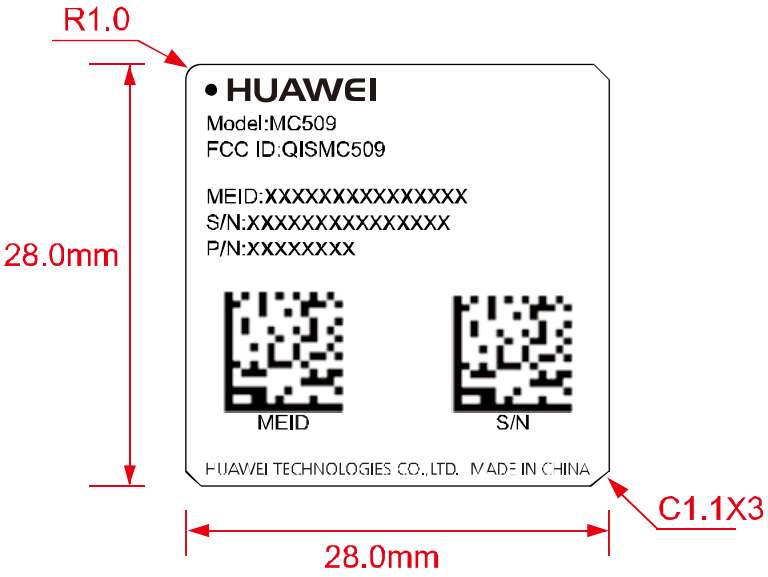
HUAWEI Mini PCIe module uses anti-vibration foam and ESD bag into cartons.



6.5 Label

The label is made from fade-resistant, and is able to endure the high temperature of 149°C.

Figure 6-3 MC509 Mini PCIe module label



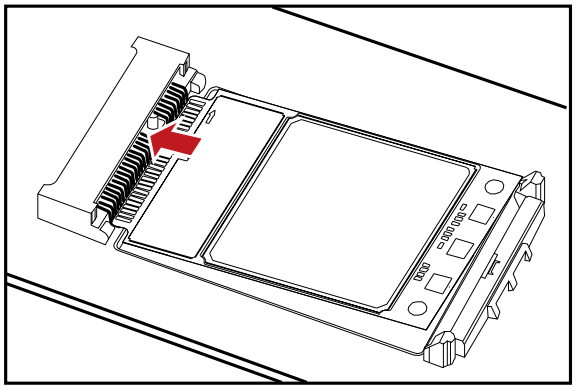
NOTE
The picture mentioned above is only for reference.

6.6 Specification Selection for Fasteners

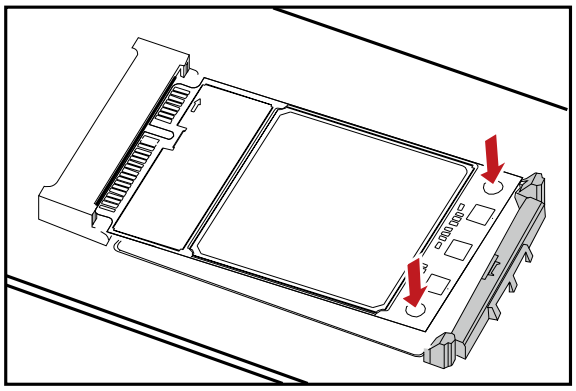
6.6.1 Installing the Mini PCIe Adapter on the Main Board

To install the Mini PCIe Adapter on the main board, do the following:

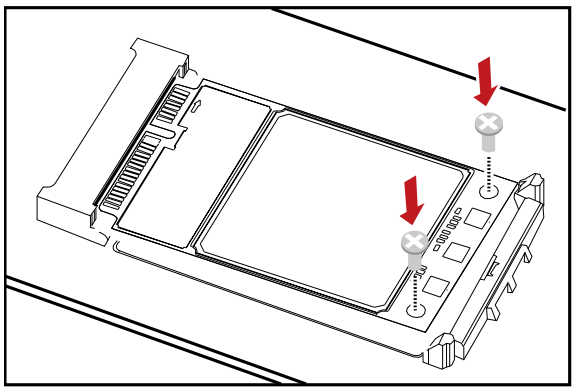
Step 1 Insert the Mini PCIe Adapter into the Mini PCI Express connector on the main board.



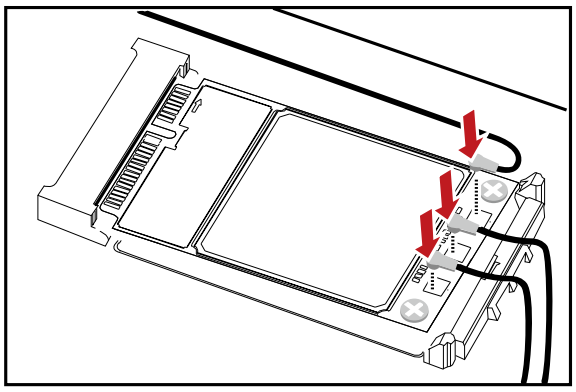
Step 2 Press downwards to fix the Mini PCIe Adapter in the module slot.



Step 3 Use a screwdriver to fix the Mini PCIe Adapter on the main board with two screws provided in the Mini PCIe Adapter packing box.



Step 4 Insert the connector of the main antenna into the MAIN antenna interface (M) of the Mini PCIe Adapter according to the indication on the label of the Mini PCIe Adapter. Insert the connector of the auxiliary antenna into the AUX antenna interface (A) of the Mini PCIe Adapter and the GPS antenna into the GPS antenna interface (G) of the Mini PCIe Adapter in the same way.

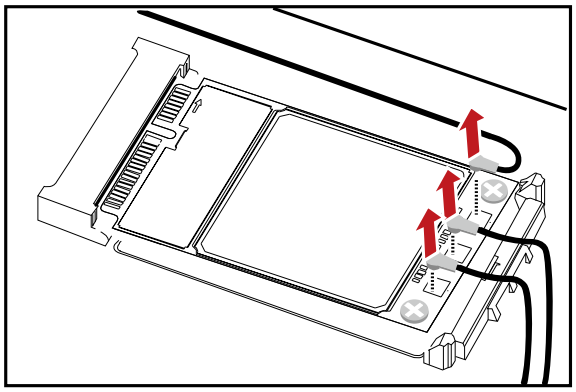


NOTE

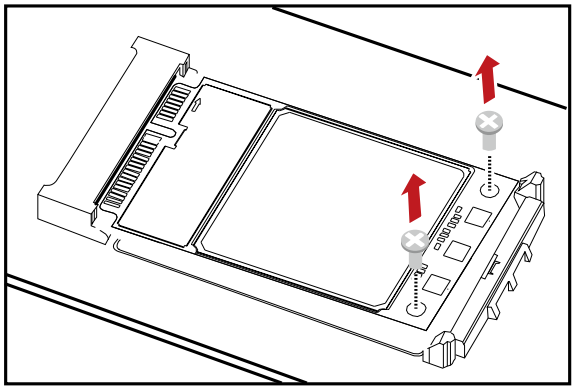
- Insert the antenna connectors vertically into the antenna interfaces of the Mini PCIe Adapter.
- Do not press or squeeze the antenna cable or damage the connectors. Otherwise, the wireless performance of the Mini PCIe Adapter may be reduced or the Mini PCIe Adapter cannot work normally.
- Ensure that the antenna cables are routed through the channel in the frame of the PC and do not lay the cables across the raised edges of the frame.
- The module could not be installed or removed when the host is powered on. Otherwise, it may result in permanent damage to the module.

6.6.2 Removing the Mini PCIe Adapter from the Main Board

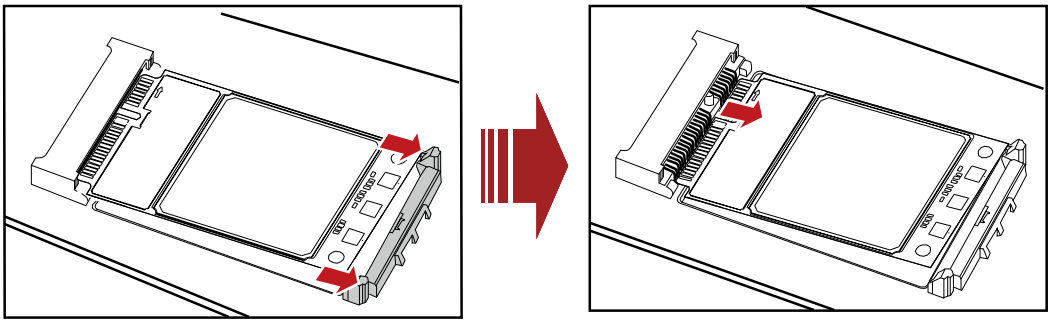
Step 1 Disconnect the antenna cables from the Mini PCIe Adapter. You can lift the connectors using a small screwdriver.



Step 2 Remove the two screws with the screwdriver.

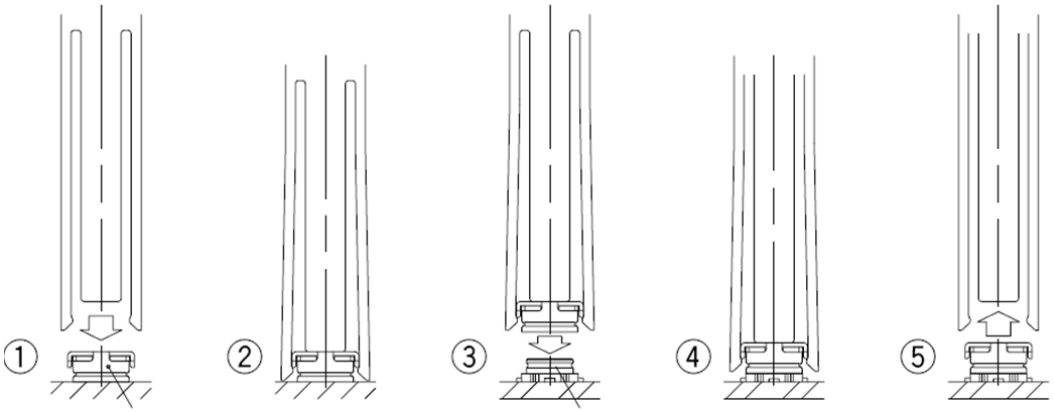


Step 3 Slide backwards the two clips to release the Mini PCIe Adapter from the slot. Then, lift up the Mini PCIe Adapter.



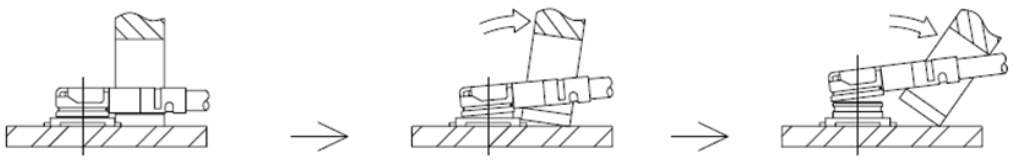
6.7 Antenna Plug

Figure 6-4 Mating the plug



1. Align the mating tool or the mating end of the tool over the plug end of the cable assembly.
2. Firmly place the tool over the plug until it is secured in the tool.
3. Place the plug cable assembly (held in the tool) over the corresponding receptacle.
4. Assure that the plug and receptacle are aligned press-down perpendicular to the mounting surface until both connectors are fully mated.
5. Remove the mating tool by pulling it up carefully.

Figure 6-5 Unmating the plug

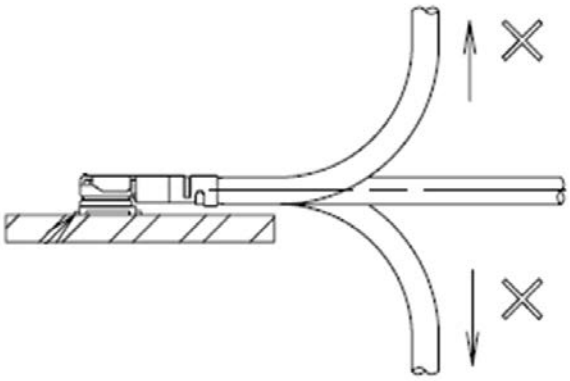


NOTE

- The extraction tool is recommended.
- Any attempt of unmating by pulling on the cable may result in damage and influence the mechanical/electrical performance.

It is recommended not to apply any pull forces after the bending of the cable, as described in Figure 6-6 .

Figure 6-6 Do not apply any pull forces after the bending of the cable

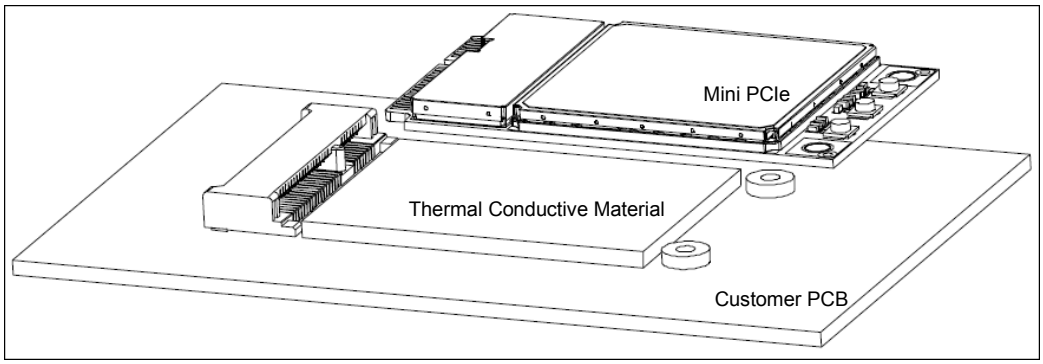


6.8 Thermal Design Guide

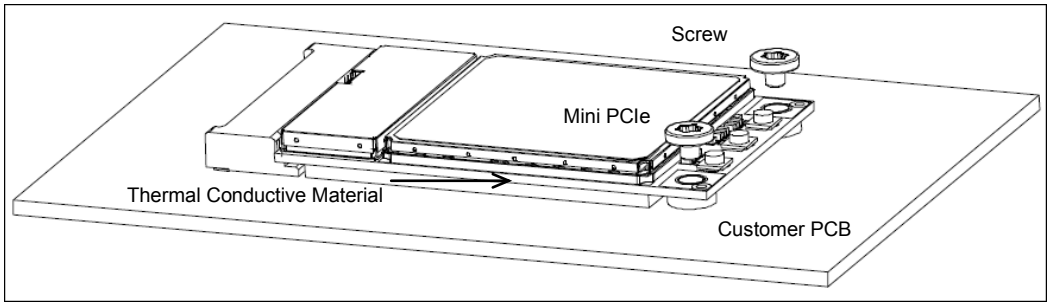
When the module works in the maximum power condition, the Mini PCIe module has high power consumption (for details, see Table 5-6). To improve the module reliability and stability, focus on the thermal design of the device to speed up heat dissipation.

Take the following heat dissipation measures:

- Do not hollow out the customer PCB.
- Attach the thermal conductive material between the Mini PCIe and the customer PCB. The recommended thermal conductivity of the thermal conductive material is 1.0 W/m-k or higher (recommended manufacturers: Laird and Bergquist). The dimensions (W x D) of the thermal conductive material are 38 mm x 28 mm (1.50 in. x 1.10 in.), and its height depends on the height of the Mini PCIe connector you use and the method for installing the Mini PCIe. When deciding the height of the thermal conductive material, you are advised to obey the following rule: After the Mini PCIe is fastened to the customer PCB, the compression amount of the thermal conductive material accounts for 15% to 30% of the thermal conductive material size. For example, if you use a connector shown in the following figure and install the Mini PCIe like this, the recommended height of the thermal conductive material is 1.8 mm (0.07 in.).



- On the customer PCB, reserve two metal screw holes, which are connected to the PCB ground plane. When installing the Mini PCIe, use two metal screws to fasten the Mini PCIe to the customer PCB. See the following figure.



- Ensure that the air flow around the Mini PCIe is sufficient.
- Try not to place any component in the Mini PCIe's projection region on the customer PCB. Do not place components with 1.5 W or higher power consumption or heat sensitive components (such as crystals) near the Mini PCIe.
- Use a large customer PCB. The recommended size (W x D) is 70 mm x 70 mm (3.15 in. x 3.15 in.).
- If the thermal conductive material is attached between the Mini PCIe and the customer PCB, then the heat dissipation performance will be better for multilayer PCB.
- Apply copper to the region for attaching the thermal conductive material to the customer PCB. Try to use the continuous ground plane design on the customer PCB, and each ground plane must be connected through holes. Therefore, reserve holes as many as possible.

NOTE

If you do not take the preceding heat dissipation measures, the overheat protection mechanism is triggered due to overheated Mini PCIe and the network connection is terminated when the Mini PCIe keeps working in enclosed space with a 70°C temperature and the Max. power condition for a period of time. You can resume the network connection only after the temperature drops.

7 Certifications

7.1 About This Chapter

This chapter gives a general description of certifications of MC509 Mini PCIe module.

7.2 Certifications

NOTE
Table 7-1 shows certifications the MC509 Mini PCIe module has been implemented. For more demands, please contact us for more details about this information.

Table 7-1 Product Certifications

Certification	Model name
	MC509
FCC	√
RoHS	√

8 Safety Information

Read the safety information carefully to ensure the correct and safe use of your wireless device. Applicable safety information must be observed.

8.1 Interference

Power off your wireless device if using the device is prohibited. Do not use the wireless device when it causes danger or interference with electric devices.

8.2 Medical Device

- Power off your wireless device and follow the rules and regulations set forth by the hospitals and health care facilities.
- Some wireless devices may affect the performance of the hearing aids. For any such problems, consult your service provider.
- Pacemaker manufacturers recommend that a minimum distance of 15 cm be maintained between the wireless device and a pacemaker to prevent potential interference with the pacemaker. If you are using an electronic medical device, consult the doctor or device manufacturer to confirm whether the radio wave affects the operation of this device.

8.3 Area with Inflammables and Explosives

To prevent explosions and fires in areas that are stored with inflammable and explosive devices, power off your wireless device and observe the rules. Areas stored with inflammables and explosives include but are not limited to the following:

- Gas station
- Fuel depot (such as the bunk below the deck of a ship)
- Container/Vehicle for storing or transporting fuels or chemical products
- Area where the air contains chemical substances and particles (such as granule, dust, or metal powder)
- Area indicated with the "Explosives" sign

- Area indicated with the "Power off bi-direction wireless equipment" sign
- Area where you are generally suggested to stop the engine of a vehicle

8.4 Traffic Security

- Observe local laws and regulations while using the wireless device. To prevent accidents, do not use your wireless device while driving.
- RF signals may affect electronic systems of motor vehicles. For more information, consult the vehicle manufacturer.
- In a motor vehicle, do not place the wireless device over the air bag or in the air bag deployment area. Otherwise, the wireless device may hurt you owing to the strong force when the air bag inflates.

8.5 Airline Security

Observe the rules and regulations of airline companies. When boarding or approaching a plane, power off your wireless device. Otherwise, the radio signal of the wireless device may interfere with the plane control signals.

8.6 Safety of Children

Do not allow children to use the wireless device without guidance. Small and sharp components of the wireless device may cause danger to children or cause suffocation if children swallow the components.

8.7 Environment Protection

Observe the local regulations regarding the disposal of your packaging materials, used wireless device and accessories, and promote their recycling.

8.8 RoHS Approval

The wireless device is in compliance with the restriction of the use of certain hazardous substances in electrical and electronic equipment Directive 2011/65/EU (RoHS Directive).

8.9 Laws and Regulations Observance

Observe laws and regulations when using your wireless device. Respect the privacy and legal rights of the others.

8.10 Care and Maintenance

It is normal that your wireless device gets hot when you use or charge it. Before you clean or maintain the wireless device, stop all applications and power off the wireless device.

- Use your wireless device and accessories with care and in clean environment. Keep the wireless device from a fire or a lit cigarette.
- Protect your wireless device and accessories from water and vapour and keep them dry.
- Do not drop, throw or bend your wireless device.
- Clean your wireless device with a piece of damp and soft antistatic cloth. Do not use any chemical agents (such as alcohol and benzene), chemical detergent, or powder to clean it.
- Do not leave your wireless device and accessories in a place with a considerably low or high temperature.
- Use only accessories of the wireless device approved by the manufacture. Contact the authorized service center for any abnormity of the wireless device or accessories.
- Do not dismantle the wireless device or accessories. Otherwise, the wireless device and accessories are not covered by the warranty.
- The device should be installed and operated with a minimum distance of 20 cm between the radiator and your body.

8.11 Emergency Call

This wireless device functions through receiving and transmitting radio signals. Therefore, the connection cannot be guaranteed in all conditions. In an emergency, you should not rely solely on the wireless device for essential communications.

8.12 Regulatory Information

The following approvals and notices apply in specific regions as noted.

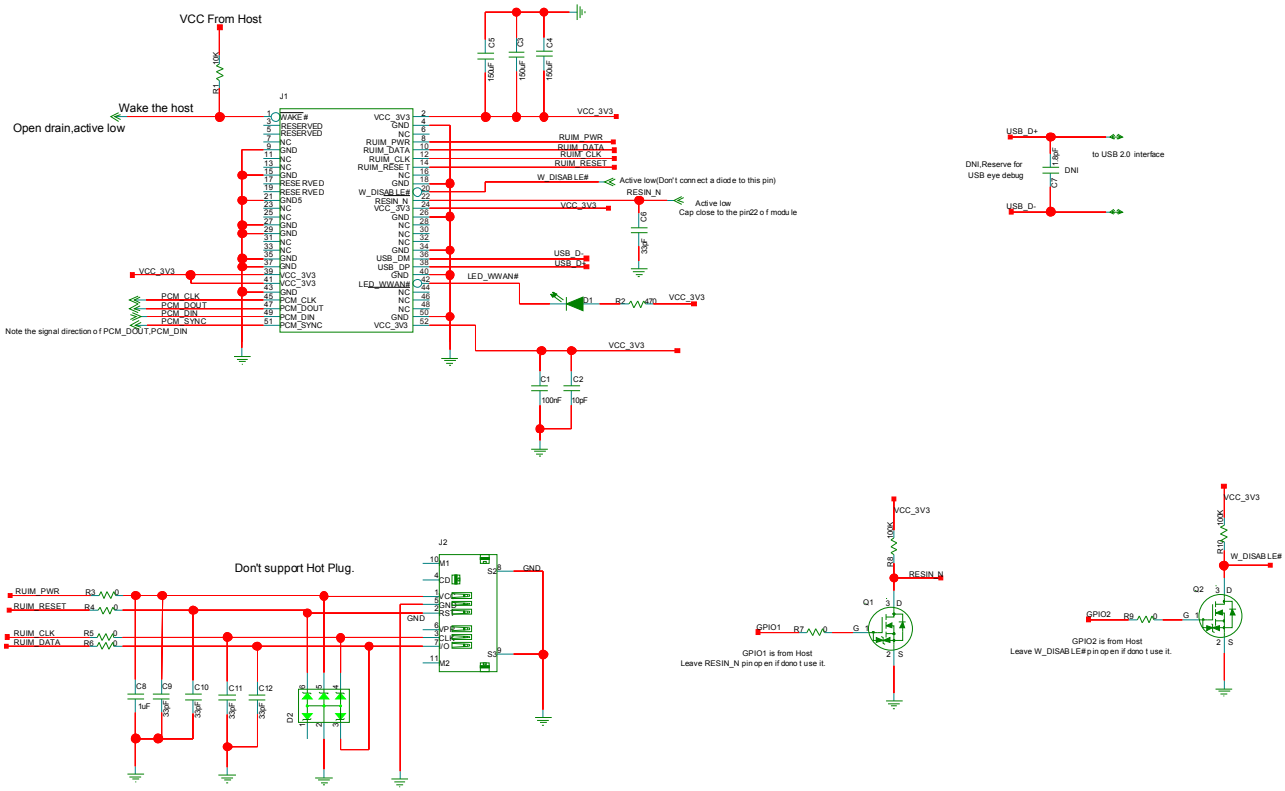
8.12.1 FCC Statement

Federal Communications Commission Notice (United States): Before a wireless device model is available for sale to the public, it must be tested and certified to the FCC that it does not exceed the limit established by the government-adopted requirement for safe exposure.

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

Warning: Changes or modifications made to this equipment not expressly approved by HUAWEI may void the FCC authorization to operate this equipment.

9 Appendix A Circuit of Typical Interface



10 Appendix B Acronyms and Abbreviations

Acronym or Abbreviation	Expansion
3GPP	Third Generation Partnership Project
AUX	Auxiliary
BIOS	Basic Input Output System
BLER	Block Error Rate
DC	Direct Current
DCE	Data Communication Equipment
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
EU	European Union
FCC	Federal Communications Commission
FER	Frame Error Rate
GPIO	General-purpose I/O
ISO	International Standards Organization
LCP	Liquid Crystal Polyester
LDO	Low-Dropout
LED	Light-Emitting Diode
OC	Open Collector
PCB	Printed Circuit Board
PER	Packet Error Ratio
RF	Radio Frequency

Acronym or Abbreviation	Expansion
RoHS	Restriction of the Use of Certain Hazardous Substances
RUIM	Removable User Identity Module
TTFF	Time to First Fix
TVS	Transient Voltage Suppressor
USB	Universal Serial Bus
VSWR	Voltage Standing Wave Ratio
WEEE	Waste Electrical and Electronic Equipment