

# MeiG 5G SRM815 Mini PCIe Hardware Design Manual

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## Revision History

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V1.02	2021-02-20	Yang Shuang Zhou Yan	<ol style="list-style-type: none"><li>1. Modify the ANT interface definition;</li><li>2. Update to support N79 frequency band, shared with GNSS, support N79 by default;</li><li>3. Increase the test connection line model;</li><li>4. Update the SIM card hot swap method;</li></ol>
V1.1	2021-08-10	Cui Chen Zhou Yan	<ol style="list-style-type: none"><li>1. Modify WCDMA B3 power consumption</li><li>2. Added 3.9.3~3.9.5 chapter content</li></ol>

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# 1 Introduction

This document defines the SRM815 Mini PCIe module and its air interface and hardware interface for connecting to customer applications.







This document helps customers quickly understand SRM815 Mini PCIe module interface specifications, electrical characteristics, mechanical specifications, and related product information. With the help of this document, combined with our application manual and user instructions, customers can quickly apply the SRM815 Mini PCIe module to wireless applications.

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## 1.1 Safety Instructions

By complying with the following safety principles, you can ensure personal safety and protect the products and working environment from potential damage:

	Driving safety first! When you drive, do not use handheld mobile terminal device unless it has a hands-free function. Please stop the car before calling!
	Please turn off the mobile terminal device before boarding. The wireless function of mobile terminal shall not be turned on in the aircraft to prevent interference with the aircraft communication system. Ignoring this reminder may affect flying safety or even violate the law.
	In hospitals or health care facilities, pay attention to whether there are restrictions on the use of mobile terminal device. RF interference will cause medical equipment to be abnormal, so mobile terminal device may need to be turned off.
	Mobile terminal device cannot always be effectively connected, for example, if the mobile device has no expense or the SIM is invalid. When you encounter the above situations in an emergency, please make an emergency call, meanwhile, ensure that your device is turned on and in an area with sufficient signal strength.
	Your mobile terminal device will receive and transmit radio frequency signals when it is turned on. There will be radio frequency interference when it is close to TV, radio, computer or other electronic equipment.
	Please keep mobile device away from inflammable gases. Please turn off the mobile terminal device when you are near a fueling station, oil depot, chemical plant or explosion site. There will be potential safety hazards when operating electronic equipment in any place with potential explosion hazard.

## 1.2 Purpose of the Document

This document describes the hardware interface and structural characteristics of SRM815 Mini PCIe wireless module, and guides users to embed the SRM815 Mini PCIe module in the design of various application terminals.

## 1.3 List of Contents

This document is divided into the following parts:

- Chapter 1, mainly introduces the safety instructions and purpose of the document;
- Chapter 2, introduces the basic functions and main features of the SRM815 Mini PCIe wireless module;
- Chapter 3, introduces the functions, characteristics and usage methods of each hardware interface of SRM815 Mini PCIe module;
- Chapter 4, introduces the electrical characteristics of SRM815 Mini PCIe module;
- Chapter 5, introduces the structural features and precautions of the SRM815 Mini PCIe module;
- Chapter 6, appendix A, reference documents and term abbreviations;
- Chapter 7, appendix B GPRS coding schemes.

## 2 Product Overview

### 2.1 Basic Description

The 5G SRM815 Mini PCIe module is a wireless communication module that supports 5G NR, LTE-TDD, LTE-FDD, and WCDMA. The module uses a Mini PCIe package and conforms to the industrial Mini PCIe standard interface definition. It can support USB3.0, GPIO, and other interfaces. Compatible with multiple types of operating systems (Android, Linux, Windows 7/8/9/10, and other operating systems), with the advantages of interface standards, simple base plate design, and easier assembly, and can be widely used in the following fields:

- Laptop and Personal Digital Assistant;
- Remote Monitoring System;
- Vehicle System;
- Wireless POS system;
- Intelligent Meter Reading System;
- Wireless router and Switch;
- Other wireless terminal device.

### 2.2 Product Description

The following table describes the SRM815 Mini PCIe series modules in details.

**Table 1 Frequency Band Supported by SRM815 Mini PCIe**

Product	Description
SRM815-EA-MiniPCle	<ul style="list-style-type: none"> <li>● 5G NR Sub-6G: N1/N3/N28/N40/N41/N77/N78/N79</li> <li>● LTE: FDD: B1/B3/B5/B7/B8/B18/B19/B20/B28 TDD: B34/B38/B39/B40/B41/B42</li> <li>● WCDMA: B1/B3/B5/B8</li> <li>● Support digital voice (optional)</li> </ul>
SRM815-CN-MiniPCle	<ul style="list-style-type: none"> <li>● 5G NR Sub-6G: N1/N28/N41/N78/N79</li> <li>● LTE: FDD: B1/B3/B5/B8/B28 TDD: B34/B38/B39/B40/B41</li> <li>● WCDMA: B1/B8</li> <li>● Support digital voice (optional)</li> </ul>

Table 2 Key Features List of the module

Parameter	Description
Power Supply	<ul style="list-style-type: none"> <li>VBAT supply voltage range: 3.3V~4.35V</li> <li>Typical supply voltage: 3.8V</li> </ul>
Transmit Power	<ul style="list-style-type: none"> <li>Class 2 (26dBm+2/-3dB) for 5G NR HPUE;</li> <li>Class 3 (23dBm±2.7dB) for TDD-LTE bands</li> <li>Class 3 (23dBm±2.7dB) for FDD-LTE bands</li> <li>Class 3 (24dBm+1.7/-3.7dB) for WCDMA bands</li> </ul>
LTE Features	<ul style="list-style-type: none"> <li>Support CAT16</li> <li>The maximum uplink rate is 200Mbps, and the maximum downlink rate is 1Gbps</li> </ul>
WCDMA Features	<ul style="list-style-type: none"> <li>Support 3GPP R8 DC-HSPA+</li> <li>Support 16-QAM, 64-QAM and QPSK modulation</li> <li>3GPP R6 CAT6 HSUPA: the maximum uplink rate is 5.76Mbps</li> <li>3GPP R8 CAT24 DC-HSPA+: the maximum downlink rate is 42.4Mbps</li> </ul>
5G NR Features	<ul style="list-style-type: none"> <li>Support 3GPP R15 standard, support SA/NSA</li> <li>The maximum uplink rate is 900Mbps, and the maximum downlink rate is 2.1Gbps</li> </ul>
Network Protocol Features	<ul style="list-style-type: none"> <li>Support TCP/UDP/PPP/ PING/NITZ/QMI protocol</li> <li>Support PAP (Password Authentication Protocol) and CHAP (Challenge Handshake Authentication Protocol)</li> </ul>
Short Message Service (SMS)	<ul style="list-style-type: none"> <li>Text and PDU mode</li> <li>Point-to-point MO and MT</li> <li>Short message storage: stored in the module by default</li> </ul>
USIM Card Interface	<ul style="list-style-type: none"> <li>Support USIM/SIM card: 1.8V and 3.0V</li> </ul>
Audio Features	<ul style="list-style-type: none"> <li>Support 1 digital audio interface: PCM interface</li> <li>WCDMA: AMR/AMR-WB</li> <li>LTE: AMR/AMR-WB</li> <li>5G NR:AMR/AMR-WB</li> </ul>
PCM Interface	<ul style="list-style-type: none"> <li>For audio use, an external Codec chip is required</li> <li>Support 8-bit A-law, u-law and 16-bit linear coding formats</li> <li>Support long frame mode and short frame mode</li> <li>Support master and slave modes, but it can only be used as master mode in long frame mode</li> </ul>
USB Interface	<ul style="list-style-type: none"> <li>Compatible with USB3.1 gen2 features (only supporting slave mode), the data transfer rate is up to 10.0Gbps</li> <li>Used for AT commands, data transmission, GNSS NMEA output, software debugging and upgrade USB driver: support Windows7, Windows 8/8.1, Windows10, Linux 2.6 or higher, Android2.3/4.0/4.2/4.4/5.0/5.1/6.0/7.0/8.0/9.0/10.0</li> </ul>
Serial Interface	<p>Master serial port:</p> <ul style="list-style-type: none"> <li>Used for AT commands and data transmission</li> </ul>

	<ul style="list-style-type: none"> <li>The maximum baud rate is 460800bps, the default value is 115200bps</li> </ul>
RX-diversity	<ul style="list-style-type: none"> <li>Support 5GNR/LTE/WCDMA diversity</li> </ul>
AT Command	<ul style="list-style-type: none"> <li>Compliant with 3GPP TS 27.007, 27.005, newly add MeiG AT command</li> </ul>
Network Indicates	<ul style="list-style-type: none"> <li>NET_STATUS pin indicates the status of the RF network</li> </ul>
Antenna Interface	<ul style="list-style-type: none"> <li>ANT0 ,ANT1, ANT2 ,ANT_3</li> <li>GNSS antenna interface ANT_GNSS (This ANT defaults to N79 interface, GNSS is closed by default)</li> </ul>
Physical Properties	<ul style="list-style-type: none"> <li>Size:51.0×49.0×5.4mm</li> <li>Weight:&lt;25g</li> </ul>
Temperature Range	<ul style="list-style-type: none"> <li>Normal working temperature: -30℃ ~ +75℃</li> <li>Restricted working temperature: -40℃ ~ +85℃</li> <li>Storage temperature: -45℃ ~ +90℃</li> </ul>
Software Upgrade	<ul style="list-style-type: none"> <li>USB interface upgrade</li> </ul>
RoHS	<ul style="list-style-type: none"> <li>All parts are fully compliant with EU RoHS standard</li> </ul>

### 2.3 Functional Block Diagram

The following is a block diagram of SRM815 Mini PCIe, which elaborates its main functional parts.

- Power Interface;
- Voice Chip;
- SRM815 Module;
- Peripheral Interface.

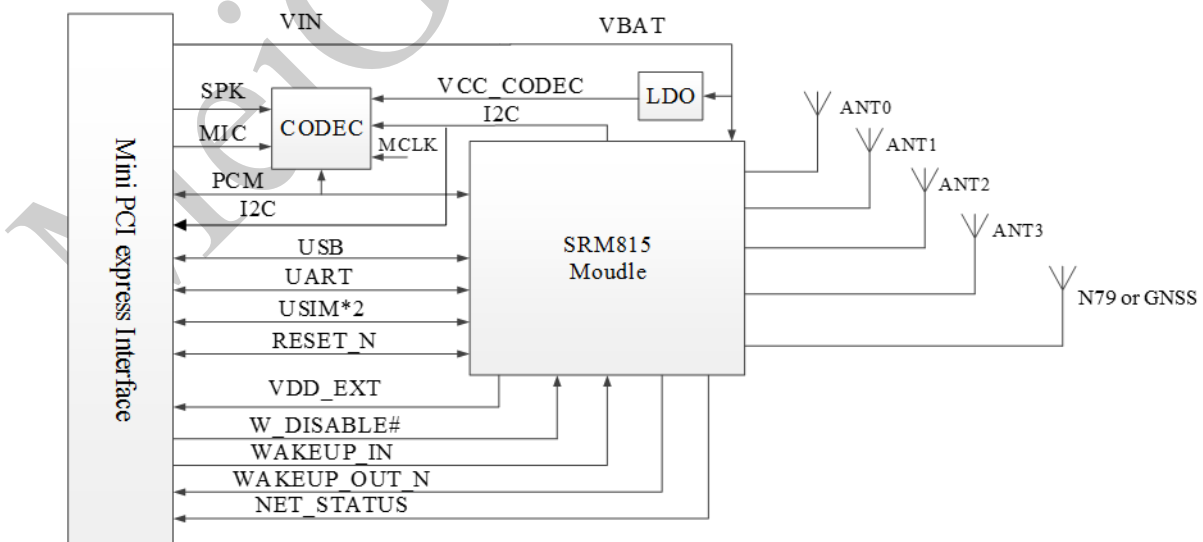


Figure 1 Functional Block Diagram

# 3 Application Interfaces

## 3.1 Basic Description

The physical interface and signal level of the SRM815 Mini PCIe module conform to the PCIe CEM specification. This chapter mainly introduces the function definition and application of the module interface:

- Power Interface;
- USIM/SIM Interface;
- USB Interface;
- UART Interface;
- PCM Interface;
- Antenna Interface;
- Hardware Reset Interface;
- Network Status Indicator Interface;
- Sleep Wake-up Control Interface;
- Flight Mode Control Interface.

## 3.2 SRM815 Mini PCIe Interface

The following table describes each pin definition of the SRM815 Mini PCIe module.

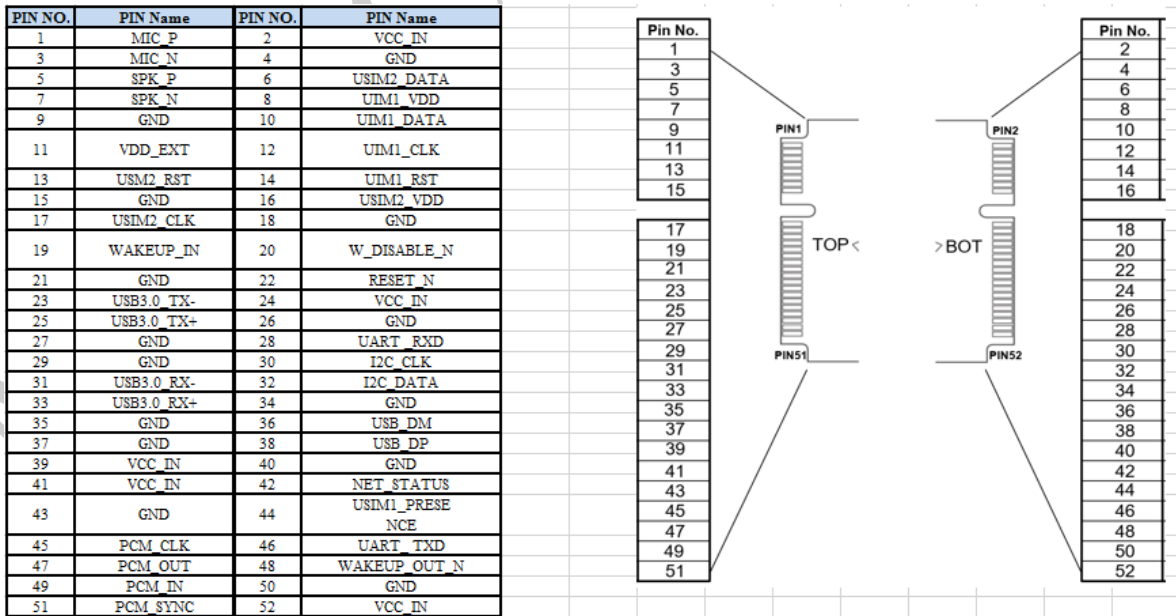


Figure 2 PIN Description

Table 3 IO Parameter Definition

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

Table 4 Pin Description

Pin Number	Mini PCIe Standard Name	SRM815 Mini PCIe Actual Name	I/O	Description	Remarks
1	WAKE#	MIC_P	AI	MIC positive input	Disconnect when not in use
2	3.3Vaux	VIN	PI	Module main power input	The typical value is 3.8V
3	COEX1	MIC_N	AI	MIC negative input	Disconnect when not in use
4	GND	GND	G	Ground	
5	COEX2	SPK_P	AO	Speaker positive output	Disconnect when not in use
6	1.5V	NC	-	-	
7	CLKREQ#	SPK_N	AO	Speaker negative output	Disconnect when not in use
8	UIM_PWR	USIM1_VDD	PO	USIM1 card power supply voltage	The module automatically recognizes 1.8V or 3.0V USIM card
9	GND	GND	G	Ground	
10	UIM_DATA	USIM1_DATA	IO	USIM card data cable	

11	REFCLK-	VDD_EXT	PO	Module 1.8V voltage output	
12	UIM_CLK	USIM1_CLK	DO	USIM card clock line	
13	REFCLK+	USIM2_RST	DO	USIM card reset line	
14	UIM_RESET	USIM1_RST	DO	USIM card reset line	
15	GND	GND	G	Ground	
16	UIM_VPP	USIM2_VDD	PO	USIM2 card power supply voltage	The module automatically recognizes 1.8V or 3.0V USIM card
17	RESERVED	USIM2_CLK	DO	USIM card clock line	
18	GND	GND	G	Ground	
19	RESERVED	WAKEUP_IN	DI	Sleep mode control input	1.8V power domain, high level wakes up the module; low level, the module enters sleep mode. Disconnect when not in use
20	W_DISABLE#	W_DISABLE_N	DI	Flight mode control input	1.8V power domain, low level makes the module enter the flight mode, and disconnect it when not in use.
21	GND	GND	G	Ground	
22	PERST#	RESET_N	DI	Module reset input	1.8V power domain, active at low level, disconnected if not used.
23	PERn0	USB_SS_TX_M	AO	Transmit USB differential negative signal	Disconnect when not in use
24	3.3Vaux	VIN	PI	Module main power input	The typical value is 3.8V
25	PERp0	USB_SS_TX_P	AO	Transmit USB differential positive signal	Disconnect when not in use
26	GND	GND	G	Ground	



27	GND	GND	G	Ground	
28	1.5V	UART_RXD	DI	Module receives data	1.8V power domain, disconnect when not in use
29	GND	GND	G	Ground	
30	SMB_CLK	I2C_SCL	OD	I2C data signal	1.8V power domain, disconnect when not in use
31	PETn0	USB_SS_RX_M	AI	Receive USB differential negative signal	Disconnect when not in use
32	SMB_DATA	I2C_SDA	OD	I2C data signal	1.8V power domain, disconnect when not in use
33	PETp0	USB_SS_RX_P	AI	Receive USB differential positive signal	Disconnect when not in use
34	GND	GND	G	Ground	
35	GND	GND	G	Ground	
36	USB_D-	USB_HS_DM	IO	USB differential data negative signal	
37	GND	GND	G	Ground	
38	USB_D+	USB_HS_DP	IO	USB differential data positive signal	
39	3.3Vaux	VIN	PI	Module main power input	The typical value is 3.8V
40	GND	GND	G	Ground	
41	3.3Vaux	VIN	PI	Module main power input	The typical value is 3.8V
42	LED_WWAN#	NET_STATUS	DO	Indicate the network operation status of the module	Only connect indicator circuit
43	GND	GND	G	Ground	
44	LED_WLAN#	USIM1_DET	DI	USIM1 card detection	1.8V power domain, need to be externally pulled up to 1.8V; disconnect when not in use

45	RESERVED	PCM_CLK	IO	PCM clock	In the 1.8V power domain, the module serves as the master device, and this pin is the output signal, and the module serves as the slave device, and this pin is the input signal. Disconnect when not in use.
46	LED_WPAN#	UART_TXD	DO	Module transmits data	1.8V power domain, disconnect when not in use
47	RESERVED	PCM_DOUT	DO	PCM data output	1.8V power domain, disconnect when not in use
48	1.5V	WAKEUP_OUT_N	DO	Wake-up signal output	1.8V power domain, disconnect when not in use
49	RESERVED	PCM_DIN	DI	PCM data input	1.8V power domain, disconnect when not in use
50	GND	GND	G	Ground	
51	RESERVED	PCM_SYNC	IO	PCM data synchronization signal	In the 1.8V power domain, the module serves as the master device, and this pin is the output signal, and the module serves as the slave device, and this pin is the input signal. Disconnect when not in use.
52	3.3Vaux	VIN	PI	Module main power input	The typical value is 3.8V

### 3.3 Power Supply Design

#### 3.3.1 Pin Description

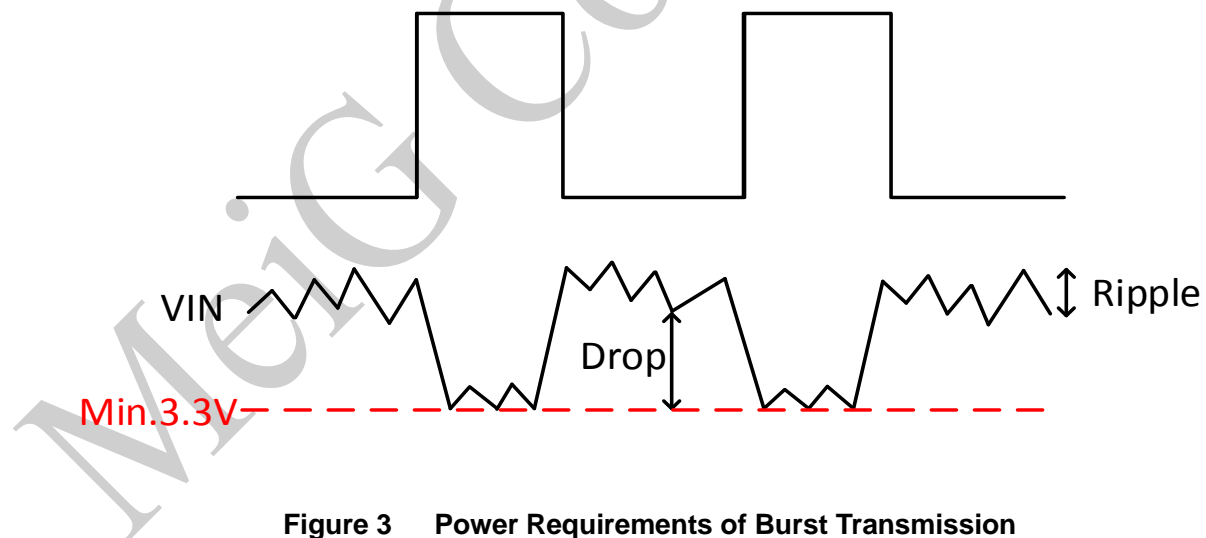
The description in this section is related to the power supply. The interfaces involved include the following:

**Table 5 Power Related Interfaces**

Pin Name	Pin Number	Description	Min. Value	Typical Value	Max. Value	Unit
VIN	2,24,39,41,52	PI	3.3	3.8	4.35	V
GND	4,9,15,18,21,26,27,29,34,35,37,40,43,50	Ground	-	0	-	V

#### 3.3.2 Reduce Voltage Drop

The power supply range of SRM815 Mini PCIe is 3.3V~4.35V, and the typical value is 3.8V. In order to ensure the normal operation of the module, the power supply must have sufficient power supply capability, and the input voltage must not be lower than 3.3V. If the instantaneous voltage drop causes the VIN supply voltage to be too low, the module will be restarted or shut down. The following figure shows the voltage drop during burst transmission in 3G, 4G and 5G networks.



**Figure 3 Power Requirements of Burst Transmission**

On the premise of ensuring sufficient VIN power supply capability, the following requirements must be met during design:

If you use a lithium-ion battery for power supply, connect a 100uF low ESR (less than 0.5Ω) ceramic voltage stabilizer capacitor to the side of the VIN input near the module. Due to the high price of ceramic capacitors with small size and large capacitance, it is recommended to replace (CA) with 220uF tantalum capacitors, and then connect a 0.1uF~1uF ceramic capacitor (CB) in parallel.

If you use DC for power supply, connect a (220uF/10V) electrolytic capacitor (CA) at the side of the VIN input near the module. If the structure is limited, you can connect two (470uF/6.3V) tantalum capacitors (CA) in parallel, and then connect a 0.1uF~1uF ceramic capacitor (CB) in parallel. **In order to ensure better power supply performance, a TVS tube is added near the VIN input of the module to improve the surge voltage withstand capability of the module.**

### 3.3.3 Power Supply Reference Circuit

The design of module power supply is very important, because the performance of the module depends heavily on power supply. SRM815 Mini PCIe must choose a power supply capable of providing at least 5A current. If the difference between the input voltage and the supply voltage of the module is not very large, it is recommended to choose LDO as the power supply. If there is a large difference between the input voltage and the output voltage, it is recommended to use DCDC as the power supply for the module. When the external power supply is connected to the module, VIN needs to use star wiring. The following figure shows the reference design of +5V power supply circuit. This design uses DCDC of SILERGY Corp., the model is SY8156ADC. Its typical output voltage is 3.8V and the peak load current is up to 5A.

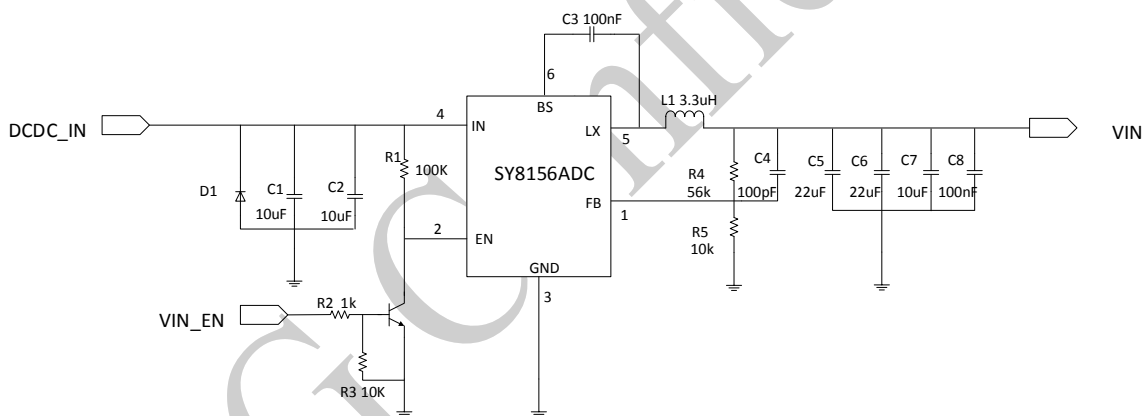


Figure 4 Reference Design of Power Supply Circuit

### 3.3.4 VDD\_EXT Voltage Output

When the SRM815 Mini PCIe module is turned on normally, there is a voltage output on Pin11-VDD\_EXT, the output voltage is 1.8V, and the current load is 50mA. This output voltage can be used as an external power supply, such as a level reference, and it can also read the pin level status to determine whether the module is turned on.

### 3.4 USIM/SIM Interface

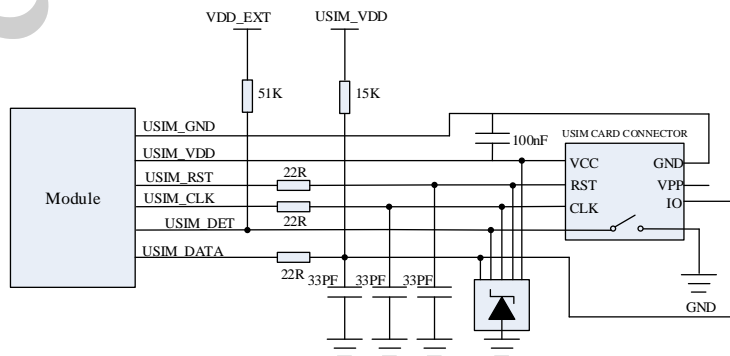
USIM card interface circuit meets the requirements of ETSI and IMT-2000 SIM interfaces. SRM815 Mini PCIe supports USIM card of 1.8V and 3.0V.

**Table 6 USIM/SIM Interface Description**

Pin Name	Pin Number	I/O	Description	Remarks
USIM1_DET	44	DI	USIM card plug detection	It needs to be pulled up to 1.8V
USIM1_VDD	8	PO	USIM card power supply	Support USIM card of 1.8V and 3.0V
USIM1_DATA	10	IO	USIM card data signal	
USIM1_CLK	12	DO	USIM card clock signal	
USIM1_RST	14	DO	USIM card reset signal	
USIM2_VDD	16	PO	USIM card power supply	Support USIM card of 1.8V and 3.0V
USIM2_DATA	6	IO	USIM card data signal	
USIM2_CLK	17	DO	USIM card clock signal	
USIM2_RST	13	DO	USIM card reset signal	

The SRM815 Mini PCIe module supports the hot plug function of USIM1 card through the USIM1\_DET pin, which supports high-level detection, **and the hot plug function is disabled by default, if you need to use it, please contact FAE for related methods.**

In the following figure, after the SIM card is inserted, the USIM1\_DET pin is at low level. When no card is detected, the USIM1\_DET pin is at high level.



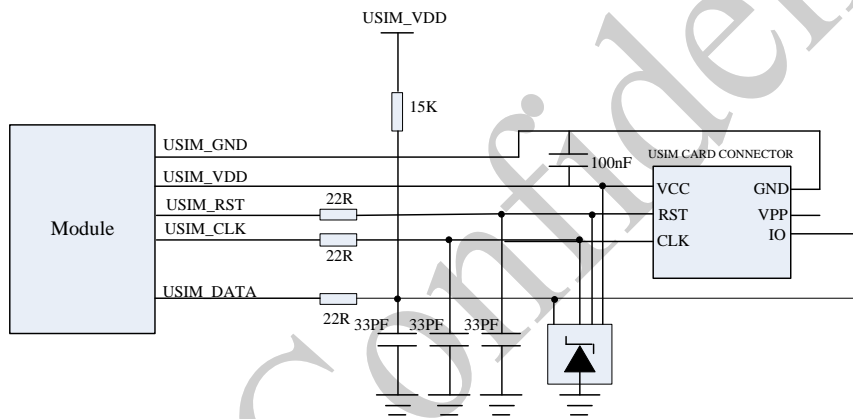
**Figure 5 Reference Design of 8-PIN USIM/SIM Card Connector**

SIM card Connectors are divided into two types according to different designs of manufacturers:

1. SIM card connector detection pin normally open type: when there is no card, the detection pin is disconnected from the ground, and the module detects a high level. The detection pin is connected to the ground when the card is inserted, and the module detects a low level.
2. SIM card connector detection pin normally closed type: the detection pin is connected to the ground when there is no card, and the module detects a low level. The detection pin is disconnected from the ground when the card is inserted, and the module detects a high level.

When in use, it is necessary to configure the detection logic of the software according to the design of the SIM card connector. The SRM815 Mini PCIe module software detects the low level by default and recognizes the card insertion.

If you do not need to use the USIM card detection function, please keep the USIM1\_DET pin disconnected. The following figure is the reference circuit of the 6-pin USIM card connector interface:



**Figure 6 Reference Design of 6-PIN USIM/SIM Card Connector**

In the circuit design of USIM card interface, in order to ensure the good performance and reliability of USIM card, it is recommended to follow the following design principles in circuit design:

- USIM\_DATA needs a pull-up resistor to USIM\_VDD, this pull-up resistor is 15kΩ; this pull-up resistor is helpful to increase the anti-interference ability of SIM card. When the routing of USIM card is too long or there is an interference source nearby, it is recommended to add a pull-up resistor near the card connector;
- Connect a 22Ω resistor in series to the USIM\_DATA, USIM\_CLK and USIM\_RST circuits, so as to suppress stray EMI, enhance ESD protection and facilitate debugging;
- In order to improve the anti-static ability, add TVS and ESD protective device with parasitic capacitance not greater than 15pF to USIM\_VDD, USIM\_DATA, USIM\_CLK and USIM\_RST circuits;
- Connect a 33pF capacitor in parallel to USIM\_VDD, USIM\_DATA, USIM\_CLK and USIM\_RST circuits to filter out radio frequency interference; the peripheral parts of USIM card should be placed as close to USIM card connector as possible;
- USIM card connector is placed close to the module, and try best to ensure that the routing length of USIM card signal line does not exceed 200mm;
- Routing of USIM card signal line shall be away from RF lines and VIN power lines;

- In order to prevent crosstalk interference of USIM\_CLK signal and USIM\_DATA, routing of the two should not be too close, and ground shield should be added between two lines;
- For the hot plug function of USIM/SIM, use the DETECT pin of the hot plug card slot and the Pin44 pin of the module. The hot plug function is disabled by default, please contact us for more details of this function.

**Note:**

1. If SIM Connectors that do not support hot plug are directly used for hot plug of USIM/SIM card, it may damage USIM /SIM card or SRM815 Mini PCIe USIM /SIM interface.
2. USIM2 does not support hot plug.

## 3.5 USB Interface

SRM815 Mini PCIe provides a USB interface that complies with the USB 3.1 Gen2 specifications and supports a theoretical maximum transmission rate of 10Gb/s. This interface is used for AT command interaction, data transmission, software debugging, and version upgrade, etc.

### 3.5.1 USB Pin Description

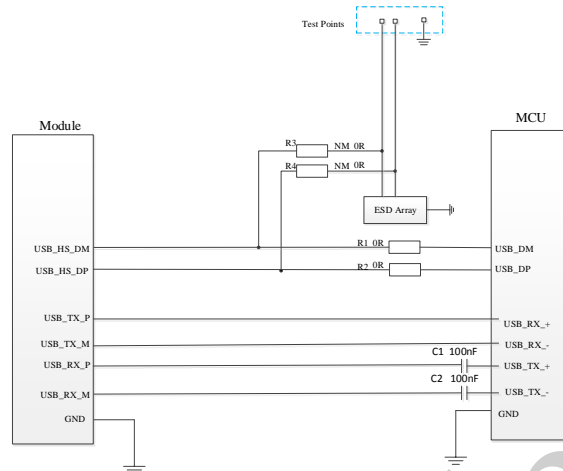
SRM815 Mini PCIe module provides one USB3.1 Super-Speed or one USB2.0 High-Speed interface.

**Table 7 USB Interface Description**

Name	Pin Name	I/O	Description	Remarks
USB_HS_DP	38	IO	USB differential data signal +	90Ω differential impedance is required
USB_HS_DM	36	IO	USB differential data signal -	90Ω differential impedance is required
USB_SS_TX_P	25	AO	USB transmits signal + at high speed	90Ω differential impedance is required
USB_SS_TX_M	23	AO	USB transmits signal - at high speed	90Ω differential impedance is required
USB_SS_RX_P	33	AI	USB receives signal + at high speed	90Ω differential impedance is required
USB_SS_RX_M	31	AI	USB receives signal - at high speed	90Ω differential impedance is required

### 3.5.2 USB Reference Circuit

USB interface reference circuit of SRM815 Mini PCIe module is shown in the following figure.



**Figure 7 Reference Design of USB Interface**

In order to meet the signal integrity requirement of USB data cable, the resistors R1/R2/R3/R4 must be placed close to the module, and the resistors must be placed close to each other. The branch circuit connecting the test points must be as short as possible.

In the design of USB interface circuit, in order to ensure USB performance, it is recommended to follow the following principles in circuit design:

- When connecting the USB interface of the module to the MCU, please note that the module USB\_TX signal is connected to the USB\_RX signal of the MCU, and the module USB\_RX signal is connected to the USB\_TX signal of the MCU;
- In order to reduce the signal interference during USB high-speed data transmission, connecting R1 and R2 in series to USB\_HS\_DM and USB\_HS\_DP interface circuits can improve the accuracy of data transmission. It is recommended to use 0Ω for both R1 and R2;
- In order to improve the anti-static performance of USB interface, it is recommended to add ESD protective devices to USB\_HS\_DP, USB\_HS\_DM, USB\_TX\_P, USB\_TX\_M, USB\_RX\_P and USB\_RX\_M interface circuits. It is recommended to use ESD devices with the junction capacitance less than 2pF; ESD protective devices for USB should be placed as close as possible to the USB interface;
- In order to improve the signal interference during USB3.1 high-speed data transmission, a 100nF capacitor is added to the TX end of MCU to improve the EMI performance.
- In order to ensure the reliable operation of USB, pay more attention to the protection of USB when designing. For example, the protection of USB during Layout requires 90Ω impedance control for USB\_HS\_DP, USB\_HS\_DM, USB\_TX\_P, USB\_TX\_M, USB\_RX\_P and USB\_RX\_M, strictly follow the differential requirements and keep as far away as possible from interference signals when wiring;
- Do not lay USB line under crystal resonator, oscillator, magnetic device and RF signal. It is recommended to use the internal differential routing and coated with ground wire up, down, left and right.



### 3.5.3 USB Driver

SRM815 Mini PCIe module supports various operating systems, such as PC operating systems: Windows 7/8, Windows 10; embedded operating systems: Linux 2.6 or higher version, Android 2.3/4.0/4.2/4.4/5.0/5.1/6.0/7.0/8.0/9.0/10.0, dedicated USB driver support is required.

USB driver can provide different driver files for different operating systems, different VIDs and PIDs. Please contact support personnel for specific requirements.

## 3.6 Serial Interface

SRM815 Mini PCIe provides two serial ports: master serial port and debug serial port. Two interface characteristics are described as below.

- The default baud rate of the master serial port is 115200bps, which is used for data transmission and AT commands;
- The debug serial port supports 115200bps baud rate, which is used for Linux control and log printing.

### 3.6.1 Serial port pin description

**Table 8 Pin Description of Main Serial Port**

Pin Name	Pin Number	I/O	Description	Remarks
UART_RXD	28	DI	Module receives data	1.8V power domain
UART_TXD	46	DO	Module transmits data	1.8V power domain

**Table 9 Description of Debug Serial Port**

Pin Name	Pin Number	I/O	Description	Remarks
DBG_RXD	-	DI	Module receives data	Reserve test points on Mini PCIe board
DBG_TXD	-	DO	Module transmits data	Reserve test points on Mini PCIe board

**Table 10 Logic Level of Serial Port**

Parameter	Min. Value	Max. Value	Unit
V <sub>IL</sub>	-0.3	0.6	V
V <sub>IH</sub>	1.2	2.0	V

V <sub>OL</sub>	0	0.45	V
V <sub>OH</sub>	1.35	1.8	V

**Note:**

The SRM815 Mini PCIe module provides a 1.8V serial port. If you use a 3.3V serial port, you need to add a level converter.

## 3.7 Control Signal

The following table is the detailed definition of each control signal.

**Table 11 Pin Definition of Control Signal**

Pin number	Pin Name	I/O	Voltage Domain	Description
19	WEAKUP_IN	DI	1.8V	Sleep mode control, active low
20	W_DISABLE_N	DI	1.8V	Flight mode control, active low
22	RESET_N	DI	1.8V	Reset signal, active low
48	WAKEUP_OUT_N	DO	1.8V	The module outputs low signal after entering sleep mode
42	NET_STATUS	DO	1.8V	LED lights indicate the network operation status of the module

### 3.7.1 WAKEUP\_IN Control Signal

The WAKEUP\_IN signal is the pin for the module to trigger the sleep mode. When the module sleep function is enabled, pull this pin low (initially high), and the module will generate a falling edge when it detects that the pin has a falling edge. After that, the sleep process will be triggered. When the sleep lock is fully released, the module will enter the sleep state smoothly.

Whether the sleep function of the module is enabled, you can query through the AT command `at+sleepen?`. When the query returns a result of 0, it means that the current state of the module disables the sleep function, and a value of 1 means that the sleep function is enabled. Similarly, you can use the AT command `at+sleepen=1` to enable the module's sleep function, or `at+sleepen=0` to disable the module's sleep function. When the module sleep function is disabled, all the pins and states related to the module sleep will be invalid.

When the module is in sleep state (WAKEUP\_IN pin is pulled low to trigger module sleep), pull this pin high, WAKEUP\_IN will generate a rising edge, the module will trigger wakeup after detecting the rising edge interrupt, and then WAKEUP\_IN will remain high level, the module remains awake state.

### 3.7.2 Flight Mode Control Signal

When the module enters the flight mode, the radio frequency function cannot be used, and all AT commands related to radio frequency are inaccessible. There are two ways to make the module enter the flight mode: hardware I/O control and AT command control.

#### 3.7.2.1 Use Hardware I/O Interface to Control Flight Mode \*

Give the module a low level signal through the W\_DISABLE\_N pin (Pin20) of SRM815 Mini PCIe, and the module enters flight mode. At this time, the RF transceiver unit will stop working. Pull Pin20 up, the module will re-enter the normal mode.

**Note:**

The module control signal level supports 1.8V logic level. If the level does not match, please use a level conversion circuit to convert it to 1.8V.

#### 3.7.2.2 AT Command to Control Flight Mode

Send AT+CFUN=4, module will enter flight mode. At this time, the RF transceiver unit will stop working. Send AT+CFUN=1 or restart, the module will re-enter the normal mode.

### 3.7.3 RESET\_N Control Signal

There are two reset modes for SRM815 Mini PCIe: reset by hardware and reset by AT command.

#### 3.7.3.1 Reset by Hardware

When the module is working, reset the module by pulling down the RESET\_N pin for at least 3s. RESET\_N signal is very sensitive to interference, so it is recommended that the routing on the module interface board should be as short as possible and coated with ground wire.

**Table 12 RESET\_N Pin Description**

Pin Name	Pin Number	Description	DC Features	Remarks
RESET_N	22	Reset module	V <sub>IH</sub> max=2.1V V <sub>IH</sub> min=1.3V V <sub>IL</sub> max=0.5V	

The reference circuit diagram is as follows: Customers can control the RESET\_N pin by using open-collector drive circuit or button.

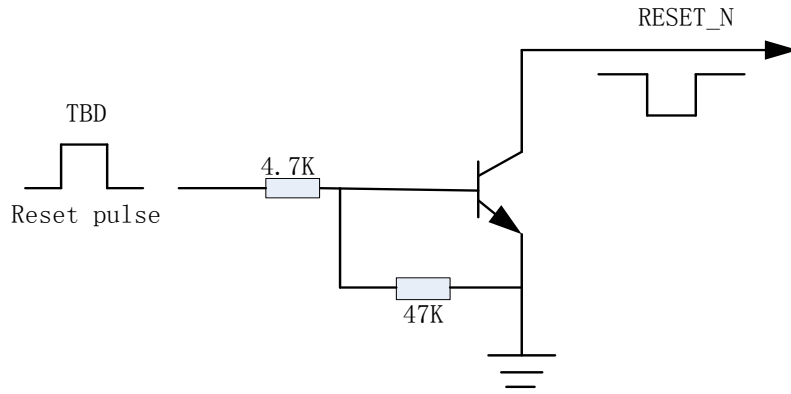


Figure 8 Reference Circuit of RESET\_N Reset Open Collector

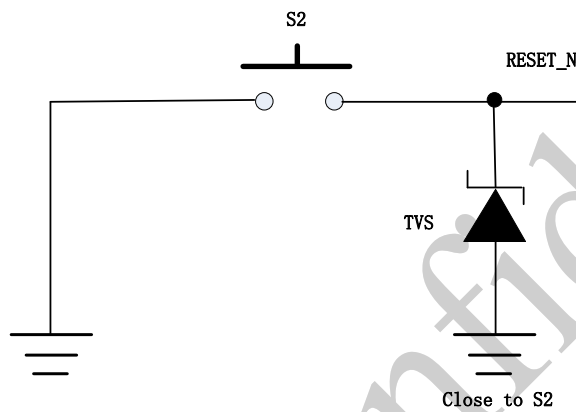


Figure 9 Reference Circuit of RESET\_N Reset Button

The reset sequence diagram is as follows:

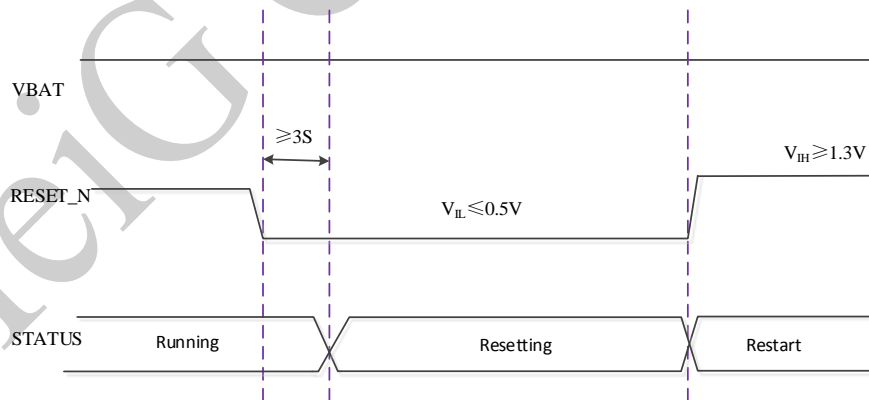


Figure 10 RESET\_N Reset Sequence Diagram

### 3.7.3.2 Reset by AT Command

Through the SRM815 Mini PCIe UART or USB AT port, enter the AT+RESET command to reset and restart the SRM815 Mini PCIe.

### 3.7.4 WAKEUP\_OUT\_N Control Signal

When the module is awakened, it outputs a high-level signal, indicating that the module is awakened by a specific event from the outside, such as a phone message or built-in protocol stack data. This signal only outputs high level when waking up; when the module is in sleep state, it outputs low level.

### 3.7.5 NET\_STATUS Control Signal

The network status indicator pin can be used to drive a network status indicator. The following table describes the pin definitions and logic levels in different network states.

**Table 13 Network Status Indicator Pin Description**

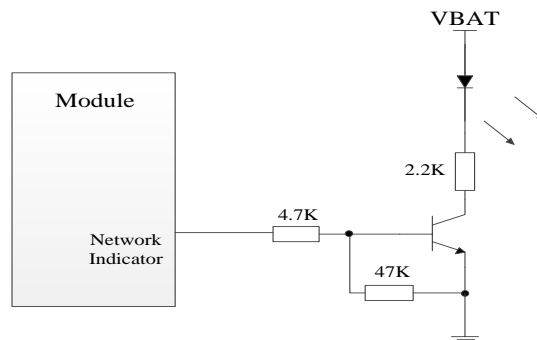
Pin Name	Pin Number	I/O	Description	Remarks
NET_STATUS	42	DO	Indicate the network operation status of the module	1.8V power domain

**Table 14 Working Status of Network Indicator Pin**

Mode	Status	Description
NET_STATUS	Blinking (100ms ON/800ms OFF)	Search network
	Blinking (100ms ON/3000ms OFF)	Register successfully
	Blinking (100ms ON/300ms OFF)	Register successfully with data service
	Close	Other

#### 3.7.5.1 Network Status Indication Reference Circuit

The network status indication interface reference circuit of SRM815 Mini PCIe is shown in the following figure. Please select the current limiting resistor according to the actual situation:



**Figure 11 Reference Design Diagram of Network Status Indication**

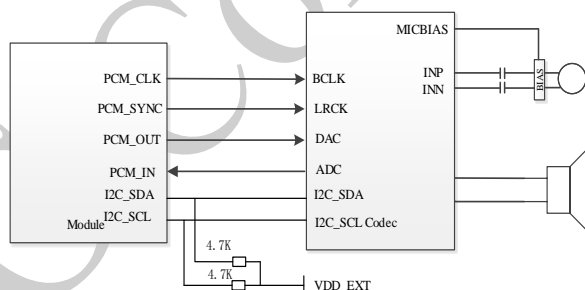
### 3.8 PCM Interface

The SRM815 Mini PCIe module provides a PCM interface.

**Table 15 PCM Interface Pin Description**

Pin Name	Pin Number	I/O	Description	Remarks
PCM_CLK	45	IO	PCM clock	1.8V power domain
PCM_DOUT	47	DO	PCM data output	1.8V power domain
PCM_DIN	49	DI	PCM data input	1.8V power domain
PCM_SYNC	51	IO	PCM data synchronization signal	1.8V power domain
I2C_SCL	30	OD	I2C clock signal	1.8V power domain, disconnect when not in use
I2C_SDA	32	OD	I2C data signal	1.8V power domain, disconnect when not in use

The following figure shows the reference design of PCM interface with external Codec chip:



**Figure 12 Reference Design of PCM Circuit**

### 3.9 Antenna Interface

#### 3.9.1 Antenna Definition

SRM815 Mini PCIe module provides five antenna pins, which are: ANT0, ANT1, ANT2, ANT3, GNSS, as shown in the following table.

RF port	ANT1(TRX)	ANT2(TRX)	GNSS	ANT0(TRX)	ANT3(TRX)
Band	LMHB DRX n77/78 TRX0	n41 TRX0 n77/78 TRX1	N79 TX0 or GNSSL1/L5	LMHB TRX n41 TRX1 n77/78 DRX0	n77/78 DRX1 N79 DRX0
Frequency	600-2690MHz 3.3-4.2GHz	2496-2690MHz 3.3-4.2GHz	4.3-5GHz or 1166-1610MHz	600-2690MHz 3.3-4.2GHz	3.3-5GHz

**Note:**

- The frequency band is defined as follows:  
 LMHB: WCDMA B1 B3 B5 B8; LTE B1 B3 B5 B7 B8 B18 B19 B20 B28 B34 B38 B39 B40 B41;  
 MHB: WCDMA B1 B3; LTE B1 B3 B7 B34 B38 B39 B40 B41;  
 UHB: LTE B42;
- GNSS and N79 cannot be supported at the same time.

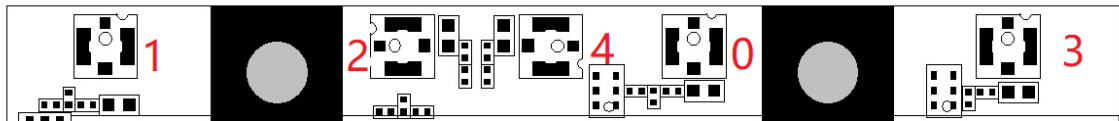


Figure 13 Antenna Location Map

Table 16 Antenna Requirements

Type	Requirements
WCDMA/ /TDD-LTE/FDD-LTE/5G_sub6	VSWR: < 2
	Gain (dBi): 1
	Maximum input power (W): 2W
	Input impedance (ohm): 50
	Polarization type: vertical direction
	Cable insertion loss: < 1.5dB (WCDMA B1/B5/B8, LTE B1/B3/B5/B8/B34/B39)
	Cable insertion loss: < 2dB (LTE B7/B38/B40/B41) (5G_sub6 n41/n78)

### 3.9.2 Recommended RF Connector

The following figure shows the size of the RF connector:

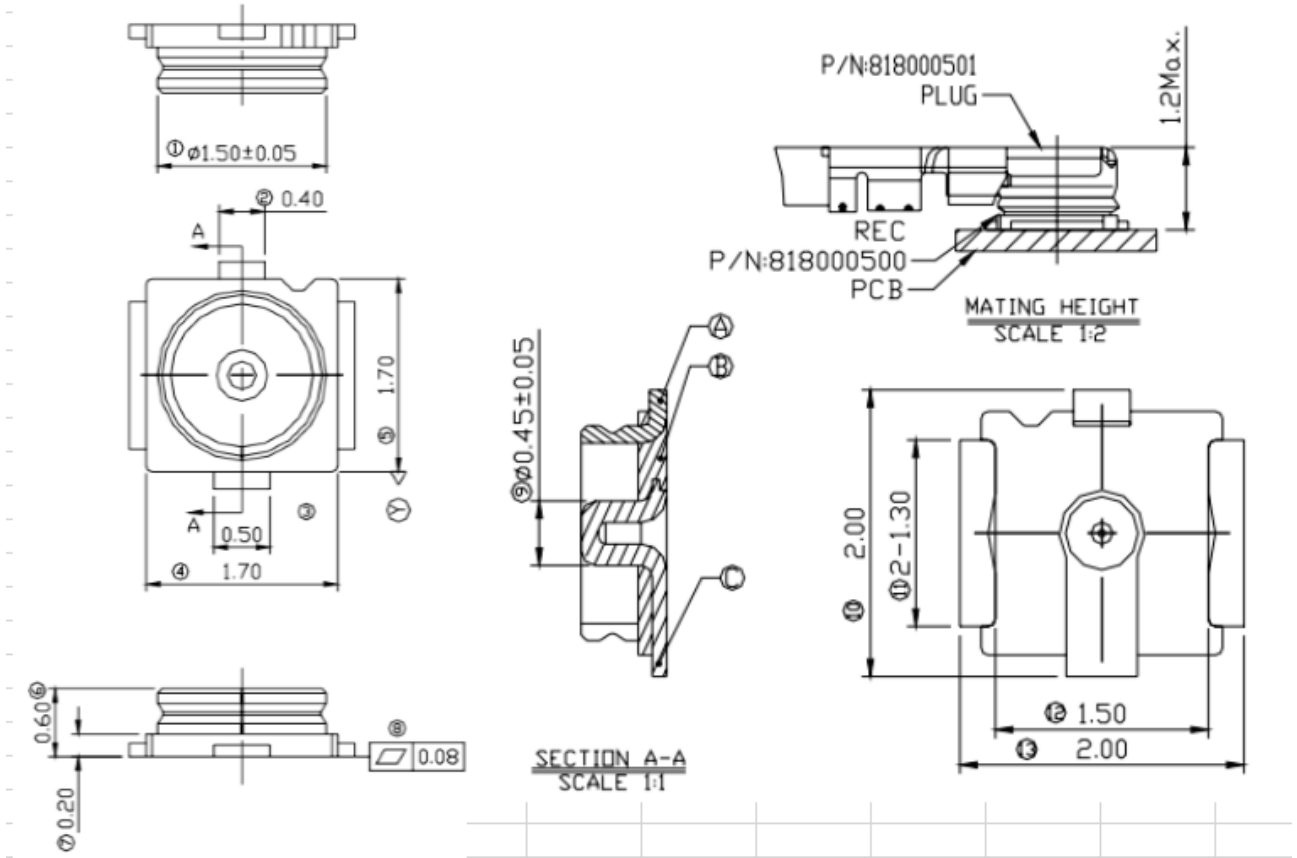


Figure 14 SMT Connection Size (unit: mm)

Use the IPEX fourth-generation cable for use, as shown in the following figure:

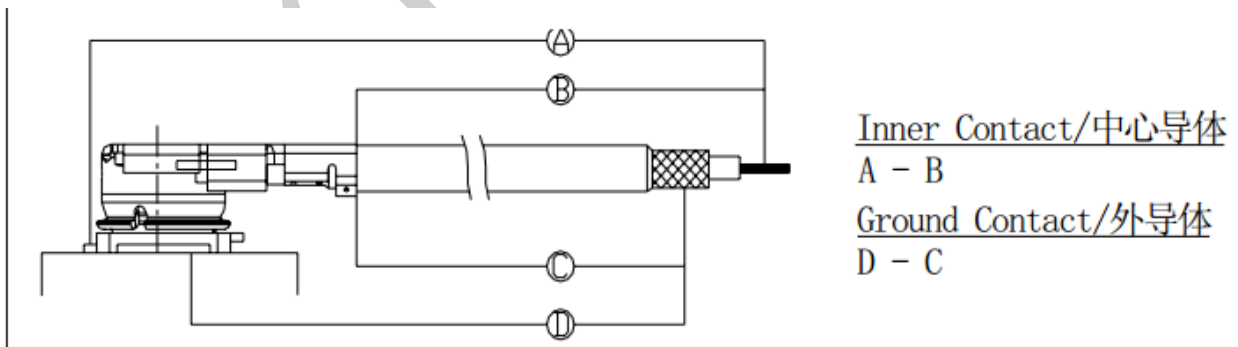


Figure 15 IPEX Fourth Generation Cable Series



### 3.9.3 Recommended RF Connector Assembly

The schematic diagram of manually inserting the coaxial cable plug is as follows,  $\theta$  must be 90°.

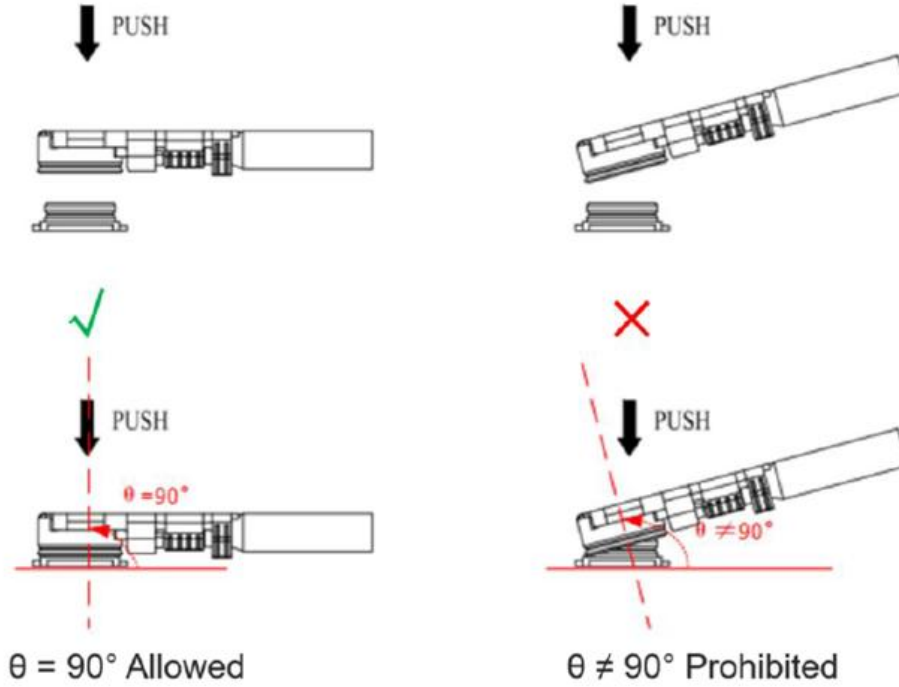


Figure 16 Schematic Diagram of Inserting the Coaxial Cable Plug

The schematic diagram of manually pulling out the coaxial cable plug is as follows,  $\theta$  must be 90°.

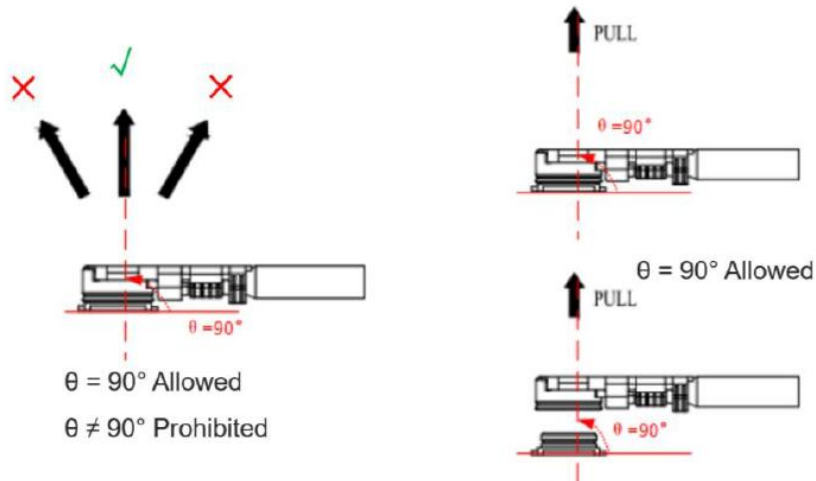


Figure 17 Schematic Diagram of Unplugging the Coaxial Cable

### 3.9.4 Fixture For Plugging And Unplugging The Coaxial Cable Plug

The schematic diagram of the jig plugging and unplugging the coaxial cable plug is as follows,  $\theta$  must be  $90^\circ$ .

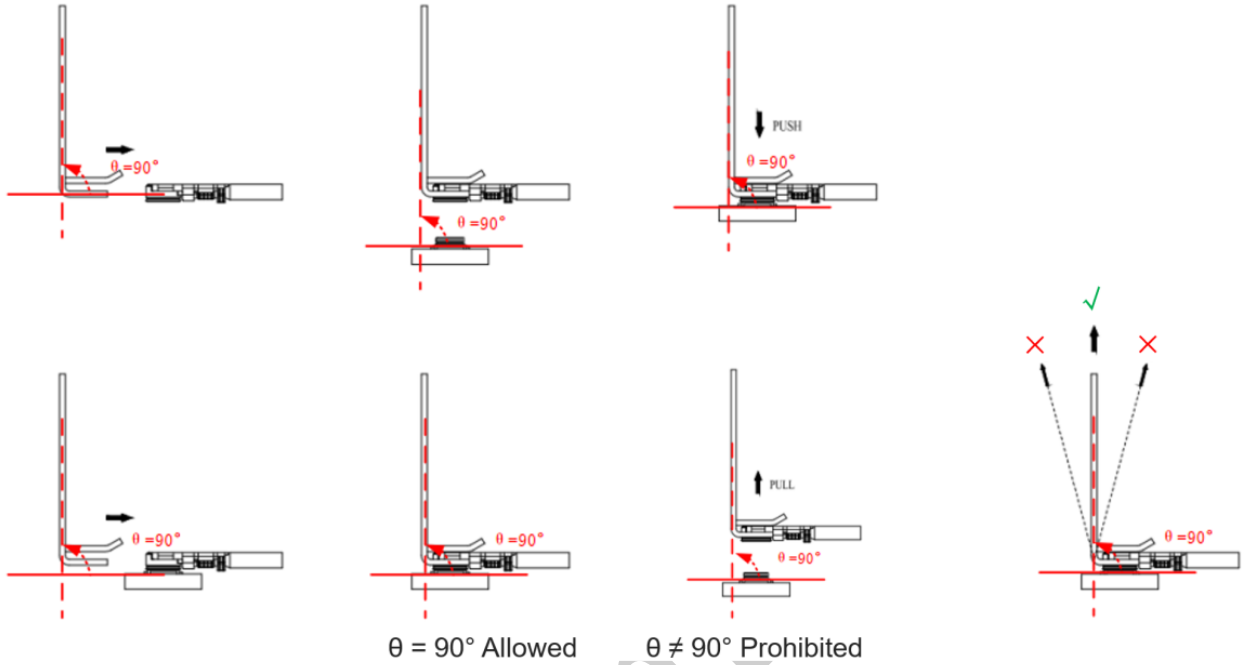


Figure 18 Schematic Diagram of a Coaxial Cable Connector Plug Fixture

### 3.9.5 Recommend RF connector and cable manufacturers

For more details, please visit <http://www.ectsz.com>.

## 4 Electrical Characteristics

### 4.1 Limiting Voltage Range

Limiting voltage range refers to the maximum voltage range that the module supply voltage and the digital and analog input / output interfaces can withstand. Working outside this range may cause damage to this product.

The limiting voltage range of SRM815 Mini PCIe is shown in the following table.

**Table 17 Limiting Working Voltage Range of the Module**

Parameter	Description	Minimum	Typical	Maximum	Unit
VIN	SRM815Mini PCIe power supply	3.3	3.8	4.35	V
	RMS average supply current	0		0.9	A
GPIO	Digital IO level supply voltage	-0.3	1.8	2.0	V
	Power supply voltage in shutdown mode	-0.25		0.25	V

### 4.2 Ambient Temperature Range

SRM815 Mini PCIe module is recommended to work in  $-30\sim+75^{\circ}\text{C}$ . It is recommended that the application side shall take temperature control measures in harsh environmental conditions. At the same time, it provides the extended working temperature range of the module. When used at the extended temperature, its function is normal, some RF indices may deteriorate. At the same time, it is recommended that the module application terminal be stored under certain temperature conditions. Modules may not work properly or be damaged if exceeding this range.

**Table 18 Temperature Range of the Module**

Parameter	Minimum	Typical	Maximum	Unit
Working temperature	-30	+25	+75	$^{\circ}\text{C}$
Extended working temperature	-40		+85	$^{\circ}\text{C}$
Storage temperature	-45		+90	$^{\circ}\text{C}$

### 4.3 Electrical Characteristics of Interface in Working Status

$V_L$ : logic low;

$V_H$ : logic high.

**Table 19 Logic Levels of Ordinary Digital IO Signals**

Signals	VL		VH		Unit
	Minimum	Maximum	Minimum	Maximum	
Digital Input	-0.3	0.3*Vpin_min	0.3*Vpin_max	Vpin_max	V
Digital Output	GND	0.2	Vpin_min-0.2	Vpin	V

**Note:**

Vpin\_min=1.45V, Vpin\_max=2.0V (Vpin is the high level of digital interface, Vpin=1.8V)

**Table 20 Electrical Characteristics of Power Supply in Working Status**

Parameter	I/O	Minimum	Typical	Maximum	Unit
VIN	PI	3.3	3.8	4.35	V
USIM_VDD	PO	1.7/2.75	1.8/2.85	1.9/2.95	V

### 4.4 Power Consumption Range of the Module

The following is the power consumption of SRM815 Mini PCIe module in each working mode. For more information on frequency band, please contact us.

**Table 21 Power Consumption**

Parameter	Description	Requirement	Typical	Unit
	Sleep mode	Module enters sleep mode after booting	1.9	mA
WCDMA		WCDMA Band 1 5M@22.7dBm	490.6	mA
		WCDMA Band 3 5M@22.9dBm	521.9	mA
		WCDMA Band 5 5M@23dBm	482	mA
		WCDMA Band 8 5M@23dBm	475.2	mA

	FDD- LTE	Band 1	10M@22dBm	536.2	mA
	FDD- LTE	Band 3	10M@22.1dBm	591.1	mA
	FDD- LTE	Band 5	10M@22dBm	493.9	mA
	FDD- LTE	Band 7	10M@22dBm	636.8	mA
	FDD- LTE	Band 8	10M@21.8dBm	502.1	mA
	FDD- LTE	Band 18	10M@21.7dBm	486	mA
	FDD- LTE	Band 19	10M@21.7dBm	466.4	mA
LTE	FDD- LTE	Band 20	10M@21.7dBm	451.5	mA
	FDD- LTE	Band 28	10M@21.9dBm	460.2	mA
	TDD- LTE	Band 34	10M@21.8dBm	273.9	mA
	TDD- LTE	Band 38	10M@22.1dBm	336.1	mA
	TDD- LTE	Band 39	10M@21.7dBm	254	mA
	TDD- LTE	Band 40	10M@22dBm	340.2	mA
	TDD- LTE	Band 41	10M@24dBm	412.3	mA
	TDD- LTE	Band 42	10M@22.9dBm	391.3	mA
	TX0	N77	100M@24.8dBm	518	mA
	TX0	N78	100M@25.3dBm	505	mA
5G TX0	TX0	N41	100M@25dBm	488	mA
	TX0	N28	200M@22.9Bm	449	mA
	2*2	N77	100M@25dBm	556	mA
5G 2*2	2*2	N78	100M@25.1dBm	549	mA
	2*2	N41	100M@25.2dBm	549	mA
	NSA	N77	100M@25.9dBm	917	mA
5G NSA	NSA	N78	100M@25.6dBm	919	mA
	NSA	N41	100M@25.1dBm	945	mA

## 4.5 Environmental Reliability Requirements

Table 22 Environmental Reliability Requirements

Test Items	Test Conditions
Low temperature storage test	Temperature -45°C, 24 hours in shutdown status
High temperature storage test	Temperature +90°C, 24 hours in shutdown status
Thermal shock test	In shutdown status, 1h at the temperature -45°C and +90°C respectively. Temperature changeover time <3min, 24 cycles in total
High temperature and high humidity test	Temperature +85°C, humidity 95%RH, 48 hours in shutdown status
Low temperature operation test	Temperature -40°C, 24 hours in working status
High temperature operation test	Temperature +85°C, 24 hours in working status
Life test of connectors	Board-to-board connector interface can be inserted and removed for 50 times; RF antenna interface cable can be inserted and removed for 30 times.
ESD test	<ol style="list-style-type: none"> <li>Test the power supply PAD and large-area ground in the call status of the module, and the ESD shall meet the following requirements: <ol style="list-style-type: none"> <li>The contact discharge should pass the test levels of ±4KV and ±5KV</li> <li>Air discharge should pass the test levels of ±8KV and ±10KV</li> </ol> </li> <li>When the module is in shutdown status, test the SIM card connector of EVB, and the ESD shall meet the following requirements: <ol style="list-style-type: none"> <li>The contact discharge should pass the test level of ±4KV</li> <li>Air discharge should pass the test level of ±8KV</li> </ol> </li> <li>For other interfaces of the module, ESD shall meet the following requirements: <ol style="list-style-type: none"> <li>The contact discharge should pass the test level of ±0.5KV</li> <li>Air discharge should pass the test level of ±1KV</li> </ol> </li> </ol>

## 4.6 ESD Features

SRM815 Mini PCIe is a consumer terminal product. Although ESD problems have been considered during module design and ESD protection has been completed, considering that there may be ESD problems during transportation and secondary development of SRM815 Mini PCIe, developers shall consider the protection against ESD problems in the final product. In addition to the anti-static treatment of the package that must be considered, please refer to the recommended circuit for interface design in the document for customer applications.

For the ESD allowable discharge range of SRM815 Mini PCIe module, refer to the following table.

**Table 23 ESD Performance Parameters (Temperature: 25°C, Humidity: 45%)**

Tested Points	Contact Discharge	Air Discharge	Unit
VIN, GND	±5	±10	KV
Other Interfaces	±0.5	±1	KV

# 5 Mechanical Characteristics

## 5.1 Basic Description

This chapter mainly describes the mechanical dimensions and packaging specifications of SRM815 Mini PCIe.

## 5.2 Dimensions of SRM815 Mini PCIe

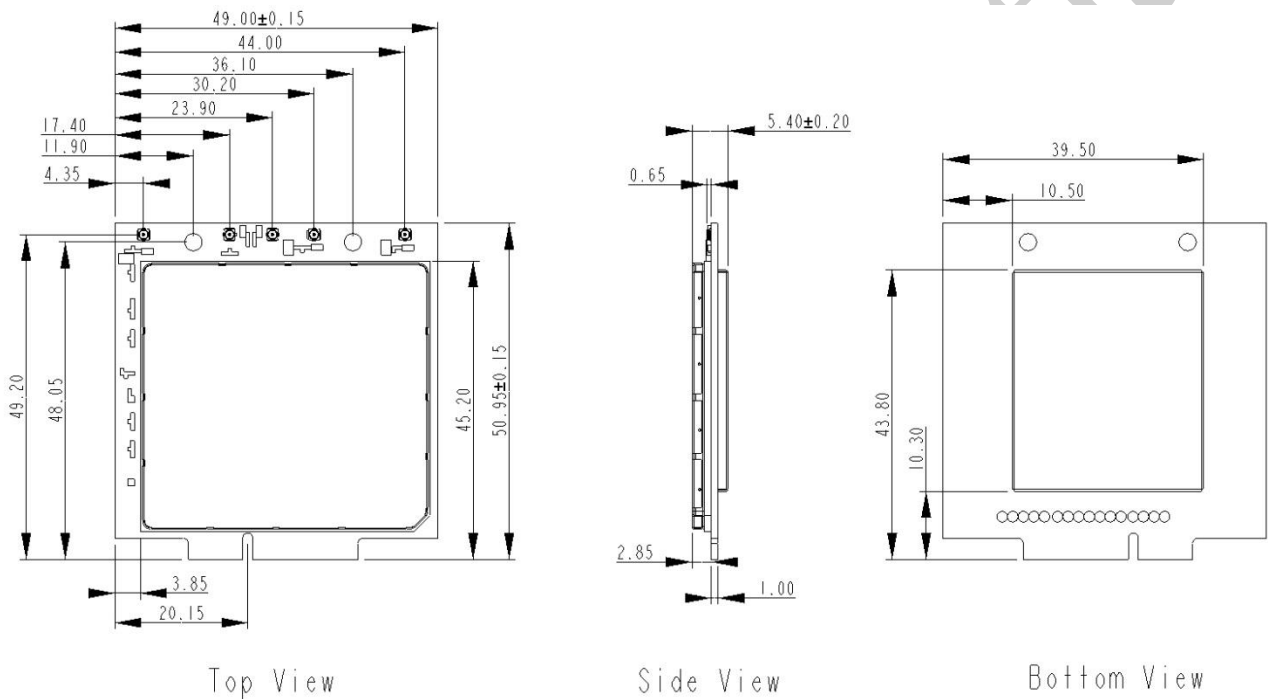


Figure 19 SRM815 Mini PCIe Mechanical Dimensions (Unit: mm)



### 5.3 Mini PCIe Standard Size

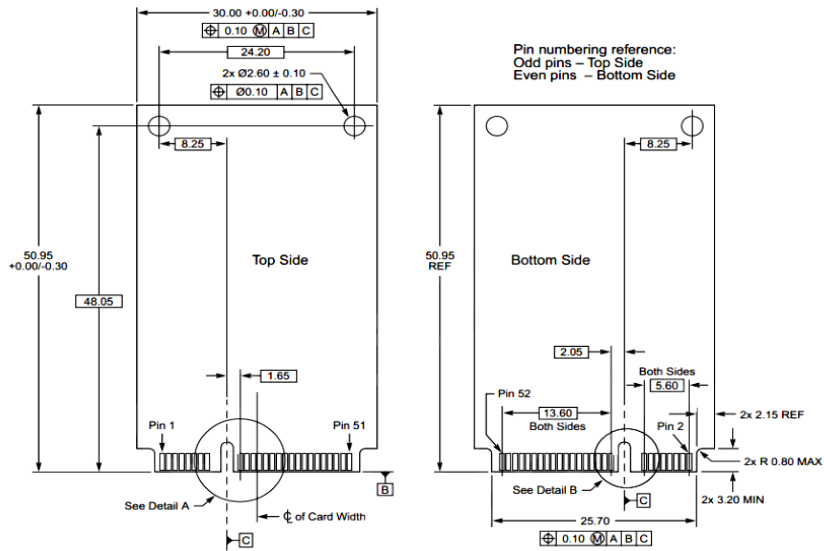


Figure 20 Mini PCIe Standard Size

SRM815 Mini PCIe uses a standard Mini PCIe connector. The user board can refer to the Mini PCI express connector of Molex company, the model is: SPSS-5256-X02R. As shown in the following figure:

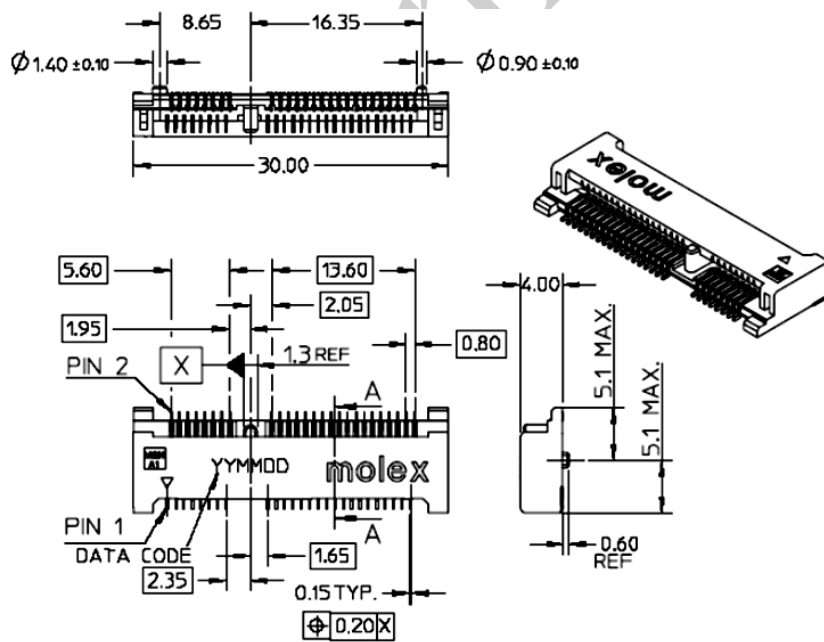


Figure 21 SPSS-5256-X02R Connector Diagram

## 5.4 Packaging

The SRM815 Mini PCIe module is packaged in trays. The specific specifications are as follows:

1. Wear gloves before working, and keep the work surface clean and tidy and free of dust;
2. Take 6 pallets (5+1) of the board after the QA inspection is OK and send it to a packing box;
3. And place an empty tray on the top layer of the board;
4. Put the tray into an electrostatic bag and place a bag of desiccant and a humidity card inside, and then use a vacuum packaging machine to vacuum to 300PA and plastic seal;
5. Fold the offset printing carton and put the vacuumed board into the offset printing carton;
6. Check the IMEI number printed in advance and put it in the offset printing carton and close the lid;
7. Paste the printed label on the upper left corner of the front of the offset printing carton;
8. Place the three finished boxes in parallel in the cartoon box, each box contains six boxes;
9. Take 1PCS box number and paste it on the upper left corner of the front of the cartoon box, and then seal the box with tape.

Packaging schematic reference:

### package



# 6 Appendix A Reference and Abbreviations

## 6.1 Reference Documents

- SRM815 AT Command Set;
- 5G\_EVB User Guide.

## 6.2 Abbreviations

Table 24 Abbreviations

Abbreviation	Description
AMR	Adaptive Multi-rate
BER	Bit Error Rate
BTS	Base Transceiver Station
PCI	Peripheral Component Interconnect
CS	Circuit Switched (CS) domain
CSD	Circuit Switched Data
DCE	● Data communication equipment
DTE	Data terminal equipment
DTR	Data Terminal Ready
EFR	Enhanced Full Rate
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
FR	Frame Relay
GMSK	Gaussian Minimum Shift Keying
GPIO	General Purpose Input Output

HR	Half Rate
HSDPA	High Speed Downlink Packet Access
HSUPA	High Speed Uplink Packet Access
HSPA	HSPA High-Speed Packet Access
HSPA+	HSPA High-Speed Packet Access+
IEC	International Electro-technical Commission
IMEI	International Mobile Equipment Identity
MEID	Mobile Equipment Identifier
I/O	Input/Output
ISO	International Standards Organization
ITU	International Telecommunications Union
bps	bits per second
LED	Light Emitting Diode
M2M	Machine to machine
MO	Mobile Originated
MT	Mobile Terminated
NTC	Negative Temperature Coefficient
PC	Personal Computer
PCB	Printed Circuit Board
PDU	Packet Data Unit
PPP	Point-to-point protocol
PS	Packet Switched
QPSK	Quadrature Phase Shift Keying
SIM	Subscriber Identity Module
TCP/IP	Transmission Control Protocol/ Internet Protocol

UART	Universal asynchronous receiver-transmitter
USIM	Universal Subscriber Identity Module
UMTS	Universal Mobile Telecommunications System
USB	Universal Serial Bus
WCDMA	Wideband Code Division Multiple Access
TD-SCDMA	Time Division-Synchronous Code Division Multiple Access
TDD-LTE	Time Division Long Term Evolution
FDD-LTE	Frequency Division Duplexing Long Term Evolution
V <sub>max</sub>	Maximum Voltage Value
V <sub>norm</sub>	Normal Voltage Value
V <sub>min</sub>	Minimum Voltage Value
V <sub>IHmax</sub>	Maximum Input High Level Voltage Value
V <sub>IHmin</sub>	Minimum Input High Level Voltage Value
V <sub>ILmax</sub>	Maximum Input Low Level Voltage Value
V <sub>ILmin</sub>	Minimum Input Low Level Voltage Value
V <sub>OHmax</sub>	Maximum Output High Level Voltage Value
V <sub>OHmin</sub>	Minimum Output High Level Voltage Value
V <sub>OLmax</sub>	Maximum Output Low Level Voltage Value
V <sub>OLmin</sub>	Minimum Output Low Level Voltage Value

## 7 Appendix B GPRS Coding Schemes

Table 25 Description of Different Coding Schemes

Mode	CS-1	CS-2	CS-3	CS-4
Code Rate	1/2	2/3	3/4	1
USF	3	3	3	3
Pre-coded USF	3	6	6	12
Radio Block excl.USF and BCS	181	268	312	428
BCS	40	16	16	16
Tail	4	4	4	-
Coded Bits	456	588	676	456
Punctured Bits	0	132	220	-
Data rate Kb/s	9.05	13.4	15.6	21.4