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CEM600 EVDO Mini PCIE Module Hardware User Guide

V1.8



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Contents

Chapter 1. Introduction.....	4
1.1 Overview.....	4
1.2 Abbreviations.....	4
Chapter 2. Module review.....	5
2.1 Product Introduction.....	5
2.2 Module function block diagram.....	5
2.3 Main function of the module.....	6
Chapter 3. Technical specifications.....	7
3.1 Overall technical indicators.....	7
3.2 RF receiving indicators.....	7
3.3 RF emission indicators.....	8
3.4 Power Supply DC Characteristics.....	9
Chapter 4 Interface definition.....	10
Chapter 5. Main function interface description.....	12
5.1 UART interface (optional function).....	12
5.2 USB interface.....	13
5.3 PCM interface (optional feature).....	14
5.4 AUDIO interface.....	15
5.5 RUIM card interface.....	16
5.6 Control and general purpose I/O interface (optional feature).....	17
5.7 Power interface.....	18
5.8 Antenna socket interface.....	19
Chapter 6. structure.....	21
6.1 Structural size.....	21
6.2 Mini PCI Express connector.....	22
6.3 RF connector.....	23



Chart catalog

Figure 2-1 Functional Block Diagram of the CEM600 Module.....	5
Figure 5-1 UART interface and microprocessor connection reference design.....	12
Figure 5-2 Serial connection reference design.....	13
Figure 5-3 USB interface signal.....	13
Figure 5-4 USB interface reference design.....	14
Figure 5-5 PCM digital voice application reference design.....	15
Figure 5-6 Differential Audio Interface Reference Design.....	16
Figure 5-8 RUIM card interface reference design.....	17
Figure 5-9 LED lamp reference design.....	18
Figure 5-10 Antenna interface ESD protection recommended.....	20
Figure 6-1 Outline drawing of the CEM600 module.....	21
Figure 6-2 CEM600 module structure size.....	22
Figure 6-3 PCI Express Mini Card Connector.....	23
Figure 6-4 Antenna connector size.....	23
Figure 6-5 Antenna connector mating plug.....	24

Table directory

Table 3-1 Overall technical indicators.....	7
Table 3-2 Radio Frequency Receive.....	7
Table 3-3 RF emissions.....	8
Table 3-4 DC characteristics of the power supply.....	9
Table 4-1 Interface definition.....	10
Table 5-1 UART Interface Definition.....	12
Table 5-2 USB Interface Definition.....	13
Table 5-3 PCM Interface Definition.....	14
Table 5-4 AUDIO Interface Definition.....	15
Table 5-5 RUIM card interface definition.....	16
Table 5-7 LED_WWAN_N Status Indicator Table.....	18
Table 5-8 Power Interface Definition.....	18
Table 5-9 Antenna interface characteristics.....	19



Chapter 1. Introduction

1.1 Overview

This document describes the functions, interfaces, technical specifications, appearance, and structure of the CEM600 module. It can help the R&D engineers using this module to provide design references.

1.2 Abbreviations

ADC	Analog-Digital Converter	模数转换
AFC	Automatic Frequency Control	自动频率控制
AGC	Automatic Gain Control	自动增益控制
ARFCN	Absolute Radio Frequency Channel Number	绝对射频信道号
B2B	Board to Board Connector	板对板连接器
BER	Bit Error Rate	比特误码率
CDMA	Code Division Multiple Access	码分多址
DAI	Digital Audio interface	数字音频接口
DAC	Digital-to-Analog Converter	数模转换
DSP	Digital Signal Processor	数字信号处理
DTR	Data Terminal Ready	数据终端准备好
EFR	Enhanced Full Rate	增强型全速率
EMC	Electromagnetic Compatibility	电磁兼容
EMI	Electro Magnetic Interference	电磁干扰
ESD	Electronic Static Discharge	静电放电
EVDO	Evolution Data Only	演进数据优化或者进化的数据
FR	Full Rate	全速率
GPRS	General Packet Radio Service	通用分组无线业务
HR	Half Rate	半速率
IMEI	International Mobile Equipment Identity	国际移动设备标识
ISO	International Standards Organization	国际标准化组织
PLL	Phase Locked Loop	锁相环
PPP	Point-to-point protocol	点到点协议
RAM	Random Access Memory	随机访问存储器
ROM	Read-only Memory	只读存储器
RTC	Real Time Clock	实时时钟
SMS	Short Message Service	短消息服务
UART	Universal asynchronous receiver-transmitter	通用异步接收/发送器
UIM	User Identifier Management	用户身份管理
USB	Universal Serial Bus	通用串行总线
VSWR	Voltage Standing Wave Ratio	电压驻波比



Chapter 2. Module review

2.1 Product Introduction

CEM600 is a PCI Express Mini Card 1.2 standard interface CDMA2000 1X EVDO Rev.A module, using Qualcomm's latest EVDO single-chip platform QSC6085, supporting embedded operating systems such as WinCE/Linux, with voice, SMS and high-speed data services. The CEM600 can be used in the following situations:

- ✧ Netbook, notebook
- ✧ PDA、MID
- ✧ Wireless POS machine
- ✧ Wireless advertising, media
- ✧ Wireless routing, switch
- ✧ Remote monitoring
- ✧ Smart meter reading
- ✧ lottery machine
- ✧ Other wireless terminals, etc.

2.2 Module function block diagram

The functional block diagram of the CEM600 module is shown in Figure 2-1 below:

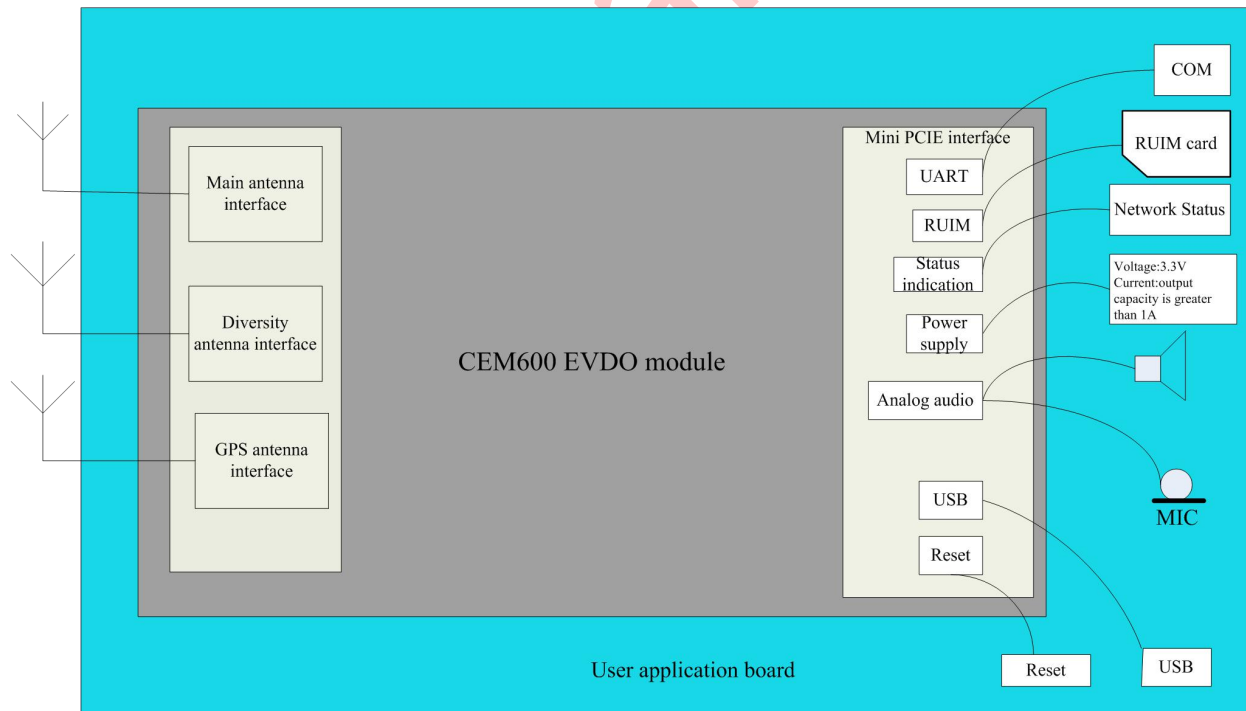


Figure 2-1 Functional Block Diagram of the CEM600 Module



2.3 Main function of the module

The main functions of the CEM600 module are as follows:

- ✧ Support CDMA800/1900 frequency band
- ✧ Support GPS function
- ✧ Support for primary/diversity antenna reception
- ✧ Support 1 USB 2.0 Fullspeed interface
- ✧ Support 1 channel RUIIM card interface (3.0V/1.8V)
- ✧ Support 1 channel 3-wire UART interface
- ✧ Support 1 PCM/I2S interface (transmits digital voice)
- ✧ Support 4 channels of GPIO
- ✧ Support 3 LED lights control
- ✧ Extended AT instruction set supporting standard AT instruction set and domain

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Chapter 3. Technical specifications

3.1 Overall technical indicators

The overall technical specifications of the CEM600 module are shown in the following table:

Table 3-1 Overall technical indicators

Characteristic		Description
CDMA standard		IS95A/B
		CDMA2000 1x Rev.0
		CDMA2000 1xEV-DO Rev. 0
		CDMA2000 1xEV-DO Rev. A
Data rate		Upstream:1.8 Mbit/s Max
		Downstream:3.1 Mbit/s Max
Working frequency	CDMA 800MHz	Send:824–849 MHz
		Receive:869–894 MHz
	CDMA 1900MHz	Send:1850–1910 MHz
		Receive:1930–1990 MHz
Operating Voltage		3.3~4.2V
Working current		Off: <10uA
		Standby: <2mA
		Peak: 700mA
Size		51mm×30mm×2.6mm
Weight		16g
Temperature	Operating temperature	-30℃ ~ +70℃ (Full parameter)
		-40℃ ~ +85℃ (Feature)
	Storage temperature	-55℃ ~ +125℃
Humidity		5% ~ 95%

3.2 RF receiving indicators

The RF receiving indicators of the CEM600 module are shown in the following table:

Table 3-2 Radio Frequency Receive

Technical indicators	Description
Frequency Range	869–894 MHz
Receiving sensitivity	<-108 dBm
Receive signal range	-25 dBm~ -104dBm
Monophonic immunity	-101dBm(FER≤1%,-30dBm@±900KHz)
Intermodulation spurious response attenuation	-101dBm(FER≤1%,-43dBm@±900 KHz /±1700KHz)
	-90dBm(FER≤1%,-32dBm @±900 KHz /±1700KHz)
	-79dBm(FER≤1%,-21dBm @±900 KHz /±1700KHz)
Conductive emission spurious emission	<-76dBm/1MHz (Receiving band)
	<-61dBm/1MHz (Transmission band)



	<-47dBm/30KHz (Other frequencies)
Demodulation of forward traffic channel under additive Gaussian white noise conditions	FER≤3.0% (Test 1: Rate Set 1 (9600bps))
	FER≤1.0% (Test 2: Rate Set 1 (9600bps))
	FER≤0.5% (Test 3: Rate Set 1 (9600bps))
	FER≤1.0% (Test 4: Rate Set 1 (4800bps))
	FER≤1.0% (Test 5: Rate Set 1 (2400bps))
	FER≤1.0% (Test 6: Rate Set 1 (1200bps))
	FER≤3.0% (Test 7: Rate Set 2 (14400bps))
	FER≤1.0% (Test 8: Rate Set 2 (14400bps))
	FER≤0.5% (Test 9: Rate Set 2 (14400bps))
	FER≤1.0% (Test 10: Rate Set 2 (7200bps))
	FER≤1.0% (Test 11: Rate Set 2 (3600bps))
	FER≤1.0% (Test 12: Rate Set 2 (1800bps))

3.3 RF emission indicators

The RF emission indicators of the CEM600 module are shown in the following table:

Table 3-3 RF emissions

Technical indicators	Description
Frequency Range	824 ~ 849 MHz
Maximum frequency deviation	±300Hz
Maximum output power	> 23dBm
Minimum output power	< -50dBm
Open loop power control	(Test 1: -25dBm/1.23MHz) -48±9.5dBm
	(Test 2: -60dBm/1.23MHz) -8±9.5dBm
	(Test 3: -93.3dBm/1.23MHz) 20±9.5dBm
Closed loop power control	±24dB(9600bps Data rate)
	±24dB(4800bps Data rate)
	±24dB(2400bps Data rate)
	±24dB(1200bps Data rate)
Conductive spurious emission	-42dBc/30KHz or -54dBm/1.23MHz (Δf : 885KHz~1.98MHz)
	-54dBc/30KHz or -54dBm/1.23MHz (Δf : 1.98MHz~4.00MHz)
	<-36dBm/1kHz (Δf > 4MHz, 9KHz < f < 150KHz,)
	<-36dBm/10kHz (Δf > 4MHz, 150kHz<f<30MHz,)
	<-36dBm/100kHz (Δf > 4MHz, 30MHz<f<1GHz)
	<-30dBm/1MHz (Δf > 4MHz, 1GHz<f<12.75GHz)



3.4 Power Supply DC Characteristics

The DC characteristics of the CEM600 module power supply are shown in the following table:

Table 3-4 DC characteristics of the power supply

Parameter	Description	Min	Typical	Max	Unit
VCC	Module input power	3.3	3.3	4.2	V
VIH	Input high level	$0.65 \cdot V_{DDIO}$		$V_{DDIO} + 0.3$	V
VIL	Input low level	-0.3		$0.35 \cdot V_{DDIO}$	V
VOH	Output high level	$V_{DDIO} - 0.45$		V_{DDIO}	V
VOL	Output low level	0		0.45	V
CIN	Input capacitance	-		7	pF

Here $V_{DDIO} = 2.6V$.



Chapter 4 Interface definition

The CEM600 module interface definition is shown in the following table:

Table 4-1 Interface definition

Pin	Standard Pin definition	Pin definition	I/O properties	Description
1	WAKE#	MIC_P	Analog input	Analog audio input positive terminal (optional feature)
2	3.3Vaux	VCC_3V3	Power input	3.3V main power supply
3	COEX1	MIC_N	Analog input	Analog audio input negative terminal (optional function)
4	GND	GND		Ground
5	COEX2	EAR_P	Analog output	Analog audio output positive terminal (optional feature)
6	1.5V	NC		Unused
7	CLKREQ#	EAR_N	Analog output	Analog audio output negative terminal (optional function)
8	UIM_PWR	VREG_RUIM	Power Output	RUIM card power supply
9	GND	GND		Ground
10	UIM_DATA	RUIM_DATA	Two way	RUIM card data
11	REFCLK-	UART1_RXD	Input	UART1 data reception (optional function)
12	UIM_CLK	RUIM_CLK	Output	RUIM card clock
13	REFCLK+	UART1_TXD	Output	UART1 data transmission (optional function)
14	UIM_RESET	RUIM_RESET	Output	RUIM card reset
15	GND	GND		Ground
16	UIM_Vpp	NC		Unused
17	Reserved	UART1_RI_N	Output	Ringling indication signal
18	GND	GND		Ground
19	Reserved	INT1_IN	Input	Interrupt input, "low" is valid (optional function)
20	W_DISABLE#	W_DISABLE_N	Input	RF inhibit control, "low" effective
21	GND	GND		Ground
22	PERST#	RESIN_N	Input	Reset control, "low" is valid
23	PERn0	UART1_CTS_N	Input	UART1 is ready to send
24	3.3Vaux	VCC_3V3	Power input	3.3V auxiliary power supply (optional function)
25	PERp0	UART1_RFR_N	Output	UART1 request to send
26	GND	GND		Ground
27	GND	GND		Ground



28	1.5V	NC		Unused
29	GND	GND		Ground
30	SMB_CLK	GPIO1	Two way	General purpose input and output signal 1 (optional function)
31	PETn0	UART1_DTR_N	Input	DTE is ready
32	SMB_DATA	GPIO3	Two way	General purpose input and output signal 3 (optional function)
33	PETp0	UART1_DCD_N	Output	Carrier detect signal indication
34	GND	GND		Ground
35	GND	GND		Ground
36	USB_D-	USB_D-	Two way	USB data cable -
37	GND	GND		Ground
38	USB_D+	USB_D+	Two way	USB data cable +
39	3.3Vaux	VCC_3V3	Power input	3.3V main power supply
40	GND	GND		Ground
41	3.3Vaux	VCC_3V3	Power input	3.3V main power supply
42	LED_WWAN#	LED_WWAN_N	Power input	Work status light control, "low" effective
43	GND	GND		Ground
44	LED_WLAN#	LED_RES1_N	Power input	Alternate LED Control 1 (optional feature)
45	Reserved	PCM_CLK	Two way	PCM clock (optional feature)
46	LED_WPAN#	LED_RES2_N	Power input	Alternate LED Control 2 (optional feature)
47	Reserved	PCM_DOUT	Two way	PCM data output (optional function)
48	1.5V	NC		Unused
49	Reserved	PCM_DIN	Two way	PCM data input (optional function)
50	GND	GND		Ground
51	Reserved	PCM_SYNC	Two way	PCM sync (optional feature)
52	3.3Vaux	VCC_3V3	Power input	3.3V main power supply

Note: (optional feature) indicates that support or no support can be selected by resistor soldering inside the CEM600 module.



Chapter 5. Main function interface description

5.1 UART interface (optional function)

Table 5-1 UART Interface Definition

Pin	Signal name	I/O properties	High value	Description
11	UART1_RXD	Input	2.6V	UART1 data reception
13	UART1_TXD	Output	2.6V	UART1 data transmission
17	UART1_RI_N	Output	2.6V	UART1 ringing indication
23	UART1_CTS_N	Input	2.6V	UART1 is ready to send
25	UART1_RFR_N	Output	2.6V	UART1 request to send
31	UART1_DTR_N	Input	2.6V	UART1 DTE is ready
33	UART1_DCD_N	Output	2.6V	UART1 carrier detection
	GND			Ground

The UART interface supports 3-wire or 8-wire serial protocols.

The UART interface supports the following features:

- ✧ Software download upgrade
- ✧ Data communication
- ✧ AT Command
- ✧ Bluetooth

When the UART interface is directly connected to the microprocessor, the reference design is as follows. If the 3-wire connection is used, the RFR and CTS should be shorted. Note that if the levels on both sides do not match, you can connect a 1k resistor in series with the signal line or add a bidirectional Schottky diode.

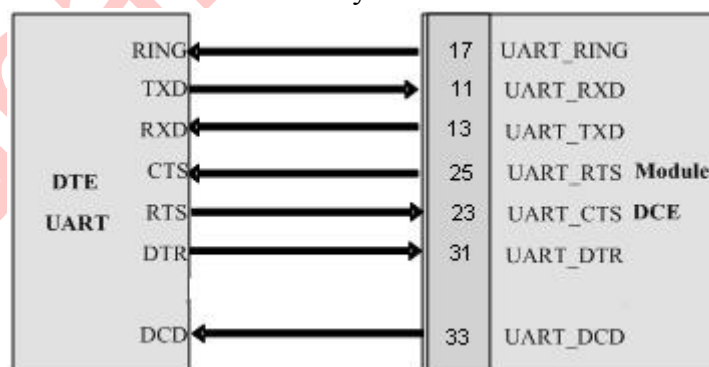


Figure 5-1 UART interface and microprocessor connection reference design

The UART interface can also be connected to the standard RS232-C interface via an RS232 level shifting chip. The MAX3232 chip is recommended. The reference design is as follows:

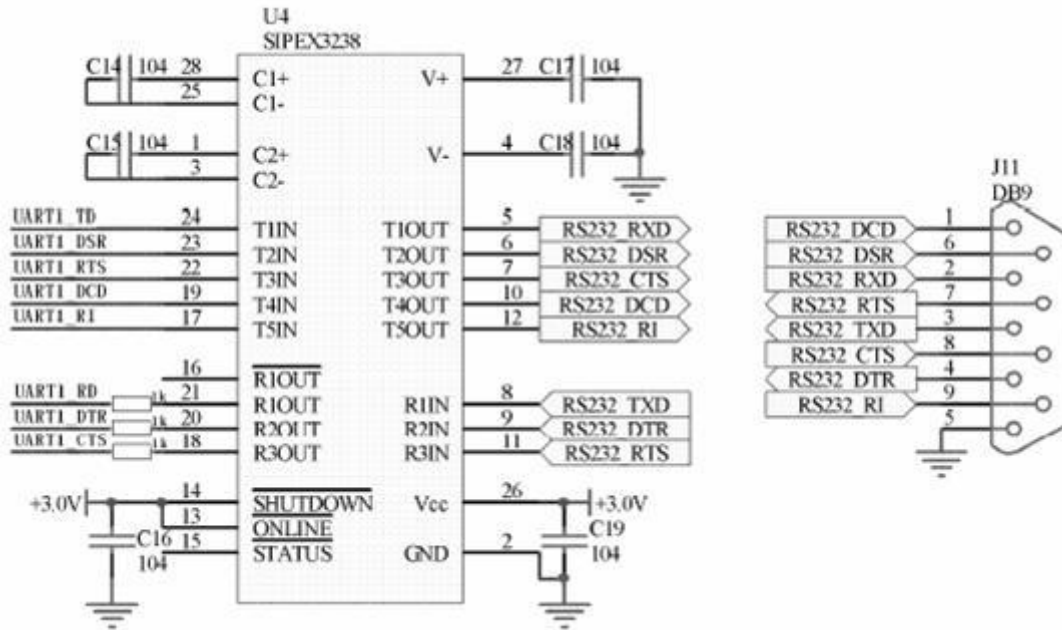


Figure 5-2 Serial connection reference design

5.2 USB interface

Table 5-2 USB Interface Definition

Pin	Signal name	I/O properties	High value	Description
36	USB_D-	Two way	3.3V	USB data cable -
38	USB_D+	Two way	3.3V	USB data cable +
	GND			Ground

The USB interface supports USB 2.0 Fullspeed and Lowspeed. Note that CEM600 can only be a slave device.

The USB interface supports the following features:

- ✧ Software download upgrade
- ✧ Data communication
- ✧ AT Command

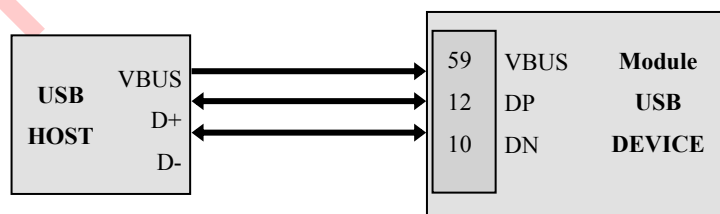


Figure 5-3 USB interface signal

The USB interface reference design is shown below. Note that the ESD protection device should be added to the data line.

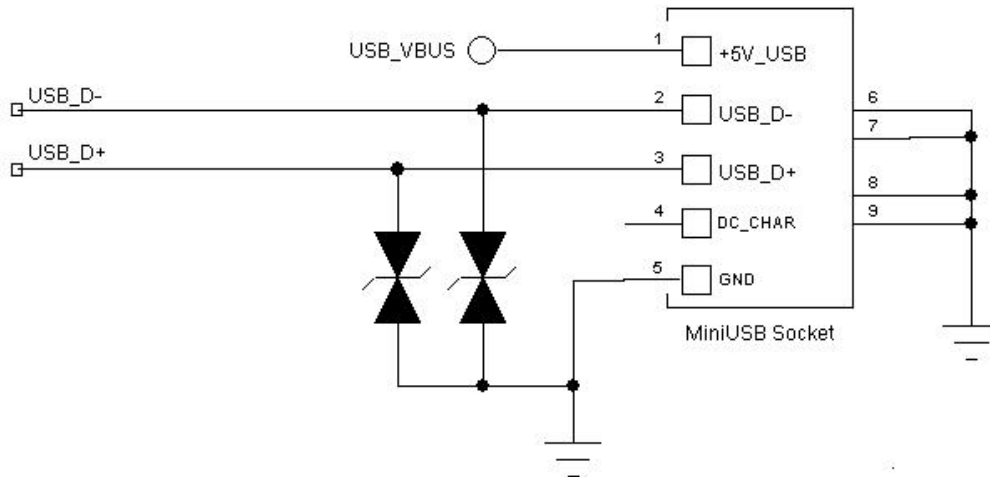


Figure 5-4 USB interface reference design

Note:

1. As shown in the USB interface reference design drawing, it should be noted that the ESD protection device should be added to the data line. The USB trace design of the DTE interface board needs to strictly follow the USB2.0 protocol requirements, and the differential trace has a control impedance of 90Ω .

2. The USB bus supply voltage is provided internally by the module and does not need to be provided externally. At the same time, since the USB interface of the module does not provide USB bus power, the module can only be used as a slave device of the USB bus.

5.3 PCM interface (optional feature)

Table 5-3 PCM Interface Definition

Pin	Signal name	I/O properties	High value	Description
45	PCM_CLK	Two way	2.6V	PCM clock
47	PCM_DOUT	Two way	2.6V	PCM data output
49	PCM_DIN	Two way	2.6V	PCM data input
51	PCM_SYNC	Two way	2.6V	PCM synchronization
	GND			Ground

This interface is a PCM/I2S interface and can support the following functions:

- ✧ Bluetooth
- ✧ Codec interface
- ✧ DAC/ADC interface

The following figure shows an application of the PCM interface for digital voice transmission. It is converted to analog voice by an external Codec chip, and then connected to the MIC and RECEIVER.

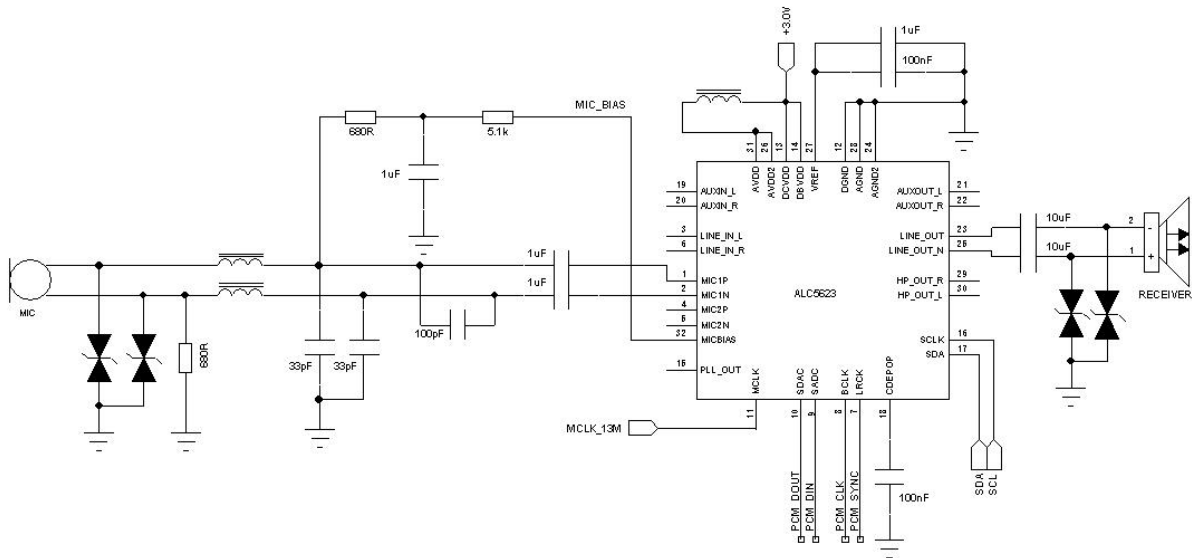


Figure 5-5 PCM digital voice application reference design

5.4 AUDIO interface

Table 5-4 AUDIO Interface Definition

Pin	Signal name	I/O properties	High value	Description
1	MIC_P	Analog input	1.8V	Audio input positive end
3	MIC_N	Analog input	1.8V	Audio input negative
5	EAR_P	Analog output	1.8V	Positive audio output
7	EAR_N	Analog output	1.8V	Audio output negative
	GND			Ground

The AUDIO interface provides an audio input and output interface in differential mode. The MIC bias voltage and DC blocking capacitors are already provided inside the module, so the external design is no longer needed. The road audio output can drive a 32 ohm receiver.

The differential line of the differential audio interface should pay attention to the parallel equidistance in the PCB design. The length of the trace should be as short as possible. The filter circuits on both sides should be as symmetrical as possible. The positive and negative differential signals should be as close as possible. The audio input and audio output need to be separated to prevent crosstalk, while away from power, RF, antenna and other circuits. In addition, ESD protection devices are recommended at the MIC, RECEIVER/SPEAKER interfaces. The reference design of the differential audio input and output interface is as follows:

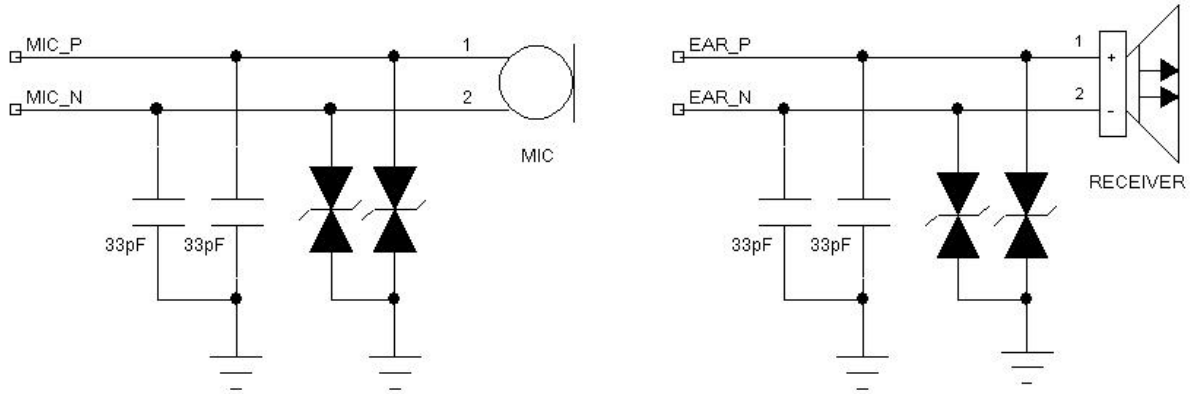


Figure 5-6 Differential Audio Interface Reference Design

The differential audio channel can also work in single-ended mode, such as an external headphone jack. The single-ended audio interface is preferably packaged on the outside of the PCB design. The audio input and the audio output need to be separated to prevent crosstalk. At the same time, keep away from power, RF, antenna and other circuits. In addition, it is recommended to add ESD protection devices at the interface.

The reference design diagram for the single-ended audio interface is as follows:

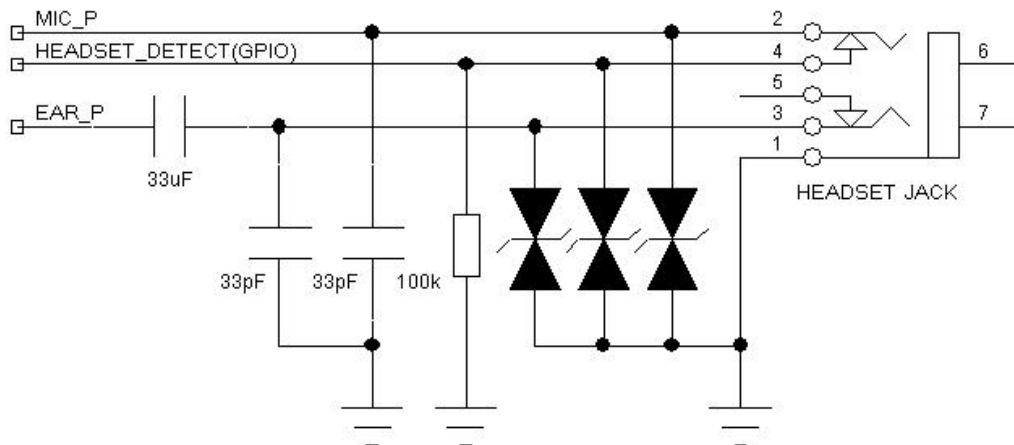


Figure 5-7 Single-ended audio interface reference design

5.5 RUIM card interface

Table 5-5 RUIM card interface definition

Pin	Signal name	I/O properties	High value	Description
8	VREG_RUIM	Output	1.8V/2.85V	RUIM card power supply
10	RUIM_DATA	Two way	1.8V/2.85V	RUIM card data
12	RUIM_CLK	Output	1.8V/2.85V	RUIM card clock
14	RUIM_RESET	Output	1.8V/2.85V	RUIM card reset
	GND			Ground

The CEM600 module can be connected to a 3.0V/1.8V RUIM card and can be automatically detected.



It is recommended to connect 33 μ capacitors in parallel between RUIIM_CLK, RUIIM_DATA, RUIIM_RESET and GND to filter out the interference of RF signals, and connect 33 ohm resistors in series on RUIIM_CLK, RUIIM_DATA, RUIIM_RESET. Also, be careful to place the ESD protection device next to the RUIIM deck.

The RUIIM card interface reference design diagram is as follows:

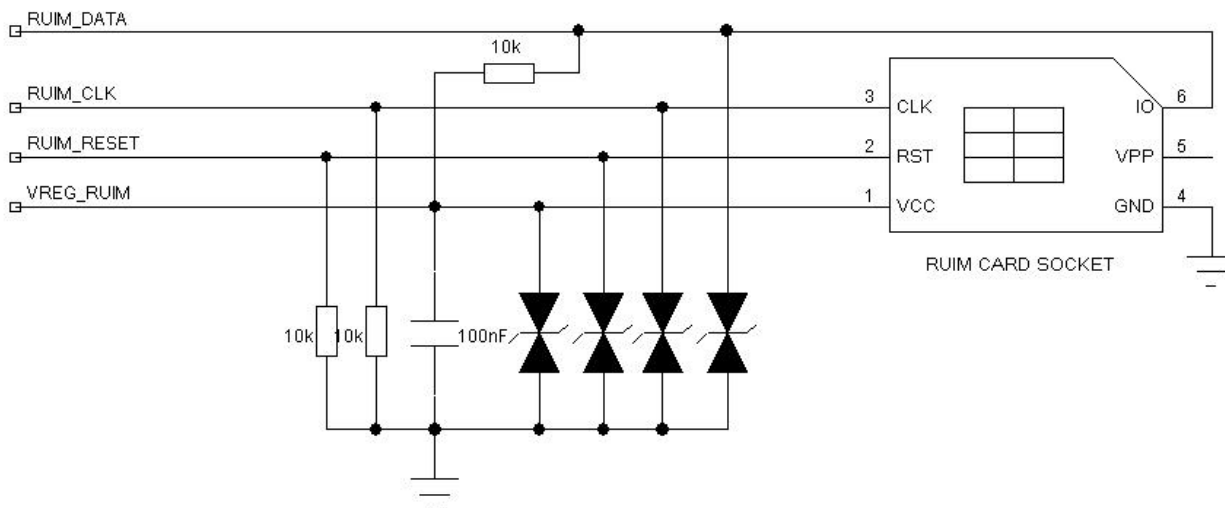


Figure 5-8 RUIIM card interface reference design

5.6 Control and general purpose I/O interface (optional feature)

Table 5-6 Control and General I/O Interface Definitions

Pin	Signal name	I/O properties	High value	Description
17	INT0_OUT(GPIO)	Output	2.6V	Interrupt output, "low" is valid, default is "high"
19	INT1_IN(GPIO)	Input	2.6V	Interrupt input, "low" active, internal pullup
20	W_DISABLE_N(GPIO)	Input	2.6V	RF is prohibited, "low" is valid, internal pull-up
22	RESIN_N	Input	2.6V	Reset control, "low" active, internal pullup
30	GPIO1	Two way	2.6V	General purpose input and output signal 1(default is input, internal pull-up)
31	GPIO2	Two way	2.6V	General purpose input and output signal 1(default is input, internal pull-up)
32	GPIO3	Two way	2.6V	General purpose input and output signal 1(default is input, internal pull-up)
33	GPIO4	Two way	2.6V	General purpose input and



				output signal 1(default is input, internal pull-up)
42	LED_WWAN_N	Current input	3.3V	Work status light, "low" is valid, default is "high"
44	LED_RES1_N	Current input	3.3V	Alternate LED light control
46	LED_RES2_N	Current input	3.3V	Alternate LED light control
	GND			Ground

INT0_OUT, INT1_IN, W_DISABLE_N: When the default functions of these 3 pins are not used, they can be multiplexed into GPIO.RESIN_N: The module can be reset by pulling this pin low for 50ms. This pin is sensitive to interference and should be protected when wiring.

LED_WWAN_N, LED_RES1_N (standby), LED_RES2_N (standby): These three pins are controlled by SINK type current source mode, and the maximum current that can flow in is 40mA. When external LED lamp is connected, the current limiting resistor must be connected in series, and the resistance value can be The rated voltage/rated current of the selected LED lamp is calculated.

The reference design of the LED light interface is as follows:

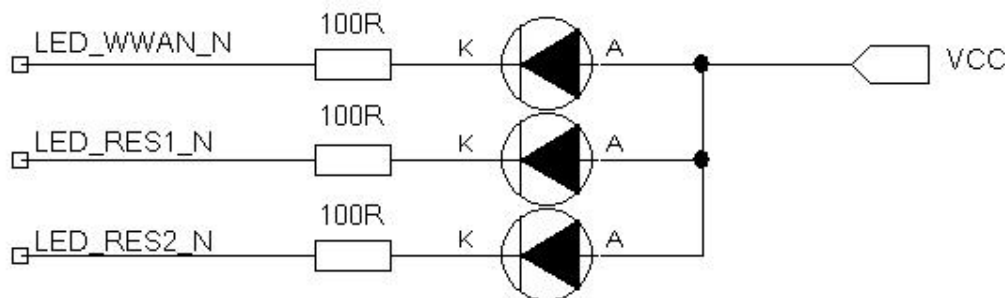


Figure 5-9 LED lamp reference design

LED_WWAN_N is the working status indicator of the CEM600G module, which is controlled by the module software. The status table is as follows:

Table 5-7 LED_WWAN_N Status Indicator Table

CEM600G working mode	LED display status
Search network	Single flash (cycle is 3s)
Successfully registered network, but in idle state (ie, not in call or data transfer state)	Double flash (cycle is 3s)
Call or data transfer status	Fast flashing (cycle is 0.2s)

5.7 Power interface

Table 5-8 Power Interface Definition

Pin	Signal name	I/O properties	High value	Description
2	VCC_3V3	power input	3.3V	3.3V main power supply
24	VCC_3V3	power input	3.3V	3.3V auxiliary power supply (optional function)
39	VCC_3V3	power input	3.3V	3.3V main power supply



41	VCC_3V3	power input	3.3V	3.3V main power supply
52	VCC_3V3	power input	3.3V	3.3V main power supply
	GND			Ground

The CEM600 module receives a 3.3V power supply from external sources ($\pm 9\%$ accuracy). The maximum average power consumption of the module is about 700mA. It is recommended to use an LDO or switching power supply of 1.5A or higher. In order to maintain the instantaneous voltage stability during operation, it is recommended to add a large storage capacitor, such as 220uF tantalum capacitor, to the power port of the motherboard.

5.8 Antenna socket interface

The module contains three RF antenna interfaces: main set, diversity and GPS. The main antenna interface (M), the diversity antenna interface (A) and the GPS antenna interface (G) provide two external antenna interfaces, namely an RF connector and an antenna pad. Both interfaces can be arbitrarily selected, but only one of them can be selected. Cables and antennas with a 50 ohm characteristic impedance must be selected.

Table 5-9 Antenna interface characteristics

Parameter	Conditions	Specifications
Sensitivity	1900 MHz	<-107 dBm (Typical)
	800 MHz	<-107 dBm (Typical)
	GPS	-155 dBm
RF output power	1900 MHz	24.5 dBm (Typical)
	800 MHz	24.5 dBm (Typical)
Gain		0 dBi (unity) gain or greater
Impedance		50Ω
VSWR		Less than 3.0:1

It is recommended to use an antenna with a gain value greater than 1 dBi.

According to the user's circuit board routing to debug the parameters of each device, you can connect 68~100nH inductor to the ground to prevent static electricity. Pay attention to the impedance matching and antistatic or lightning strike of the antenna.

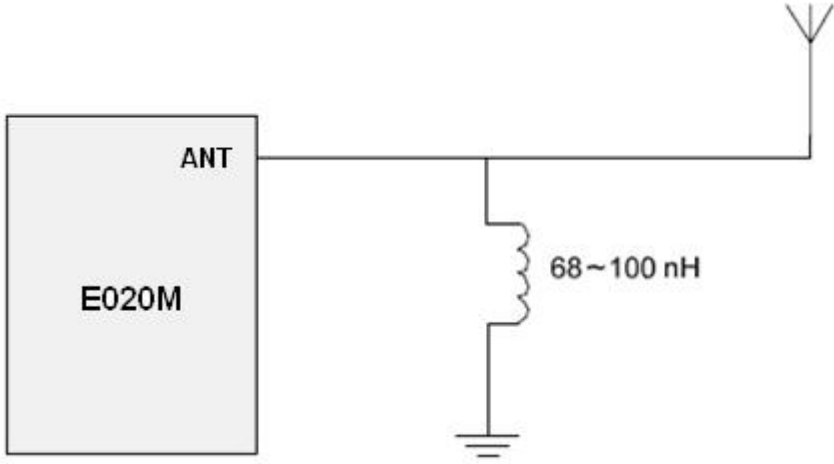


Figure 5-10 Antenna interface ESD protection recommended

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Chapter 6. structure

6.1 Structural size

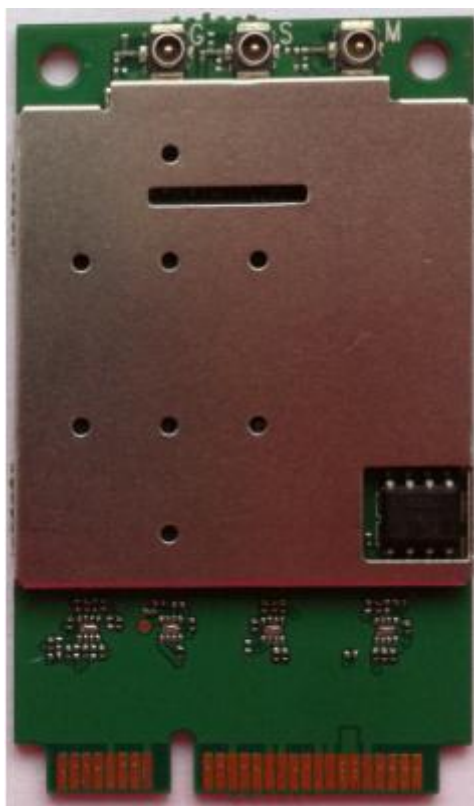


Figure 6-1 Outline drawing of the CEM600 module



The structural dimensions of the CEM600 module are as follows:

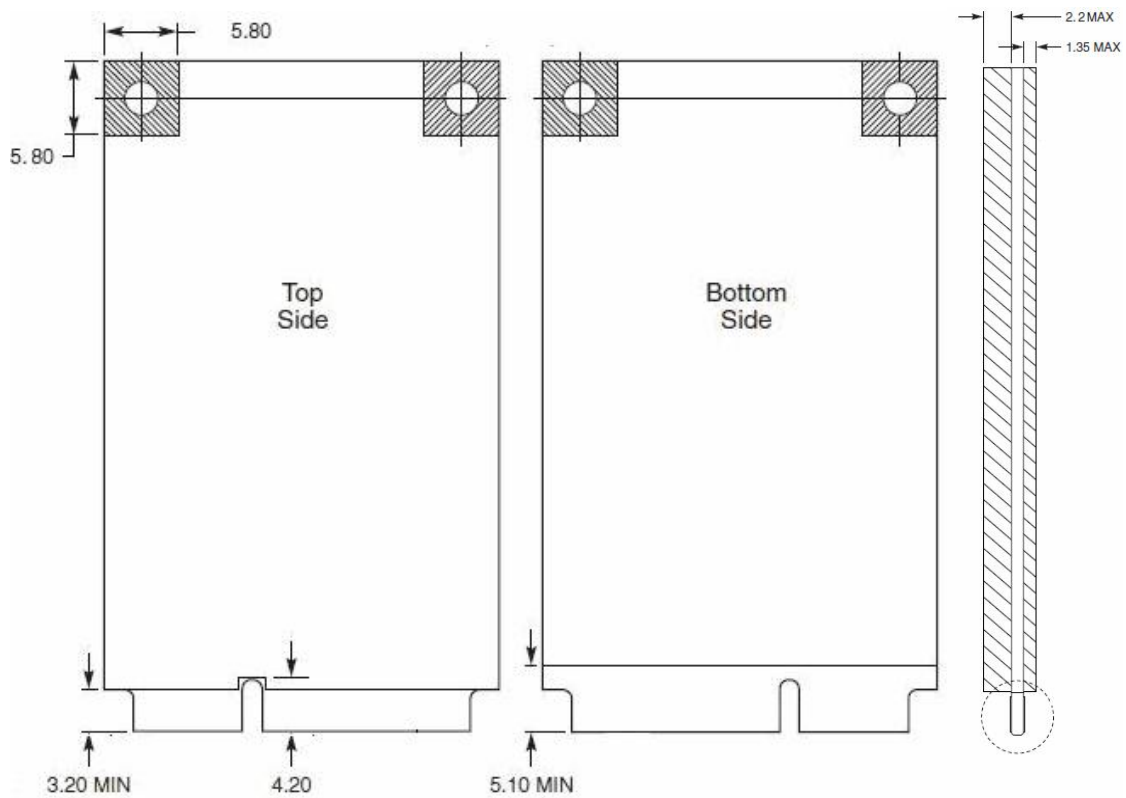


Figure 6-2 CEM600 module structure size

Specific size: 51mm (length) × 30mm (width) × 2.6mm (height)

6.2 Mini PCI Express connector

The CEM600 module interface complies with the PCI Express Mini Card 1.2 interface standard, and PCI Express Mini Card connectors conforming to this standard can be used with it, such as Molex's 679100002.

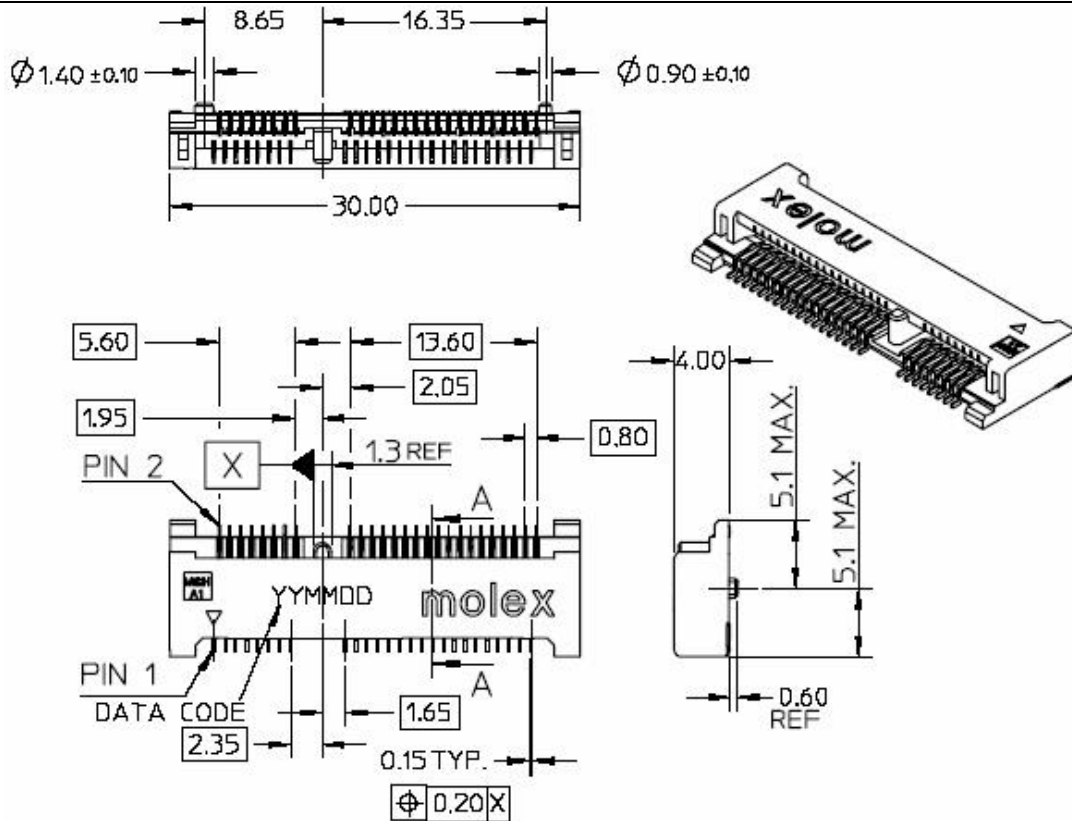


Figure 6-3 PCI Express Mini Card Connector

6.3 RF connector

The RF connector used on the CEM600 module is U.FL-R-SMT-1 (10) from HRS.

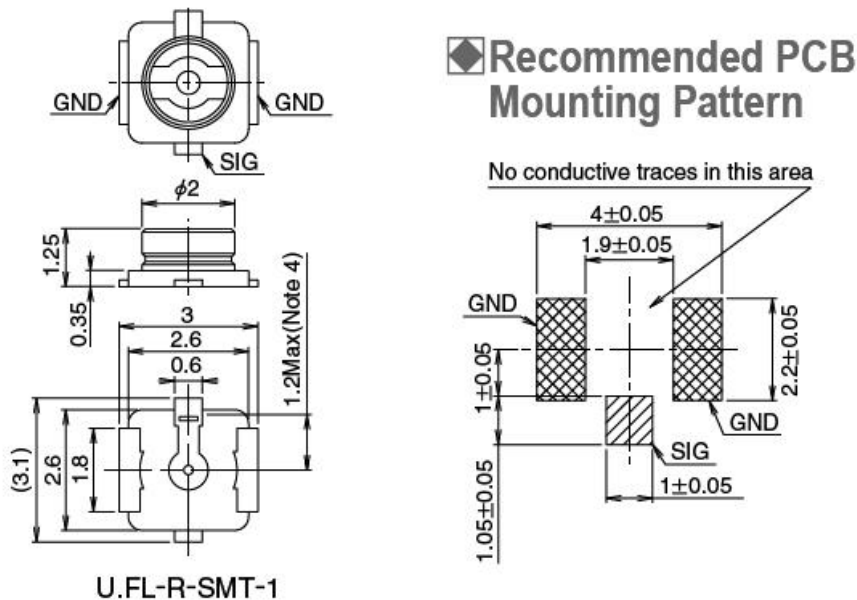


Figure 6-4 Antenna connector size

The RF connector plug for this connector is the U.FL-LP series from HRS.



Part No.	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
Mated Height	2.5mm Max. (2.4mm Nom.)	2.5mm Max. (2.4mm Nom.)	2.0mm Max. (1.9mm Nom.)	2.4mm Max. (2.3mm Nom.)	2.4mm Max. (2.3mm Nom.)
Applicable cable	Dia. 0.81mm Coaxial cable	Dia. 1.13mm and Dia. 1.32mm Coaxial cable	Dia. 0.81mm Coaxial cable	Dia. 1mm Coaxial cable	Dia. 1.37mm Coaxial cable
Weight (mg)	53.7	59.1	34.8	45.5	71.7
RoHS	YES				

Figure 6-5 Antenna connector mating plug

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