



Sierra Wireless RC7110

Hardware Integration Guide



SIERRA
WIRELESS®

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Rev 1

Important Notice

Due to the nature of wireless communications, transmission and reception of data can never be guaranteed. Data may be delayed, corrupted (i.e., have errors) or be totally lost. Although significant delays or losses of data are rare when wireless devices such as the Sierra Wireless modem are used in a normal manner with a well-constructed network, the Sierra Wireless modem should not be used in situations where failure to transmit or receive data could result in damage of any kind to the user or any other party, including but not limited to personal injury, death, or loss of property. Sierra Wireless accepts no responsibility for damages of any kind resulting from delays or errors in data transmitted or received using the Sierra Wireless modem, or for failure of the Sierra Wireless modem to transmit or receive such data.

Safety and Hazards

Do not operate the Sierra Wireless modem in areas where blasting is in progress, where explosive atmospheres may be present, near medical equipment, near life support equipment, or any equipment which may be susceptible to any form of radio interference. In such areas, the Sierra Wireless modem **MUST BE IN AIRPLANE MODE OR POWERED OFF**. The Sierra Wireless modem can transmit signals that could interfere with this equipment.

Do not operate the Sierra Wireless modem in any aircraft, whether the aircraft is on the ground or in flight. In aircraft, the Sierra Wireless modem **MUST BE IN AIRPLANE MODE OR POWERED OFF**. When operating, the Sierra Wireless modem can transmit signals that could interfere with various onboard systems.

Note: Some airlines may permit the use of cellular phones while the aircraft is on the ground and the door is open. Sierra Wireless modems may be used at this time.

The driver or operator of any vehicle should not operate the Sierra Wireless modem while in control of a vehicle. Doing so will detract from the driver or operator's control and operation of that vehicle. In some states and provinces, operating such communications devices while in control of a vehicle is an offence.

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Corporate and product information	Web: sierrawireless.com

Revision History

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1: Introduction

The Sierra Wireless RC7110 is LGA 239-pad module that provides data connectivity on LTE cat 1bis networks.

Accessories

A hardware development kit is available for Sierra Wireless RC Series modules. The kit contains hardware components for evaluating and developing with the module, including:

- Development board
- Cables
- Antennas (additional antennas may be required to support all bands)
- Other accessories

>> 2: Power

Power Supply

The host provides power to the Sierra Wireless RC7110 through multiple power and ground pins. The host must provide safe and continuous power at all times; the module does not have an independent power supply, or protection circuits to guard against electrical issues.

For detailed pinout and voltage/current requirements of this module, see the Sierra Wireless RC7110 Product Technical Specification.

Module Power States

The module has five basic power states, as described in [Table 2-1](#).

For detailed power states behavior of this module, see section 3.2.3 in the Sierra Wireless RC7110 Product Technical Specification.

Table 2-1: Supported Power States

State	Description
Active/Idle	- Highest power consumption state - All OS system interrupts can wakeup task. - Network IP data transmission
Sleep	- Lower power consumption than Active/Idle, but higher than Lite Hibernate - No delay for incoming/outgoing data session
Lite Hibernate	- Application Processor is OFF, and cellular processor (modem) is possible in DRX or eDRX state. - Retention IO^a keeps its state (latch level—high or low) when it enters Lite-Hibernate.
Hibernate	- Application Processor is OFF, and cellular processor (modem) is possible in eDRX or PSM state, or in LPM (Low Power mode). - Retention IO^a is OFF (it does not keep its state (latch level—high or low) when it enters Hibernate), and module is in lowest power consumption state.
Off	Module is off (VBATT is ON): - Active state (POWER_ON_N is asserted)—This is a low-level signal to turn on the module. - POWER_ON_N is deasserted

a. Retention IOs—GPIO2, GPIO21, UART1_RI, UART1_DSR

>> 3: RF Specifications

The Sierra Wireless RC7110 operates on the frequency bands listed below

Frequency Band Support

Table 3-1: RC7110 Supported Bands /Connectivity

Technology	RF Band	Transmit Band (Tx) (MHz)	Receive Band (Rx) (MHz)	Notes
LTE	B2	1850–1910	1930–1990	
	B4	1710–1755	2110–2155	
	B8	880–915	925–960	
	B12	699–716	729–746	
	B13	777–787	746–756	
	B66	1710–1780	2110–2200	

Conducted Tx Max Output Power Tolerances—LTE

Table 3-2: RC7110 Conducted Tx Max Output Power Tolerances—LTE ^a

RF Band	Operating Condition	Minimum (dBm)	Typical (dBm)	Maximum (dBm)	Notes
B2	Normal (25°C)	21	23	24	Power class 3
B4	Normal (25°C)	21	23	24	Power class 3
B8	Normal (25°C)	21	23	24	Power class 3
B12	Normal (25°C)	21	23	24	Power class 3
B13	Normal (25°C)	21	23	24	Power class 3
B66	Normal (25°C)	21	23	24	Power class 3

a. Stated typical power tolerance satisfies 3GPP TS 36.521-1 requirements for normal (25°C).

>> 4: Routing Constraints and Recommendations

This section describes general routing constraints and recommendations for the Sierra Wireless RC7110.
For detailed design guideline and requirements of this module, see the Sierra Wireless RC7110 Product Technical Specification.

Note: This is a non-exhaustive list of suggested design guidelines. The developer is responsible for deciding whether to implement these guidelines.

General Rules and Recommendations

Clock and other high-frequency digital signals (e.g. serial buses) should be routed as far as possible from the module's analog signals.

If the application design makes it possible, all analog signals should be separated from digital signals by a ground trace on the PCB.

Tip: *Avoid routing any signals under the module on the application board.*

PCB Layout Recommendations

Ground pads should be re-flowed on to the host PCB with < 25% voiding to allow effective heat dissipation.

Power Supply

When designing the power supply, make sure that VBAT_BB/VBAT_RF meet the requirements listed in the Sierra Wireless Product Technical Specification.

Careful attention should be paid to the following:

- Power supply quality—PFM, or PSM systems should be avoided; Low ripple, linear regulation or PWM converters are preferred for low noise.
- Capacity to deliver high current peaks in a short time (for pulsed radio emission)
- VBAT_BB/VBAT_RF must support peak currents with an acceptable voltage drop that guarantees the minimum required VBAT_BB/VBAT_RF value.
- VBAT_BB/VBAT_RF signal pads must never exceed the maximum required VBAT_BB/VBAT_RF value, otherwise the module's power amplifier may be severely damaged.
- A weakly-designed (not robust) power supply could affect EMC performance, the emission spectrum, and the phase error and frequency error.

Antenna

Sierra Wireless strongly recommends working with an antenna manufacturer either to develop an antenna adapted to the application, or to adapt an existing solution to the application.

For information on routing constraints for the RF circuit, see [RF Circuit on page 14](#).

PCB Specifications for the Application Board

Sensitive signals (such as audio, UIM, and clocks) should be protected by ground planes/fills. Routing sensitive signals close to noisy signals could result in noise being coupled.

Recommended PCB Land Pattern

Refer to RC Series Customer Process Guidelines, available at <http://source.sierrawireless.com>.

Routing Constraints

Power Supply

If the following design recommendations are not followed, phase error (peak) and power loss could occur.

- Since the maximum peak current can reach 800mA, Sierra Wireless strongly recommends having a large width for the layout of the power supply signal (to avoid voltage loss between the external power supply and VBAT_BB/VBAT_RF).
- The trace widths of the power supplies should be as wide as possible (> 40 mils) to minimize voltage drops and reduce electromagnetic interference risks.

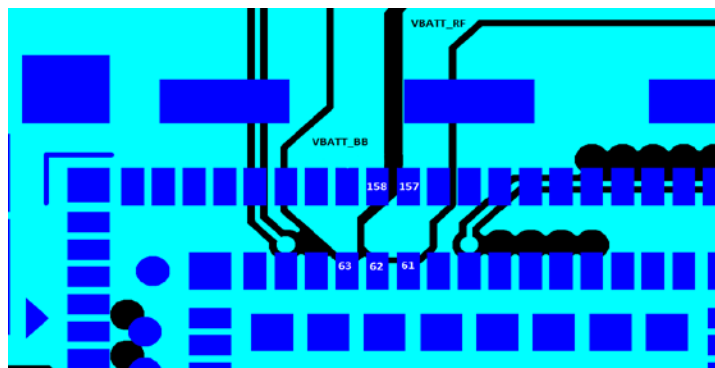


Figure 4-1: Power Supply Routing Example

Note: Figure 4-1 shows separate traces for VBAT_BB and VBAT_RF. If VBAT_BB and VBAT_RF share a single power supply, these traces should be connected.

Note: For optimal decoupling, place the capacitors on the underside of the board, directly under the pins.

- Filtering capacitors (100 nF to 1500 μ F) are recommended near the module's power supply. Depending on the quality and stability of the power supply.
- Attention should be paid to the ground trace or the ground plane on the application board for the power supply that supplies the module. The ground trace or ground plane, as well as the VBAT trace, must be able to support current peaks.
- If the ground trace between the module and the power supply is a copper plane, make sure it is a solid plane.
- Design routing to make sure total line impedance does not exceed 10 m Ω .

Ground Plane Connection

The Sierra Wireless RC7110 requires a solid, central ground plane (with solder mask defined pads) located directly under the module. This will:

- Ensure high current signal returns
- Provide heat dissipation under higher operating temperatures

The ground plane should be connected (with vias) to the reference ground layer of the application board.

UIM Interface

- The length of the tracks between the Sierra Wireless RC7110 and the UIM socket should be as short as possible. Maximum recommended length is 10cm.
- ESD protection is mandatory on the UIM lines unless there is no physical access to the UIM.
- The decoupling capacitor(s) should be placed as close as possible to the UIM card connector for the UIM_VCC signal.
- Isolate UIM1_CLK/UIM2_CLK and UIM1_DATA/UIM2_DATA from other signals and from each other.
Close routing between each UIM's Clock and Data signals is not recommended. And it recommends:
 - 2x spacing between UIM1_CLK and UIM1_DATA
 - 2x spacing between UIM2_CLK and UIM2_DATA
 - 50ohm impedance control

RF Circuit

The RF signal must be routed on the application board using tracks with a 50Ω characteristic impedance and have a solid ground.

The characteristic impedance depends on the dielectric, the track width and the ground plane spacing.

It is recommended to use stripline design if the RF path is fairly long (more than 1.5 cm), since microstrip design is not shielded. Consequently, the RF (transmit) signal may interfere with neighboring electronic circuits. In the same way, the neighboring electronics (micro-controllers, etc.) may interfere with the RF (receive) signal and degrade the reception performance.

The RF trace is routed under the module, to account for the metallic mass of the module, the RF trace width may need to be slightly reduced before going under the module. Thus, under the module, the structure of the RF line becomes a stripline.

Include a copper keep-out under the RF pads to reduce stray capacitance losses

All RF traces must be well-isolated from other noisy circuits such as switching power supply, clock and antenna control signals, and sensitive functions and traces.

Make sure the signal is not susceptible to interference and does not interfere with other signals.

Edge mount RF connectors are strongly suggested for better impedance matching.

When designing PCB traces, avoid routing designs that use different layers with via transitions, since this may introduce additional RF losses and path inductance. And do not use right angle RF traces.

The RF trace on the development board is routed from the module Main antenna port to the RF connector (SMA). The RF trace is designed as a 50Ω coplanar stripline and its length. It is advisable to design the trace length to be within 15mm will be better.

The following drawings show the location of the Sierra Wireless RC7110 on the development board, the routing cross section and the top view of the RF trace on the development board.

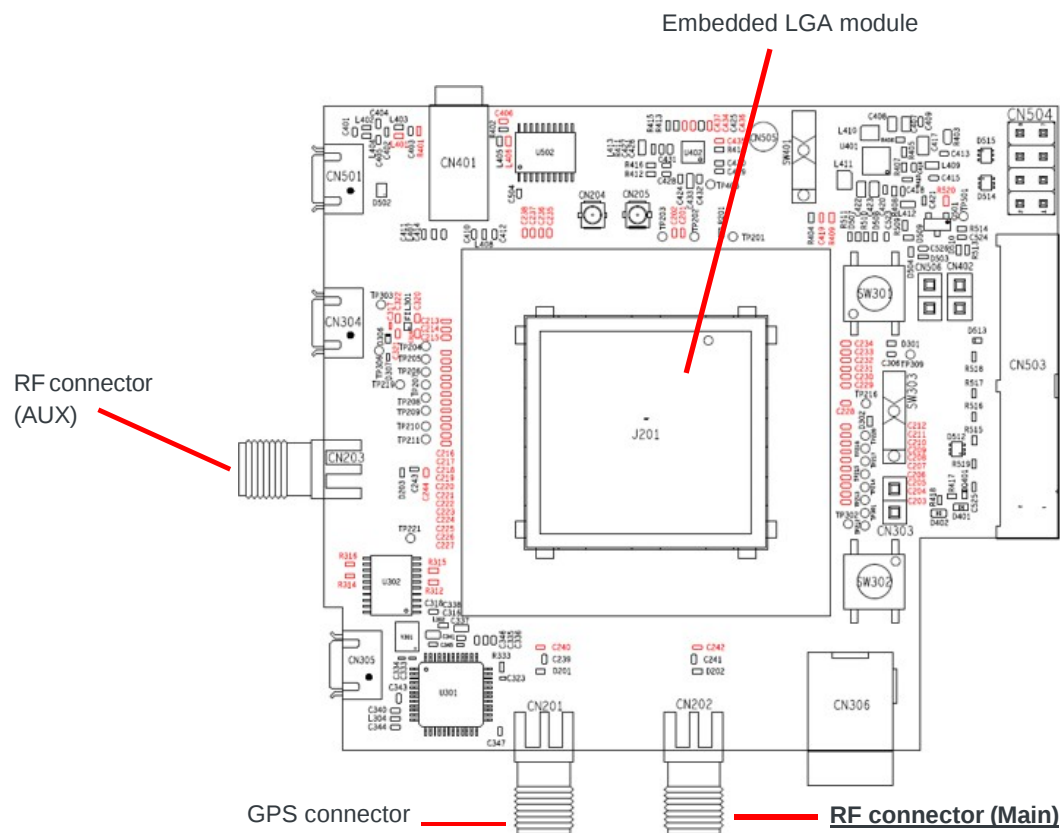


Figure 4-2: Module Location on Development Board (The RC71 supports only a single antenna on the Main port.)

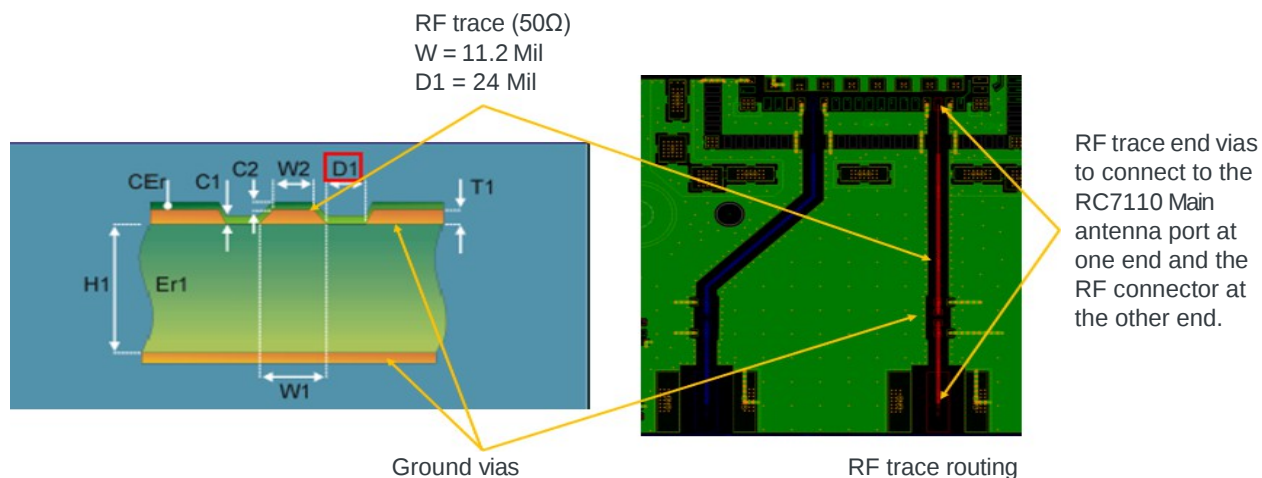


Figure 4-3: Development Board RF Trace Design for reference

USB Interface

When the USB interface is externally accessible, ESD protection is required on the USB_VBUS, USB_D+, and USB_D- signals. HS-USB guidelines:

- Up to 480 Mbps data rate.
- 90ohm differential, $\pm 10\%$ trace impedance.
- Differential data pair matching < 3.8 mm (150mils).
- Other comments and guidelines:
 - External components should be located near the USB connector.
 - Relatively fast edge rates, so they should be routed away from sensitive circuits and signals (RF, system clock).
 - VBUS trace width must be sized depending on the length of VBUS and the expected current.
 - Loading on the USB DP/DM lines could cause USB receiver sensitivity issues.
 - Perform USB electrical tests (eye diagram and receiver sensitivity) to ensure proper USB functionality.
 - It is not recommended to install series switches on the USB lines.
 - Trace width and trace spacing for DP and DM based on impedance calculator.
 - Avoid discontinuity. The trace width should be equal from source to destination. Keep impedance constant.
 - Avoid having multiple vias. Vias are a source of discontinuity, which can cause signal reflection.
 - Avoid crossing different power planes for USB signals. This causes an unpredictable return path current and causes a signal quality issue.
 - Test points added on USB traces must comply with radio frequency signal routing rules to avoid degradation of USB signal quality.
 - The USB power supplies should have wider traces and not narrow traces, which cause IR drop. This affects the jitter performance of the USB signal.

Thermal Considerations

When transmitting, the Sierra Wireless RC7110 can generate significant amounts of heat (due to the internal Power Amplifier) that must be dissipated in the host device for safety and performance reasons.

The amount of thermal dissipation required depends on the following factors:

- Supply voltage—Maximum power dissipation for these modules can be up to 2.75 W at voltage supply limits.
- Usage—Typical power dissipation values depend on the location within the host, amount of data transferred, etc.

To enhance heat dissipation:

- Maximize airflow over / around the module
- Locate the module away from other components that generate heat
- Ensure the module is connected to a solid ground plane

EMC and ESD Recommendations

EMC tests must be performed on the application as soon as possible to detect any potential problems.

When designing, special attention should be paid to:

- Possible spurious emissions radiated by the application to the RF receiver in the receiver band
- ESD protection—Typically, ESD protection is mandatory for externally accessible signals, including:
 - VBAT_RF/VBAT_BB
 - UIM (if accessible from outside)
 - Serial link
 - USB
 - Antennas
 - Key Feature (Control signals)
- Length of the UIM interface lines (preferably <10 cm)
- EMC protection on audio input/output (filters against 900 MHz emissions)
- Ground plane: Sierra Wireless recommends a common ground plane for analog/digital/RF grounds

Note: The Sierra Wireless RC7110 does not include any protection against over-voltage.

The host device must provide adequate ESD protection on digital circuits and antenna ports as detailed in the following table.

Note: The level of protection required depends on your application.

Table 4-1: ESD Specifications ^{a,b}

Category	Connection	Specification
Operational	RF ports UIM connector USB connector UART connector Key Feature	IEC-61000-4-2 - Level (Electrostatic Discharge Immunity Test) • $\pm 6\text{kV}$ Contact • $\pm 8\text{kV}$ Air
Non-operational	Host connector interface	Unless otherwise specified: • JS-001 $\pm 2\text{kV}$ Human Body Model • JS-002 $\pm 500\text{V}$ Charged Device Model

a. ESD specifications are preliminary, subject to change.

b. ESD protection is highly recommended at the point where the UIM contacts are exposed, and for any other signals that would be subjected to ESD by the user.

Mechanical Integration

Attention should be paid to:

- Antenna cable integration (bending, length, position, etc)
- Pads of the Sierra Wireless RC7110 to be soldered to the ground plane
- Ensuring proper board layout
- Providing sufficient space around the module for heat dissipation

Signal Reference Schematics

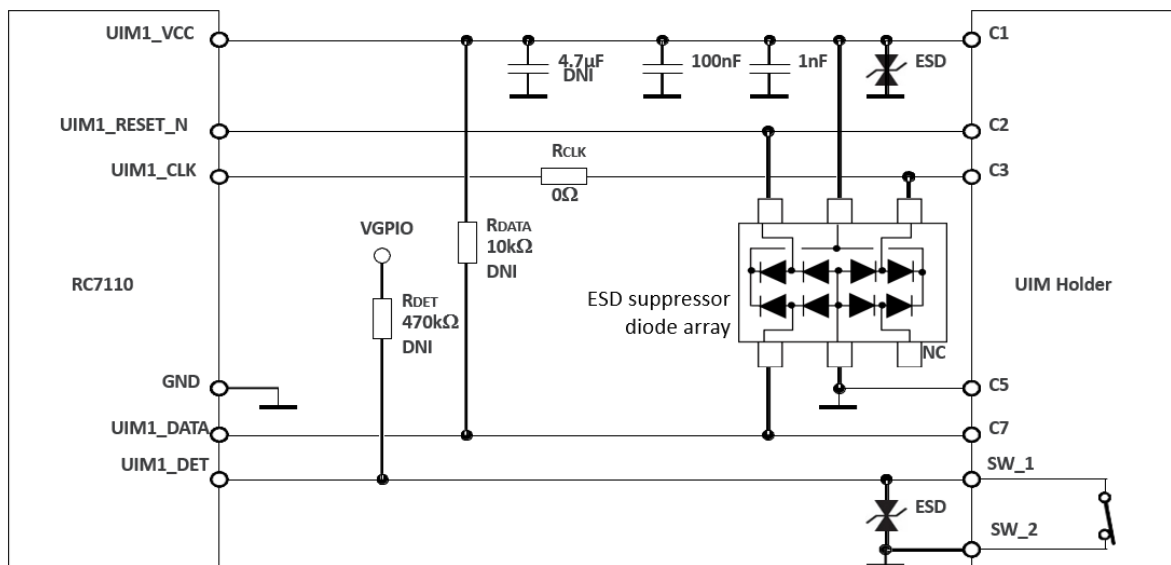


Figure 4-4: UIM Interface for UIM1 and UIM2

USB2.0 Interface Example

Note : Reserve a footprint for an additional 2pF capacitor between the D+ and D- data lines in order to ensure USB compliance.

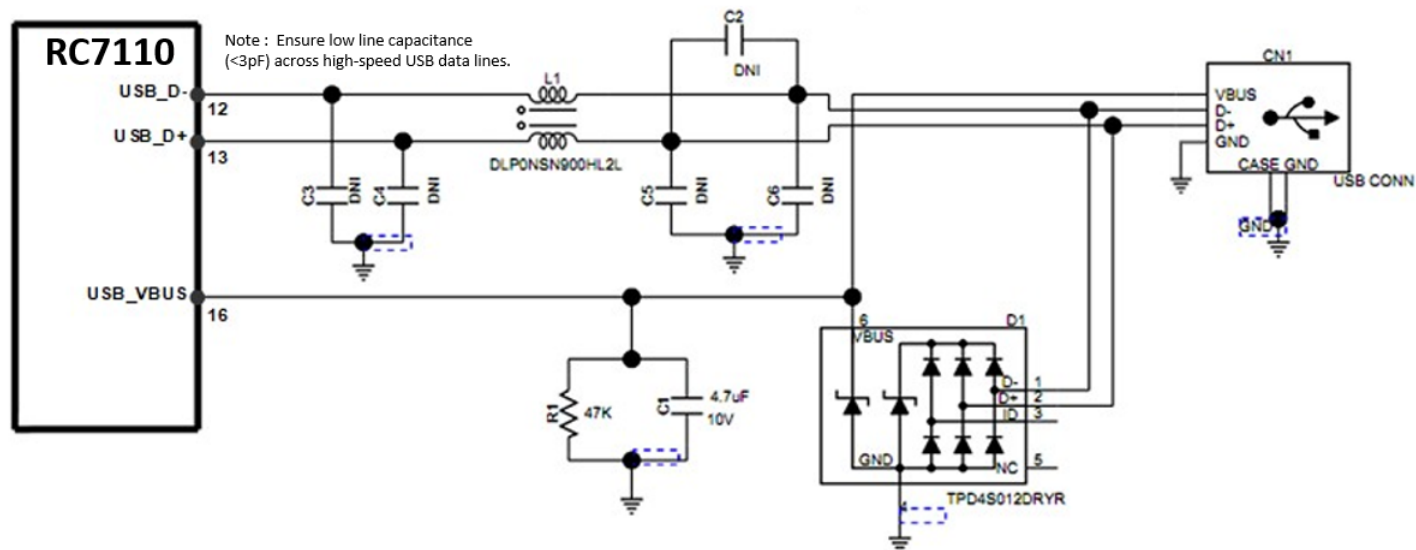


Figure 4-5: USB2.0 Interface

>> 5: Regulatory Compliance and Industry Certifications

Disposing of the Product

This electronic product is subject to the EU Directive 2012/19/EU for Waste Electrical and Electronic Equipment (WEEE). As such, this product must not be disposed of at a municipal waste collection point. Please refer to local regulations for directions on how to dispose of this product in an environmental friendly manner.

Important Notice

Due to the nature of wireless communications, transmission and reception of data can never be guaranteed. Data may be delayed, corrupted (i.e., have errors) or be totally lost. Although significant delays or losses of data are rare when wireless devices such as the Sierra Wireless modem are used in a normal manner with a well-constructed network, the Sierra Wireless modem should not be used in situations where failure to transmit or receive data could result in damage of any kind to the user or any other party, including but not limited to personal injury, death, or loss of property. Sierra Wireless accepts no responsibility for damages of any kind resulting from delays or errors in data transmitted or received using the Sierra Wireless modem, or for failure of the Sierra Wireless modem to transmit or receive such data.

Safety and Hazards

Do not operate your Sierra Wireless RC7110 embedded module:

- In areas where blasting is in progress
- Where explosive atmospheres may be present including refueling points, fuel depots, and chemical plants
- Near medical equipment, life support equipment, or any equipment which may be susceptible to any form of radio interference.

In such areas, the Sierra Wireless RC7110 **MUST BE IN AIRPLANE MODE OR POWERED OFF**. Otherwise, the module can transmit signals that could interfere with this equipment.

In an aircraft, the Sierra Wireless RC7110 **MUST BE IN AIRPLANE MODE OR POWERED OFF**. Otherwise, the module can transmit signals that could interfere with various onboard systems and may be dangerous to the operation of the aircraft or disrupt the cellular network. Use of a cellular phone in an aircraft is illegal in some jurisdictions. Failure to observe this instruction may lead to suspension or denial of cellular telephone services to the offender, or legal action or both.

Some airlines may permit the use of cellular phones while the aircraft is on the ground and the door is open. The module may be used normally at this time.

Compliance Acceptance and Certification

Final regulatory and operator certification requires regulatory agency testing and approval with the fully integrated UE host device incorporating the Sierra Wireless RC7110 module.

The OEM host device and, in particular, the OEM antenna design and implementation will affect the final product functionality, RF performance, and certification test results.

Note: Tests that require features not supported by the Sierra Wireless RC7110 (as defined by this document) are not supported.

Certification Compliance

Important Compliance Information for North American Users

The Sierra Wireless RC7110 module have been granted modular approval for mobile applications. Integrators may use these modules in their final products without additional FCC/IC certification if they meet the following conditions. Otherwise, additional FCC/IC approvals must be obtained.

1. The end product must use the RF trace design approved with the Sierra Wireless RC7110 module. The Gerber file of the trace design can be obtained from Sierra Wireless upon request.
2. At least 20 cm separation distance between the antenna and the user's body must be maintained at all times.
3. To comply with FCC regulations limiting both maximum RF output power and human exposure to RF radiation, the maximum antenna gain including cable loss in a mobile-only exposure condition must not exceed the limits stipulated in [Table 5-1](#).

4. The Sierra Wireless RC7110 may transmit simultaneously with other collocated radio transmitters within a host device, provided the following conditions are met:
- Each collocated radio transmitter has been certified by FCC/IC for mobile application.
 - At least 20 cm separation distance between the antennas of the collocated transmitters and the user's body must be maintained at all times.
 - The radiated power of a collocated transmitter must not exceed the EIRP limit stipulated in [Table 5-1](#).

Table 5-1: Antenna Gain Collocated Radio Transmitter Specifications

RC7110	Operating Mode		Tx Freq. Range (MHz)	Max Conducted Power (dBm)	FCC			IC		
					Max Antenna Gain (dBi)		Maximum EIRP (dBm)	Max Antenna Gain (dBi)		Maximum EIRP (dBm)
					Standalone	Collocated		Standalone	Collocated	
RC7110	LTE	Band 2	1850-1910	24	9	6.4	33	9	6.4	33
		Band 4	1710-1755	24	6	6	30	6	6	30
		Band 8	880-915	24	10.5	4	34.5	-	-	-
		Band 12	699-716	24	6.6	3.5	30.6	6.6	3.5	30.6
		Band 13	777-787	24	6.9	3.8	30.9	6.9	3.8	30.9
		Band 66	1710-1780	24	6	6	30	6	6	30
Collocated Transmitters	WLAN 2.4GHz		2400-2500	26	-	5	31	-	5	31
	WLAN 5GHz		5150-5850	26	-	5	31	-	5	31
	Bluetooth		2400-2500	15	-	5	20	-	5	20

a. Valid collocated transmitter combinations: WLAN+BT (WLAN+ BT is not permitted.)

5. A label must be affixed to the outside of the end product into which the Sierra Wireless RC7110 is incorporated, with a statement similar to the following:
- **(RC7110) This device contains FCC ID: N7NRC71A / IC: 2417C-RC71A**

6. A user manual with the end product must clearly indicate the operating requirements and conditions that must be observed to ensure compliance with current FCC/IC RF exposure guidelines.

The end product with an embedded RC7110 may also need to pass the FCC Part 15 unintentional emission testing requirements and be properly authorized per FCC Part 15.

Note: If this module is intended for use in a portable device, you are responsible for separate approval to satisfy the SAR requirements of FCC Part 2.1093 and IC RSS-102.

Industry Canada Statement

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions:

- (1) this device may not cause interference, and
- (2) this device must accept any interference, including interference that may cause undesired operation of the device.

This module is intended for OEM integrator. The OEM integrator is responsible for the compliance to all the rules that apply to the product into which this certified RF module is integrated. Additional testing and certification may be necessary when multiple modules are used.

This equipment complies with IC RSS-102 radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20 cm between the radiator and your body.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

- (1) l'appareil ne doit pas produire de brouillage, et
- (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

L'intégrateur OEM doit être conscient de ne pas fournir des informations à l'utilisateur final quant à la façon d'installer ou de supprimer ce module RF dans le manuel de l'utilisateur du produit final qui intègre ce module. Le manuel de l'utilisateur final doit inclure toutes les informations réglementaires requises et avertissements comme indiqué dans ce manuel.

Cet équipement est conforme aux limites d'exposition aux rayonnements IC établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec un minimum de 20 cm de distance entre la source de rayonnement et votre corps.