



M.2 Accessory Board Product Technical Specification

RC7611, RC7611D

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Contact Information

Sales information and technical support, including warranty and returns	Web: sierrawireless.com/company/contact-us/ Global toll-free number: 1-877-687-7795 6:00 am to 5:00 pm PST
Corporate and product information	Web: sierrawireless.com

Revision History

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1	November 2025	Document creation

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1: Introduction

This document defines the high-level product features and illustrates the interfaces for RC7611/RC7611D M.2 Accessory Board. It covers the hardware aspects of the product series, including electrical and mechanical.

1.1 General Features

The RC7611/RC7611D M.2 Accessory Board belongs to the EM Series product family and provides data connectivity on the wireless networks listed in [Table 1-1](#).

Table 1-1: Supported Networks

Device	Networks	LTE Category
RC7611/RC7611D M.2 Accessory Board	LTE	Cat4

GNSS functionality is available on all RC7611/RC7611D M.2 Accessory Board variants.

The following tables detail supported RF bands/connectivity.

Table 1-2: RC7611/RC7611D M.2 Accessory Board Supported Bands / Connectivity

Technology	RF Band	Transmit Band (Tx) (MHz)	Receive Band (Rx) (MHz)	Notes
LTE	B2	1850–1910	1930–1990	MIMO ^a and diversity
	B4	1710–1755	2110–2155	
	B5	824–849	869–894	
	B12	699–716	729–746	
	B13	777–787	746–756	
	B14	788–798	758–768	
	B25	1850–1915	1930–1995	
	B26	814–849	859–894	
	B66	1710–1780	2110–2200	
	B71	663–698	617–652	
GNSS ^b	GPS		1575.42 ± 1.023	
	GLONASS		1597–1606	
	Galileo		1575.42 ± 2.046	
	BeiDou		1561.098 ± 2.046	

a. Downlink MIMO 2x2

b. GNSS support is SKU-dependent.

1.2 Interfaces

The RC7611/RC7611D M.2 Accessory Board provides the following interfaces and peripheral connectivity:

- VCC power supply — See [Power Supply](#)
- RF (Main Antenna, Diversity Antenna) — See [RF](#)
- GNSS (GNSS Antenna) — See [GNSS](#)
- ON/OFF control — See [POWER_ON \(Power Control\)](#)
- (1x) USB 2.0 — See [USB](#)
- (1x) 1.8V/3V SIM — See [UIM Interface](#)
- WAKE_ON_WWAN — Signal to wake host when specific events occur. See [WAKE_ON_WWAN_N](#)
- SAFE_POWER_REMOVE — See [SAFE_PWR_REMOVE_N](#)
- RESET — See [Reset Signal \(SYSTEM_RESET_N\)](#)

1.3 Physical Dimensions and Connection Interface

The RC7611/RC7611D M.2 Accessory Board is a compact, robust device with a fully shielded and labeled (laser-etched) embedded RC7611 module. The RC7611/RC7611D M.2 Accessory Board's dimensions are noted in [Table 1-3](#).

Table 1-3: Physical Parameters^a

Parameter	Nominal	Tolerance	Units
Length	42	±0.15	mm
Width	29.90	±0.15	mm
Thickness	3.55	±0.40	mm
Weight	7.8		g

a. Dimensions are approximate, subject to confirmation.

For device views, see [Figure 4-2](#) on page 42 and [Figure 4-3](#) on page 42. For a product marking example, see [Figure 6-1](#) on page 45.

1.4 ESD

The OEM is responsible for ensuring that the M.2 card host interface pins are not exposed to ESD during handling or normal operation. (For specifications, see [Table 4-1](#) on page 35.)

ESD protection is highly recommended for the SIM connector at the point where the contacts are exposed, and for any other signals from the host interface that would be subjected to ESD by the user of the product. (The embedded RC module includes ESD protection on its antenna ports.)

1.5 Accessories

The Universal Development Kit (UDK) is a hardware development platform for EM-series modules. It contains hardware components for evaluating and developing with the module, including:

- Development board
- Cables
- Antennas (Additional antennas may be required to support all bands.)

- Initial allotment of support hours
- Other accessories

For instructions on setting up the UDK (Part # 6000270), see [5] PCI Express Mini Card Dev Kit Quick Start Guide.

For over-the-air LTE and GNSS testing, ensure that suitable antennas are used.

1.6 Required Connectors

Table 1-4 describes the connectors used to integrate RC7611/RC7611D M.2 Accessory Boards into your host device.

Table 1-4: Required host-module connectors^a

Connector type	Description
RF cables	<ul style="list-style-type: none">▪ Mate with Hirose U.FL connectors (model U.FL #CL331-0471-0-10)▪ Three connector jacks
SIM	<ul style="list-style-type: none">▪ Industry-standard connector. Type depends on how host device exposes the SIM socket▪ Example: UDK board uses ITT CCM03-3518

a. Manufacturers/part numbers are for reference only and are subject to change. Choose connectors that are appropriate for your own design.

2: Functional Specifications

2.1 Architecture

The following figures present overviews of the RC7611/RC7611D M.2 Accessory Board's internal architecture and external interfaces.

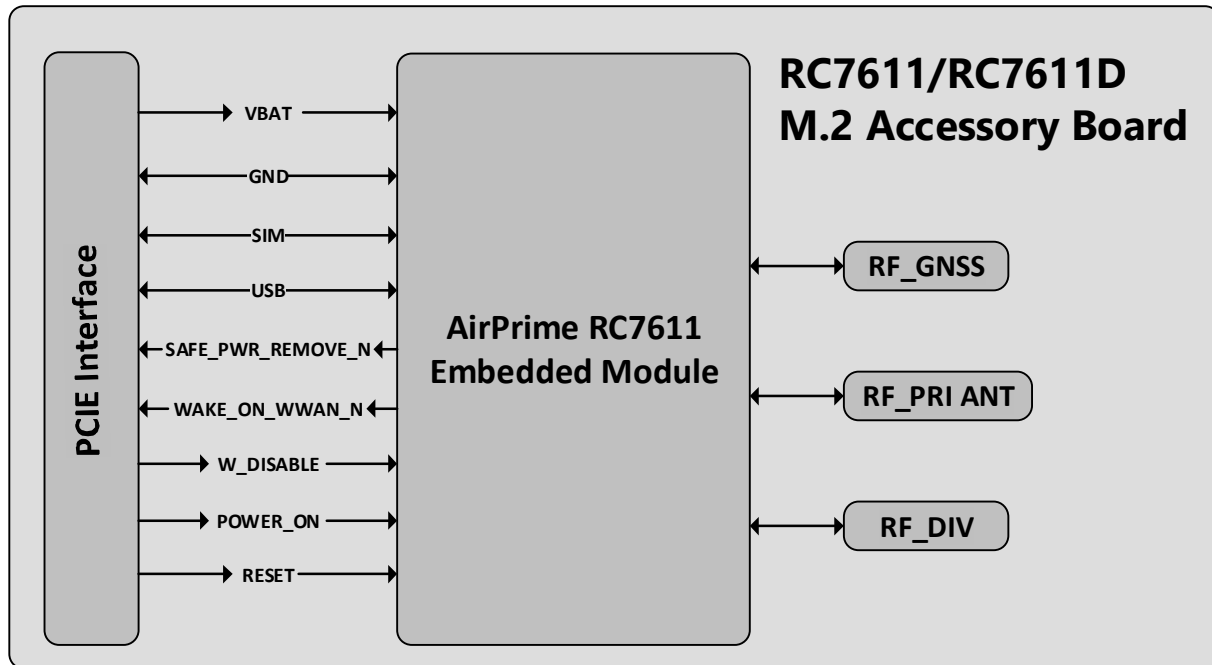


Figure 2-1: RC7611/RC7611D M.2 Accessory Board Architecture Overview

Telecom Features

Table 2-1 summarizes the RC7611/RC7611D M.2 Accessory Board's telecom capabilities.

Table 2-1: General Features

Feature	Description
Physical	<ul style="list-style-type: none"> RF connection (RF main interface) Baseband signals connection
Electrical	Supply voltage (VCC): <ul style="list-style-type: none"> RC7611/RC7611D M.2 Accessory Board—3.2–4.3 V
RF	Supported bands — See Table 1-2 on page 8.
SIM interface	<ul style="list-style-type: none"> 1.8V/3V support SIM extraction SIM/USIM support Conforms with ETSI UICC Specifications Supports SIM application tool kit with proactive SIM commands

Table 2-1: General Features

Feature	Description
Application interface	<ul style="list-style-type: none"> ▪ NDIS NIC interface support ▪ Multiple non-multiplexed USB channel support ▪ Dial-up networking ▪ USB selective suspend to maximize power savings ▪ AT command interface— 3GPP 27.007 standard, plus proprietary extended AT commands
SMS	<ul style="list-style-type: none"> ▪ SMS MO and MT ▪ CS and PS support ▪ SMS saving to UIM card or ME storage ▪ SMS reading from UIM card or ME storage ▪ SMS sorting ▪ SMS concatenation ▪ SMS Status Report ▪ SMS replacement support ▪ SMS storing rules (support of AT+CNMI, AT+CNMA)
Connectivity	<ul style="list-style-type: none"> ▪ Multiple (up to 24) cellular packet data profiles ▪ Sleep mode for minimum idle power draw ▪ Mobile-originated PDP context activation / deactivation ▪ Support QoS profile <ul style="list-style-type: none"> • Release 97 - Precedence Class, Reliability Class, Delay Class, Peak Throughput, Mean Throughput • Release 99 QoS negotiation - Background, Interactive, and Streaming ▪ Static and Dynamic IP address. The network may assign a fixed IP address or dynamically assign one using DHCP (Dynamic Host Configuration Protocol). ▪ Supports PAP and CHAP authentication protocols ▪ PDP context type (IPv4, IPv6, IPv4v6). IP Packet Data Protocol context ▪ RFC1144 TCP/IP header compression

2.2 RF

The RC7611/RC7611D M.2 Accessory Board includes three RF connectors for use with host-supplied antennas:

- Main RF connector — Rx / Tx path
- GNSS connector 1 — Dedicated GNSS
- Diversity / MIMO connector — Diversity or MIMO

The module does not have integrated antennas.

2.2.1 RF Connections

When attaching antennas to the module:

- Use Hirose U.FL connectors (3 mm x 3 mm, low profile; model U.FL #CL331-0471-0-10) to attach antennas to connection points on the module, as shown in [Figure 2-1](#).
(To disconnect the antenna, make sure you use the Hirose U.FL connector removal tool (Part # UFL-LP-N-2(01)) to prevent damage to the module or coaxial cable assembly.)
- Match coaxial connections between the module and the antenna to 50 Ω .
- Minimize RF cable losses to the antenna; the recommended maximum cable loss for antenna cabling is 0.5 dB.

-
- To ensure best thermal performance, mounting holes must be used to attach (ground) the device to the main PCB ground or a metal chassis.

Note: If the antenna connection is shorted or open, the modem will not sustain permanent damage.

2.2.2 Shielding

The RC7611/RC7611D M.2 Accessory Board's embedded module is fully shielded to protect against EMI. The shielding must not be removed.

2.2.3 Antenna and Cabling

When selecting the antenna and cable, it is critical to RF performance to optimize antenna gain and cable loss.

Note: For detailed electrical performance criteria, see [WWAN Antenna Recommendations](#) and [GNSS Antenna Recommendations](#).

2.2.3.1 Choosing the Correct Antenna and Cabling

When matching antennas and cabling:

- The antenna (and associated circuitry) should have a nominal impedance of 50 Ω with a recommended return loss of better than 10 dB across each frequency band of operation.
- The system gain value affects both radiated power and regulatory (FCC, IC, CE, etc.) test results.

2.2.3.2 Designing Custom Antennas

Consider the following points when designing custom antennas:

- A skilled RF engineer should do the development to ensure that the RF performance is maintained.
- If multiple RF modules will be installed in the same platform, you may want to develop separate antennas for maximum performance.

2.2.3.3 Determining the Antenna's Location

When deciding where to put the antennas:

- Antenna location may affect RF performance. Although the module is shielded to prevent interference in most applications, the placement of the antenna is still very important — if the host device is insufficiently shielded, high levels of broadband noise or spurious interference can degrade the module's performance.
- Connecting cables between the module and the antenna must have 50 Ω impedance. If the impedance of the module is mismatched, RF performance is reduced significantly.
- Antenna cables should be routed, if possible, away from noise sources (switching power supplies, LCD assemblies, etc.). If the cables are near the noise sources, the noise may be coupled into the RF cable and into the antenna. See [Interference from Other Wireless Devices](#) on page 14.

2.2.3.4 Disabling the Diversity Antenna

Certification testing of a device with an integrated RC7611/RC7611D M.2 Accessory Board may require the board's main and diversity antennas to be tested separately.

To facilitate this testing, receive diversity can be enabled/disabled using the AT command **!RXDEN**. See RC76xx AT Command Reference Guide for details.

Important: *LTE networks expect modules to have more than one antenna enabled for proper operation. Therefore, customers must not commercially deploy their systems with the diversity antenna disabled.*

Note: A diversity antenna is used to improve connection quality and reliability through redundancy. Because two antennas may experience different interference effects (signal distortion, delay, etc.), when one antenna receives a degraded signal, the other may not be similarly affected.

2.2.4 Ground Connection

When connecting the module to system ground:

- Prevent noise leakage by establishing a very good ground connection to the module through the host connector.
- Connect to system ground using the two mounting holes at the top of the module.
- Minimize ground noise leakage into the RF.

Depending on the host board design, noise could potentially be coupled to the module from the host board. This is mainly an issue for host designs that have signals traveling along the length of the module, or circuitry operating at both ends of the module interconnects.

2.2.5 Interference and Sensitivity

Several interference sources can affect the module's RF performance (RF desense). Common sources include power supply noise and device-generated RF.

RF desense can be addressed through a combination of [Methods to Mitigate Decreased Rx Performance](#) on page 15 and [Radiated Sensitivity Measurement](#) on page 15.

Note: The RC7611/RC7611D M.2 Accessory Board is based on ZIF (Zero Intermediate Frequency) technologies. When performing EMC (Electromagnetic Compatibility) tests, there are no IF (Intermediate Frequency) components from the module to consider.

2.2.5.1 Interference from Other Wireless Devices

Wireless devices operating inside the host device can cause interference that affects the module.

To determine the most suitable locations for antennas on your host device, evaluate each wireless device's radio system, considering the following:

- Any harmonics, sub-harmonics, or cross-products of signals generated by wireless devices that fall in the module's Rx range may cause spurious response, resulting in decreased Rx performance.
- The Tx power and corresponding broadband noise of other wireless devices may overload or increase the noise floor of the module's receiver, resulting in Rx desense.

The severity of this interference depends on the closeness of the other antennas to the module's antenna. To determine suitable locations for each wireless device's antenna, thoroughly evaluate your host device's design.

2.2.5.2 Host-generated RF Interference

All electronic computing devices generate RF interference that can negatively affect the receive sensitivity of the module.

Proximity of host electronics to the antenna in wireless devices can contribute to decreased Rx performance.

Components that are most likely to cause this include:

- Microprocessor and memory
- Display panel and display drivers
- Switching-mode power supplies

2.2.5.3 Device-generated RF Interference

The module can cause interference with other devices. Wireless devices such as embedded modules transmit in bursts (pulse transients) for set durations (RF burst frequencies). Hearing aids and speakers convert these burst frequencies into audible frequencies, resulting in audible noise.

2.2.6 Methods to Mitigate Decreased Rx Performance

It is important to investigate sources of localized interference early in the design cycle. To reduce the effect of device-generated RF on Rx performance:

- Put the antenna as far as possible from sources of interference.
- Shield the host device. The module itself is well shielded to avoid external interference. In most instances, it is necessary to employ shielding on the components of the host device (such as the main processor and parallel bus) that have the highest RF emissions.
- Filter out unwanted high-order harmonic energy by using discrete filtering on low frequency lines.
- Form shielding layers around high-speed clock traces by using multi-layer PCBs.
- Route antenna cables away from noise sources.

2.2.7 Radiated Sensitivity Measurement

A wireless host device contains many noise sources that contribute to a reduction in Rx performance.

To determine the extent of any receiver performance desensitization due to self-generated noise in the host device, over-the-air (OTA) or radiated testing is required. This testing can be performed by Semtech or you can use your own OTA test chamber for in-house testing.

2.2.7.1 Semtech's Sensitivity Testing and Desensitization Investigation

Although embedded modules are designed to meet network operator requirements for receiver performance, they are still susceptible to various performance inhibitors.

As part of the Engineering Services package, Semtech offers modem OTA sensitivity testing and desensitization (desense) investigation. For more information, contact your account manager or the Sales Desk (see [Contact Information](#) on page 3).

Note: Semtech has the capability to measure TIS (Total Isotropic Sensitivity) and TRP (Total Radiated Power) according to CTIA's published test procedure.

2.2.7.2 Sensitivity vs. Frequency

For LTE bands, sensitivity is defined as the RF level at which throughput is 95% of maximum.

2.2.8 Supported Frequencies

The following tables indicate the RF frequencies supported by RC7611/RC7611D M.2 Accessory Boards. For additional RF information, see [RF](#) on page 29.

Table 2-2: RC7611 Supported Bands / Connectivity

Technology	RF Band	Transmit Band (Tx) (MHz)	Receive Band (Rx) (MHz)	Notes
LTE	B2	1850–1910	1930–1990	MIMO ^a and diversity
	B4	1710–1755	2110–2155	
	B5	824–849	869–894	
	B12	699–716	729–746	
	B13	777–787	746–756	
	B14	788–798	758–768	
	B25	1850–1915	1930–1995	
	B26	814–849	859–894	
	B66	1710–1780	2110–2200	
	B71	663–698	617–652	
GNSS ^b	GPS		1575.42 ± 1.023	
	GLONASS		1597–1606	
	Galileo		1575.42 ± 2.046	
	BeiDou		1561.098 ± 2.046	

- a. Downlink MIMO 2x2
- b. GNSS support is SKU-dependent.

2.2.9 Network Technology Specifications

2.2.9.1 LTE Specifications

The following table describes LTE specifications for RC7611/RC7611D M.2 Accessory Boards.

Table 2-3: Supported LTE Specifications

Standard	Feature Description
R13	<ul style="list-style-type: none"> ▪ eDRX (Extended Discontinuous Reception) to extend battery life in devices that do not require frequent network access
R10	<ul style="list-style-type: none"> ▪ Release 10 mandatory LTE features ▪ Data rates — Cat 4 FDD (up to 150 Mbps downlink, 50 Mbps uplink) ▪ 1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz and 20 MHz RF bandwidth ▪ IPv6, QoS ▪ Inter-RAT capabilities with HSPA+ ▪ NAS & RRC standalone security
R10	<ul style="list-style-type: none"> ▪ Commercial Mobile Alert System (CMAS) ▪ ETWS (Earthquake Tsunami Warning System) notification ▪ Inter-frequency/bandwidth mobility ▪ DRX cycle while in: <ul style="list-style-type: none"> · Connected mode · Idle mode ▪ UE IRAT support for Self Organizing Networks and Automatic Neighbor Relation (SON AR) ▪ LTE/GW Data Silent Redial for InterRAT ▪ Attach/detach PS during Voice Call or SMS
System Determination	<ul style="list-style-type: none"> ▪ Frequency Scan and System Selection within LTE ▪ LTE BPLMN support ▪ LTE Connected mode OOS ▪ System selection across RATs, Standalone Security, Dedicated EPS Bearer Management and Dormancy ▪ System selection across LTE, UMTS, GERAN ▪ 256 UPLMN and 256 OPLMN entries in UIM support ▪ Carrier Specific BSR Requirements
Data	<ul style="list-style-type: none"> ▪ Data call throttling ▪ Default IPv4 bearer activation at attach/IPv4 data call ▪ NW and UE initiated QoS ▪ Dual IP and IPv4/IPv6 continuity ▪ IPv4/IPv6 session continuity ▪ W/G IP session continuity ▪ Emergency services — LTE NAS Support for Control Plane LTE Positioning Protocol

2.2.10 Modem Specifications

Table 2-4: Supported Modem Specifications^a

Standard	Feature Description
Data	<ul style="list-style-type: none">▪ IPHC protocol as RFC 2509▪ Stateless DHCPv4 protocol to get P-CSCF and DNS addresses▪ IPv4 / IPv6▪ Dual IP on single QMAP PDN▪ Multi-QMAP PDN Data Call

a. Preliminary

3: Technical Specifications

3.1 Environmental

The environmental specifications for operation and storage of the RC7611/RC7611D M.2 Accessory Board are defined in Table 3-1.

Table 3-1: Environmental Specifications^a

Parameter	Range	Operating Class
Ambient Operating Temperature	-30°C to +70°C	Class A (Operational, 3GPP compliant)
	-40°C to +85°C	Class B
Ambient Storage Temperature	-40°C to +85°C	-
Relative Humidity	≤ 85%	

a. For more detailed specifications, see [Table 4-1](#) on page 35

Class A is defined as the operating temperature range within which the device:

- Shall exhibit normal function during and after environmental exposure.
- Shall meet the minimum requirements of 3GPP or appropriate wireless standards.

Class B is defined as the operating temperature range within which the device:

- Shall remain fully functional during and after environmental exposure
- Shall exhibit the ability to establish any of the device's supported call modes (SMS, Data, and emergency calls) at all times even when one or more environmental constraints exceed the specified tolerances.
- Unless otherwise stated, full performance should return to normal after the excessive constraint(s) have been removed.

3.2 Power Supply

The host provides power to the RC7611/RC7611D M.2 Accessory Board through multiple power and ground pins as summarized in [Table 3-2](#) on page 19.

The host must provide safe and continuous power at all times; the RC7611/RC7611D M.2 Accessory Board does not have an independent power supply, or protection circuits to guard against electrical issues.

Table 3-2: Power and Ground Pin Specifications

Pin	Name	Direction	Function
2, 4, 70, 72, 74	VCC	Input	Power supply
3, 5, 11, 27, 33, 39, 45, 51, 57, 67, 71, 73	GND	-	Ground

Table 3-3: Operating Conditions^a

Parameter	Min	Typ	Max	Units	Notes	
Power supply voltage ^b	3.2	3.7	4.3	V	Must be within min / max values over all operating conditions (including voltage ripple, drop, and transient).	
Power supply ripple	-	-	100	mV _{pp}	See Figure 3-1 on page 20.	
Power supply voltage droop	-	-	250 ^c	mV	See Figure 3-1 on page 20.	
Power supply voltage transient (overshoot/undershoot)	-	-	300 ^c	mV	See Figure 3-1 on page 20.	
Supply current	LTE	-	0.8	1.5	A	<ul style="list-style-type: none"> Typical value varies and depends on output power, band, and operating voltage. See Current Consumption on page 28 for values measured under normal operating conditions. Max value measured over 100 μs period.

- a. Preliminary values, subject to change.
- b. Power supply voltage outside the required range may affect call quality (dropped calls, data transfer errors, etc.)
- c. Values to be confirmed for RC7611/RC7611D M.2 Accessory Board

Customer should characterize the ripple, drop, and transient response (overshoot / undershoot) of the power supply delivery system at the RC7611/RC7611D M.2 Accessory Boards embedded module input under full transmit power in LTE mode if not. To minimize voltage variation, add suitable capacitors to the supply line as close as possible to the embedded module — depending on the power supply design, these capacitors may range from tens to several thousand μF.

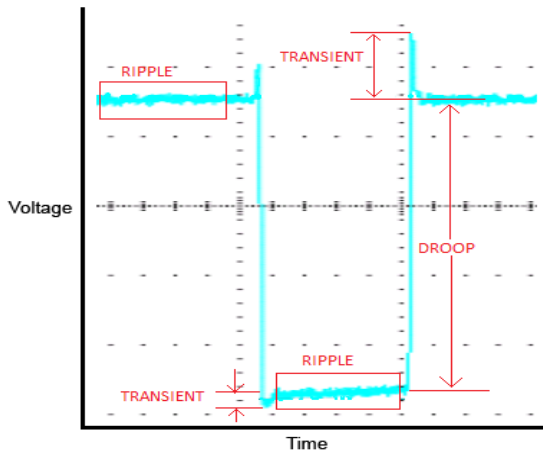


Figure 3-1: Power Supply Characteristics (capture enlarged)

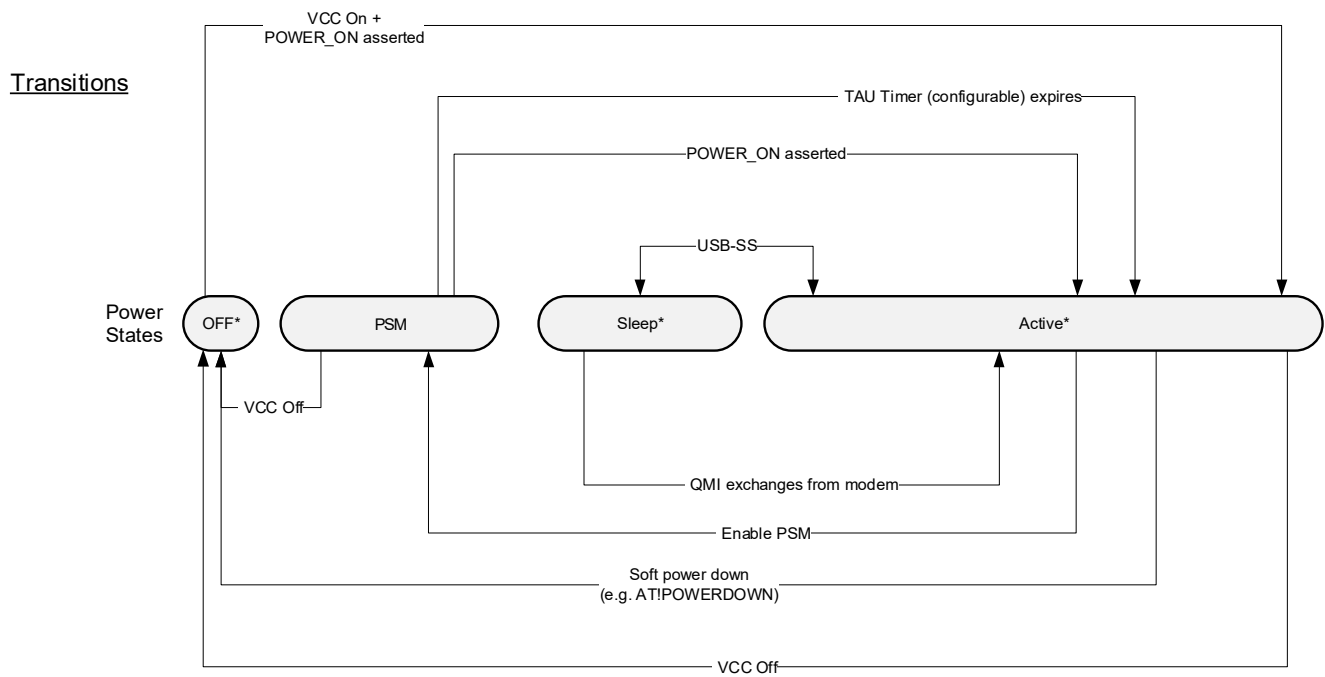
The RC7611/RC7611D M.2 Accessory Board has three basic power states (Active, Sleep, and Off). As the RC7611/RC7611D M.2 Accessory Board transitions between power states, the range of available device functionality adjusts appropriately, as described in [Table 3-4](#) on page 21.

Table 3-4: Supported Power States

State	Description
Active	<p>Module is fully powered and operating in one of the following modes:</p> <ul style="list-style-type: none"> Full function (WWAN radio active; GNSS radio can be turned on/off) —Highest power consumption. Idle mode (WWAN radio on; Module registered on network, but no active connection; GNSS radio can be turned on/off) Airplane mode (WWAN radio off; GNSS radio can be active if allowed by PRI) eDRX (Extended Discontinuous Reception)—eDRX mode provides a ‘flexible sleep’ for the modem, which significantly reduces energy consumption. For eDRX details, see Extended Discontinuous Reception (eDRX) on page 26.
Sleep	<p>Lower power consumption than Active state.</p> <ul style="list-style-type: none"> Modem is in DRX/eDRX. The module monitors signals (triggers) that can ‘wake’ it—see Wakeup Interrupt (Sleep State) on page 60 for details. <p>Sleep state can be entered based on USB-SS (if USB is connected to the module), configured GPIOs, and QMI exchanges from the modem.</p> <p><i>Note: On Windows systems, due to limitations of the Windows ECM driver, Sleep state is only supported if ECM is disabled or USB is disconnected.</i></p>
LTE Power Saving Mode (PSM)	<p>3GPP Release 12 introduced network support of PSM. PSM allows the module to negotiate, with the network, an extended period during which registration context with the network is retained while the module is unreachable. During the negotiated period, the module enters PSM, which enables the module to attain its lowest power consumption.</p> <p>When a wakeup source triggers exit from PSM, the modem boots up and the module sends a TAU (Tracking Area Update) to the network.</p> <p>After sending the TAU, the module remains active to allow any pending data to be exchanged with the network. Then, after a negotiated period of inactivity, the module automatically repeats the PSM cycle.</p> <p><i>Note: Wakeup sources are retained across PSM cycles, but may be changed by the application during the active period, if desired.</i></p> <p>For PSM details, see Power Saving Mode (PSM) on page 22.</p>
OFF	<p>Module is OFF (no power to the system).</p> <p>Apply power and de-assert W_DISABLE_N to go to the Active state. For details, see Power Sequence on page 37.</p>

Table 3-5: PSM Wakeup Sources

Type	Description
PSM TAU timer	<p>Periodic TAU—PSM Cycle Timer (T3412)</p> <p>Configurable timer specifying PSM sleep duration. See Table 3-6 on page 24 for configuration methods.</p>
Wakeup timer	<p>Timer that triggers after a specified period. Derived from TAU timer (value is automatically set slightly shorter than TAU timer to ensure module boot completes before TAU timer expires).</p>
POWER_ON	<p>Wakes the module when asserted (transitions from OFF to ON).</p>



* Refer to [Table 3-4](#) on page 21 for Power State definitions.

Figure 3-2: Power State Transitions

3.2.1 Power Saving Mode (PSM)

Power Saving Mode (PSM) is a 3GPP feature that allows the RC7611/RC7611D M.2 Accessory Board to minimize power consumption by registering on a PSM-supporting LTE network, entering a very low power 'dormant' state for a pre-configured duration (via a periodic TAU (Tracking Area Update) timer), and then booting up for a short period to transmit/receive data, before re-entering PSM. During the dormant period, the module remains unreachable by the network until it is woken by the TAU timer expiring or by being rebooted.

Note: Simplified current consumption pattern to illustrate general structure of PSM cycle power state transitions.

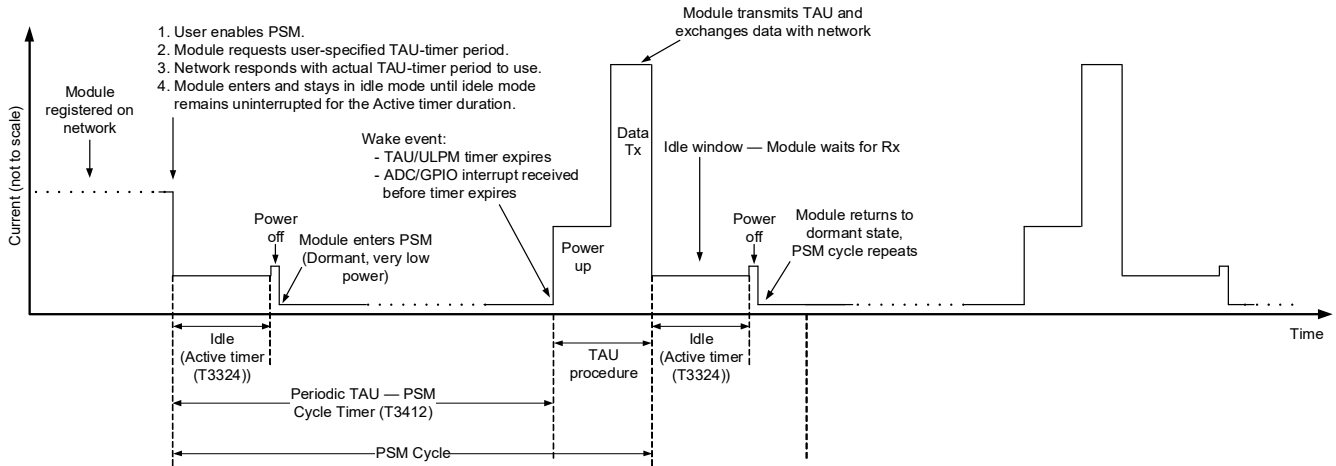


Figure 3-3: PSM Example (Simplified)

Typical candidates for PSM are systems (such as monitors and sensors) that:

- Require long battery life (low power consumption)
- Tolerate very long latency for mobile-terminated SMS/data
- Do not use mobile-terminated voice
- Send and/or receive data infrequently and periodically (e.g. on a given schedule of once every few hours, days, weeks, etc.)

For example, the RC7611/RC7611D M.2 Accessory Board connected to a sensor can be configured to:

- Wake periodically to transmit collected data to a server or network entity (e.g. once per week schedule), then
- Wait a short (configured) period of time to receive transmissions (e.g 60 seconds) and then return to its dormant state.

Table 3-6 identifies available AT commands that are used to configure PSM.

Table 3-6: PSM-Related AT Commands

Command ^a /Interface	Description
<p><i>Note: PSM can be enabled and configured using either +CPSMS, or the combination of !POWERMODE and !POWERWAKE. Setup may be easier (more clear) using !POWERMODE/!POWERWAKE since timer values are specified in integer format instead of the bitmap format used by +CPSMS.</i></p>	
<p>+CPSMS</p>	<p>3GPP-defined command (3GPP TS27.007 Release 12) that allows direct control of all LTE PSM parameters, and is useful for advanced users wanting to test/experiment with different options. This command is limited to networks that support PSM.</p> <p>It is not expected that every user must be fully versed in the details of PSM to take advantage of its capabilities.</p> <p>Use this command to:</p> <ul style="list-style-type: none"> ▪ Enable/disable LTE PSM. ▪ Configure Period TAU timer (T3412) with a requested maximum duration of the dormant period. ▪ Configure Active timer (T3324) with a requested 'idle mode time' (the duration the module remains idle before going dormant) ▪ For usage details, refer to the RC76xx AT Command Reference Guide. (This command follows the 3GPP TS 27.007, Release 12 specification, with exceptions noted for certain parameters.) <p><i>Note: The requested timer values are negotiated with the network and the final negotiated values take effect immediately, then persist across power cycles (e.g. after a power cycle, the settings will be used during network attach).</i></p>
<p>!POWERMODE and !POWERWAKE</p>	<p>Custom Semtech commands used to configure the TAU timer and Active timer, and to enable/ disable PSM.</p> <hr/> <p>Important: <i>When using !POWERMODE to enable PSM, make sure to set <mode>=2 (Enable PSM with wakeup sources). Do not use option 1 (Enable PSM with ULPM fallback).</i></p> <hr/>
<p>Important: <i>Semtech recommends not combining use of +CPSMS and !POWERWAKE/!POWERMODE. These commands have some functional overlap, which may result in unexpected effects.</i></p>	

a. For AT command details, refer to the RC76xx AT Command Reference Guide, available from the device's page on source.sierrawireless.com.
For API library function details, refer to docs.legato.io/latest/legatoServicesPowerMain.html.

Example: PSM Process

The following example describes how the module uses PSM (as shown in [Figure 3-3](#) on page 23):

1. Module registers on an LTE network.
2. User enables PSM via AT command or API library function, specifying the desired TAU timer and Active timer periods.
3. Module submits the PSM request (including desired TAU timer) to the network.
4. Network responds and indicates whether PSM is supported and (if it is) indicates the actual TAU timer to use.
5. If the network supports PSM:
 - a. Module enters idle mode (waiting for Rx from network).
 - b. When module has remained idle for the Active timer period, module powers off (except for maintaining timer and interrupts) and enters PSM.
 - c. Module remains in PSM for the specified TAU timer period or until `W_DISABLE_N` wakes it.

Note: If traffic must be transmitted when the module is in the sleep portion of the cycle, the module can initiate data/SMS session immediately.

- d. Module powers up before TAU timer expires, then transmits TAU and/or exchanges data with network.
- e. Module enters idle mode and cycle repeats.

Note: When the module is powered up, the PSM request can be re-issued with different timers and triggers to adjust the PSM behavior. These new settings take effect immediately.

Important Notes

- Carefully select the PSM Periodic-TAU timer and Active Time values to match the intended use case(s) for the module:
 - Periodic TAU PSM Cycle timer (T3412) — Note that while the module is dormant (for the duration of this timer, unless woken by `POWER_ON`), it will be completely unreachable by the network.
 - Active Time (Idle mode time after transmission (T3324)) — Make sure to set the Active timer high enough to provide appropriate delay-tolerance for mobile-terminated / network-originated transmissions to be received.
- When using multiple devices, consider scheduling the modules to wake at different times so that the network does not get flooded by all modules waking and transmitting simultaneously.

3.2.2 Active State to PSM Transition

If the module will be used in situations where it needs to be active very infrequently (for example, in a remote monitoring station that must transmit data periodically—e.g. on a regular schedule ranging from days to weeks or more), PSM may be used to reduce power consumption much more than is possible in Sleep state (low power active state):

1. Configure the PSM TAU timer.

Note: The TAU timer value is persistent — if the module enters PSM and then returns to Active power state, the configured timer value remains in effect.

2. Initiate PSM. The module will enter PSM.

3.2.3 Extended Discontinuous Reception (eDRX)

The RC7611/RC7611D M.2 Accessory Board supports eDRX, which is a ‘flexible sleep’ active mode that allows for longer sleep duration (T_{C-eDRX} , T_{I-eDRX}) and a significant decrease in power consumption compared to regular DRX (T_{C-DRX} , T_{I-DRX}).

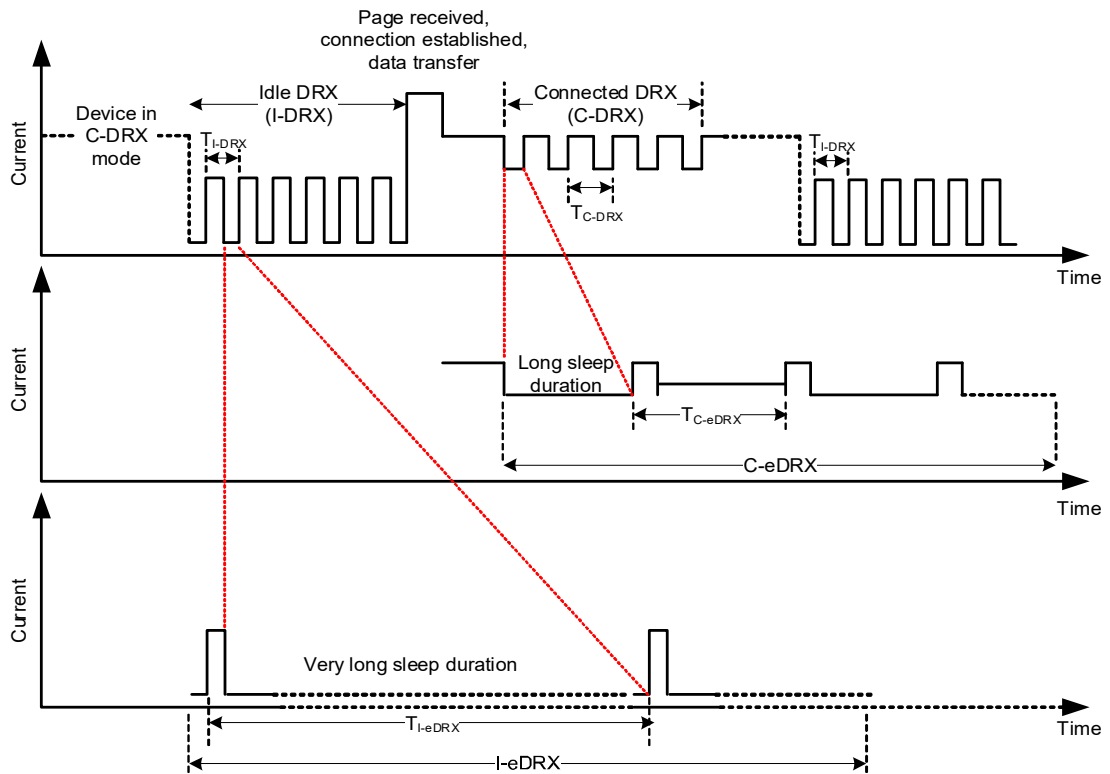


Figure 3-4: eDRX Example (Simplified)

Specifically, the RC7611/RC7611D M.2 Accessory Board supports two forms of eDRX, both of which extend the DRX cycle (the paging cycle comprised of a paging window during which the module is awake and able to receive or transmit on the network, and a sleep period during which the network cannot wake the module) by increasing the sleep duration beyond the DRX maximum of 2.56 seconds:

- I-eDRX (Idle mode eDRX) — The sleep duration of the DRX cycle can be set up to 44 minutes for LTE-M.

Note that I-eDRX has wider network support than C-eDRX.

- C-eDRX (Connected mode eDRX) — The sleep duration of the DRX cycle can be set up to 10 seconds.

Note: If traffic must be transmitted when the module is in the sleep portion of the cycle, the module can initiate data/SMS session immediately.

Table 3-7 describes the available methods for configuring eDRX.

Table 3-7: eDRX-Related Commands^a

Type	Command	Description
AT	+CEDRXS	Enable/disable eDRX, and configure related settings
AT	+CEDRXRDP	Display current eDRX settings

a. For AT command details, refer to the RC76xx AT Command Reference Guide on source.sierrawireless.com.

Example: eDRX Process

- Use the AT+CEDRXS command to configure the desired eDRX behavior.
- During the network attachment process:
 - eDRX request and settings are sent to the network
 - Network responds and indicates whether eDRX is supported for the connection and may adjust the eDRX parameters.
- If eDRX is supported by the network:
 - While in active mode (connected), the C-eDRX sleep duration is used if supported, otherwise the regular DRX sleep duration is used.
 - While in idle mode, the I-eDRX sleep duration is used if supported, otherwise the network uses the standard LTE I-DRX value.

Important Notes

- The sleep duration must be carefully selected to match the intended use case(s) for the module. While the module is asleep, it will be unreachable by the network. The duration should provide appropriate delay-tolerance for mobile-terminated/network-originated transmissions to be received.
- Due to the extended sleep time compared to regular DRX, eDRX is not suitable for most mobile-terminated voice connections.
- Network-side store and forward is supported — Packets will be stored until the module is reachable.

3.2.4 Current Consumption

Power consumption measurements in the tables below are for the RC7611/RC7611D M.2 Accessory Board connected to the host PC via USB. The module does not have its own power source and depends on the host device for power. For a description of input voltage requirements, see [Power Supply](#) on page 19.

Table 3-8: RC7611/RC7611D M.2 Accessory Board Averaged Standby DC Power Consumption^a

Signal	Description	Bands	Current		Notes / configuration
			Typ	Unit	
VCC	Standby current consumption (Sleep mode activated ^b)				
	LTE	LTE bands	7	mA	DRX cycle = 8 (2.56 s)
	Standby current consumption (Sleep mode deactivated ^b)				
	LTE	LTE bands	33	mA	DRX cycle = 8 (2.56 s)
	Low Power Mode (LPM)				
	PSM		56	μA	
	Leakage current				
	Module powered off—W_DISABLE_N is Low, and the module is in OFF state while VCC is supplied		55	μA	

- a. Preliminary values
- b. Assumes USB bus is fully suspended during measurements

Table 3-9: RC7611/RC7611D M.2 Accessory Board Averaged Call Mode DC Power Consumption^a

Description	Band	Current ^b	
		Typ	Unit
LTE	B2	700	mA
	B4	710	mA
	B5	610	mA
	B12	630	mA
	B13	680	mA
	B14	700	mA
	B25	720	mA
	B26	580	mA
	B66	700	mA
	B71	605	mA

- a. Preliminary values
- b. Measured at 30°C/nominal 3.7 V voltage

3.3 RF

RC7611/RC7611D M.2 Accessory Boards are designed to be compliant with the standards in [Table 3-10](#).

Table 3-10: Standards Compliance

Technology	Standards	RC7611
LTE	3GPP Release 10	Yes

3.3.1 Tx Output Power / Rx Sensitivity

Conducted Rx sensitivity and conducted Tx output power values for the RC7611/RC7611D M.2 Accessory Board depend on the model of embedded RC module on the board.

For Tx output power values, refer to [Table 3-11](#).

Table 3-11: RC7611 Conducted Tx Max Output Power Tolerances—LTE^a

RF Band	Operating Condition	Min	Typ	Max	Units	Notes
B2	Normal (25°C)	21	23	24	dBm	Power class 3
B4	Normal (25°C)	21	23	24	dBm	Power class 3
B5	Normal (25°C)	21	23	24	dBm	Power class 3
B12	Normal (25°C)	21	23	24	dBm	Power class 3
B13	Normal (25°C)	21	23	24	dBm	Power class 3
B14	Normal (25°C)	21	23	24	dBm	Power class 3
B25	Normal (25°C)	21	23	24	dBm	Power class 3
B26	Normal (25°C)	21	23	24	dBm	Power class 3
B66	Normal (25°C)	21	23	24	dBm	Power class 3
B71	Normal (25°C)	21	23	24	dBm	Power class 3

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

Table 3-12 presents the Rx sensitivity values for the RC7611 accessory boards.

Important: The Rx sensitivity values measured below are for RC7611 modules integrated on RC7611 accessory boards—these values will differ from values in the RC76xx Product Technical Specification (PTS) due to sensitivity drops incurred by the accessory board. As well, changes to the RC76xx PTS values that occur after publication of this RC7611 Accessory Board Product Specification may need to be considered.

Table 3-12: RC7611 Accessory Board^a Conducted Rx Sensitivity—LTE Bands^b

LTE Bands		+25 °C (dBm)			Class A (dBm)			SIMO (Worst case) ^c
		Primary (Typical)	Secondary (Typical)	SIMO (Typical)	Primary (Typical)	Secondary (Typical)	SIMO (Typical)	
B2	Full RB BW: 10 MHz ^d	-98	-98	-100	-97	-97.5	-99.5	-94.3
B4		-98	-97.5	-99.5	-97	-96.5	-98.5	-96.3
B5		-99	-98	-100.5	-98	-97	-99.5	-94.3
B12		-97	-96	-99	-96	-95.5	-98	-93.3
B13		-97.5	-95	-99	-96	-94	-98	-93.3
B14		-96.5	-97	-99.5	-96.5	-96	-98.5	-93.3
B25		-98	-98	-100	-97	-97.5	-99.5	-92.8
B26		-99	-98	-100.5	-98	-97	-99.5	-93.8
B66		-98	-98	-100	-97	-97	-99	-95.8
B71		-98	-97.5	-100	-96.5	-97	-99	-93.5

- a. Limited Availability
- b. RF sensitivity values are for soldered-down modules.
- c. Per 3GPP specification.
- d. Sensitivity values scale with bandwidth: $x_MHz_Sensitivity = 10_MHz_Sensitivity - 10 \times \log(10\text{ MHz}/x_MHz)$
Note: Bandwidth support is dependent on firmware version

3.3.2 WWAN Antenna Recommendations

Table 3-13 defines the key characteristics to consider for antenna selection.

Table 3-13: Antenna Recommendations^{a,b}

Parameter		Recommendations	Comments
Antenna system		External multi-band antenna system	Dual WWAN antennas for diversity (Antenna 1 / Antenna 2) ^c
Operating bands	RC7611/ RC7611D M.2 Accessory Board	617–798 MHz	Operating bands depend on the module’s supported bands / modes.
		814–894 MHz	
		1710–2200 MHz	
VSWR		< 2.5:1 (worst case)	<ul style="list-style-type: none"> On all bands including band edges Applies to both antennas
Total radiated efficiency		> 50% on all bands	<ul style="list-style-type: none"> Measured at the RF connector. Applies to both antennas. Includes mismatch losses, losses in the matching circuit, and antenna losses, excluding cable loss. Semtech recommends using antenna efficiency as the primary parameter for evaluating the antenna system. Peak gain is not a good indication of antenna performance when integrated with a host device (the antenna does not provide omnidirectional gain patterns). Peak gain can be affected by antenna size, location, design type, etc. — the antenna gain pattern remains fixed unless one or more of these parameters change.
Radiation patterns		Nominally omnidirectional radiation pattern in azimuth plane.	
Envelope correlation coefficient between Antenna 1 and Antenna 2		<ul style="list-style-type: none"> < 0.4 on B5 Rx (869–894 MHz), B12 Rx (729–746 MHz), B13 Rx (746–756 MHz), B14 Rx (758–768 MHz), B26 Rx (859–894 MHz) and B71 Rx (617–652 MHz) < 0.2 on B2 Rx (1930–1990 MHz), B4 Rx (2110–2155 MHz), B25 Rx (1930–1995 MHz) and B66 Rx (2110–2200 MHz) 	
Mean Effective Gain (MEG)		≥ -3 dBi	
Mean Effective Gain Imbalance — Antenna 1 and Antenna 2 (MEG1 / MEG2)		< 6 dB for diversity operation	
Maximum antenna gain		Must not exceed antenna gains due to RF exposure and ERP/EIRP limits, as listed in the module’s FCC grant.	

Table 3-13: Antenna Recommendations^{a,b} (Continued)

Parameter	Recommendations	Comments
Isolation between Antenna 1 and Antenna 2 (S21)	> 10 dB	<ul style="list-style-type: none"> If antennas can be moved, test all positions for both antennas. Make sure all other wireless devices (Bluetooth or WLAN antennas, etc.) are turned OFF to avoid interference.
Power handling	> 1 W on all bands > 2 W RF power on low bands	<ul style="list-style-type: none"> Measure power endurance over 4 hours (estimated talk time) using a 2 W CW signal — set the CW test signal frequency to the middle of the PCS Tx band (1880 MHz for PCS). Visually inspect device to ensure there is no damage to the antenna structure and matching components. VSWR/TIS/TRP measurements taken before and after this test must show similar results.

- a. These worst-case VSWR figures for the transmitter bands may not guarantee RSE levels to be within regulatory limits. The device alone meets all regulatory emissions limits when tested into a cabled (conducted) 50 ohm system. With antenna designs with up to 2.5:1 VSWR or worse, the radiated emissions could exceed limits. The antenna system may need to be tuned in order to meet the RSE limits as the complex match between the module and antenna can cause unwanted levels of emissions. Tuning may include antenna pattern changes, phase/delay adjustment, passive component matching.
- b. All values are preliminary and subject to change.
- c. Antenna 1 — Primary, Antenna 2 — Secondary (Diversity/MIMO)

3.4 GNSS

The RC7611/RC7611D M.2 Accessory Board includes Global Navigation Satellite System (GNSS) capabilities via the QUALCOMM IZat™ Gen8C Engine (formerly gpsOne), capable of operation in assisted and standalone GNSS modes (GPS/Galileo/GLONASS/BeiDou).

3.4.1 GNSS Characteristics

The GNSS implementation supports GPS L1, Galileo E1, BeiDou-B1 and GLONASS L1 FDMA operation.

Table 3-14: GNSS Characteristics^{a,b}

Parameter	Value	
Sensitivity ^c	Standalone or MS-based tracking sensitivity	-160 dBm
	Cold start acquisition sensitivity	-145 dBm
	MS-assisted acquisition sensitivity	-158 dBm
Accuracy in open sky (1 Hz tracking)	< 2 m CEP-50	
Satellite channels available ^d	Acquisition	118
	Simultaneous tracking	40
Support for predicted orbits	Yes	
Predicted orbit CEP-50 accuracy	5 m	

Table 3-14: GNSS Characteristics^{a,b}

Parameter	Value	
Standalone Time To First Fix (TTFF)	Hot	1 s
	Warm	29 s
	Cold	32 s
Altitude (max)	18,2888 m (60,000 ft)	
Velocity (max)	1,852 km/h (1 150.8 mph)	
Acceleration (max)	20 m/s ²	
GNSS message protocols	NMEA	

- a. All values are preliminary and subject to change.
- b. Acquisition / tracking sensitivity performance figures assume open sky with active patch GNSS antenna and a 2.5 dB noise figure.
- c. GNSS sensitivity may degrade for modules installed in snap-in sockets.
- d. Resources are dynamically assigned and not constellation-specific.

3.4.2 GNSS Antenna Recommendations

Table 3-15 defines the key characteristics to consider for GNSS antenna selection.

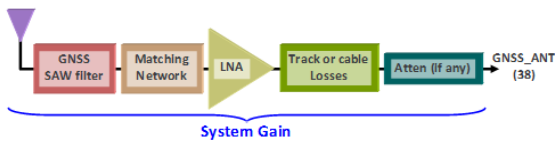
Table 3-15: GNSS Standalone Antenna Recommendations^a

Parameter	Recommendations	Notes
Frequency range	<ul style="list-style-type: none"> ▪ Wide-band GPS, Galileo, GLONASS, and BeiDou: 1559–1606 MHz recommended ▪ Narrow-band GPS: 1575.42 MHz ± 2.046 MHz minimum 	
Field of view (FOV) ^b	<ul style="list-style-type: none"> ▪ Omni-directional in azimuth ▪ -45° to +90° in elevation 	
Polarization (average Gv / Gh)	> 0 dB	Vertical linear polarization is sufficient.
Free space average gain (Gv+Gh) over FOV	> -6 dBi (preferably > -3 dBi)	Gv and Gh are measured and averaged over -45° to +90° in elevation, and ±180° in azimuth.
Gain	<ul style="list-style-type: none"> ▪ Maximum gain and uniform coverage in the high elevation angle and zenith. ▪ Gain in azimuth plane is not desired. 	
Average 3D gain	> -5 dBi	
Isolation between GNSS and RF Antenna	> 20 dB in all uplink bands	
Typical VSWR	< 2.5:1	
Polarization	Any other than LHCP (left-hand circular polarized) is acceptable.	Type of antenna and polarization (RHCP/linear) to be implemented is a matter of consideration based on specific end application.

Table 3-15: GNSS Standalone Antenna Recommendations^a (Continued)

Parameter	Recommendations	Notes
Maximum voltage applied to antenna	6.3 VDC	
700 MHz harmonic ^{b,c}	< -56 dBm (input jammer 787.76 MHz at -25 dBm and measure the harmonic tone at 1575.42 MHz)	This specification is for B13 and B14 coexistence.
IIP2 ^{b,c}	> 45 dBm (Input jammers at 824.6 MHz with level -25 dBm and 2400 MHz with level -32 dBm and measure output IM2 at 1575.4 MHz)	Out of band
IIP3 ^{b,c}	> 2 dBm (Input jammers at 1712.7 MHz with level -20 dBm and 1850 MHz with level -65 dBm and measure output IM3 at 1575.4 MHz)	Out of band
Input 1 dB power compression point ^{b,c}	> -10 dBm	
Out of band rejection for an active antenna		
663–716 MHz	> 50 dB	
777–798 MHz	> 50 dB	
814–915 MHz	> 40 dB	50 dB is preferred
925–960 MHz	> 30 dB	50 dB is preferred
1427–1463 MHz	> 35 dB	
1710–1785 MHz	> 35 dB	
1850–1980 MHz	> 40 dB	
2010–2025 MHz	> 40 dB	
2305–2315 MHz	> 40 dB	
2401–2483 MHz	> 40 dB	
2500–2570 MHz	> 35 dB	

- a. All values are preliminary and subject to change.
- b. Noise figure: < 2dB, System gain: [14-17dB].



- c. For the LNA used by an active antenna

4: Mechanical and Environmental Specifications

The RC7611/RC7611D M.2 Accessory Board complies with the mechanical and environmental specifications in [Table 4-1](#). Final product conformance to these specifications depends on the OEM device implementation.

Table 4-1: Mechanical and environmental specifications

	Mode	Details
Temperature	Operational	Ambient temperature: <ul style="list-style-type: none"> ▪ Class A¹: -30°C to +70°C (3GPP compliant) Class A is defined as the operating temperature range within which the device: <ul style="list-style-type: none"> • Exhibits normal function during and after environmental exposure. • Meets the minimum requirements of 3GPP, 3GPP2, or appropriate wireless standards.
		Ambient temperature: <ul style="list-style-type: none"> ▪ Class B¹: -40°C to +85°C (non-3GPP compliant) Class B is defined as the operating temperature range within which the device: <ul style="list-style-type: none"> • Remains functional during and after environmental exposure. • Exhibits the ability to establish SMS or DATA calls (emergency call) at all times even when one or more environmental constraints exceed the specified tolerances.
		Internal module temperature: <ul style="list-style-type: none"> • Class A — Recommended temperature²: < 85°C (3GPP compliant) • Class B — Maximum temperature²: < 100°C (non-3GPP compliant)
	Non-operational	-40°C to +85°C, 96 hours (from MIL-STD 202 Method 108)
Relative humidity	Non-operational	85°C, 85% relative humidity for 48 hours (non-condensing)
FFT1	Non-operational	1 m on concrete on each of six faces, one time
(Electrostatic discharge (See ESD on page 9.)	Operational	The RF port (antenna launch and RF connector) complies with the IEC 61000-4-2 standard: <ul style="list-style-type: none"> ▪ Electrostatic Discharge Immunity: Test: Level3 ▪ Contact Discharge: ±6 kV
	Non-operational	The host connector Interface complies with the following standard only: <ul style="list-style-type: none"> ▪ minimum ±500 V Human Body Model (JESD22-A114-B)
Thermal considerations		See Thermal Considerations on page 36.

Table 4-1: Mechanical and environmental specifications (Continued)

	Mode	Details
Dimensions		Length: 50.80 ± 0.15 mm Width: 29.90 ± 0.15 mm Thickness: 3.55 ± 0.40 mm Weight: 7.8 g

1. Ambient temperature (temperature around the module). Proper mounting, heat sinks and active cooling may be required, depending on the integrated application.
2. Measured by AT!PCTEMP

4.5 Thermal Considerations

When transmitting, the RC7611/RC7611D M.2 Accessory Board’s embedded module can generate significant amounts of heat that must be dissipated in the host device for safety and performance reasons.

The amount of thermal dissipation required depends on:

- Supply voltage — Maximum power dissipation for the module can be up to 3 W at voltage supply limits.
- Usage — Typical power dissipation values depend on the location within the host, throughput, amount of data transferred, etc.

To enhance heat dissipation:

- Maximize airflow over / around the module.
- Locate the accessory board away from other heat-generating components.
- Module mounting holes must be used to attach (ground) the device to the main PCB ground or a metal chassis.
- You may need to add a heat sink that mounts the assembly board to the main PCB (thermal compound or pads must be used between the assembly board and the heat sink).
- You may also need active cooling to pull heat away from the assembly board.

Note: Adequate dissipation of heat is necessary to ensure that the assembly board functions properly.

5: Interfaces Specification

5.1 Overview

This section describes the interfaces supported by the RC7611/RC7611D M.2 Accessory Board and provides specific voltage, timing, and circuit recommendations for each interface.

5.2 POWER_ON (Power Control)

The host device uses POWER_ON (pin 6) to power on the RC7611 Accessory Board's embedded RC module.

As described in [Power On/Off Timing](#) on page 37, POWER_ON must be driven high to turn the embedded RC module on.

Letting this signal logic high (at least 200ms) allows the module to operate normally.

5.2.1 Power Sequence

5.2.1.1 Power On/Off Timing

Figure 5-2 describes the timing sequence for powering the assembly board's embedded RC module on and off.

Note: Before reaching the 'Active' state, signals on the host port are considered to be undefined and signal transitions may occur. This undefined state also applies when the module is in reset mode, during a firmware update, or during the Power-off sequence. The host must consider these undefined signal activities when designing the module interface.

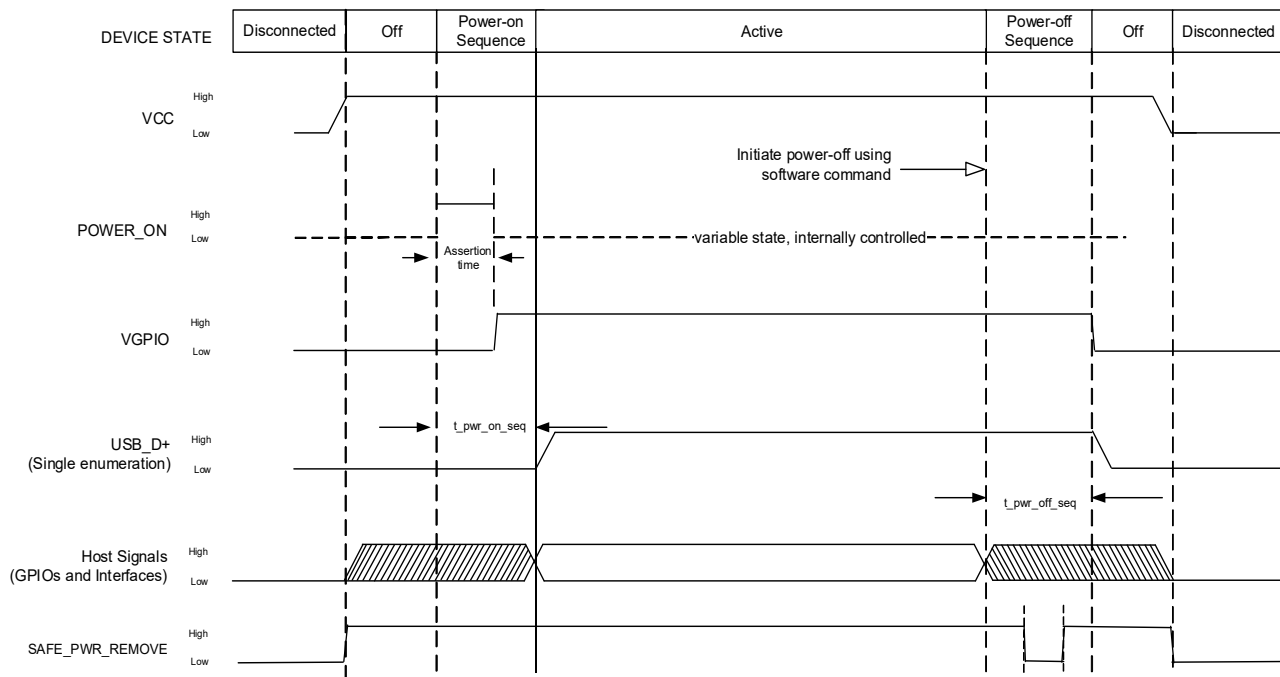


Figure 5-1: Signal Timing (POWER_ON, and USB Enumeration)

Table 5-1: Power Sequence Timing Parameters

Parameter	Min	Typ	Max	Units
t_pwr_on_seq	-	7	26	s
t_pwr_off_seq	-	0.4–5.5	6	s
Assertion time ^a	200			ms

a. Assertion time is the time required to keep POWER_ON at a high level to ensure that the module can be powered ON successfully.

5.2.1.2 USB Enumeration

The unit supports single USB enumeration with the host. Enumeration starts within (maximum) t_pwr_on_seq seconds of power-on.

5.2.1.3 Software-Initiated Power Down

To power down the module via software:

1. Initiate the power down process:
AT!POWERDOWN
2. Wait at least 2 seconds, then remove power.

5.3 Power On Use Cases

Table 5-2 lists the behavior of the RC7611/RC7611D M.2 Accessory Board for POWER_ON and AT!POWERDOWN use cases.

Table 5-2: W_DISABLE_N and AT!POWERDOWN Use Cases

Use Case		RC7611
POWER_ON	VCC is applied then POWER_ON is asserted	Turns ON
	POWER_ON is asserted then VCC is applied	Turns ON
AT!POWERDOWN AT Command	POWER_ON is asserted then the power OFF command is sent	Turns OFF
	POWER_ON is de-asserted then the power OFF command is sent	Turns OFF

5.4 Tx Power Control

The module’s Tx power limit may be controlled using the following methods:

- SAR backoff AT commands (see document the RC76xx AT Command Guide Reference):
 - ISARSTATEDFLT — Set (or report) the default SAR backoff state that the device uses when it powers up. This setting is persistent across power cycles and overrides any PRI setting.
 - ISARSTATE — Set (or report) the current SAR backoff state (override the default state). This change in state is non-persistent across power cycles.

- !SARBACKOFF — Set (or report) the maximum Tx power limit for a specific band / technology / state combination.

5.5 USB

The USB interface is the path for communication between the host and module.

The RC7611/RC7611D M.2 Accessory Board implements a high-speed USB 2.0 Interface, which conforms to the *Universal Serial Bus Specification, Revision 2.0*, and the host device must be designed to the same standard. (When designing the host device, careful PCB layout practices must be followed.)

Table 5-3: USB Pin Descriptions

Pin	Signal name	Direction	Function
12	USB_D-	Input/Output	Differential data interface negative
13	USB_D+	Input/Output	Differential data interface positive

USB interface features include:

- Data rate: Full-speed (12 Mbps)/High-speed (480 Mbps)
- Module enumeration:
 - Windows: Modem or COM ports, using host Windows drivers
 - Linux: /dev/ttyUSBn devices for Linux systems with the Semtech driver installed
- USB-compliant transceivers
- Selective suspend mode
- Resumption initiated by host or module

5.5.1 USB High/Full Speed Throughput Performance

This device has been designed to achieve optimal performance and maximum throughput using USB high speed mode. Although the device may operate with a full speed host, throughput performance will be on an “as is” basis and needs to be characterized by the OEM. Note that throughput will be reduced and may vary significantly based on packet size, host interface, and firmware revision. Semtech does not recommend using this device in USB full speed mode.

5.6 UIM Interface

Note: Host support for UIM interface signals is required.

The RC7611/RC7611D M.2 Accessory Board supports one UIM interface (UIM1), which allows for control of external 1.8 V / 3 V UIMs. The SIM holds account information, allowing users to use their account on multiple devices.

[Table 5-4](#) describes the SIM pins that provide the connections necessary to interface to a SIM socket located on the host device as shown in [Figure 5-2](#) on page 40. Voltage levels over this interface comply with 3GPP standards.

Table 5-4: UIM Interface Pins

Pin	Name	Description	UIM contact ^a	Direction ^b	Function	If Unused
30	UIM1_RESET_N	Reset	2	Output	Active low UIM reset	Leave open
32	UIM1_CLK	Serial clock	3	Output	Serial clock for UIM data	Leave open
34	UIM1_DATA	Data I/O	7	Input/Output	Bi-directional UIM data line	Leave open
36	UIM1_VCC	UIM voltage	1	Output	Power supply for UIM	Leave open
66	UM1_DET	Detect		Input	UIM detect	Leave open
	USIM_GND	Ground	5		Ground reference. Common to module ground.	

- a. See Figure 5-3 on page 40 for UIM card contacts.
- b. Signal direction with respect to the module. Examples: UIM1_DET (pin 64) is an input to the module from the host; UIM1_RESET_N (pin 29) is an output from the module to the host.

Figure 5-2 illustrates the recommended implementation of a UIM holder.

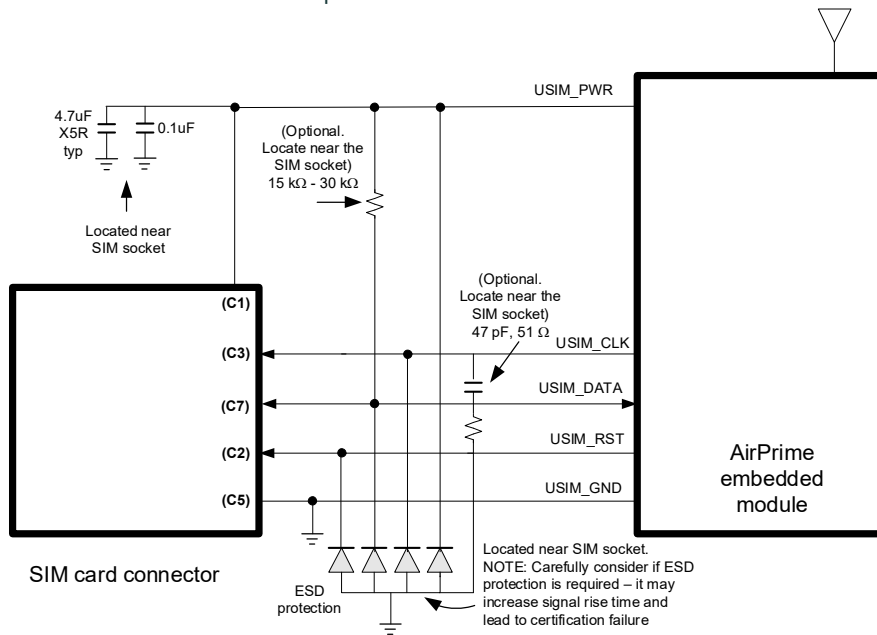


Figure 5-2: Recommended UIM Holder Implementation

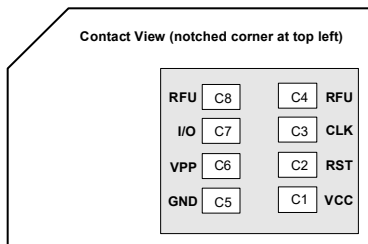


Figure 5-3: SIM card contacts (contact view)

5.6.1 SIM Implementation

Note: For interface design requirements, refer to (2G) 3GPP TS 51.010-1, section 27.17, or (3G) ETSI TS 102 230 V5.5.0, section 5.2.

When designing the remote SIM interface, you must make sure that SIM signal integrity is not compromised.

Some design recommendations include:

- Total impedance of the VCC and GND connections to the SIM, measured at the module connector, should be less than $1\ \Omega$ to minimize voltage drop (includes any trace impedance and lumped element components — inductors, filters, etc.).
- Position the SIM connector ≤ 10 cm from the module. If a longer distance is required because of the host device design, use a shielded wire assembly — connect one end as close as possible to the SIM connector and the other end as close as possible to the module connector. The shielded assembly may help shield the SIM interface from system noise.
- Reduce crosstalk on the USIM_DATA line to reduce the risk of failures during GCF approval testing.
- Avoid routing the USIM_CLK and USIM_DATA lines in parallel over distances > 2 cm — cross-coupling of these lines can cause failures.
- 3GPP has stringent requirements for I/O rise time ($< 1\ \mu\text{s}$), signal level limits, and noise immunity — consider this carefully when developing your PCB layout.
 - Keep signal rise time $< 1\ \mu\text{s}$ — keep USIM signals as short as possible, and keep very low capacitance traces on the USIM_DATA and USIM_CLK signals. High capacitance increases signal rise time, potentially causing your device to fail certification tests.
- Add external pull-up resistors (15–30 k Ω), if required, between the USIM_DATA and USIM_PWR lines to optimize the signal rise time.
- VCC line should be decoupled close to the SIM socket.
- SIM is specified to run up to 5 MHz (SIM clock rate). Take note of this speed in the placement and routing of the SIM signals and connectors.
- You must decide whether additional ESD protection is required for your product, as it is dependent on the application, mechanical enclosure, and SIM connector design. The SIM pins will require additional ESD protection if they are exposed to high ESD levels (i.e. can be touched by a user).
- Putting an optional decoupling capacitor at USIM_PWR near the SIM socket is recommended — the longer the trace length (impedance) from the socket to the module, the greater the capacitance requirement to meet compliance tests.
- Putting an optional series resistor and shunt capacitor to ground at USIM_CLK at the SIM socket to reduce EMI and increase signal integrity is recommended if the trace length between the SIM socket and module is long — 47 pF and 50 Ω resistor are recommended.
- Test your first prototype host hardware with a Comprion IT³ SIM test device at a suitable testing facility.

5.7 Temperature Monitoring

The RC7611/RC7611D M.2 Accessory Board provides internal temperature monitoring of the module's baseband thermistor, as detailed below in Figure 5-4 and Table 5-5.

The temperature state can be queried directly, and unsolicited notifications of temperature state transitions can be received by using:

- AT!PATEMP — Display the current temperature state (normal, hi or low warning, hi or low critical).
- AT+WUSLMSK — Enable unsolicited notifications for !PATEMP, to be received over the AT port whenever the state changes.

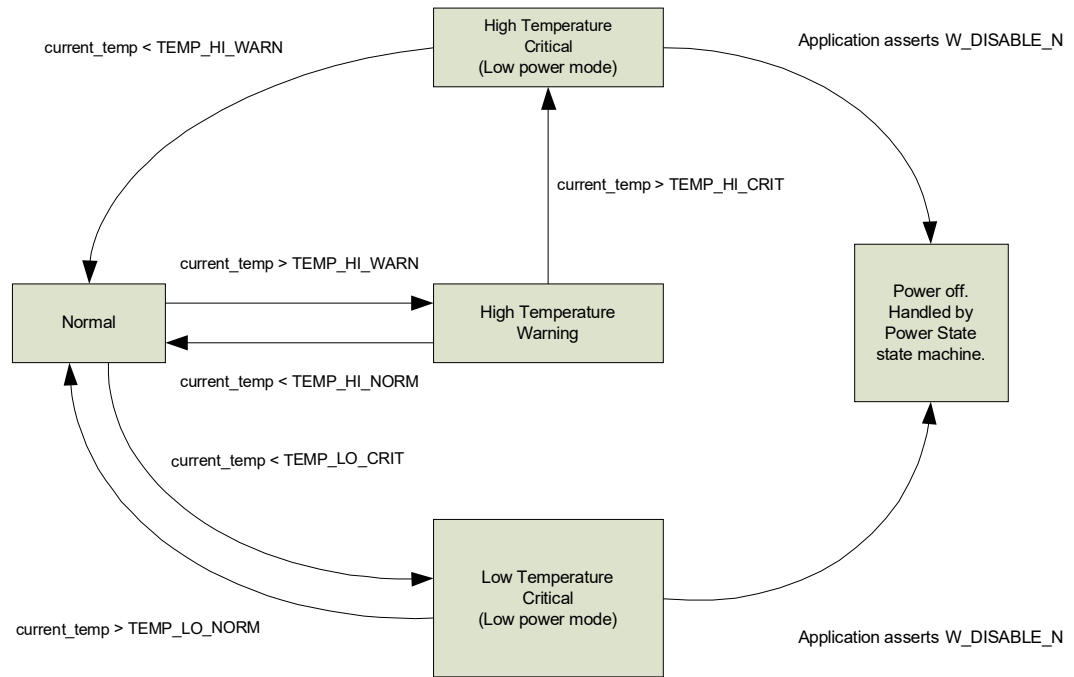


Figure 5-4: Temperature Monitoring State Machine

Table 5-5: Temperature Monitoring States

State	Description	Threshold	Default Temp value (C) ^a	Functionality
Normal	Baseband thermistor is between	TEMP_HI_NORM	+100	Class A
		TEMP_LO_NORM	-40	Class B
High Temperature Warning	Baseband thermistor has exceeded	TEMP_HI_WARN	+110	Class B
High Temperature Critical	Baseband thermistor has exceeded	TEMP_HI_CRIT	+115	Low Power Mode
Low Temperature Critical	Baseband thermistor has descended past	TEMP_LO_CRIT	-45	Low Power Mode

a. Junction (PA thermistor) temperature

To restore full operation, the baseband thermistor’s temperature reading must be within the normal or high temperature warning state thresholds.

5.7.1 WAKE_ON_WWAN_N

Note: Host support for WAKE_ON_WWAN signal is optional.

The RC7611/RC7611D M.2 Accessory Board drives WAKE_ON_WWAN low to wake the host when specific events occur.

The host must provide a 5–100 k Ω pullup resistor that considers total line capacitance (including parasitic capacitance) such that when WAKE_ON_WWAN_N is de-asserted, the line will rise to VCC (Host power rail) in < 100 ns.

See [Figure 5-5](#) on page 43 for a recommended implementation.

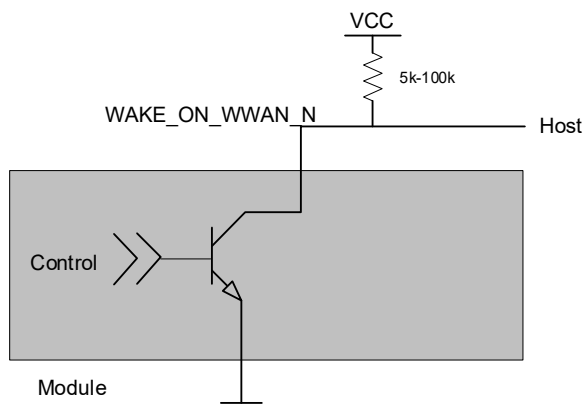


Figure 5-5: Recommended WAKE_ON_WWAN Connection

5.8 SAFE_PWR_REMOVE_N

The SAFE_PWR_REMOVE signal is provided by Semtech RC76xx to indicate to the host device that the main power supply (VBATT) can be safely turned off after a positive pulse. The pulse width is 13.26ms.

5.9 Reset Signal (SYSTEM_RESET_N)

SYSTEM_RESET_N (pin 67) has an internal 1.8 V internal pull up. Set this signal to active low to reset the device. Note that the minimum pulse width is 13 ms.

6: Software and Tools

6.1 Support Tools

The RC7611/RC7611D M.2 Accessory Board is compatible with Semtech's SwiLogPlus trace tool that allows users to send error logs to Semtech.

6.2 SED (Smart Error Detection)

The RC7611/RC7611D M.2 Accessory Board uses a form of SED to track premature module resets. In such cases, the module automatically forces a pause in boot-and-hold mode at power-on to accept an expected firmware download to resolve the problem.

1. Module tracks consecutive resets within 30 seconds of power-on.
2. After a sixth consecutive reset, the module waits in boot-and-hold mode (up to 30 seconds) for a firmware download to resolve the power-cycle problem.

A RAM dump tool that can be used to help isolate the cause of premature resets is available from Semtech. Contact your Semtech account representative for assistance.

6.3 Firmware Upgrade

Firmware upgrades are downloaded to the embedded module over the USB interface or over the air via Semtech's AVMS (AirVantage Management System). Contact your Semtech account representative for assistance.

6.4 Product Marking



Figure 6-1: Unit Product Marking—Laser-etched, Typical Representation

Note: The figure above is not to scale. Contents will vary by SKU.

The RC7611/RC7611D M.2 Accessory Board product marking is laser-etched and may contain:

- Product identification (Model name, serial number)
- IMEI or MEID number and barcode
- Fabrication country
- Required regulatory markings
- Pin 1 indicator

Note: The RC7611/RC7611D M.2 Accessory Board supports OEM partner specific product marking requirements.

7: Debug and Assembly Considerations

7.1 Testing Assistance Provided by Semtech

Semtech offers optional professional services based assistance to OEMs with regulatory approvals.

7.2 Integration Requirements

When integrating the RC7611/RC7611D M.2 Accessory Board, the following items must be addressed:

- Mounting — Effect on temperature, shock, and vibration performance
- Power supply — Impact on battery drain and possible RF interference
- Antenna location and type — Impact on RF performance
- Regulatory approvals — As described in [Approval](#) on page 74
- Service provisioning — Manufacturing process

Semtech provides guidelines for successful RC7611/RC7611D M.2 Accessory Board integration with the document suite and offers integration support services as necessary.

7.3 IOT/Operator

Interoperability and Operator/Carrier testing of the finished system is the responsibility of the OEM. The test process will be determined with the chosen network operator(s) and will be dependent upon your business relationship with them, as well as the product's application and sales channel strategy.

Semtech offers assistance to OEMs with the testing process, if required.

7.4 Module Integration Testing

When testing your integration design:

- Test to your worst case operating environment conditions (temperature and voltage)
- Test using worst case operation (transmitter on 100% duty cycle, maximum power)
- Monitor the embedded RC module's junction temperature using **AT!PCTEMP**. This command polls a thermistor located near the module's power amplifier (typically the hottest spot on the module). (See the RC76xx AT Command Reference Guide.)

Note: Make sure that your system design provides sufficient cooling for the module—proper mounting, heat sinks, and active cooling may be required, depending on the integrated application. The RC module's RF shield temperature should not be exposed to an ambient temperature greater than 85°C, to prevent damage to the RC module's components.

(For acceptance, certification, quality, and production (including RF) test suggestions, see [Testing](#) on page 56.)

7.5 RF Output Accessibility

During the integration phase of the RC7611/RC7611D M.2 Accessory Board, it can be helpful to connect the module to a simulator to check critical RF TX parameters and power behavior for supported RATs.

Although the RC7611/RC7611D M.2 Accessory Board has been certified, some parameters may have degraded if some basic precautions have not been followed (poor power supply, for example). This may not affect the functionality of the product, but the product may not comply with 3GPP specifications.

The following TX parameters can be checked using a Radio Communication tester:

- Phase & Frequency Error
- Output Power and Burst Time
- Output Spectrum (Modulation and Switching)

The following are available typical Radio Communication testers:

- Rohde & Schwarz: CMU200, CMW500
- Keysight (formerly Agilent): 8960
- Anritsu: MD8475

Because of the high prices associated with Radio Communication testers and the necessary RF know-how to perform simulations, customers can check their applications in the Semtech laboratories. Contact the Semtech support team for more information.

8: Legal Information

This chapter describes the current certification status of the RC7611 modules collectively referred to as the RC76xx series modules or RC76xx module. Certifications in other countries may be attained upon customer request — contact your Semtech account representative for details.

Additional testing and certification may be required for the host product with an embedded RC76xx series module and are the responsibility of the OEM. Semtech offers professional services-based assistance to OEMs with the testing and certification process, if required.

** Limited availability*

8.1 Regulatory and Industry Approvals/ Certifications

The RC76xx Series modules are designed to meet, and upon commercial release, will meet the requirements of the following regulatory bodies and regulations, where applicable:

- Federal Communications Commission (FCC) of the United States
- The Certification and Engineering Bureau of Industry Canada (IC)
- Electrical Regulatory Authorities Council (Australia and New Zealand)

Upon commercial release, the following industry certifications will have been obtained, where applicable:

- GCF
- PTCRB

Additional certifications and details on specific country approvals may be obtained upon customer request — contact your Semtech account representative for details.

8.2 Compliance Acceptance and Certification

Final regulatory and operator certification requires regulatory agency testing and approval with the fully integrated UE host device incorporating the Semtech RC76xx 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 Semtech RC76xx (as defined by this document) are not supported.

8.3 Certification Compliance

8.3.1 Important Compliance Information for North American Users

The Semtech RC7611 modules 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 follow the RF trace routing recommendations on [RF Routing Recommendations](#).
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 8-1](#).

Table 8-1: Antenna Gain Specifications

Device	Technology	Band	Frequency (MHz)	Maximum Antenna Gain (dBi)
RC7611	LTE	2	1850–1910	6
		4	1710–1755	6
		5	824–849	6
		12	699–716	6
		13	777–787	6
		14	788–798	6
		25	1850–1915	6
		26	814–849	6
		66	1710–1780	6
		71	663–698	6

4. The Semtech RC7611 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 8-2](#).

Table 8-2: Collocated Radio Transmitter Specifications

Device	Technology	Frequency (MHz)	EIRP Limit (dBm)
Collocated transmitters ^a	WLAN	2400–2500	25
		5150–5850	27
	WiMAX	2300–2400	25
		2500–2700	25
		3300–3800	25
	BT	2400–2500	15

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

5. A label must be affixed to the outside of the end product into which the Semtech RC7611 is incorporated, with a statement similar to the following:
- **(RC7611) This device contains FCC ID: N7NRC76B / IC: 2417C-RC76B**

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 RC7611 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.

8.3.1.1 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.

9: Pinout

Table 9-1 describes the RC7611/RC7611D M.2 Accessory Board's host I/O connector pins.

Note: Pins marked as 'Leave open' or 'Reserved' should not be used or connected.

9.1 Pin Description

Table 9-1: Connector pin assignments^a

Pin	Signal	Description	I/O ^b	Pin type ^c	Power Supply Domain	Active
1	NC	No connect	-	-		-
2	VCC	Power supply	I	V	3.2 V (Min) 3.7 V (typ) 4.3 V (max)	Power
3	GND	Ground	I	V	0 V	Power
4	VCC	Power supply	I	V	3.2 V (Min) 3.7 V (typ) 4.3 V (max)	Power
5	GND	Ground	I	V	0 V	Power
6	POWER_ON	Control Signal	I	V	VCC	High
7	USB_DP	USB data positive	I/O	-		Differential
8	W_DISABLE_N	Wireless Disable	I	-	VCC	Low
9	USB_DN	USB data negative	I/O	-		Differential
10	NC	No connect	-	-		-
11	GND	Ground	I	V	0 V	Power
20	NC	No connect	-	-		-
21	NC	No connect	-	-		-
22	NC	No connect	-	-		-
23	WAKE_ON_WWAN_N	Wakeup host	O	V	VCC	Low
24	NC	No connect	-	-		-
25	NC	No connect	-	-		-
26	NC	No connect	-	-		-
27	GND	Ground	I	V	0 V	Power

Table 9-1: Connector pin assignments^a (Continued)

Pin	Signal	Description	I/O ^b	Pin type ^c	Power Supply Domain	Active
28	SAFE_PWR_REMOVE_N	Indication	O	V	VCC	Low
29	NC	No connect	-	-		-
30	UIM1_RST	SIM Reset	O	-	1.8 V / 3V	Low
31	NC	No connect	-	-		-
32	UIM1_CLK	SIM Clock	O	-	1.8 V / 3V	Low
33	GND	Ground	I	V	0 V	Power
34	UIM1_DATA	SIM I/O pin	I/O	-	1.8 V / 3V	Low
35	NC	No connect	-	-		-
36	UIM1_VCC	SIM VCC supply	O	-	1.8 V / 3V	Power
37	NC	No connect	-	-		-
38	NC	No connect	-	-		-
39	GND	Ground	I	V	0 V	Power
40	NC	No connect	-	-		-
41	NC	No connect	-	-		-
42	NC	No connect	-	-		-
43	NC	No connect	-	-		-
44	NC	No connect	-	-		-
45	GND	Ground	I	V	0 V	Power
46	NC	No connect	-	-		-
47	NC	No connect	-	-		-
48	NC	No connect	-	-		-

Table 9-1: Connector pin assignments^a (Continued)

Pin	Signal	Description	I/O ^b	Pin type ^c	Power Supply Domain	Active
49	NC	No connect	-	-		-
		(I2S_DIN) I ² S Data In	I			Low
50	NC	No connect	-	-		-
51	GND	Ground	I	V	0 V	Power
52	NC	No connect	-	-		-
53	NC	No connect	-	-		-
54	NC	No connect	-	-		-
55	NC	No connect	-	-		-
56	NC	No connect	-	-		-
57	GND	Ground	I	V	0 V	Power
58	NC	No connect	-	-		-
59	NC	No connect	-	-		-
60	NC	No connect	-	-		-
61	NC	No connect	-	-		-
62	NC	No connect	-	-		-
63	NC	No connect	-	-		-
64	NC	No connect	-	-		-
65	NC	No connect	-	-		-
66	UIM1_DET	SIM detect	I	-	1.8 V	High
67	SYSTEM_RESET_N	Reset	I	-	1.8 V	Low
68	NC	No connect	-	-		-

Table 9-1: Connector pin assignments^a (Continued)

Pin	Signal	Description	I/O ^b	Pin type ^c	Power Supply Domain	Active
69	NC	No connect	-	-		-
70	VCC	Power supply	I	V	3.2 V (Min) 3.7 V (typ) 4.3 V (max)	Power
71	GND	Ground	I	V	0 V	Power
72	VCC	Power supply	I	V	3.2 V (Min) 3.7 V (typ) 4.3 V (max)	Power
73	GND	Ground	I	V	0 V	Power
74	VCC	Power supply	I	V	3.2 V (Min) 3.7 V (typ) 4.3 V (max)	Power
75	NC	No connect	-	-		-

a. The host should leave all 'NC' ('no connect) pins unconnected.

b. Signal direction with respect to the accessory board. For example, WAKE_ON_WWAN_N (pin 1) is an output from the module to the host. I—Input; O—Output; I/O—Input/Output

c. A—Analog; I—Input; NP—No pull; O—Digital output; OC—Open Collector; PU—Digital input (internal pull up); PD—Digital output (internal pull down); V—Power or ground

10: Testing

10.1 Certification Testing

Note: Typically, certification testing of your device with the integrated assembly board is required one time only.

When you produce a host device with a Semtech embedded module (such as the one on the RC7611/RC7611D M.2 Accessory Board), you must obtain certifications for the final product from appropriate regulatory bodies in the jurisdictions where it will be distributed.

The following are *some* of the regulatory bodies from which you may require certification — it is your responsibility to make sure that you obtain all necessary certifications for your product from these or other groups:

- FCC (Federal Communications Commission — www.fcc.gov)
- Industry Canada (www.ic.gc.ca)
- GCF (Global Certification Forum — www.globalcertificationforum.org) outside of North America
- PTCRB (PCS Type Certification Review Board — www.ptcrb.com) in North America

10.2 Production Testing

Note: Production testing typically continues for the life of the product.

Production testing ensures that, for each assembled device, the assembly board is installed correctly (I/O signals are passed between the host and assembly board), and the antenna is connected and performing to specifications (RF tests).

Typical items to test include:

- Host connectivity
- Baseband (host/assembly board connectors)
- RF assembly (Tx and/or Rx, as appropriate)
- Network availability
- Host/device configuration issues

*Note: The number and types of tests to perform are **your** decision — the tests listed in this section are guidelines only. Make sure that the tests you perform exercise functionality to the degree that **your** situation requires.*

Use an appropriate test station and use AT commands to control the integrated assembly board.

Note: Your test location must be protected from ESD to avoid interference with the assembly board and antenna(s), assuming that your test computer is in a disassembled state. Also, consider using an RF shielding box — local government regulations may prohibit unauthorized transmissions. The tests described in this chapter are done using a Linux O/S (e.g. Ubuntu 16.04).

10.3 Functional Production Test

This section presents a suggested procedure for performing a basic manual functional test on a laboratory bench using the RC7611/RC7611D M.2 Accessory Board and a hardware development kit. When you have become familiar with the testing method, use it to develop your own automated production testing procedures.

10.3.1 Suggested Production Tests

Consider the following tests when you design your production test procedures for devices with the RC7611/RC7611D M.2 Accessory Board installed.

- Visual check of the assembly board's connectors and RF assemblies
- Embedded module is operational
- USB connection is functional
- LED is functional
- Power on/off
- Firmware revision check
- Rx tests on main and auxiliary paths
- Tx test

10.3.2 Production Test Procedure

The following is a suggested test plan — you must decide which tests are appropriate for your product. You may wish to add additional tests that more fully exercise the capabilities of your product.

Using an appropriate test station, and referring to the appropriate AT command references:

1. Visually inspect the assembly board for obvious defects (such as tainted or damaged shields) before installing it in the test station.
2. Ensure that the assembly board is powered off (no voltage on VCC) before beginning your tests.
3. Determine whether any USB devices are currently connected to the computer:
 - a. Open a shell window and enter the command `ls /dev/tty/USB*`.
 - b. Record the `ttyUSBn` values that are returned; these are the currently connected USB devices. If the command returns "no such file or directory", there are no devices currently connected.
4. Provide power to the assembly board (voltage on VCC).
5. Test `W_DISABLE_N` — Turn on the module by driving `W_DISABLE_N` low, as shown in [Figure 5-1](#) on page 37.
6. Test USB functionality — Check for USB enumeration.

Enter the command `ls /dev/tty/USB*` and then record and compare the results with those from [Step 3](#). If there are any new `ttyUSBn` devices, then the modem has enumerated successfully. (The AT port is usually the *last* new device.)
7. Make sure your modem is connected and running, and then establish contact with the module:

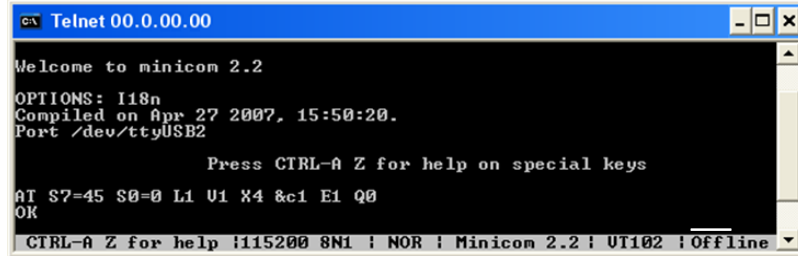
Use a terminal emulation/communications program such as `minicom` to connect over the device handle for AT commands (see listings in [Step 6](#)):

Note: If the command "minicom" is not found, then use a different program, or download minicom and repeat this step. See [Downloading and Configuring minicom for Linux Systems](#) on page 58 for details.

- a. Start `minicom`:

- First use of the modem: From the command line, type `minicom -s`. (The '-s' switch shows the configuration menu.)
- Subsequent uses: From the command line, type `minicom`. (The '-s' switch is assumed.)

The minicom configuration details appear and the message OK appears when the connection is established.



```
cx Telnet 00.0.00.00
Welcome to minicom 2.2
OPTIONS: I18n
Compiled on Apr 27 2007, 15:50:20.
Port /dev/ttyUSB2

Press CTRL-A Z for help on special keys

AT S7=45 S0=0 L1 U1 X4 &c1 E1 Q0
OK
CTRL-A Z for help !i15200 8N1 ! NOR ! Minicom 2.2 ! UT102 ! Offline
```

8. Display the firmware version:
 - `ATI`
9. Unlock the extended AT command set. (Note: Use `AT!ENTERCND?` to check command syntax, which is SKU-dependent):
 - `AT!ENTERCND=<password>`
10. Test the LED — Visually confirm that the LED turns on and off using:
 - `AT!LDTEST=0,1` (LED on)
 - `AT!LDTEST=0,0` (LED off)
11. Put the module in diagnostic / factory test mode:
 - `AT!DAFTMACT`
12. Communicate with the SIM using `AT+CPIN` or `AT+CIMI`.
13. Test RF transmission, if desired:
 - (LTE) See [LTE RF Transmission Path Test](#) on page 59.
14. Test RF reception, if desired:
 - (LTE) See [LTE RF Receive Path Test](#) on page 61.
15. Test standalone GNSS functionality — See [GNSS RF Receive Path Test](#) on page 63.
16. Remove power from the module.

10.3.2.1 Downloading and Configuring minicom for Linux Systems

Note: This procedure is for Ubuntu systems. If you are using a different Linux distribution, use the appropriate commands for your system to download minicom.

To download and configure minicom in a Ubuntu system:

Note: To install minicom, you must have root access, or be included in the sudoers list.

1. Download and install minicom — enter the following command:
`sudo apt-get install minicom`
2. When prompted, enter your user password to begin the download and installation. When minicom is installed, the shell prompt appears.
3. Configure minicom to communicate with your modem:

- a. Start minicom with the following command:

```
minicom -s
```
4. Use the down-arrow key to select the **Serial port setup** option.
5. Refer to [Step 6](#) on page 57 to identify the device file handle (/dev/ttyUSBn) used for AT commands.
6. Indicate the file handle to use for AT commands— Enter A and then replace the serial device string with the AT file handle.
7. Press **Enter** twice.
8. Use the down-arrow key to select **Save setup as dfi**.
9. Select **Exit**.

10.4 LTE RF Transmission Path Test

Note: This procedure segment is performed in [Step 13](#) of the [Production Test Procedure](#) on page 57.

The suggested test procedure that follows uses the parameters in the following tables.

Table 10-1: Test Settings — RC7611/RC7611D M.2 Accessory Board LTE Transmission Path

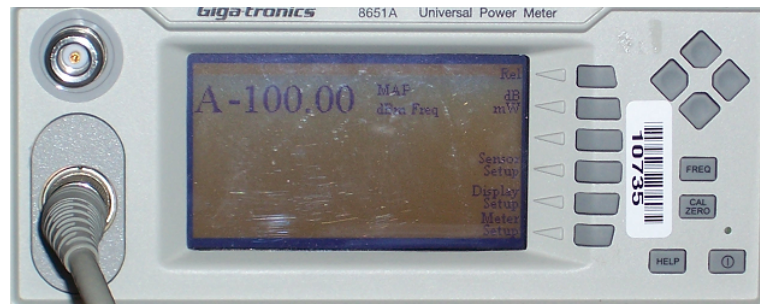
Band		Frequency (MHz)	Band ID	Channel ^a
1900 MHz	B2	1880.0	43	18900
1700 MHz	B4	1732.4	42	20175
850 MHz	B5	836.5	45	20525
700 MHz	B12	707.5	50	23095
700 MHz	B13	782.0	36	23230
700 MHz	B14	793.0	51	23330
1900 MHz	B25	1882.5	61	26365
850 MHz	B26	831.5	62	26865
1700 MHz	B66	1745.0	83	132322
600 MHz	B71	680.5	97	133297

- a. Channel value used by the **!DASCHAN** command (**!DASCHAN** uses uplink (Tx) channel at the center of the corresponding band, for both Tx and Rx testing)

To test the DUT's transmitter path:

Note: This procedure describes steps using the 'Power Meter: Gigatronics 8651A" (with Option 12 and Power Sensor 80701A).

1. Set up the power meter:



- a. Make sure the meter has been given sufficient time to warm up, if necessary, to enable it to take accurate measurements.
- b. Zero-calibrate the meter.
- c. Enable MAP mode.
2. Prepare the DUT using the following AT commands (adjusting the band, channel, bandwidth, modulation, RB allocation, NS, and power level as necessary):
 - a. **AT+ENTERCND=<password>** (Unlock extended AT command set.)
 - b. **AT+IDAFTMACT** (Enter test mode.)
 - c. **AT+IDASBAND=<bandValue>** (Set frequency band (e.g. 34 for LTE B1.)
 - See tables 10-1–10-5 for appropriate <bandValue> values.
 - d. **AT+IDALSTXBW=3** (Set Tx bandwidth to 10 MHz.)
 - e. **AT+IDALSRXBW=3** (Set Rx bandwidth to 10 MHz.)
 - f. **AT+IDASCHAN=<channel>** (Set modem channel (e.g. 18300 for LTE B1).)
 - See tables 10-1–10-5 for appropriate <channel> values.
 - g. **AT+IDALSTXMOD=0** (Set Tx modulation type to QPSK.)
 - h. **AT+IDALSWAVEFORM=1,12,0,19** (Set the Tx waveform characteristics. Make sure to set the correct resource block allocation (2nd parameter) appropriately. For example, 12 is used to produce max power—refer to 3GPP 36.521 table for Maximum Power Reduction (MPR) for Power Class 3 for more information.)
 - i. **AT+IDALSNSVAL=1** (Set the LTE NS (Net Sig) value.)
 - j. **AT+IDASTXON** (Turn on the transmitter. Note that the transmitter will put out the last power level that was programmed.)
 - k. **AT+IDALSTXPWR=1,10** (Begin transmitting at requested power level.)
 - l. Take the measurement.
 - m. Repeat [Step k](#) with different power levels if desired.
 - n. **AT+IDALSTXPWR=0,0** (Reduce Tx power to 0, so next time transmitter is turned on, it will come on with 0 dBm power.)
 - o. **AT+IDASTXOFF** (Turn off the transmitter.)
3. Test limits — Run ten or more good DUTs through this test procedure to obtain a nominal output power value.
 - Apply a tolerance of ± 5 to 6 dB to each measurement (assuming a good setup design).
 - Monitor these limits during mass-production ramp-up to determine if further adjustments are needed.

Note: The module has a nominal output power of +23 dBm \pm 1 dB in LTE mode. However, the value measured by the power meter is significantly influenced (beyond the stated \pm 1 dB output power tolerance) by the test setup (host RF cabling loss, antenna efficiency and pattern, test antenna efficiency and pattern, and choice of shield box). When doing the same test over the air in an RF chamber, values are likely to be significantly lower.

10.5 LTE RF Receive Path Test

Note: This procedure segment is performed in [Step 14](#) of the [Production Test Procedure](#) on page 57.

The suggested test procedure that follows uses the parameters in the following tables.

Table 10-2: Test Settings — RC7611/RC7611D M.2 Accessory Board LTE Receive Path

Band		Frequency ^a (MHz)	Band ID	Channel ^b
1900 MHz	B2	1962.00	43	18900
1700 MHz	B4	2134.50	42	20175
850 MHz	B5	883.50	45	20525
700 MHz	B12	739.50	50	23095
780 MHz	B13	753.00	36	23230
700 MHz	B14	763.0	51	23330
1900 MHz	B25	1964.5	61	26365
850 MHz	B26	878.5	62	26865
1700 MHz	B66	2157	83	132322
600 MHz	B71	635.5	97	133297

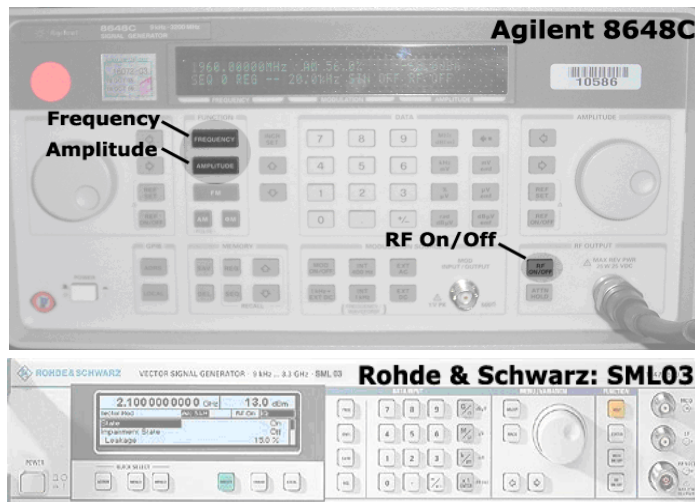
a. Receive frequencies shown are 2 MHz offset from center.

b. Channel value used by the `!DASCHAN` command (`!DASCHAN` uses uplink (Tx) channel at the center of the corresponding band, for both Tx and Rx testing).

To test the DUT's receive path (or diversity path, while connected to the diversity antenna):

Note: This procedure describes steps using the Agilent 8648C signal generator—the Rohde & Schwarz SML03 is shown for reference only.

1. Set up the signal generator:



- a. Set the amplitude to -70 dBm
- b. Set the frequency for the band being tested. See tables 10-4–10-3 for frequency values.
2. Set up the DUT:
 - a. **ATIINTERCND="<password>"** (Unlock extended AT command set.)
 - b. **ATIDAFTMACT** (Put modem into factory test mode.)
 - c. **ATIDASBAND=<band>** (Set frequency band.)
 - See tables 10-4–10-3 for <band> values
 - d. **ATIDALSRXBW=2** (Set Rx LTE bandwidth to 5MHz.)
 - e. **ATIDALSTXBW=2** (Set Tx LTE bandwidth to 5MHz.)
 - f. **ATIDASCHAN=<channel>** (Set modem channel)
 - See tables 10-4–10-3 for <channel> values
 - g. **ATIDALGAVGAGC=<channel>,0** (Get averaged Rx AGC)
 - See tables 10-4–10-3 for <channel> values
3. Test limits — Run ten or more good DUTs through this test procedure to obtain a nominal received power value.
 - Apply a tolerance of ± 5 to 6 dB to each measurement (assuming a good setup design).
 - Make sure the measurement is made at a high enough level that it is not influenced by DUT-generated and ambient noise.
 - The Signal Generator power level can be adjusted and new limits found if the radiated test needs greater signal strength.
 - Monitor these limits during mass-production ramp-up to determine if further adjustments are needed.

Note: The value measured from the DUT is significantly influenced by the test setup and DUT design (host RF cabling loss, antenna efficiency and pattern, test antenna efficiency and pattern, and choice of shield box).

10.6 GNSS RF Receive Path Test

The GNSS receive path uses the dedicated GNSS connector.

To test the GNSS receive path:

1. Inject a carrier signal at -110dBm, frequency 1575.52 MHz into the GNSS Rx path at the connector. (Note that this frequency is 100 kHz higher than the actual GPS L1 center frequency.)
2. Test the signal carrier-to-noise level at the GNSS receiver:
 - a. **ATIENTERCND=<password>** (Unlock extended AT command set.)
 - b. **ATIDAFTMACT** (Put modem into factory test mode.)
 - c. **ATIDACGPSTESTMODE=1** (Start CGPS diagnostic task.)
 - d. **ATIDACGPSSTANDALONE=1** (Enter standalone RF mode.)
 - e. **ATIDACGPSMASKON** (Enable log mask.)
 - f. **ATIDACGPSCTON** (Return signal-to-noise and frequency measurements.)
 - g. Repeat **ATIDACGPSCTON** five to ten times to ensure the measurements are repeatable and stable.
3. Leave the RF connection to the embedded module intact, and turn off the signal generator.
4. Take several more **IDACGPSCTON** readings. This will demonstrate a 'bad' signal in order to set limits for testing, if needed. This frequency offset should fall outside of the guidelines in the note below, which indicates that the CtoN result is invalid.
5. (Optional) Turn the signal generator on again, and reduce the level to -120dBm. Take more **IDACGPSCTON** readings and use these as a reference for what a marginal / poor signal would be.

*Note: The response to **ATIDACGPSCTON** for a good connection should show CtoN within 58 +/- 5dB and Freq (frequency offset) within 100000 Hz +/- 5000 Hz.*

A: Appendix

For more details, several references can be consulted, as detailed below.

A.1 Web Site Support

Check <http://source.sierrawireless.com> for the latest documentation available for the RC7611/RC7611D M.2 Accessory Board.

A.2 Reference Documents

- [1] RC76xx AT Command Reference
Reference number: 41113566
- [2] RC76xx Product Technical Specification
Reference number: 41113440
- [3] Inter-Chip USB Supplement to the USB 2.0 Specification Revision 1.0
- [4] I²C Bus Specification, Version 2.1, January 2000
Reference: Phillips Semiconductor document number 9398 393 40011
- [5] PCI Express Mini Card Dev Kit Quick Start Guide
Reference number: 2130705

A.3 Abbreviations

Table A-1: Acronyms and Definitions

Acronym or term	Definition
3GPP	3rd Generation Partnership Project
8PSK	Octagonal Phase Shift Keying
ADC	Analog to Digital Converter
AF	Audio-Frequency
API	Application Programming Interface
AT	Attention (prefix for modem commands)
BeiDou	BeiDou Navigation Satellite System A Chinese system that uses a series of satellites in geostationary and middle earth orbits to provide navigational data.
BER	Bit Error Rate — A measure of receive sensitivity
BLER	Block Error Rate
Bluetooth	Wireless protocol for data exchange over short distances
CEP CEP-##	Circular Error Probability — Measure of GPS horizontal accuracy indicating the radius of a circle around the actual position that contains 50% of GPS measurements. CEP-## — Radius of circle containing ##% of GPS measurements (e.g. CEP-90 indicates 90% of measurements contained within circle)
CF3	Common Flexible Form Factor
CLK	Clock
CMOS	Complementary Metal Oxide Semiconductor
CPU	Central Processing Unit
CQI	Channel Quality Indication
CS	Circuit-Switched Coding Scheme
CTS	Clear To Send
CW	Continuous waveform
DAC	Digital to Analog Converter
dB	Decibel = $10 \times \log_{10} (P1/P2)$ <i>P1 is calculated power; P2 is reference power</i> Decibel = $20 \times \log_{10} (V1/V2)$ <i>V1 is calculated voltage, V2 is reference voltage</i>
dBm	A logarithmic (base 10) measure of relative power (dB for decibels); relative to milliwatts (m). A dBm value will be 30 units (1000 times) larger (less negative) than a dBW value, because of the difference in scale (milliwatts vs. watts).
DC	Direct Current

Table A-1: Acronyms and Definitions (Continued)

Acronym or term	Definition
DCD	Data Carrier Detect
DCS	Digital Cellular System A cellular communication infrastructure that uses the 1.8 GHz radio spectrum.
DL	Downlink (network to mobile)
DRX	Discontinuous Reception
DSR	Data Set Ready
DTR	Data Terminal Ready
E-GSM	Extended GSM
EDGE	Enhance Data rates for GSM Evolution
EFR	Enhanced Full Rate
EGPRS	Enhance GPRS
EIRP	Effective (or Equivalent) Isotropic Radiated Power
EMC	Electromagnetic Compatibility
EN	Enable
ERP	Effective Radiated Power
ESD	Electrostatic Discharges
eSIM	Embedded SIM
ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission The U.S. federal agency that is responsible for interstate and foreign communications. The FCC regulates commercial and private radio spectrum management, sets rates for communications services, determines standards for equipment, and controls broadcast licensing. Consult www.fcc.gov .
FDD	Frequency Division Duplexing
FDMA	Frequency Division Multiple Access
firmware	Software stored in ROM or EEPROM; essential programs that remain even when the system is turned off. Firmware is easier to change than hardware but more permanent than software stored on disk.
FOV	Field Of View
FR	Full Rate
FSN	Factory Serial Number—A unique serial number assigned to the module during manufacturing.
Galileo	A European system that uses a series of satellites in middle earth orbit to provide navigational data.
GCF	Global Certification Forum

Table A-1: Acronyms and Definitions (Continued)

Acronym or term	Definition
GLONASS	Global Navigation Satellite System — A Russian system that uses a series of 24 satellites in middle circular orbit to provide navigational data.
GMSK	Gaussian Minimum Shift Keying modulation
GND	Ground
GNSS	Global Navigation Satellite Systems (GPS, GLONASS, BeiDou, and Galileo)
GPIO	General Purpose Input Output
GPRS	General Packet Radio Service
GPS	Global Positioning System An American system that uses a series of 24 satellites in middle circular orbit to provide navigational data.
GSM	Global System for Mobile communications
Hi Z	High impedance (Z)
Host	The device into which an embedded module is integrated
HR	Half Rate
HSDPA	High Speed Downlink Packet Access
HSUPA	High Speed Uplink Packet Access
Hz	Hertz = 1 cycle/second
I/O	Input/Output
IC	Industry Canada
IC	Integrated Circuit
IMEI	International Mobile Equipment Identity
IMS	IP Multimedia Subsystem — Architectural framework for delivering IP multimedia services.
inrush current	Peak current drawn when a device is connected or powered on
IOT	Interoperability Testing
IS	Interim Standard. After receiving industry consensus, the TIA forwards the standard to ANSI for approval.
ISIM	IMS Subscriber Identity Module.
LED	Light Emitting Diode. A semiconductor diode that emits visible or infrared light.
LGA	Land Grid Array
LHCP	Left-Hand Circular Polarized
LNA	Low noise Amplifier

Table A-1: Acronyms and Definitions (Continued)

Acronym or term	Definition
LTE	Long Term Evolution—a high-performance air interface for cellular mobile communication systems.
MAX	Maximum
MCS	Modulation and Coding Scheme
MHz	Megahertz = 10e6 Hz
MIC	Microphone
MIMO	Multiple Input Multiple Output—wireless antenna technology that uses multiple antennas at both transmitter and receiver side. This improves performance.
MIN	Minimum
MO	Mobile Originated
MT	Mobile Terminated
N/A	Not Applicable
NMEA	National Marine Electronics Association
NOM	Nominal
OEM	Original Equipment Manufacturer—a company that manufactures a product and sells it to a reseller.
PA	Power Amplifier
packet	A short, fixed-length block of data, including a header, that is transmitted as a unit in a communications network.
PBCCH	Packet Broadcast Control Channel
PC	Personal Computer
PCB	Printed Circuit Board
PCL	Power Control Level
PCS	Personal Communication System A cellular communication infrastructure that uses the 1.9 GHz radio spectrum.
PDN	Packet Data Network
PFM	Power Frequency Modulation
PLL	Phase Lock Loop
PMIC	Power Management Integrated Circuit
PSM	Phase Shift Modulation
PSS	Primary synchronization signal
PST	Product Support Tools
PTCRB	PCS Type Certification Review Board

Table A-1: Acronyms and Definitions (Continued)

Acronym or term	Definition
PWM	Pulse Width Modulation
QAM	Quadrature Amplitude Modulation. This form of modulation uses amplitude, frequency, and phase to transfer data on the carrier wave.
QMAP	Qualcomm MUX and Aggregation Protocol
QPSK	Quadrature Phase-Shift Keying
R2C	Ready-To-Connect
RAM	Random Access Memory
RAT	Radio Access Technology
RF	Radio Frequency
RHCP	Right Hand Circular Polarization
RI	Ring Indicator
RSE	Radiated Spurious Emissions
RSSI	Received Signal Strength Indication
RST	Reset
RTC	Real Time Clock
RTS	Request To Send
RX	Receive
SCLK	Serial Clock
SED	Smart Error Detection
Sensitivity (Audio)	Measure of lowest power signal that the receiver can measure.
Sensitivity (RF)	Measure of lowest power signal at the receiver input that can provide a prescribed BER/BLER/ SNR value at the receiver output.
SIM	Subscriber Identity Module.
SIMO	Single Input Multiple Output—Wireless antenna technology that uses multiple antennas at the receiver side and one antenna at the source (transmitter).
SKU	Stock Keeping Unit—identifies an inventory item: a unique code, consisting of numbers or letters and numbers, assigned to a product by a retailer for purposes of identification and inventory control.
SMS	Short Message Service
SNR	Signal-to-Noise Ratio
SPI	Serial Peripheral Interface
SPK	Speaker
SW	Software

Table A-1: Acronyms and Definitions (Continued)

Acronym or term	Definition
TBC	To Be Confirmed
TBD	To Be Determined
TIA/EIA	Telecommunications Industry Association / Electronics Industry Association. A standards setting trade organization, whose members provide communications and information technology products, systems, distribution services and professional services in the United States and around the world. Consult www.tiaonline.org .
TIS	Total Isotropic Sensitivity
TP	Test Point
TRP	Total Radiated Power
TX	Transmit
TYP	Typical
UART	Universal Asynchronous Receiver-Transmitter
UE	User Equipment
UICC	Universal Integrated Circuit Card
UIM	User Identity Module. Generic term used in this document to refer to UICC, where the application on the UICC (USIM, ISIM, CSIM, etc.) varies depending on the provider of the card.
UL	Uplink (mobile to network)
UMTS	Universal Mobile Telecommunications System
USB	Universal Serial Bus
USB-SS	USB Selective Suspend/USB not enumerated
USIM	Universal Subscriber Identity Module (UMTS)
USSD	Unstructured Supplementary Services Data
UTRA	UMTS Terrestrial Radio Access
VBAT-BB	Baseband power supply
VBAT-RF	RF power supply
VCC	Supply voltage
VSWR	Voltage Standing Wave Ratio
WCDMA	Wideband Code Division Multiple Access (also referred to as UMTS)
WLAN	Wireless Local Area Network
WWAN	Wireless Wide Area Network
ZIF	Zero Intermediate Frequency