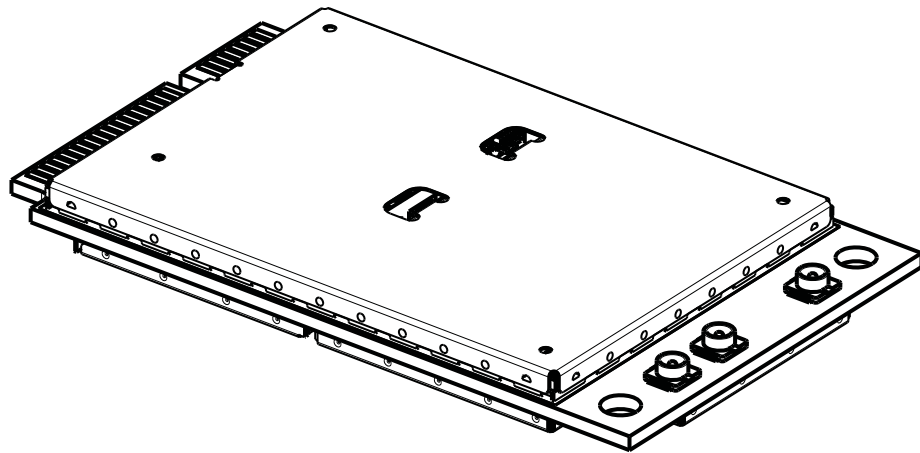




# Product Technical Specification & Customer Design Guidelines

AirPrime MC7750



**SIERRA**  
WIRELESS™

2400074

Rev 6

Contents subject to change



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## Important Notice

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

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

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Consult our website for up-to-date product descriptions, documentation, application notes, [firmware](#) upgrades, troubleshooting tips, and press releases:

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## Revision History

Revision number	Release date	Changes
1	August 2010	Initial release.
2	January 2011	<p>Resolved most TBDs.</p> <p>Removed references to dial-up networking.</p> <p>Updated <a href="#">Figure 4-1, System block diagram</a>, on page 24;  <a href="#">Figure 4-2, Expanded RF block diagram</a>, on page 25;  <a href="#">Figure 8-2, Dimensioned view</a>, on page 54.</p> <p>Updated <a href="#">Table 5-5, Conducted Rx (Receive) sensitivity—CDMA bands</a>, on page 42;  <a href="#">Table 6-1, Averaged standby DC power consumption</a>, on page 45;  <a href="#">Table 6-3, Averaged call mode DC power consumption (LTE)</a>, on page 46;  <a href="#">Table 6-4, Averaged Call Mode DC power consumption (GSM/EDGE)</a>, on page 70.</p> <p>Added a list of tables and list of figures.</p> <p>Removed unused glossary entries.</p>
3	May 2011	General review and redraft
4	September 2011	<p>Updated LED table</p> <p>Removed UMTS/GSM references</p> <p>Updated LTE power consumption</p> <p>Added suggested antenna part number</p>
5	January 2013	<p>Updated preface.</p> <p>Updated pinout table (<a href="#">Table 4-1</a> now uses same pins as MC7700/MC7710) added pin explanation sections (e.g. WAKE_N, GPS_EN_N), updated GPIO list.</p> <p>Corrected GPRS/EDGE class details.</p> <p>Updated current consumption - standby+sleep activated, LPM+sleep deactivated (<a href="#">Table 6-1</a>)</p>
6	February 2013	Updated developer zone URL





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# 1: Introduction

The Sierra Wireless MC7750 PCI Express Mini Card is a compact, lightweight, wireless LTE- and CDMA-based modem, designed to be Verizon Wireless certified.

The MC7750 provides LTE, CDMA, and GPS connectivity for portable and handheld computers, point-of-sale devices, telemetry products and other machine-to-machine and vertical applications over several radio frequency bands.

## Supported RF bands

The modem, based on Qualcomm's MDM9600 baseband processor, supports data operation on LTE and CDMA networks.

Table 1-1: Supported RF bands

Technology	Bands	Diversity
LTE	<ul style="list-style-type: none"><li>Band 13: 700 MHz</li></ul>	✓ (MIMO)
CDMA	<ul style="list-style-type: none"><li>Cellular (800 MHz)</li><li>PCS (1900 MHz)</li></ul>	✓
GPS	<ul style="list-style-type: none"><li>1575.42 MHz</li></ul>	n/a

## Physical features

- Small form factor—conforms to F1 as specified in *PCI Express Mini Card Electromechanical Specification Revision 1.2*.
- Operating temperature range: -30 °C to +60 °C

## Application interface features

- USB interface (QMI )
- **NDIS NIC** interface support for Windows 7, Windows Vista, and Windows XP platforms
- Multiple non-multiplexed **USB** channel support
- USB selective suspend to maximize power savings
- AT command interface ([1] *AT Command Set for User Equipment (UE) (Release 6) (Doc# 3GPP TS 27.007)*, plus proprietary extended AT commands)
- Software Development Kit (**SDK**) including a Linux API (Application Program Interface)
- WMC DLL support for Verizon Wireless PC-**OEM** (Windows)

- OMA DM (Open Mobile Alliance Device Management) support
- FOTA (Firmware Over The Air) support

## Packet mode features

- LTE data rates (category 3, MIMO)
  - 100 Mbps DL within 20 MHz bandwidth
  - 50 Mbps UL within 20 MHz bandwidth
- CDMA IS-856 (1xEV-DO Rev. A) data rates
  - Up to 3.1 Mbps forward channel
  - Up to 1.8 Mbps reverse channel
- CDMA IS-2000 data rates—Up to 153 kbps, simultaneous forward and reverse channel
- Circuit-switched data bearers (up to 14.4 for CDMA)

## LTE features

- Basic cell selection and system acquisition
  - PSS/SSS/MIB decode
  - SIB1, SIB2, SIB3 decoding
- NAS/AS security procedures
  - Snow 3G/AES security
- CQI/RI reporting
- Paging procedures
  - Paging in Idle and Connected mode
- Dedicated bearer
  - Network-initiated dedicated bearer
  - UE-initiated dedicated bearer
- Multiple PDN connections (IPv4 and IPv6 combinations)
- Connected mode intra-LTE mobility
- Idle mode intra-LTE mobility
- iRAT between LTE/2G (future release)  
iRAT between LTE/3G for idle and connection release with redirection (future release)
- Detach procedure
  - Network-initiated detach with reattach required
  - Network-initiated detach followed by connection release
- LTE → eHRPD redirection with data continuity (IPv4/IPv6)

## Short Message Service (SMS) features

- Mobile-terminated SMS for CDMA
- Mobile-originated SMS for CDMA
- Mobile-terminated SMS over IMS for LTE/eHRPD



- Mobile-originated SMS over IMS for LTE/eHRPD

## Position location (GPS)

- Standalone mode
- GLONASS support on GPS connector 1 (future release)
- DC bias on GPS connector 1 to support external active GPS antenna

## Warranty and support

The MC7750 offers the following support features:

- Standard 1-year warranty
- Enabling software (drivers, [SDK](#), etc.) for Android, Linux, Windows 7, Windows Vista, and Windows XP

## Supporting documents

Several additional documents describe Mini Card design, usage, integration, and other features. See [References on page 87](#).

## Accessories

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

- Development board
- Cables
- Antennas (Bands 17, 13, and 7 are not supported by supplied antennas)
- Documentation suite
- Initial allotment of support hours
- Other accessories

For instructions on setting up the UDK, see *[4] PCI Express Mini Card Dev Kit Quick Start Guide (Doc# 2130705)*.

For over-the-air LTE testing, ensure that suitable antennas are used. (Two antennas are required for this testing; Sierra Wireless offers an LTE-capable antenna covering 700–2600 MHz BW—please order part number 6000492 (Qty 1—this contains two antennas).)

## Required connectors

[Table 1-2](#) describes the connectors used to integrate AirPrime MC-series modules into your host device.

**Table 1-2: Required host-module connectors<sup>1</sup>**

Connector type	Description
RF cables	<ul style="list-style-type: none"> <li>Mate with Hirose U.FL connectors (model U.FL #CL331-0471-0-10)</li> <li>Two or three connector jacks, depending on module support for diversity and GPS functionality. (Note: The UDK has two connector jacks.)</li> </ul>
EDGE (52-pin)	<ul style="list-style-type: none"> <li>Industry-standard mating connector</li> <li>Some manufacturers include Tyco, Foxconn, Molex</li> <li>Example: UDK board uses Molex 67910-0001</li> </ul>
<a href="#">SIM</a>	<ul style="list-style-type: none"> <li>Industry-standard connector. Type depends on how host device exposes the SIM socket</li> <li>Example: UDK board uses ITT CCM03-3518</li> </ul>

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

## Ordering information

To order, contact the Sierra Wireless Sales Desk at +1 (604) 232-1488 between 8 AM and 5 PM Pacific Time.

## Integration requirements

Sierra Wireless provides, in the document suite, guidelines for successful Mini Card integration and offers integration support services as necessary.

When integrating the MC7750 PCI-Express Mini Card, the following items need to 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 discussed in [Regulatory and Industry Approvals on page 59](#).
- **Service provisioning**—Manufacturing process
- **Software**—As discussed in [Software Interface on page 51](#).
- **Host Interface**, compliance with interface voltage levels

## 2: Technology Overview

### LTE

LTE (Long Term Evolution) is a 4th-generation wireless standard. The [3GPP](#) Release 8 specification outlines the features and requirements.

Key features include.

- Peak data rate:
  - 100 Mbps DL within 20 MHz bandwidth (Peak DL data rate in 10 MHz bandwidth: 70 Mbps (approx.) for Cat 3 device)
  - 50 Mbps UL within 20 MHz bandwidth

Actual throughput is dependent on the network configuration, bandwidth assigned to the UE, the number of users, and RF signal conditions.

- Up to 200 active users in a cell (5 MHz)
- Less than 5 ms user-plane latency
- Supported bandwidths: 5 MHz/10 MHz
- Spectrum flexibility: 1.4–20 MHz (3–20 MHz in future F/W release)
- Enhanced support for end-to-end [QoS](#)
- Physical layer uses:
  - [DL](#): OFDMA (Orthogonal Frequency Division Multiple Access). Modulation: QPSK, [16QAM](#), and 64QAM
  - [UL](#): Single Carrier FDMA (single carrier modulation and orthogonal frequency multiplexing) Modulation: QPSK, [16QAM](#)
- MIMO (Multi-Input Multi-Output) antenna support

### CDMA

#### 1xEV-DO

1xEV-DO is backwards compatible to both [1X](#) and [IS-95A/B](#) standards. However, 1xEV-DO represents an evolutionary enhancement, specifically designed and optimized for high-speed wireless data access. This was driven by fundamental differences between voice and data traffic characteristics.

eHRPD (Enhanced High Rate Packet Data) is an enhancement of 1xEV-DO that enables LTE to CDMA handover.

To optimize for data, there are some fundamental characteristics and differences between 1X and 1xEV-DO, including:

- The network has dedicated spectrum (1.25 MHz) for data traffic using 1xEV-DO standard, so resources don't compete with 1X data/voice (hybrid mode used to monitor 1X carriers)
- BTS always transmits at maximum available power
- Each user receives data from only one base station at a time (no forward link soft handoff)
- 1xEV-DO lets each user use 100% of available resources, while dynamically allocating time resources among users for maximum efficiency
- 1xEV-DO uses time-division multiplexing of users on forward link (slots assigned for [packet](#) transmission)
- Forward link supports higher order modulation (QPSK, 8-PSK and 16-QAM)
- Reverse link (1xEV-DO Revision A) supports higher order modulation (8-PSK)
- Mobile supports dynamic channel estimation using measured [S/N](#) to set the highest rate it can decode (uses Data Rate Control channel to communicate to network access point)
- Mobiles can support Rx diversity for S/N enhancements particularly in multi-path/fading environments

## 1X and IS-95A

The type of data connection made at any given time depends on the services available from the carrier in the given coverage area. If 1X packet services are not available, the modem connects using circuit-switched data over [IS-95A](#) technology. The modem automatically selects the fastest connection mode available when a data call is connecting.

When [roaming](#), the modem **does not** automatically change connection modes. If the modem connects using 1X and then roams outside of the packet service area, the connection is dropped. To resume data communication, a new connection using IS-95A has to be created. Similarly, an IS-95A call established in one area does not automatically transition to 1X when the unit enters the 3G coverage area.

## 3: Standards Compliance

The MC7750 Mini Card complies with the mandatory requirements described in the following standards. The exact set of requirements supported is carrier-dependent.

**Table 3-1: Standards compliance**

Technology	Standards
LTE	<ul style="list-style-type: none"><li>• 3GPP Release 8</li></ul>
CDMA	<ul style="list-style-type: none"><li>• TIA/EIA/IS-2000.1 through .6. <i>cdma2000® Standards for Spread Spectrum Systems. Release 0.</i> April 2000</li><li>• TIA/EIA/IS-2000.1-1 through .6-1. <i>cdma2000® Addendum 1.</i> April 2000</li><li>• TIA/EIA/IS-2000.1-2 through .6-2. <i>cdma2000® Addendum 2.</i> June 2001</li><li>• TIA/EIA/IS-95-B. <i>Mobile Station-Base Station Compatibility Standard for Dual-Mode Spread Spectrum Systems.</i> December 4, 1998</li><li>• TIA/EIA/IS-. <i>cdma2000® High Rate Packet Data Air Interface Specification.</i> November 2000</li></ul>



## 4: Electrical Specifications

The system block diagram in [Figure 4-1](#) represents the MC7750 module integrated into a host system. The module includes the following interfaces to the host:

- **Power**—Supplied to the module by the host.
- **W\_DISABLE\_N**—Active low input from a hardware switch to the MC7750 that disables the main RF radio.
- **GPS\_EN\_N**—Active low input from a hardware switch to the MC7750 that disables the GPS radio.
- **WAKE\_N**—Signal used to wake the host when specific events occur.
- **WLAN\_LED\_N**—Active-low **LED** drive signal provides an indication of RADIO ON state, either WAN or GPS.
- **Antenna**—Three U.FL **RF** connectors (two for Rx/Tx, and one for GPS). For details, see [RF Specifications on page 37](#).  
Note that GPS can use either the dedicated GPS port, or the diversity/**MIMO** port. GLONASS is supported only on the dedicated GPS port.
- **SIM**—Supported through the interface connector. The **SIM** cavity / connector must be placed on the host device for this feature.
- **USB**—Interface to the host for data, control, and status information.
- **GPIO**—Four GPIOs reserved for future use.

The MC7750 has two main interface areas—the host I/O connector and the **RF** ports. Details of these interfaces are described in the sections that follow.

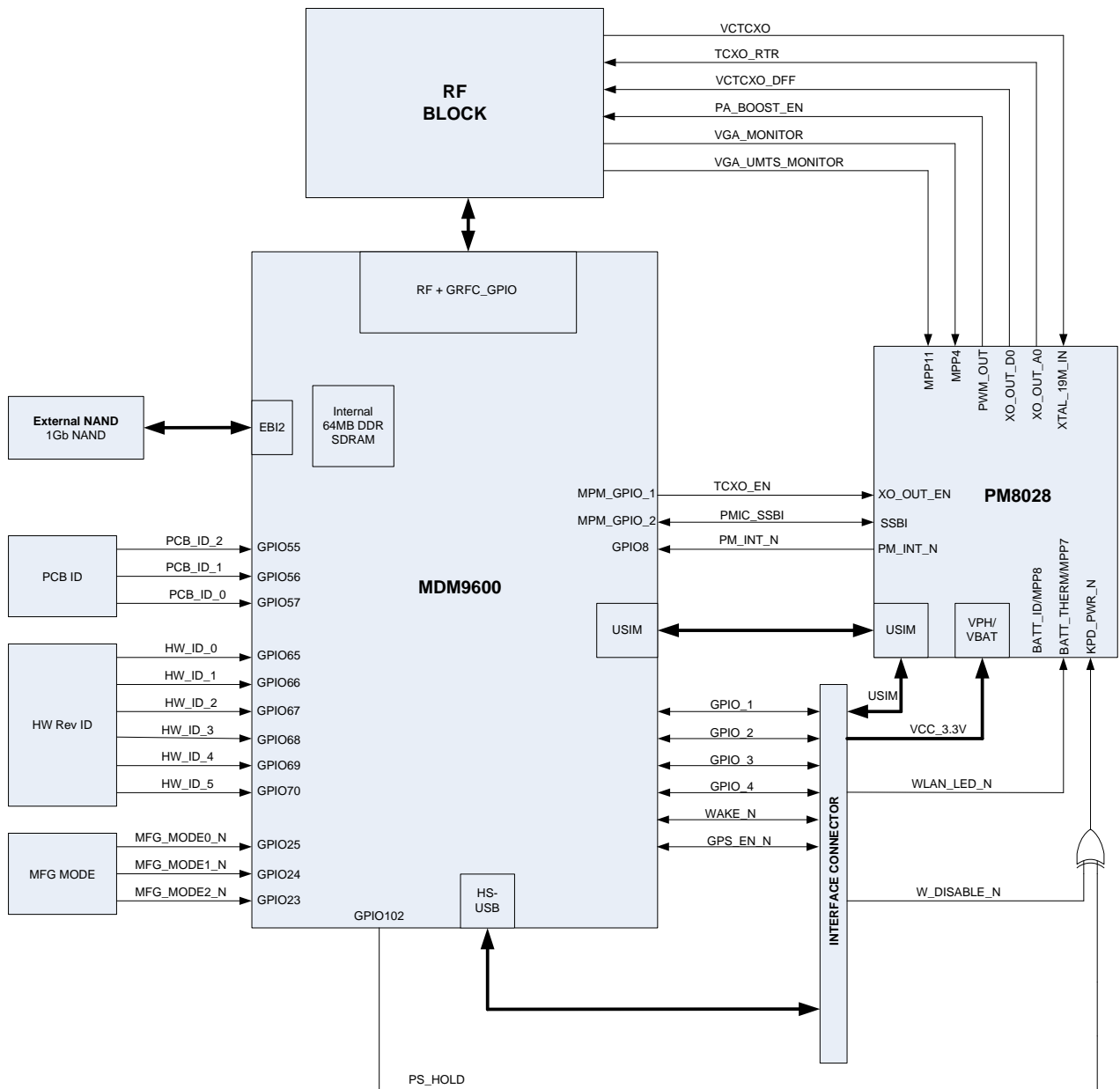


Figure 4-1: System block diagram



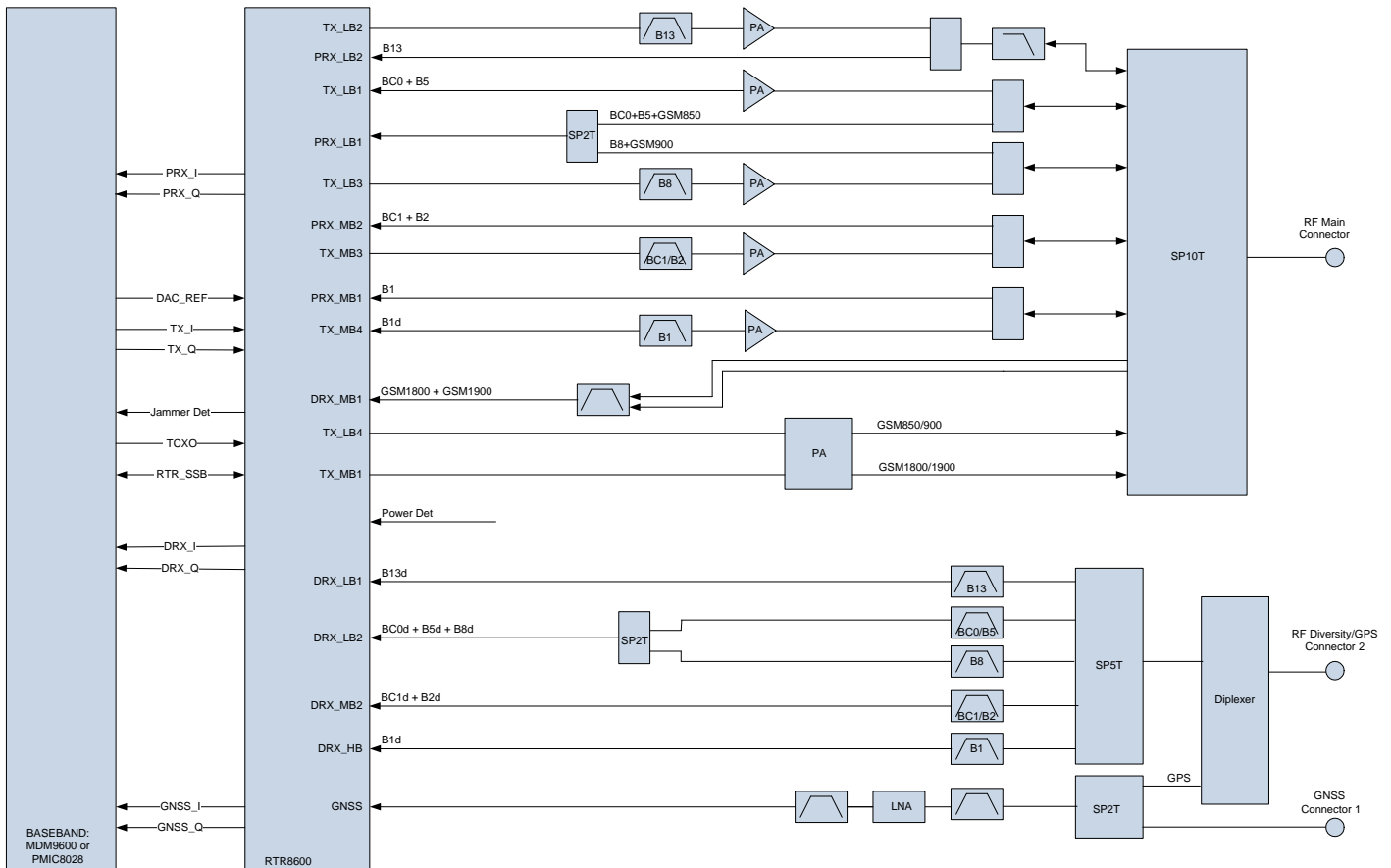


Figure 4-2: Expanded RF block diagram

## Host interface pin assignments

The MC7750 host I/O connector provides pins for power, serial communications, and control. Pin assignments are listed in [Table 4-1](#). See the following tables for pin details based on interface types:

- [Table 4-2, Power and ground specifications, on page 29](#)
- [Table 4-3, USB interface, on page 29](#)
- [Table 4-4, SIM interface signal, on page 30](#)
- [Table 4-5, Module control signals, on page 33](#)

*Note: On any given interface (USB, SIM, etc.), leave unused inputs and outputs as no-connects.*

Note: The following table describes the **internal** structure of the module. GPIO pins are reserved for future use. For applications not requiring GPIO functionality, leave these pins not connected on the host.

**Table 4-1: Connector pin assignments<sup>1,2</sup>**

Pin	Signal name	Pin type <sup>3</sup>	Description	Direction to module	Active state	Voltage levels (V)		
						Min	Typ	Max
1	WAKE_N <sup>4</sup>		Wake host	Output	Low	-	-	0.2
2	VCC	V	3.3 V supply	Input	Power	3.0	3.3	3.6
3	GPIO1	-	General purpose I/O	Input high	-	1.17	1.80	2.10
				Input low	-	-0.3	-	0.63
				Output high	-	1.35	-	1.80
				Output low	-	0	-	0.45
4	GND	V	Ground	Input	Power	-	0	-
5	GPIO2	-	General purpose I/O	Input high	-	1.17	1.80	2.10
				Input low	-	-0.3	-	0.63
				Output high	-	1.35	-	1.80
				Output low	-	0	-	0.45
6	NC	-	No connect	-	-	-	-	-
7	NC	-	No connect	-	-	-	-	-
8	USIM_PWR	-	SIM VCC supply	Output	Power	2.95 (3V SIM) 1.75 (1.8V SIM)	3.00 (3V SIM) 1.8 (1.8V SIM)	3.05 (3V SIM) 1.85 (1.8V SIM)
9	GND	V	Ground	Input	Power	-	0	-
10	USIM_DATA	-	SIM IO pin	Input	Low	-0.3 (3V SIM) -0.3 (1.8V SIM)	-	1.05 (3V SIM) 0.63 (1.8V SIM)
					High	1.95 (3V SIM) 1.17 (1.8V SIM)	3.0 (3V SIM) 1.8 (1.8V SIM)	3.3 (3V SIM) 2.1 (1.8V SIM)
				Output	Low	0	-	0.45
					High	2.55 (3V SIM) 1.35 (1.8V SIM)	-	3.0 (3V SIM) 1.8 (1.8V SIM)
11	NC	-	No connect	-	-	-	-	-
12	USIM_CLK	-	SIM Clock	Output	Low	0	-	0.45
					High	2.55 (3V SIM) 1.35 (1.8V SIM)	-	3.0 (3V SIM) 1.8 (1.8V SIM)
13	NC	-	No connect	-	-	-	-	-

Table 4-1: Connector pin assignments<sup>1,2</sup> (Continued)

Pin	Signal name	Pin type <sup>3</sup>	Description	Direction to module	Active state	Voltage levels (V)		
						Min	Typ	Max
14	USIM_RST	-	SIM Reset	Output	Low	0	-	0.45
					High	2.55 (3V SIM) 1.35 (1.8V SIM)	-	3.0 (3V SIM) 1.8 (1.8V SIM)
15	GND	V	Ground	Input	Power	-	0	-
16	NC	-	No connect	-	-	-	-	-
17	NC	-	No connect	-	-	-	-	-
18	GND	V	Ground	Input	Power	-	0	-
19	NC	-	No connect	-	-	-	-	-
20	W_DISABLE_N	-	Wireless Disable (main RF radio)	Input	Low	-	-	0.4
21	GND	V	Ground	Input	Power	-	0	-
22	NC	-	No connect	-	-	-	-	-
23	NC	-	No connect	-	-	-	-	-
24	VCC	V	3.3 V supply	Input	Power	3.0	3.3	3.6
25	NC	-	No connect	-	-	-	-	-
26	GND	V	Ground	Input	Power	-	0	-
27	GND	V	Ground	Input	Power	-	0	-
28	NC	-	No connect	-	-	-	-	-
29	GND	V	Ground	Input	Power	-	0	-
30	NC	-	No connect	-	-	-	-	-
31	NC	-	No connect	-	-	-	-	-
32	NC	-	No connect	-	-	-	-	-
33	NC	-	No connect	-	-	-	-	-
34	GND	V	Ground	Input	Power	-	0	-
35	GND	V	Ground	Input	Power	-	0	-
36	USB_D-	-	USB data negative	Input/Output	Differential	-	-	-
37	GND	V	Ground	Input	Power	-	0	-
38	USB_D+	-	USB data positive	Input/Output	Differential	-	-	-
39	VCC	V	3.3 V supply	Input	Power	3.0	3.3	3.6
40	GND	V	Ground	Input	Power	-	0	-
41	VCC	V	3.3 V supply	Input	Power	3.0	3.3	3.6
42	WLAN_LED_N	-	LED Driver	Output	Low	0	-	0.45

**Table 4-1: Connector pin assignments<sup>1,2</sup> (Continued)**

Pin	Signal name	Pin type <sup>3</sup>	Description	Direction to module	Active state	Voltage levels (V)		
						Min	Typ	Max
43	GND	V	Ground	Input	Power	-	0	-
44	GPIO3	-	General purpose I/O	Input high	-	1.17	1.80	2.10
				Input low	-	-0.3	-	0.63
				Output high	-	1.35	-	1.80
				Output low	-	0	-	0.45
45	NC	-	No connect	-	-	-	-	-
46	GPIO4	-	General purpose I/O	Input high	-	1.17	1.80	2.10
				Input low	-	-0.3	-	0.63
				Output high	-	1.35	-	1.80
				Output low	-	0	-	0.45
47	NC	-	No connect	-	-	-	-	-
48	NC	-	No connect	-	-	-	-	-
49	NC	-	No connect	-	-	-	-	-
50	GND	V	Ground	Input	Power	-	0	-
51	GPS_EN_N <sup>4</sup>	-	Wireless disable (GPS radio)	Input	Low	-	-	0.7
52	VCC	V	3.3 V supply	Input	Power	3.0	3.3	3.6

1. The host should leave all 'NC' ('no connect) pins unconnected.
2. Pinout refers to HW ver 2.0 or higher. For HW ver 1.0, refer to revision 4 of this document.
3. A—Analog; I—Input; NP—No pull; O—Digital output; PU—Digital input (internal pull up); PD—Digital output (internal pull down); V—Power or ground
4. Support for this signal is firmware dependent. Contact your Sierra Wireless account representative to determine specific availability.

## Power supply

The host provides power to the MC7750 through multiple power and ground pins as summarized in [Table 4-2](#).

The host must provide safe and continuous power at all times; the module does not have an independent power supply, or protection circuits to guard against electrical issues.

**Table 4-2: Power and ground specifications**

Name	Pins	Specification	Min	Typ	Max	Units
VCC	2, 24, 39, 41, 52	Voltage range	See <a href="#">Table 4-1 on page 26</a> .			
		Ripple voltage	-	-	100	mV <sub>pp</sub>
GND	4, 9, 15, 18, 21, 26, 27, 29, 34, 35, 37, 40, 43, 50	-	-	0	-	V

## USB interface

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

The interface complies with the *[12] Universal Serial Bus Specification, Rev 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 4-3: USB interface**

Name	Pin	Description
USB_D-	36	USB data negative
USB_D+	38	USB data 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/ttyUSB $n$  devices for Linux systems with the Sierra Wireless driver installed
- USB-compliant transceivers
- Selective suspend mode
- Resumption initiated by host or module

## 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. Sierra Wireless does not recommend using this device in USB full speed mode.

## User-developed drivers

If you will be developing your own USB drivers, see *[5] AirCard/AirPrime USB Driver Developer's Guide (Doc# 2130634)*.

## SIM interface

The module supports one SIM (Subscriber Identity Module) (1.8 V or 3 V). The SIM holds account information, allowing users to use their account on multiple devices.

The [SIM](#) pins ([Table 4-4](#)) provide the connections necessary to interface to a SIM socket located on the host device as shown in [Figure 4-3 on page 31](#). Voltage levels over this interface comply with 3GPP standards.

**Table 4-4: SIM interface signal**

Name	Pin	Description	SIM contact number <sup>1</sup>	Notes
USIM_PWR	8	SIM voltage	1	Power supply for SIM
USIM_DATA	10	Data I/O	7	Bi-directional SIM data line
USIM_CLK	12	Serial clock	3	Serial clock for SIM data
USIM_RST	14	Reset	2	Active low SIM reset
USIM_GND		Ground	5	Ground reference USIM_GND is common to module ground

1. See [Figure 4-4 on page 31](#) for SIM card contacts.

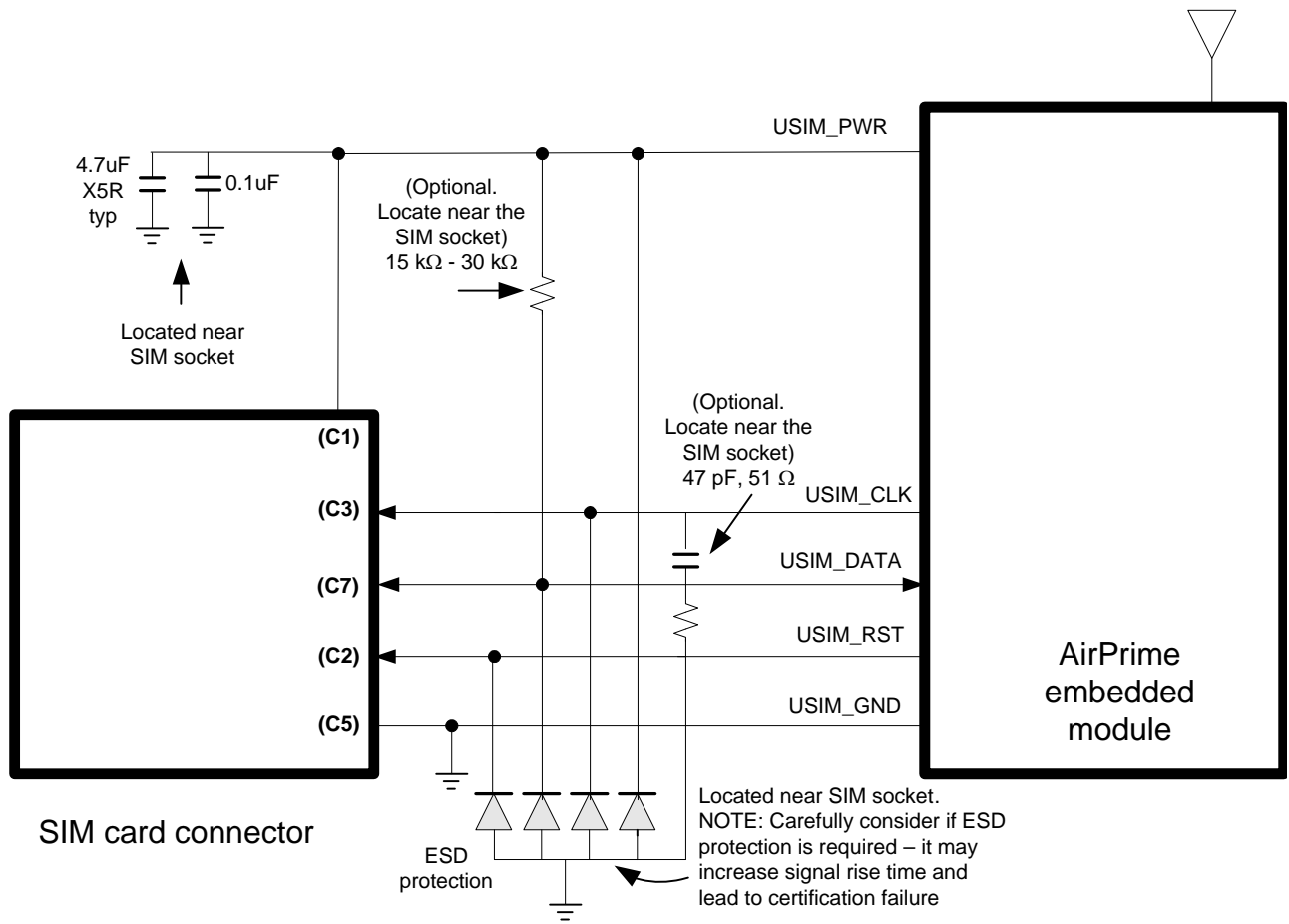


Figure 4-3: SIM application interface

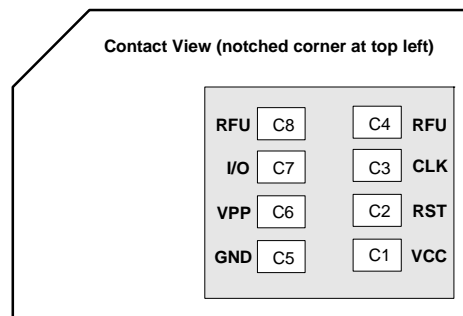


Figure 4-4: SIM card contacts (contact view)

## SIM implementation

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*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.*

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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  $\leq 10$  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 k $\Omega$ –30 k $\Omega$ ), 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 capacitor and resistor termination (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  $\Omega$  resistor are recommended.
- Test your first prototype host hardware with a Comprion IT<sup>3</sup> SIM test device at a suitable testing facility.



## Control interface (Signals)

The MC7750 provides signals for:

- Power control of the module from the host
- LED driver output

These signals are summarized in [Table 4-5](#) and paragraphs that follow.

**Table 4-5: Module control signals**

Name	Pin	Description	Type <sup>1</sup>
WAKE_N <sup>2</sup>	1	Wake host	O
W_DISABLE_N	20	Wireless disable (Main RF)	PU
WLAN_LED_N	42	LED driver	O
GPS_EN_N <sup>2</sup>	51	Wireless disable (GPS)	PU

1. O—Digital pin Output; PU—Digital pin Input, internal pull up
2. Support for this signal is firmware dependent. Contact your Sierra Wireless account representative to determine specific availability.

### WAKE\_N — Wake host

The module uses WAKE\_N to wake the host when specific events occur. (Support for this signal is firmware dependent. Contact your Sierra Wireless account representative to determine specific availability.)

The host must provide a 5 k $\Omega$ –100 k $\Omega$  pullup resistor that considers total line capacitance (including parasitic capacitance) such that when WAKE\_N is deasserted, the line will rise to 3.3 V in < 100 ns.

See [Figure 4-5 on page 33](#) for a recommended implementation.

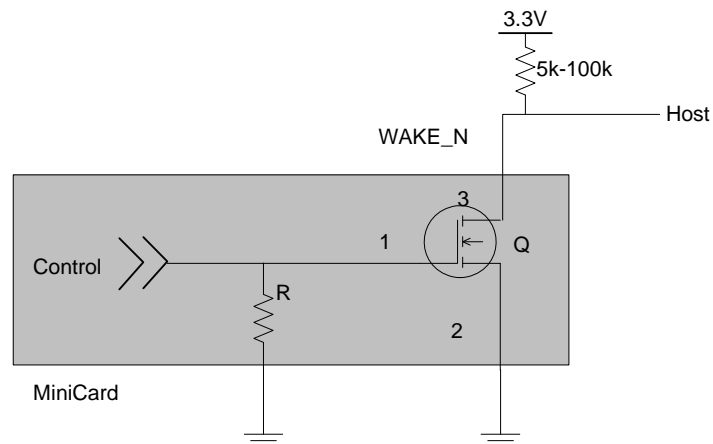


Figure 4-5: Recommended WAKE\_N connection

## W\_DISABLE\_N and GPS\_EN\_N — Wireless disable

The host device uses:

- W\_DISABLE\_N (pin 20) to enable/disable the WWAN or radio modem. When disabled, the modem cannot transmit or receive information.
- GPS\_EN\_N (pin 51) to enable/disable GPS functionality on the device. (Support for this signal is firmware dependent. Contact your Sierra Wireless account representative to determine specific availability.)

Letting these signals float high allows the module to operate normally. These switches follow the behavior described in [11] *PCI Express Mini Card Electromechanical Specification Revision 1.2*. These pins have 20 kΩ pull-up resistors. See [Figure 4-6 on page 34](#) for a recommended implementation.

When integrating with your host device, keep the following in mind:

- The signal is an input to the module and should be driven LOW only for its active state (controlling the power state); otherwise it should be floating or (High impedance). It should never be driven to a logic high level. The module has an internal pull-up resistor to Module Power (3.3V) in place, so if the signal is floating or (high impedance), the module will power on.
- Wait for two seconds after asserting W\_DISABLE\_N before disconnecting power.
- If the host never needs to assert this power state control to the module, leave this signal unconnected from the host interface.

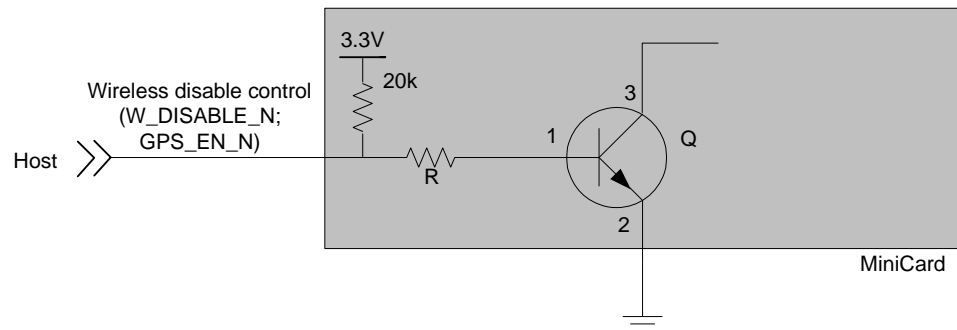


Figure 4-6: Recommended wireless disable connection

## WLAN\_LED\_N—LED output

The module drives the LED output according to [11] *PCI Express Mini Card Electromechanical Specification Revision 1.2*, as described in [Table 4-6](#) (below).

If desired, LED behavior can be configured using AT!LEDCTRL.

**Table 4-6: LED states (Default behavior)**

State	LED behavior			Description	!LEDCTRL index
	Period (s)	On	Off		
Off	0	0%	100%	Module is not powered. (W_DISABLE_N asserted with PCOFFEN=1)	N/A
Airplane mode	2	50%	50%	Module is in low power mode. (W_DISABLE_N asserted with PCOFFEN=0)	4
Power up	5.2	96%	4%	Module is performing initial power up activities.	N/A
Searching		96%	4%	Module is searching service.	1
Connected	0.5	80%	20%	Module has an active context.	3
Connected, with data transfer occurring	0.5	80%	20%	Module has an active context and data is being transferred.	5
Error	1.6	20%	80%	Device error has occurred.	N/A
Attached	1	100%	0%	Module has attached to a network and is not currently in a call.	2

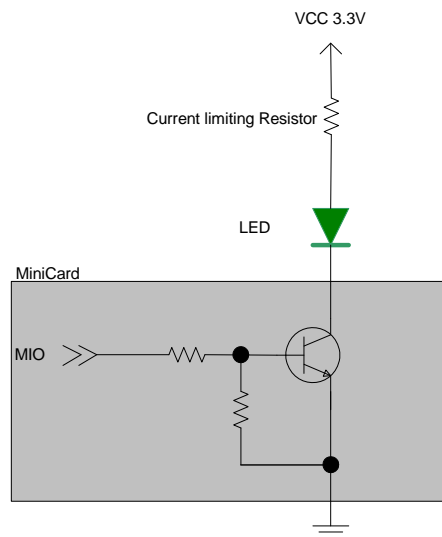


Figure 4-7: Example LED

## Digital interface

The MC7750 Mini Card provides the general purpose digital I/O (GPIO) signals listed in [Table 4-7](#):

- By default, all GPIO pins are set as inputs.
- Voltage should not be applied until > 1s after VCC is applied to the minicard.
- GPIO pins are available for OEM-defined purposes but may, in future firmware releases, be allocated by Sierra Wireless for specific functionality.
- For applications not requiring GPIO functionality, leave these pins not connected on the host.

**Table 4-7: GPIO signals**

Name	Pin	Description	Type <sup>1,2</sup>
GPIO1	3	General purpose IO	PU
GPIO2	5	General purpose IO	PU
GPIO3	44	General purpose IO	PU
GPIO4	46	General purpose IO	PU

1. GPIO pins are initialized as PU by the firmware.
2. PU—Digital pin Input, internal pull up

## 5: RF Specifications

The MC7750 includes three RF connectors for use with host-supplied antennas:

- Main RF connector—Rx/Tx path
- GPS connector 1—Standalone GPS
- Diversity/MIMO/GPS connector 2—Diversity, MIMO, or GPS

The module does not have integrated antennas.

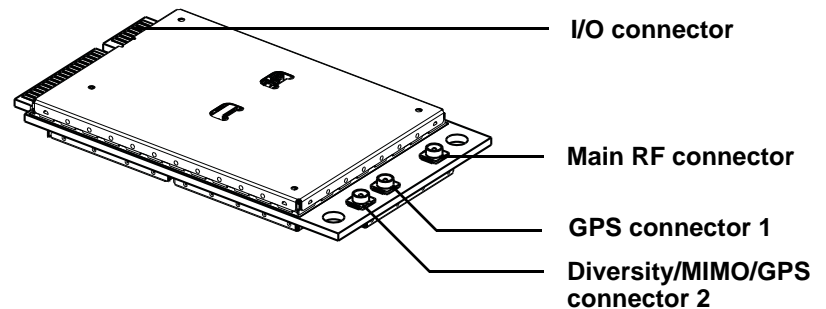


Figure 5-1: Module connectors

### 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 5-1 on page 37](#).
- Match coaxial connections between the module and the antenna to 50  $\Omega$ .
- Minimize RF cable losses to the antenna; the recommended maximum cable loss for antenna cabling is 0.5 dB.
- To ensure best thermal performance, if possible use the mounting holes to attach (ground) the device to the main PCB ground or a metal chassis.

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*Note: To **disconnect** the antenna, make sure you use the Hirose U.FL connector removal tool (P/N UFL-LP-N-2(01)) to prevent damage to the module or coaxial cable assembly.*

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

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### Shielding

The module is fully shielded to protect against EMI and must not be removed.

## Antenna and cabling

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

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*Note: For detailed electrical performance criteria, see [Appendix A: Antenna Specification](#) on page 65.*

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### Choosing the correct antenna and cabling

When matching antennas and cabling:

- The antenna (and associated circuitry) should have a nominal impedance of 50  $\Omega$  with a 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.

### 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 both CDMA and UMTS modules will be installed in the same platform, you may want to develop separate antennas for maximum performance.

### 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 or spurious noise can degrade the module's performance.
- Connecting cables between the module and the antenna must have 50  $\Omega$  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 39](#).

### Disabling the diversity antenna

- For LTE bands, use the AT command **!RXDEN=0** to disable receive diversity or **!RXDEN=1** to enable receive diversity.
- For CDMA bands, use the AT command **!DIVERSITY** to enable or disable receive diversity.

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

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## 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 (shown in [Figure 5-1 on page 37](#)).
- 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.

## 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 mitigation techniques ([Methods to mitigate decreased Rx performance on page 40](#)) and radiated sensitivity measurement ([Radiated sensitivity measurement on page 41](#)).

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*Note: The MC7750 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.*

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## 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.

## 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

## Device-generated RF interference

The module can cause interference with other devices. Wireless devices such as AirPrime 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.

## 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. The drawback is that the module may be less convenient to use.
- Shield the host device. The module itself is well shielded to avoid external interference. However, the antenna cannot be shielded for obvious reasons. 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.

## Radiated Spurious Emissions (RSE)

When designing an antenna for use with AirPrime embedded modules, the host device with an AirPrime embedded module must satisfy the radiated spurious emission (RSE) test cases described in:

- (CDMA) Refer to CDMA standards for receive-only mode, and local regulatory bodies for transmit mode (transmitter is operating).



Note that antenna impedance affects radiated emissions, which must be compared against the conducted 50-ohm emissions baseline. (AirPrime embedded modules meet the 50-ohm conducted emissions requirement.)

## 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 Sierra Wireless or you can use your own OTA test chamber for in-house testing.

## Sierra Wireless' sensitivity testing and desensitization investigation

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

As part of the Engineering Services package, Sierra Wireless 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 4](#)).

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

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## Sensitivity vs. frequency

For CDMA bands, sensitivity is defined as the input power level in dBm that produces a FER (Frame Error Rate) of 0.5%. Sensitivity should be measured at all CDMA frequencies across each band.

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

## Supported frequencies

The MC7750 supports:

- Single-band LTE—See [Table 5-1 on page 42](#).
- Dual-band CDMA—See [Table 5-3 on page 42](#).
- GPS
- Radio transceiver requirements for 3GPP Release 7

- Inter-RAT and inter-frequency cell reselection and handover between supported frequency bands

**Table 5-1: LTE frequency band support**

Band	Frequencies
Band 13	Tx: 777–787 MHz Rx: 746–756 MHz

**Table 5-2: LTE bandwidth support<sup>1</sup>**

Band	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
Band 13	✗	✗	✓ <sup>2</sup>	✓ <sup>2</sup>	✗	✗

1. Table contents are derived from 3GPP TS 36.521-1 v9.4.1, table 5.4.2.1-1.
2. Bandwidth for which a relaxation of the specified UE receiver sensitivity requirement (Clause 7.3 of 3GPP TS 36.521-1 v9.4.1) is allowed.

**Table 5-3: CDMA frequency band support**

Band	Frequencies
PCS	Tx: 1850–1910 MHz Rx: 1930–1990 MHz
Cellular	Tx: 824–849 MHz Rx: 869–894 MHz

## Conducted Rx sensitivity / Tx power

**Table 5-4: Conducted Rx (Receive) sensitivity — LTE bands**

LTE bands		Conducted Rx sensitivity (dBm)			
		Primary (Typical)	Secondary (Typical)	SIMO (Typical)	SIMO <sup>1</sup> (Worst case)
LTE Band 13	Full RB BW: 10 MHz <sup>2</sup>	-97.0 <sup>3</sup>	-96.5 <sup>3</sup>	-100.0 <sup>3</sup>	-93.3

1. Per 3GPP specification
2. Sensitivity values scale with bandwidth:  
 $x\_MHz\_Sensitivity = 10\_MHz\_Sensitivity - 10 \cdot \log(10\text{ MHz}/x\_MHz)$
3. Verizon Test Method

**Table 5-5: Conducted Rx (Receive) sensitivity — CDMA bands**

CDMA bands		Conducted Rx sensitivity (dBm)	
		Typical	Worst case
Cellular (800 MHz)	CDMA 1x 0.5% FER	-108.0	-104.0
	EVDO rev A 0.5% PER	-110.0	-105.5

**Table 5-5: Conducted Rx (Receive) sensitivity — CDMA bands**

CDMA bands		Conducted Rx sensitivity (dBm)	
		Typical	Worst case
PCS (1900 MHz)	CDMA 1x 0.5% FER	-107.5	-104.0
	EVDO rev A 0.5% PER	-109.5	-105.5

**Table 5-6: Conducted Tx (Transmit) power tolerances**

Parameter	Conducted transmit power (dBm) <sup>1</sup>	Notes
<b>LTE</b>		
LTE, Band 13	+23 dBm ± 1dB	
<b>CDMA</b>		
CDMA Band Class 0 (Cellular)	+24 dBm ± 1dB	
CDMA Band Class 1 (PCS)	+23.5 dBm ± 1dB (channel 1175)	
	+24 dBm ± 1dB (other channels)	

1. Preliminary values

## GPS specifications

Note: For detailed electrical performance criteria, see [Recommended GPS antenna specifications on page 67](#).

**Table 5-7: GPS specifications <sup>1</sup>**

Parameter/feature	Description
Satellite channels	12 channel, continuous tracking
Protocols	NMEA 0183 V3.0
Acquisition time	Hot start: 1 s Warm start: 29 s Cold start: 32 s
Accuracy	Horizontal: < 2 m (50%); < 5 m (90%) Altitude: < 4 m (50%); < 8 m (90%) Velocity: < 0.2 m/s

**Table 5-7: GPS specifications (Continued)<sup>1</sup>**

Parameter/feature	Description
Sensitivity	Tracking <sup>2</sup> : -161 dBm Acquisition <sup>3</sup> (Assisted, non-LTE): -158 dBm Acquisition (Assisted, LTE): -153 dBm Acquisition (Standalone): -145 dBm
Operational limits	Altitude <6000 m or velocity <100 m/s (Either limit may be exceeded, but not both.)

1. All values are preliminary.
2. Tracking sensitivity is the lowest GPS signal level for which the device can still detect an in-view satellite 98% of the time when in sequential tracking mode.
3. Acquisition sensitivity is the lowest GPS signal level for which the device can still detect an in-view satellite 50% of the time.

## Power consumption

*Note: All specifications in these tables are preliminary, based on chipset published expectations.*

Power consumption measurements in the tables below are for the MC7750 Mini Card module 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 29](#).

**Table 6-1: Averaged standby DC power consumption<sup>1</sup>**

Signal	Description	Bands <sup>2</sup>	Current <sup>3</sup>			Notes / configuration	
			Typ	Max <sup>4</sup>	Unit		
VCC	<b>Standby current consumption (Sleep mode activated<sup>5</sup>)</b>						
	LTE	LTE Bands	3.2	7	mA	DRX cycle = 8 (2.56 s)	
	CDMA EVDO	CDMA bands	6	9.5	mA		
	<b>Standby current consumption (Sleep mode deactivated<sup>5</sup>)</b>						
	LTE	LTE bands	55	65	mA		
	CDMA EVDO	CDMA bands	58	65	mA		
	<b>Low Power Mode (LPM)/Offline Mode (Sleep mode activated<sup>5</sup>)</b>						
	RF disabled, but module is operational			2.5	3.0	mA	
	<b>Low Power Mode (LPM)/Offline Mode (Sleep mode deactivated<sup>5</sup>)</b>						
	RF disabled, but module is operational			45	50	mA	

1. 3.3V supply voltage
2. For supported bands, see [Table 5-1, LTE frequency band support](#), on page 42 and [Table 5-3, CDMA frequency band support](#), on page 42.
3. All measurements are preliminary.
4. Measured at 30°C/nominal voltage.
5. Assumes USB bus is fully suspended during measurements

**Table 6-2: CDMA DC power consumption (+3.3V)**

Description	Bands	Typ	Max	Units	Notes / configuration
IS-2000 1X Data current	PCS	366	-	mA	SO32, RC3 (Fwd) / RC3 (Rvs), 153.6 kbps (Fwd) / 76.8 kbps (Rvs), CDG Urban Profile, USB active
		423	-	mA	SO32, RC3 (Fwd) / RC3 (Rvs), 153.6 kbps (Fwd) / 76.8 kbps (Rvs), CDG Suburban Profile, USB active
	Cellular	327	-	mA	SO32, RC3 (Fwd) / RC3 (Rvs), 153.6 kbps (Fwd) / 76.8 kbps (Rvs), CDG Urban Profile, USB active
		370	-	mA	SO32, RC3 (Fwd) / RC3 (Rvs), 153.6 kbps (Fwd) / 76.8 kbps (Rvs), CDG Suburban Profile, USB active
IS-856 1xEV-DO Revision 0 Data current	PCS	404	-	mA	CDG Urban Profile, USB active
		475	-	mA	CDG Suburban Profile, USB active
	Cellular	324	-	mA	CDG Urban Profile, USB active
		377	-	mA	CDG Suburban Profile, USB active
IS-856A 1xEV-DO Revision A Data current	PCS	408	-	mA	CDG Urban Profile, USB active
		479	-	mA	CDG Suburban Profile, USB active
	Cellular	331	-	mA	CDG Urban Profile, USB active
		386	-	mA	CDG Suburban Profile, USB active
Maximum peak current – operational	PCS or Cellular		1.2	A	Max RF output power, full rate, full operating temperature range.
Maximum peak current – call connected			1.0	A	Max RF output power, full rate, full operating temperature range

**Table 6-3: Averaged call mode DC power consumption (LTE)<sup>1</sup>**

Signal	Description	Band <sup>2</sup>	Current		Notes / configuration
			Max <sup>3</sup>	Unit	
VCC	<b>Data current consumption</b> (includes USB bus current)				
	LTE category 3	LTE bands	550	mA	100/50 Mbps—0 dBm Tx power

1. All measurements are preliminary values
2. For supported bands, see [Table 5-1, LTE frequency band support](#), on page 42 and [Table 5-3, CDMA frequency band support](#), on page 42.
3. Measured at 30°C/nominal voltage.

Table 6-4: Miscellaneous DC power consumption<sup>1</sup>

Signal	Description	Current		Unit	Notes / configuration
		Typ	Max		
VCC	Module OFF leakage current	490	830	μA	Full operating temperature range
	USB active current	18	25	mA	High speed USB connection, C <sub>L</sub> = 50 pF on D+ and D- signals
	Inrush current	750	3000	mA	<ul style="list-style-type: none"> <li>Assumes power supply turn on time &gt; 100μs</li> <li>Dependent on host power supply rise time.</li> </ul>
GPS signal connector	Active bias on GPS port		3.3 (100 mA)	V	GPS connector 1 in <a href="#">Figure 5-1 on page 37</a> .

1. All measurements are preliminary values

## Module power states

The module has five power states, as described in [Table 6-5](#).

Table 6-5: Module power states

State	Details	Host is powered	Module is powered	USB interface active	RF enabled
<b>Normal (Default state)</b>	<ul style="list-style-type: none"> <li>Module is active</li> <li>Default state when VCC is first applied in the absence of W_DISABLE_N control</li> <li>Module is capable of placing/receiving calls, or establishing data connections on the wireless network</li> <li>Current consumption is affected by several factors, including: <ul style="list-style-type: none"> <li>Radio band being used</li> <li>Transmit power</li> <li>Receive gain settings</li> <li>Data rate</li> <li>Number of active Tx time slots</li> </ul> </li> </ul>	✓	✓	✓	✓
<b>Low power ('Airplane mode')</b>	<ul style="list-style-type: none"> <li>Module is active</li> <li>State is controlled by host interface using software commands: <ul style="list-style-type: none"> <li>+CFUN=0 ([1] AT Command Set for User Equipment (UE) (Release 6) (Doc# 3GPP TS 27.007))</li> </ul> </li> </ul>	✓	✓	✓	✗
<b>Sleep</b>	<ul style="list-style-type: none"> <li>Normal state of module between calls or data connections</li> <li>Module cycles between wake (polling the network) and sleep, at network provider-determined interval.</li> </ul>	✓	✓	✗	✗

**Table 6-5: Module power states (Continued)**

State	Details	Host is powered	Module is powered	USB interface active	RF enabled
Off	<ul style="list-style-type: none"> <li>Host keeps module powered off by driving W_DISABLE_N low</li> <li>Module draws minimal current</li> <li>See <a href="#">W_DISABLE_N and GPS_EN_N — Wireless disable on page 34</a> for more information.]</li> </ul>	✓	✗	✗	✗
Disconnected	<ul style="list-style-type: none"> <li>Host power source is disconnected from the module and all voltages associated with the module are at 0 V.</li> </ul>	✗	✗	✗	✗

## Power state transitions

The module uses state machines to monitor supply voltage and operating temperature, and notifies the host when critical threshold limits are exceeded. (See [Table 6-6](#) for trigger details and [Figure 6-1](#) for state machine behavior.)

Power state transitions may occur:

- Automatically, when critical supply voltage or module temperature trigger levels are encountered.
- Under host control, using available AT commands in response to user choices (for example, opting to switch to airplane mode) or operating conditions.

**Table 6-6: Power state transitions (including voltage/temperature trigger levels)**

Transition	Voltage		Temperature <sup>1</sup>		Notes
	Trigger	v <sup>2</sup>	Trigger	°C	
Normal to Low Power	VOLT_HI_CRIT	3.6	TEMP_LO_CRIT	-25	• RF activity suspended
	VOLT_LO_CRIT	2.9	TEMP_HI_CRIT	95	
Low Power to Normal	VOLT_HI_NORM	3.5	TEMP_NORM_LO	-15	• RF activity resumed
Low Power to Normal or Remain in Normal (Remove warnings)	VOLT_LO_NORM	3.1	TEMP_HI_NORM	80	
Normal (Issue warning)	VOLT_LO_WARN	3.0	TEMP_HI_WARN	85	
Power off/on (Host-initiated)	-	-	-	-	• Power off recommended when supply voltage or module operating temperature is critically low or high.

1. Module-reported temperatures at the printed circuit board.  
 2. Supply voltage—3.3V



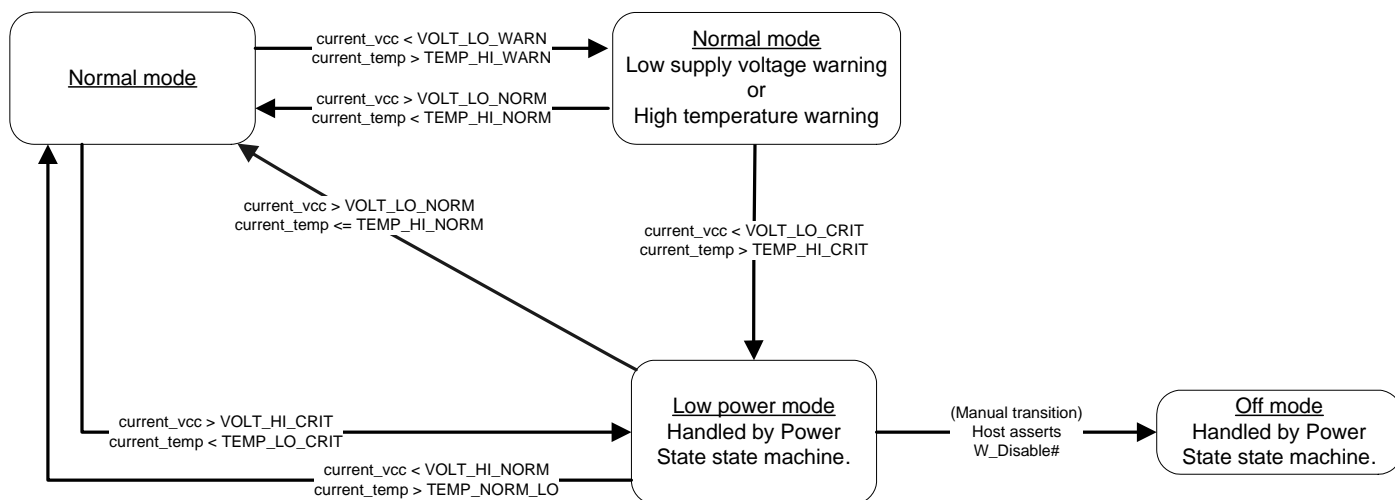


Figure 6-1: Voltage/temperature monitoring state machines

## Power interface

### Power ramp-up

On initial power up, inrush current depends on the power supply rise time—turn on time >100 μs is required for < 3A inrush current.

The supply voltage must remain within specified tolerances while this is occurring.

### Power-up timing

The unit is ready to enumerate with a USB host within a maximum of 3–5 seconds after power-up. Figure 6-2 on page 49 illustrates the power-up timing sequence.

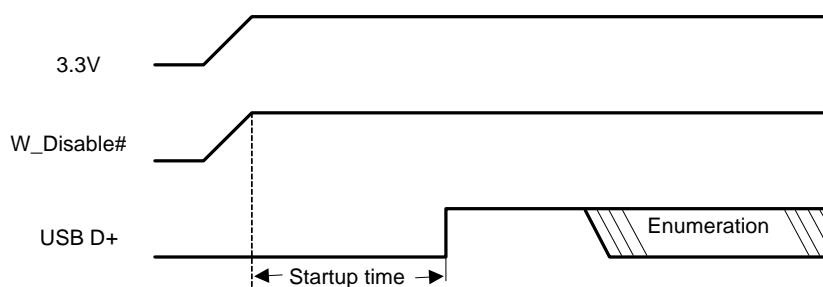


Figure 6-2: Power-up timing diagram

*Note: Startup time is the time after power-up when the modem is ready to begin the enumeration sequence.*

## Power supply noise

Noise in the power supply can lead to noise in the RF signal.

The power supply ripple limit for the module is no more than 200 mVp-p 1 Hz to 100 kHz. This limit includes voltage ripple due to transmitter burst activity.

Additional decoupling capacitors can be added to the main VCC line to filter noise into the device.

## SED (Smart Error Detection)

The module uses a form of SED to track premature modem resets.

- Module tracks consecutive resets occurring soon after power-on.
- After a sixth consecutive reset, the module waits in boot-and-hold mode for a firmware download to resolve the power-cycle problem.

## 7: Software Interface

# 7

### Support tools

The MC7750 is compatible with the following support tools from Sierra Wireless and authorized third parties:

- Firmware update utilities from Sierra Wireless
- Sierra Wireless Product Support Tool (SW-PST)
- CDMA Air Interface Tool (CAIT) from QUALCOMM
- QXDM from QUALCOMM
- QUALCOMM Product Support Tool (QPST)

### USB interface

The device supports the Qualcomm QMI interface.

Please contact your Sierra Wireless account representative for QMI interface documentation.

### MTU size

The MTU (Maximum Transmission Unit) size is configured using a driver installer command line option:

MTUSize=<value> (<value> is the size in bytes)

Verizon Wireless requires the MTU size to be 1428 bytes.

Example:

```
driverinstaller /MTUSize=1428
```

### TCP window size (Windows XP)

The TCP window size for Windows XP is 128 kB (131072 bytes).



## 8: Mechanical and Environmental Specifications

The MC7750 module complies with the mechanical and environmental specifications in [Table 8-1](#). Final product conformance to these specifications depends on the [OEM](#) device implementation.

**Table 8-1: Mechanical and environmental specifications**

	Mode	Details
Temperature	Operational	-30°C to +60°C – Full <a href="#">RF</a> compliance
	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)
Vibration	Non-operational	Random vibration, 10 to 1000 Hz, nominal 6 G rms in each of three mutually perpendicular axes. Test duration of 60 minutes for each axis, for a total test time of three hours.
Shock	Non-operational	Half sine shock, 2 ms, 180 in/s (375 g). Tested in each of three mutually perpendicular axes, positive and negative (5 x 6, 30 bumps total).
Drop	Non-operational	1 m on concrete on each of six faces, two times (module only).
(Electrostatic discharge (See <a href="#">Electrostatic discharge (ESD)</a> on page 55.)	Operational	The RF port (antenna launch and RF connector) complies with the IEC 61000-4-2 standard: <ul style="list-style-type: none"> <li>Electrostatic Discharge Immunity: Test: Level3</li> <li>Contact Discharge: ±6 kV</li> <li>Air Discharge: ±8 kV</li> </ul>
	Non-operational	The host connector Interface complies with the following standards only: <ul style="list-style-type: none"> <li>+/- 1 kV Human Body Model (JESD22-A114-B)</li> <li>+/- 125 V Charged Device Model (JESD22-C101)</li> </ul>
Thermal considerations		See <a href="#">Thermal considerations</a> on page 56.
Form factor		PCI-Express Mini Card shielded with metal and metalized fabric
Dimensions		Length: 50.95 mm Width: 30 mm Thickness: 4.75 mm Weight: Approximately 10 g

## Device views

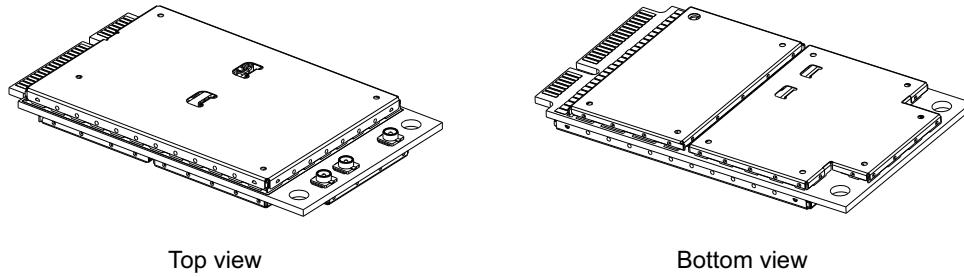


Figure 8-1: Top and bottom views

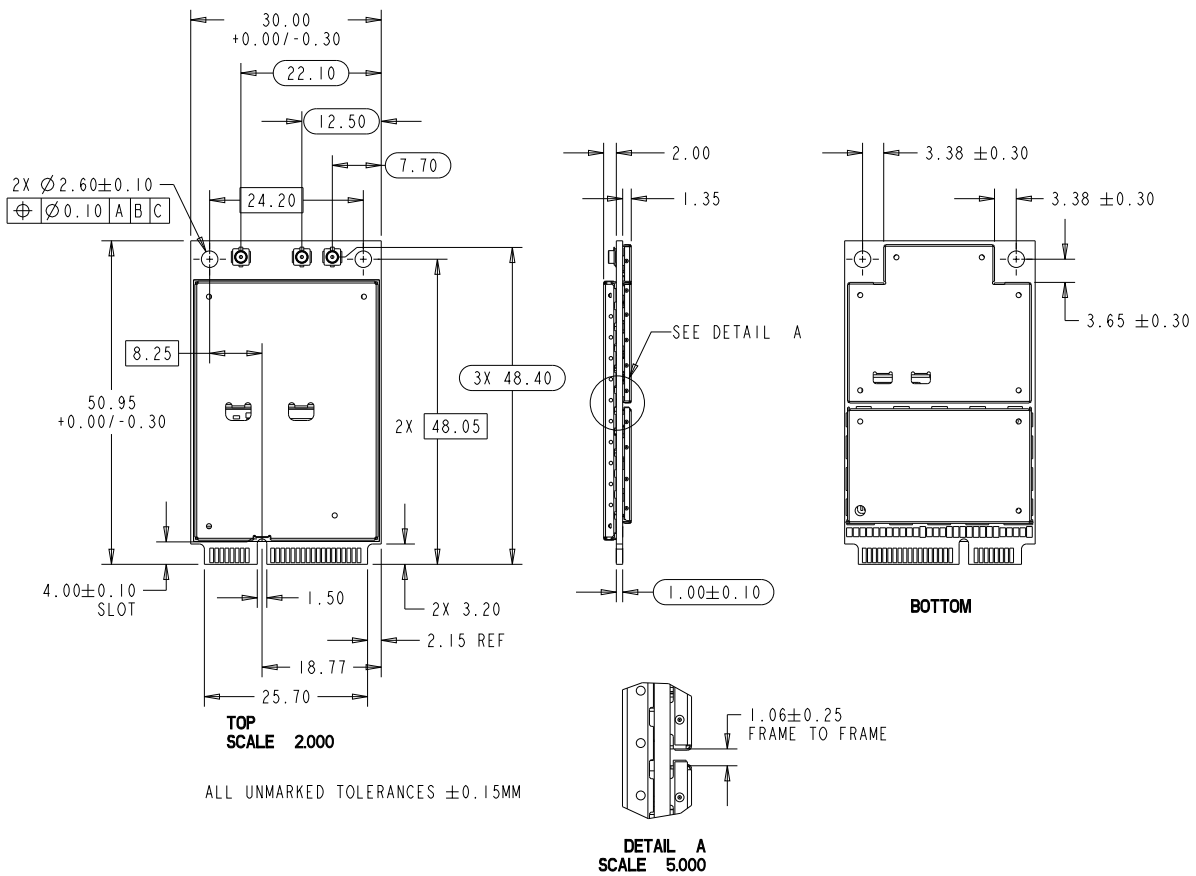


Figure 8-2: Dimensioned view

## Labeling



Figure 8-3: Unit label

Note: The displayed label is an example only. The production label will vary by [SKU](#).

The MC7750 label is non-removable and contains:

- Sierra Wireless logo and product name
- [IMEI](#) number in Code-128 barcode format
- [SKU](#) number (when required)
- Factory Serial Number ([FSN](#)) in alphanumeric format
- Manufacturing date code (incorporated into FSN)
- Licensed vendor logo
- Certification marks/details

Note: The MC7750 supports [OEM](#) partner-specific label requirements.

## Electrostatic discharge (ESD)

The OEM is responsible for ensuring that the Mini Card host interface pins are not exposed to ESD during handling or normal operation. (See [Table 8-1 on page 53](#) for specifications.)

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 device includes ESD protection on the antenna.)

## Thermal considerations

Embedded modules can generate significant amounts of heat that must be dissipated in the host device for safety and performance reasons.

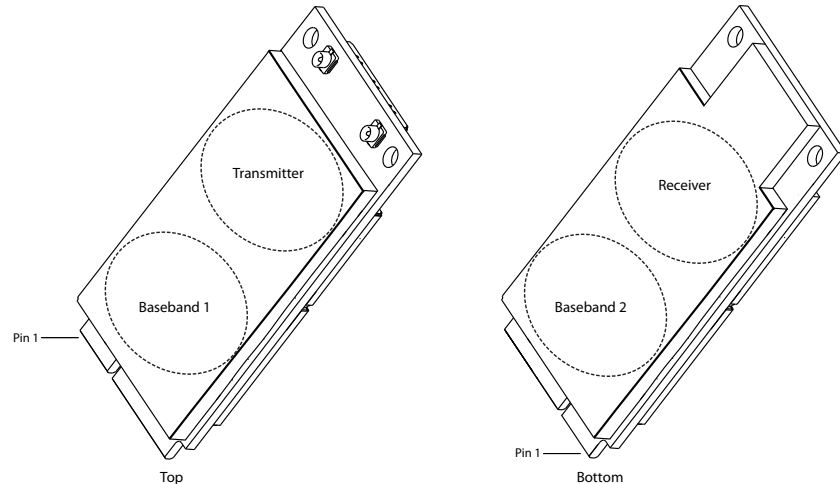


Figure 8-4: Shield locations

The amount of thermal dissipation required depends on:

- Supply voltage—See [Chapter 6: Power](#) on page 45 for details of max power dissipation for various operating modes.
- Usage—Typical power dissipation values depend on the location within the host, amount of data transferred, etc.

Specific areas requiring heat dissipation are shown in [Figure 8-4](#):

- Transmitter—Top face of module near RF connectors. Likely to be the hottest area.
- Baseband 1—Top face of module, below the transmitter.
- Receiver—Bottom face of module, behind the transmitter.
- Baseband 2—Bottom face of module, behind Baseband 1.

To enhance heat dissipation:

- Maximize airflow over/around the module.
- Locate the module away from other hot components.
- If possible, use the mounting holes to attach (ground) the device to the main PCB ground or a metal chassis.

---

*Note: Adequate dissipation of heat is necessary to ensure that the module functions properly, and to comply with the thermal requirements in [11] PCI Express Mini Card Electromechanical Specification Revision 1.2.*

---

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**Caution:** Thermal putty is not recommended—incorrect application of the material could require excessive pressure to be applied when seating the board, resulting in damage to the board.

---



## 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 temperature at all shield locations. Attach thermocouples to the areas indicated in [Figure 8-4 on page 56](#) (Transmitter, Baseband 1, Receiver, Baseband 2).

---

*Note: Make sure that your system design provides sufficient cooling for the module. RF shield temperature should be kept below 90°C when integrated to prevent damage to the module's components.*

---

(For acceptance, certification, quality, and production (including RF) test suggestions, see [Testing on page 71](#).)



## 9: Regulatory and Industry Approvals

This module is designed to and, upon commercial release, will be certified to meet carrier requirements (e.g. Verizon Wireless).

Upon commercial release, the following regulatory approvals will have been attained:

- [FCC](#)
- IC (Industry Canada)

Upon commercial release, the following industry approvals will have been obtained:

- GCF-CC (may be obtained upon customer request)

Additional approvals may be obtained upon customer request—contact your Sierra Wireless account representative for details.

Additional testing and certification may be required for the end product with an embedded MC7750 modem and are the responsibility of the [OEM](#). Sierra Wireless offers professional services-based assistance to OEMs with the testing and certification process, if required.

### Important notice

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

### Safety and hazards

Do not operate your MC7750 modem:

- In areas where blasting is in progress
- Where explosive atmospheres may be present including refuelling points, fuel depots, and chemical plants
- Near medical equipment, life support equipment, or any equipment which may be susceptible to any form of radio interference. In such areas, the MC7750 modem **MUST BE**

**POWERED OFF.** Otherwise, the MC7750 modem can transmit signals that could interfere with this equipment.

In an aircraft, the MC7750 modem **MUST BE POWERED OFF.** Otherwise, the MC7750 modem can transmit signals that could interfere with various onboard systems and may be dangerous to the operation of the aircraft or disrupt the cellular network. Use of a cellular phone in an aircraft is illegal in some jurisdictions. Failure to observe this instruction may lead to suspension or denial of cellular telephone services to the offender, or legal action or both.

Some airlines may permit the use of cellular phones while the aircraft is on the ground and the door is open. The MC7750 modem may be used normally at this time.

## Important compliance information for North American users

The MC7750 modem has been granted modular approval for mobile applications. Integrators may use the modem in their final products without additional FCC/IC (Industry Canada) certification if they meet the following conditions. Otherwise, additional FCC/IC approvals must be obtained.

- Although the MC7750 modem has been granted module approval, there are many conditions attached to this approval; final host integration will likely require additional testing. Detailed guidelines are described in [OEM device classification process on page 61](#) to assist OEM module integrators in determining the extent of additional testing necessary to comply with FCC requirements.
- The end product with an embedded MC7750 modem must be evaluated for simultaneous transmission requirements. See [Simultaneous transmission evaluation on page 62](#) for details.
- 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. See [OEM product instruction manual content on page 63](#) for details.
- To comply with FCC / IC 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:
  - Part 22 (Cellular): 7.3 dBi
  - Part 24 (PCS): 3 dBi
  - Part 27 (Band 13): 9 dBi
- A label must be affixed to the outside of the end product into which the MC7750 modem is incorporated, with a statement similar to the following:
  - **This device contains FCC ID: N7NMC7750**
  - **This equipment contains equipment certified under IC: 2417C-MC7750**

The end product with an embedded MC7750 modem 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.

## OEM integration

### Application of regulatory guidelines

Because ‘near-body’ devices (handhelds, laptops, tablets, scanners, etc.) vary widely in design features, physical configurations, and use-models, module integrators shall follow the guidelines below regarding device classification and simultaneous transmission, and seek guidance from their preferred regulatory test lab to determine how regulatory guidelines will impact the device compliance. Proactive management of the regulatory process will minimize unexpected schedule delays and costs due to unplanned testing activities.

### Device classifications

The OEM integrator must determine the minimum distance required between their device and the user’s body.

The FCC provides device classification definitions to assist in making the correct determination. Note that these classifications are guidelines only; strict adherence to a device classification may not satisfy the regulatory requirement as near-body device design details may vary widely.

FCC definitions:

Portable: (§2.1093)—A portable device is defined as a transmitting device designed to be used so that the radiating structure(s) of the device is/are within 20 centimeters of the body of the user.

Mobile: (§2.1091)(b)—A mobile device is defined as a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter’s radiating structure(s) and the body of the user or nearby persons.

Per §2.1091d(d)(4) In some cases (for example, modular or desktop transmitters), the potential conditions of use of a device may not allow easy classification of that device as either Mobile or Portable. In these cases, applicants are responsible for determining minimum distances for compliance for the intended use and installation of the device based on evaluation of either specific absorption rate (SAR), field strength, or power density, whichever is most appropriate.

### OEM device classification process

The primary factor in determining whether a device will be classified as a Portable product or as a Mobile product is antenna separation distance (body to radiating antenna element).

The review process between the OEM module integrator and the preferred regulatory test lab is a crucial step in determining the appropriate device classification, as it is impractical for Sierra Wireless to define all possible combinations of design features, antennas, physical configurations, and use-models.

1. Perform a device review with the preferred regulatory test lab to confirm device classification.
2. Determine the Certification type (Standalone or C2PC from an existing Modular Grant).
3. If the device classification is:
  - Portable: Preferred regulatory test lab to determine if a PBA or KDB is required.
  - Mobile: Preferred regulatory test lab to determine if a PBA is required.(Note: A PBA or KDB will likely be required for new technologies such as LTE or WiMAX.)
4. If the device classification is Mobile, confirm the antenna does not violate the Gain Limits specific to the module grant as specified in [Important compliance information for North American users on page 60](#).
5. Outline and execute a test plan with the preferred regulatory test lab. Testing is likely to include some or all of Parts 15, 22, 24, 27, and either SAR (for Portable devices) or MPE (for Mobile devices).
6. Follow product labeling requirements as described in [Important compliance information for North American users on page 60](#). (Ref §2.925)
7. Include the [OEM product instruction manual content on page 63](#) boilerplate text within the host product's instruction manual.

## Simultaneous transmission evaluation

The MC7750 modem has **not** been evaluated or approved for simultaneous transmission as the number of possible multi-transmission scenarios for this device is large. Any simultaneous transmission condition established through module integration into a customer-specific product **must** be evaluated per the requirements in KDB447498D01(8) and KDB616217D01,D03 (for laptop, notebook, netbook, and tablet applications).

These requirements include, but are not limited to:

- Transmitters and modules certified for mobile or portable exposure conditions can be incorporated in mobile host devices without further testing or certification when:
  - The closest separation among all simultaneous transmitting antennas is  $\geq 20$  cm,or
  - Antenna separation distance and MPE compliance requirements for All simultaneous transmitting antennas have been specified in the application filing of at least one of the certified transmitters within the host device. In addition, when transmitters certified for portable use are incorporated in a mobile host device, the antenna(s) must be  $\geq 5$  cm from all other simultaneous transmitting antennas.

- All antennas in the final product must be at least 20 cm from users and nearby persons.

## OEM product instruction manual content

Consistent with §2.909(a), the following text must be included within the user's manual or operator instruction guide for the final commercial product. (OEM-specific content is *displayed in italics*.)

### Operating Requirements and Conditions

The design of (*Product Name*) complies with U.S. Federal Communications Commission (FCC) guidelines respecting safety levels of radio frequency (RF) exposure for (*OEM to insert device classification: Mobile or Portable*) devices.

FCC ID: (*Include Standalone FCC ID or Module FCC ID as required*)

---

*Note: Include the following RF Exposure statement for Mobile devices only.*

---

RF Exposure - This device is only authorized for use in a mobile application. At least 20 cm (8 inches) of separation distance between the (*Product Name*) device and the user's body must be maintained at all times.

---

*Note: Include the following RF Exposure statement for Portable devices only.*

---

RF Exposure - This device has been tested for compliance with FCC RF exposure limits in a portable configuration. At least (*Insert Required Separation Distance from RF Exposure Evaluation*) cm of separation distance between the (*Product Name*) device and the user's body must be maintained at all times. This device must not be used with any other antenna or transmitter that has not been approved to operate in conjunction with this device.

---

*Note: Always include the following Caution statement.*

---

CAUTION: Any changes or modifications not expressly approved by (*Company Name*) or Sierra Wireless could void the user's authority to operate the equipment.

---

*Note: Include the following statement if Part 15 of the FCC Rules is required. Integration into host devices containing unlicensed devices may require additional comments in this section. The OEM should confirm the extent of their user's guide content with their preferred regulatory test lab.*

---

Note: This equipment has been tested and found to comply with the limits for a (*OEM to insert device type: Class A or Class B*) digital device, pursuant to Part 15 of the FCC Rules. (*OEM must follow Part 15 guidelines (§15.105 and §15.19) to determine additional statements required in this section for their device class*)





# »» A: Antenna Specification

This appendix describes recommended electrical performance criteria for main path, diversity path, and GPS antennas used with AirPrime embedded modules.

The performance specifications described in this section are valid while antennas are mounted in the host device with antenna feed cables routed in their final application configuration.

*Note: Antennas should be designed **before** the industrial design is finished to make sure that the best antennas can be developed.*

**Table A-1: Antenna requirements <sup>a</sup>**

Parameter	Requirements	Comments
<b>Antenna system</b>	External multi-band 2x2 MIMO antenna system (Ant1/Ant2) <sup>b</sup>	If Ant2 includes GPS, then it must also satisfy requirements in <a href="#">Table A-2 on page 67</a> .
<b>Operating bands of Ant1 and Ant2<sup>c</sup></b>	700–960 MHz	
	1710–1990 MHz	
	2110–2170 MHz	
	2500–2700 MHz	
<b>VSWR of Ant1 and Ant2</b>	1:1 (ideal) < 2.5:1 (recommended)	On all bands including band edges
<b>Total radiated efficiency of Ant1 and Ant2</b>	> 50% on all bands	<ul style="list-style-type: none"> <li>Measured at the RF connector.</li> <li>Includes mismatch losses, losses in the matching circuit, and antenna losses, excluding cable loss.</li> <li>Sierra Wireless 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 omni-directional gain patterns). Peak gain can be affected by antenna size, location, design type, etc.—the antenna gain patterns remain fixed unless one or more of these parameters change.</li> </ul>
<b>Radiation patterns of Ant1 and Ant2</b>	Nominally Omni-directional radiation pattern in azimuth plane.	

**Table A-1: Antenna requirements (Continued)<sup>a</sup>**

Parameter	Requirements	Comments
<b>Envelope correlation coefficient between Ant1 and Ant2</b>	< 0.4 on 730–960 MHz band	
	< 0.3 on 1800–1990 MHz and 2110–2170 MHz bands	
	< 0.2 on 2600–2700 MHz band	
<b>Mean Effective Gain of Ant1 and Ant2 (MEG1, MEG2)</b>	≥ -3 dBi	
<b>Ant1 and Ant2 Mean Effective Gain Imbalance I MEG1 / MEG2 I</b>	< 2 dB for MIMO operation < 6 dB for diversity operation	
<b>Maximum antenna gain</b>	Must not exceed antenna gains due to RF exposure and ERP/EIRP limits, as listed in the module's FCC grant.	See <a href="#">Important compliance information for North American users on page 60</a> .
<b>Isolation between Ant1 and Ant2 (S21)</b>	> 10 dB	<ul style="list-style-type: none"> <li>If antennas can be moved, test all positions for both antennas.</li> <li>Make sure all other wireless devices (Bluetooth or WLAN antennas, etc.) are turned OFF to avoid interference.</li> </ul>
<b>Power handling</b>	<ul style="list-style-type: none"> <li>&gt; 2 W RF power on low bands</li> <li>&gt; 1 W on high bands</li> </ul>	<ul style="list-style-type: none"> <li>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).</li> <li>Visually inspect device to ensure there is no damage to the antenna structure and matching components.</li> <li>VSWR/TIS/TRP measurements taken before and after this test must show similar results.</li> </ul>

- 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, pahse/delay adjustment, passive component matching. Examples of the application test limits would be included in FCC Part 22 and Part 24, test case 12.2.1 for GSM (3GPP TS 51.010), and test case 4.2.2 for WCDMA (ETSI EN 301 511).
- Ant1—Primary, Ant2—Secondary (Diversity/MIMO/GPS connector 2)
- Stated band ranges satisfy requirements for both Ant1 and Ant2.

## Recommended GPS antenna specifications

**Table A-2: GPS standalone antenna requirements**

Parameter	Requirements	Comments
<b>Frequency range</b>	<ul style="list-style-type: none"> <li>1575.42 MHz <math>\pm</math>2 MHz minimum</li> <li>1565–1606 MHz recommended</li> </ul>	
<b>Field of view (FOV)</b>	<ul style="list-style-type: none"> <li>Omni-directional in azimuth</li> <li>-45° to +90° in elevation</li> </ul>	
<b>Polarization (average Gv/Gh)</b>	> 0 dB	Vertical linear polarization is sufficient.
<b>Free space average gain (Gv+Gh) over FOV</b>	> -6 dBi (preferably > -3 dBi)	Gv and Gh are measured and averaged over -45° to +90° in elevation, and $\pm$ 180° in azimuth.
<b>Gain</b>	<ul style="list-style-type: none"> <li>Maximum gain and uniform coverage in the high elevation angle and zenith.</li> <li>Gain in azimuth plane is not desired.</li> </ul>	
<b>Average 3D gain</b>	> -5 dBi	
<b>Isolation between GPS and Ant1</b>	> 10 dB in all uplink bands	
<b>Typical VSWR</b>	< 2.5:1	
<b>Polarization</b>	Any other than LHCP (left-hand circular polarized) is acceptable.	

## Antenna tests

The following guidelines apply to the requirements described in [Table A-1 on page 65](#) and [Table A-2 on page 67](#):

- Perform electrical measurements at room temperature (+20°C to +26°C) unless otherwise specified
- For main and diversity path antennas, make sure the antennas (including contact device, coaxial cable, connectors, and matching circuit with no more than six components, if required) have nominal impedances of 50  $\Omega$  across supported frequency bands.
- All tests (except isolation/correlation coefficient)—Test the main or diversity antenna with the other antenna terminated.

- Any metallic part of the antenna system that is exposed to the outside environment needs to meet the electrostatic discharge tests per IEC61000-4-2 (conducted discharge +8kV).
- The functional requirements of the antenna system are tested and verified while the embedded module's antenna is integrated in the host device.

---

*Note: Additional testing, including active performance tests, mechanical, and accelerated life tests can be discussed with Sierra Wireless' engineering services. Contact your Sierra Wireless representative for assistance.*

---

## »» B: Design Checklist

# B

This chapter provides a summary of the design considerations mentioned throughout this guide. This includes items relating to the power interface, RF integration, thermal considerations, cabling issues, and so on.

*Note: This is NOT an exhaustive list of design considerations. It is expected that you will employ good design practices and engineering principles in your integration.*

**Table B-1: Hardware integration design considerations**

Suggestion	Section where discussed
<b>Component placement</b>	
Protect the SIM socket so the SIM cannot be removed while the host is powered up.	<a href="#">SIM implementation on page 32</a>
If an ESD suppressor is not used, allow space on the SIM connector for series resistors in layout. (Up to 100 $\Omega$ may be used depending on ESD testing requirements).	<a href="#">SIM implementation on page 32</a>
Minimize RF cable losses as these affect performance values listed in product specification documents.	<a href="#">RF connections on page 37</a>
<b>Antennas</b>	
Match the module/antenna coax connections to 50 $\Omega$ — mismatched antenna impedance and cable loss negatively affect RF performance.	<a href="#">RF connections on page 37</a>
If installing CDMA and UMTS modules in the same device, consider using separate antennas for maximum performance.	<a href="#">Antenna and cabling on page 38</a>
<b>Power</b>	
Make sure the power supply can handle the maximum current specified for the module type.	<a href="#">Power consumption on page 45</a>
Limit the total impedance of VCC and GND connections to the SIM at the connector to less than 1 $\Omega$ (including any trace impedance and lumped element components—inductors, filters, etc.). All other lines must have a trace impedance less than 2 $\Omega$ .	<a href="#">SIM implementation on page 32</a>
Decouple the VCC line close to the SIM socket. The longer the trace length (impedance) from socket to module, the greater the capacitance requirement to meet compliance tests.	<a href="#">SIM implementation on page 32</a>
<b>EMI/ESD</b>	
Investigate sources of localized interference early in the design cycle.	<a href="#">Methods to mitigate decreased Rx performance on page 40</a>

**Table B-1: Hardware integration design considerations (Continued)**

Suggestion	Section where discussed
Provide ESD protection for the SIM connector at the exposed contact point (in particular, the CLK, VCC, IO, and RESET lines).	<a href="#">SIM implementation on page 32</a>
Keep very low capacitance traces on the USIM_DATA and USIM_CLK signals.	<a href="#">SIM implementation on page 32</a>
To minimize noise leakage, establish a very good ground connection between the module and host.	<a href="#">Ground connection on page 39</a>
Route cables away from noise sources (for example, power supplies, LCD assemblies, etc.).	<a href="#">Methods to mitigate decreased Rx performance on page 40</a>
Shield high RF-emitting components of the host device (for example, main processor, parallel bus, etc.).	<a href="#">Methods to mitigate decreased Rx performance on page 40</a>
Use discrete filtering on low frequency lines to filter out unwanted high-order harmonic energy.	<a href="#">Methods to mitigate decreased Rx performance on page 40</a>
Use multi-layer PCBs to form shielding layers around high-speed clock traces.	<a href="#">Methods to mitigate decreased Rx performance on page 40</a>
<b>Thermal</b>	
Test to worst case operating conditions—temperature, voltage, and operation mode (transmitter on 100% duty cycle, maximum power).	<a href="#">Thermal considerations on page 56</a>
Use appropriate techniques to reduce module temperatures (for example, airflow, heat sinks, heat-relief tape, module placement, etc.).	<a href="#">Thermal considerations on page 56</a>
<b>Host/Modem communication</b>	
Make sure the host USB driver supports remote wakeup, resume, and suspend operations, and serial port emulation.	<i>[5] AirCard/AirPrime USB Driver Developer's Guide (Doc# 2130634)</i>
When no valid data is being sent, do not send SOF tokens from the host (causes unnecessary power consumption).	<i>[5] AirCard/AirPrime USB Driver Developer's Guide (Doc# 2130634)</i>

---

*Note: All AirPrime embedded modules are factory-tested to ensure they conform to published product specifications.*

---

Developers of OEM devices integrating Sierra Wireless AirPrime embedded modules should include a series of test phases in their manufacturing process to make sure that *their* devices work properly with the embedded modules.

Suggested phases include:

- [Acceptance testing](#)—Testing of modules when they are received from Sierra Wireless
- [Certification testing](#)—Testing of completed devices to obtain required certifications before beginning mass production
- [Production testing](#)—Testing of completed devices with the modules embedded
- [Quality assurance testing](#)—Post-production

## AT command entry timing requirement

Some AT commands require time to process before additional commands are entered. For example, the modem will return “OK” when it receives `ATIDAFTMACT`. However, if `ATIDASBAND` is received too soon after this, the modem will return an error.

When building automated test scripts, ensure that sufficient delays are embedded where necessary to avoid these errors.

## Acceptance testing

---

*Note: Acceptance testing is typically performed for **each** shipment received.*

---

When you receive a shipment from Sierra Wireless, you should make sure it is suitable before beginning production.

From a random sampling of units, test that:

- Units are operational
- Units are loaded with the correct firmware version

## Acceptance test requirements

To perform the suggested tests, you require a test system in which to temporarily install the module, and you must be able to observe the test device's LED indicator.

## Acceptance test procedure

The following is a suggested acceptance testing procedure using Sierra Wireless' Watcher™ software:

---

*Note: You can perform these tests using appropriate AT commands.*

---

### Test 1: Check power-up and initialization

1. After installing the module, start the test system.
2. Launch Watcher.
3. Check the LED—If the LED is off, there is a problem with the module or with the connection to the LED.

### Test 2: Check version numbers

1. From Watcher, select **Help > About**.
2. Verify that the firmware version in the **About** window is correct.
3. Close the **About** window.

If the module fails either of these tests, or is not recognized by Watcher:

1. Replace the module with one that is known to work correctly and repeat the tests.
2. If the tests are successful, reinstall the original module and repeat the tests.

If the module still does not work correctly, contact your account manager.

## Certification testing

---

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

---

The AirPrime embedded module has been certified as described in [Regulatory and Industry Approvals on page 59](#).

When you produce a host device with a Sierra Wireless AirPrime embedded module, 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](http://www.fcc.gov))
- Industry Canada ([www.ic.gc.ca](http://www.ic.gc.ca))
- CSA (Canadian Standards Association—[www.csa.ca](http://www.csa.ca))



- Factory Mutual (FM Global—[www.allendale.com](http://www.allendale.com))
- Underwriters Laboratories Inc. ([www.ul.com](http://www.ul.com))
- CDG (CDMA Development Group—[www.cdg.org](http://www.cdg.org))
- GCF (Global Certification Forum—[www.globalcertificationforum.org](http://www.globalcertificationforum.org)) outside of North America
- PTCRB (PCS Type Certification Review Board—[www.ptcrb.com](http://www.ptcrb.com)) in North America

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## Production testing

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

---

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

Typical items to test include:

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

---

*Note: The amount 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 for your testing environment (see [Acceptance test requirements on page 72](#) for suggestions) and use AT commands to control the integrated module.

---

*Note: Your test location must be protected from ESD to avoid interference with the module 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.*

---

## Functional production test

This section presents a suggested procedure for performing a basic manual functional test on a laboratory bench using an AirPrime embedded module and a Mini Card Dev Kit. When you have become familiar with the testing method, use it to develop your own automated production testing procedures.

## Suggested production tests

Consider the following tests when you design your production test procedures for devices with the AirPrime module installed.

- Visual check of the module’s connectors and RF assemblies
- Module is operational
- USB connection is functional
- LED is functional
- W\_DISABLE\_N (module power down)
- Firmware revision check
- Rx tests on main and auxiliary paths
- Tx test

## 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 Dev Kit-based test station, and referring to the appropriate AT command references:

1. Visually inspect the module’s connectors and RF assemblies for obvious defects before installing it in the test station.
2. Ensure that the module is turned off before beginning your tests—Drive W\_DISABLE\_N low.
3. If using Linux, determine if 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. Test W\_DISABLE\_N—Turn on the module by letting W\_DISABLE\_N float (high impedance).
5. Test USB functionality—Check for USB enumeration.
  - (Windows systems) The Device Manager shows Sierra Wireless items under Ports (COM & LPT). The devices shown depend on the module type. For example:]



- (Linux systems) 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. (There should be seven *new* devices) For example:

- With one other USB device already connected and assigned to ttyUSB1:

```

C:\ Telnet 00.0.00.00
xxxxxC-Linuxdev2:~$ ls /dev/ttyUSB*
/dev/ttyUSB0 /dev/ttyUSB2 /dev/ttyUSB4 /dev/ttyUSB6
/dev/ttyUSB1 /dev/ttyUSB3 /dev/ttyUSB5 /dev/ttyUSB7
xxxxxC-Linuxdev2:~$

```

(Note: The AT port is the fourth *new* device—/dev/ttyUSB4.)

6. Make sure your modem is connected and running, and then establish contact with the module:
  - **Windows systems:** Use a terminal emulation/communications program such as Microsoft HyperTerminal® to connect over the COM port reserved for AT commands (see listings in [Step 5](#)):
    - a. Start HyperTerminal.
    - b. Select **File > Connection Description**. The Connection Description dialog box appears.
      - i. Type Sierra in the Name box and click **OK**. The Connect To dialog box appears.
      - ii. Click **OK** without changing any of the displayed information. The Connect dialog box appears.
      - iii. Click **Cancel**.
      - iv. Type ATZ in the HyperTerminal window. If the connection is established, the message OK appears.
    - **Linux systems:** Use a terminal emulation/communications program such as minicom to connect over the device handle for AT commands (see listings in [Step 5](#)):
      - i. 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.

```

C:\ 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 !115200 8N1 ! NOR ! Minicom 2.2 ! UT102 ! Offline

```

---

*Note: If necessary, use ATE1 to enable echo.*

---



---

*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 76](#) for details.*

---

7. Display the firmware version:
  - **AT!GVER**
8. Test the LED—Set the LED in blinking mode using this command, then visually verify that the LED turns off and on:
  - **AT!LEDCTRL**
9. Unlock the extended AT command set:
  - **AT!ENTERCND**
10. Put the module in diagnostic/factory test mode:
  - **AT!DAFTMACT**
11. Communicate with the SIM using **+CPIN** or **+CIMI**.  
When performing RF tests, use a test platform as described in [Suggested testing equipment on page 81](#).
12. Test RF transmission, if desired:
  - (LTE) To test the LTE transmission path, use a call box.
13. Test RF reception, if desired:
  - (CDMA) See [Testing CDMA RF Receive path on page 77](#).
  - (LTE) See [LTE RF receive path test on page 78](#).
14. Test standalone GPS functionality—See [GPS standalone connector test on page 80](#).
15. Drive **W\_DISABLE\_N** low and confirm that the module powers down:
  - Windows systems—The Sierra Wireless items under the Ports (COM & LPT) entry in Device Manager disappear as the module powers off.
  - Linux systems—Enter the command `ls /dev/tty/USB*`. The devices enumerated in [Step 5](#) will not appear after the module powers off.

## 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:

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 5](#) on page 74 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 (for example, `/dev/ttyUSB4` as shown in the example in [Step 5](#) on page 74).
7. Press **Enter** twice.

---

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

---

8. Use the down-arrow key to select **Save setup as dfl.**
9. Select **Exit.**

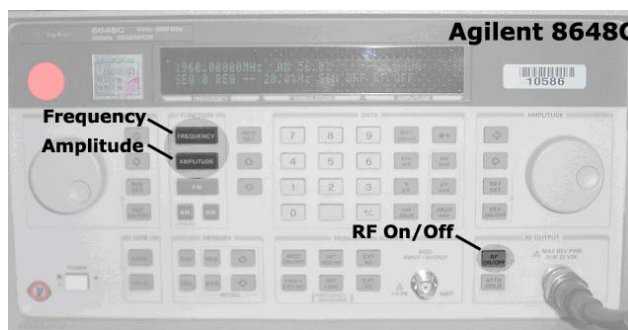
## Testing CDMA RF Receive path

*Note: This procedure segment is performed in [Step 13](#) of the [Production test procedure on page 74](#).*

To test the DUT's receive path:

1. Set up the signal generator:

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



*Note: This example setup uses a 200 kHz offset from band center for testing using a continuous wave—you can use any appropriate baseband frequency offset (for example, 100 kHz, 300 kHz, etc.).*

*If using a modulated signal, set the frequency to band center with no offset.*

- a. Press the **Frequency** button to set the frequency to 1960.200 MHz for PCS band, Channel 600, or 881.720 MHz for Cellular band, Channel 384
  - b. Press the **Amplitude** button to set the amplitude to -55.0 dBm.
  - c. Press the **RF ON/OFF** button to enable or disable the RF port of the signal generator.
2. Read back the power level from the main receiver:
    - a. **ATIINTERCND** (Unlock the extended AT command set.)
    - b. **ATIDAFTMACT** (Enter test mode.)
    - c. **ATICHAN=600,1** (PCS band, channel 600)  
or  
**ATICHAN=384,0** (Cellular band, channel 384)
    - d. **ATIRX=1** (Turn on the main receiver.)
    - e. **ATIRXAGC?** (Read back the power level, in dBm, from the main receiver.)  
Response examples:
      - **RXAGC = 0xFFFFF33** = -77 dBm (Signal generator's RF port is OFF)
      - **RXAGC = 0x0021** = -60 dBm typical (Signal generator's RF port is ON)

*Note: The dBm value displayed is calculated to reflect the power at the input connector.*

- f. **ATIRX2=1** (Turn on diversity receiver.)
  - g. **ATIRX2AGC?** (Read back the power level, in dBm, from the diversity receiver.)  
 Response examples:
    - RX2AGC = 0xFFFFF76 = -84 dBm (Signal generator's RF port is OFF)
    - RX2AGC = 0xFFFFFC6 = -69 dBm typical (Signal generator's RF port is ON)
  - h. **ATIRX=0** (Turn off main receiver.)
  - i. **ATIRX2=0** (Turn off diversity receiver.)
3. Test limits—Run ten or more good DUTs through this test procedure to obtain a nominal received power value.
- Apply a tolerance of  $\pm 5$  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 should be at least -50 dBm.
  - Monitor these limits during mass-production ramp-up to determine if further adjustments are needed.

*Note: The value measured by the DUT depends on the test setup and DUT design. Host RF cabling loss, antenna efficiency and pattern, test antenna efficiency and pattern, and choice of shield box all significantly influence the measurement.*

*Note: When doing the same test over the air in an RF chamber, values are likely to be significantly lower.*

## LTE RF receive path test

*Note: This procedure segment is performed in [Step 13](#) of the [Production test procedure on page 74](#).*

**Table C-1** contains parameters used in the suggested test procedure that follows.

**Table C-1: Test settings — Receive path**

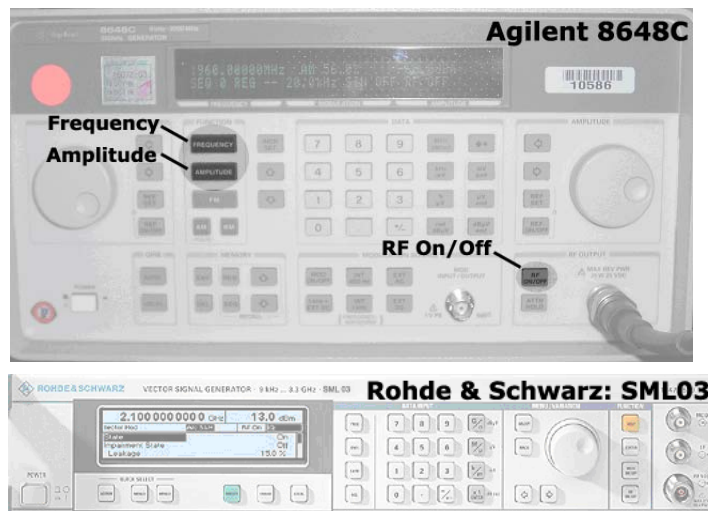
Mode	Test category	Bands		
		B13	B17	B4
LTE	Frequency <sup>a</sup> (MHz)	753.0	742.0	2134.5
	Band	36	37	42
	Channel <sup>b</sup>	23230	23790	20175

- a. All values offset from actual center channel by +2 MHz
- b. Channel values shown are at the center of the corresponding bands.

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 [Table C-1](#) for frequency values.
2. Set up the DUT:
    - a. ATIENTERCND (Unlock extended AT command set.)
    - b. ATIDAFTMACT (Put modem into factory test mode.)
    - c. ATIDASBAND=<band> (Set frequency band.)
      - See [Table C-1 on page 78](#) for <band> values
    - d. ATIDASCHAN=<channel> (Set modem channel)
      - See [Table C-1 on page 78](#) for <channel> values
    - e. ATIDALGAVGAGC=<channel>,0 (Get averaged Rx AGC)
      - See [Table C-1 on page 78](#) 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  $\pm 5$  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).*

---

## GPS standalone connector test

GPS testing should be done on devices that support a dedicated GPS connector.

If the MC7750 supports a dedicated GPS connector/path (that is, not shared with the diversity connector), then GPS testing may be done by characterizing some known-good MC devices and checking for carrier to noise levels.

To test the GPS path:

1. Inject a carrier signal at -110dBm, frequency 1575.52 MHz into the GPS Rx path. (Note that this is 100kHz higher than the actual GPS frequency.)
2. Test the signal carrier-to-noise level at the GPS receiver:
  - a. **ATIINTERCND** (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 Mini Card device 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 .*

---

## Quality assurance testing

---

*Note: QA is an ongoing process based on random samples from a finished batch of devices.*

---

The quality assurance tests that you perform on your finished products should be designed to verify the performance and quality of your devices.

The following are *some* testing suggestions that can confirm that the antenna is interfaced properly, and that the RF module is calibrated and performs to specifications:

- Module registration on cellular networks



- Power consumption
- Originate and terminate data and voice (if applicable) calls
- Cell hand-off
- Transmitter and receiver tests
- FER (Frame Error Rate) as an indicator of receiver sensitivity/performance
- Channel and average power measurements to verify that the device is transmitting within product specifications
- RF sensitivity tests
- CDMA:
  - FER testing—Test receiver sensitivity for conditions of minimum cell power. FER can be measured for the specified receiver sensitivity of -104 dBm. The objective of this test is to determine if the FER measured is within the acceptable limits for the specified receiver sensitivity of the module. Unlike the FER tests performed during production testing, this test determines the receiver performance without the influence of the noise factor (AWGN), but with extremely low cell power. The reported FER and the confidence level must be <1% and >95% respectively for the test to be considered a pass.

## Suggested testing equipment

To perform production and post-production tests, you will require appropriate testing equipment. A test computer can be used to coordinate testing between the integrated module (on the development kit or host) and the measurement equipment, usually with GPIB connections. The suggested setup includes a power meter to test RF output power and a signal generator to evaluate the receiver.

## Testing assistance provided by Sierra Wireless

Extended AT commands have been implemented to assist with performing FTA GCF tests and portions of CE Mark tests requiring radio module access. These are documented in the [2] *AirCard/AirPrime UMTS Devices Supported AT Command Reference (Doc# 2130617)* and [3] *AirPrime MC8xxx Embedded Modules Extended AT Command Reference (Doc# 2130616)*.

Sierra Wireless offers optional professional services based assistance to [OEMs](#) with regulatory approvals.

## IOT/Operator testing

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.

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

## Extended AT commands for testing

Sierra Wireless provides proprietary AT commands that may help in hardware integration design and testing (these commands are NOT intended for use by end users):

- [3] *AirPrime MC8xxx Embedded Modules Extended AT Command Reference (Doc# 2130616)*
- [2] *AirCard/AirPrime UMTS Devices Supported AT Command Reference (Doc# 2130617)*

Some useful commands from these documents for use in hardware integration are listed in [Table C-2 on page 82](#).

**Table C-2: Extended AT commands**

Command	Description
<b>Password commands</b>	
<b>!ENTERCND</b>	Enable access to password-protected commands
<b>!SETCND</b>	Set AT command password
<b>Modem reset and status commands</b>	
<b>!GRESET</b>	Reset the modem
<b>!GSTATUS</b>	Return the operation status of the modem (mode, band, channel, and so on)
<b>Diagnostic commands</b>	
<b>!BAND</b>	Select a set of frequency bands or reports current selection
<b>!GBAND</b>	Read/set the current operating band
<b>Test commands</b>	
<b>!ALLUP</b>	Turn transmitter on/off and simulate 'All UPs'
<b>!CHAN</b>	Tune synthesizer to channel/band
<b>!DAFTMACT</b>	Put the modem into FTM (Factory Test Mode)
<b>!DAFTMDEACT</b>	Put the modem into online mode
<b>!DAGGRSSI</b>	Return the RSSI (Received Signal Strength Indicator) in dBm (GSM mode)
<b>!DAGGAVGRSSI</b>	Return an averaged RSSI (Received Signal Strength Indicator) in dBm (GSM mode)
<b>!DAGGRSSIRAW</b>	Return the raw RSSI (GSM mode)
<b>!DAGINFO</b>	Return GSM mode RF information
<b>!DAGSLOCK</b>	Return the RF synthesizer lock state
<b>!DAGSRXBURST</b>	Set the GSM receiver to burst mode
<b>!DAGSRXCONT</b>	Set the GSM receiver continually on

**Table C-2: Extended AT commands (Continued)**

Command	Description
<b>!DAGSTXBURST</b>	Set the GSM transmitter to burst mode
<b>!DAGSTXFRAME</b>	Set the GSM Tx frame structure
<b>!DALGAVGAGC</b>	Return averaged Rx AGC value (LTE)
<b>!DALGRXAGC</b>	Return Rx AGC value (LTE)
<b>!DALGTXAGC</b>	Return Tx AGC value and transmitter parameters (LTE)
<b>!DAOFFLINE</b>	Place modem offline
<b>!DASBAND</b>	Set the frequency band (UMTS/GSM)
<b>!DASCHAN</b>	Set the modem channel (frequency) (UMTS/GSM)
<b>!DASLNAGAIN</b>	Set the LNA (Low Noise Amplifier) gain state
<b>!DASPDM</b>	Set the PDM (Pulse Duration Modulation) value
<b>!DASTXOFF</b>	Turn off the Tx PA (Power Amplifier)
<b>!DASTXON</b>	Turn on the Tx PA (Power Amplifier)
<b>!DAWGAVGAGC</b>	Return averaged RX AGC value (WCDMA)
<b>!DAWGRXAGC</b>	Return the Rx AGC (Automatic Gain Control) value (UMTS)
<b>!DAWINFO</b>	Return WCDMA mode RF information
<b>!DAWSCONFIGRX</b>	Set the UMTS receiver to factory calibration settings
<b>!DAWSPARANGE</b>	Set the PA range state machine (UMTS)
<b>!DAWSCHAINTCM</b>	Place receive chain in test call mode (WCDMA)
<b>!DAWSSCHAIN</b>	Enable secondary receive chain (WCDMA)
<b>!DAWSTXCW</b>	Set the waveform used by the transmitter (UMTS)
<b>!DAWSTXPWR</b>	Set desired Tx power level (WCDMA)
<b>!IMSTESTMODE</b>	Enable/disable IMS test mode
<b>!KEYOFF</b>	Key off the transmitter
<b>!KEYON</b>	Key on the transmitter
<b>!OSDSM</b>	Display memory usage for DSM (Distributed Shared Memory) buffer pools
<b>\$QCAGC</b>	Read Rx AGC (CDMA/WCDMA)
<b>!RX2</b>	Turn second receiver on/off
<b>!RX2AGC</b>	Read second receiver Rx AGC
<b>!RXAGC</b>	Read first receiver Rx AGC

**Table C-2: Extended AT commands (Continued)**

Command	Description
<b>!TX</b>	Turn transmitter on/off
<b>!TXAGC</b>	Set desired Tx AGC

## »» D: Packaging

D

Sierra Wireless AirPrime Mini Cards are shipped in sealed boxes. The standard packaging (see [Figure 4-1](#)), contains a single tray with a capacity of 100 modules. (Note that some SKUs may have custom packaging—contact Sierra Wireless for SKU-specific details.)

In the standard packaging, Mini Cards are inserted, system connector first, into the bottom portion (T1) of a two-part tray. All facing the same direction. This allows the top edge of each Mini Card to contact the top of the triangular features in the top portion (T2) of the tray (see Detail A).

The top and bottom portions of the tray snap together at the four connection points.

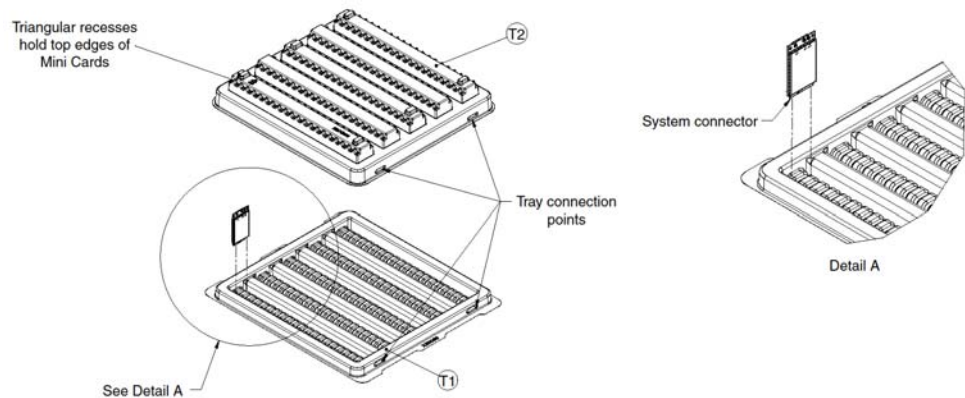


Figure 4-1: Device placement in module tray

The tray is placed in a manufacturing box (T2 at the top), sealed with a security tape (P1), and a manufacturing label is placed on the bottom-right corner, above the security tape. (See [Figure 4-2](#).)

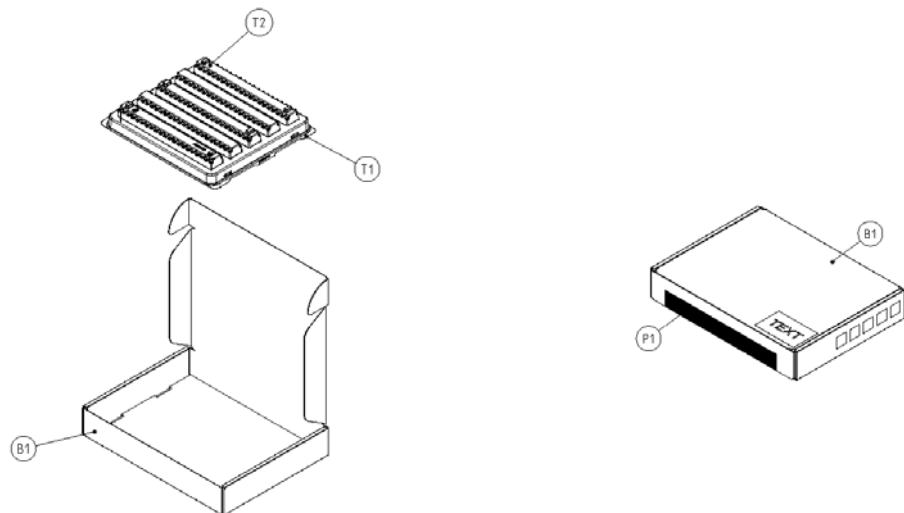


Figure 4-2: Shipping package



## »» | E: References

## E

This guide deals specifically with hardware integration issues that are unique to AirPrime embedded modules.

### Web site support

For additional documents describing embedded module design, usage, and integration issues (AT command references, integration guides, etc.), visit [developer.sierrawireless.com](http://developer.sierrawireless.com).

### Sierra Wireless documents

The following Sierra Wireless documents are available from [developer.sierrawireless.com](http://developer.sierrawireless.com).

#### Command documents

- [1] AT Command Set for User Equipment (UE) (Release 6)  
(Doc# 3GPP TS 27.007)
- [2] AirCard/AirPrime UMTS Devices Supported AT Command Reference (Doc# 2130617)
- [3] AirPrime MC8xxx Embedded Modules Extended AT Command Reference (Doc# 2130616)

#### Other Sierra documents

- [4] PCI Express Mini Card Dev Kit Quick Start Guide  
(Doc# 2130705)
- [5] AirCard/AirPrime USB Driver Developer's Guide (Doc# 2130634)

#### Industry/other documents

The following non-Sierra Wireless references are not included in your documentation package:

- [6] CDMA 1x Standard (CDMA 200 Series Release A (2000))  
(Doc# TIA/EIA/IS-2000 Series, Release A)
- [7] FCC Regulations - Part 15 - Radio Frequency Devices
- [8] IEC-61000-4-2 level 3
- [9] IEC-61000-4-2 level (Electrostatic Discharge Immunity Test)
- [10] Mobile Station (MS) Conformance Specification; Part 4:  
Subscriber Interface Module (Doc# 3GPP TS 11.10-4)

[11] PCI Express Mini Card Electromechanical Specification Revision 1.2

[12] Universal Serial Bus Specification, Rev 2.0

[13] JESD22-A114-B

[14] JESD22-C101



# »» F: Acronyms



Table F-1: Acronyms and definitions

Acronym or term	Definition
<b>1xEV-DO</b>	Single Carrier (1X) EVolution – Data Only. A high-speed standard for cellular <a href="#">packet</a> data communications. Supports Internet connections with data rates up to 3.1 Mbps (downlink from the network) and 1.8 Mbps (uplink to the network). Average data rates are roughly: for Rev. A: 600 1300 kbps (downlink from the network) and 300 400 kbps (uplink to the network); for Rev. 0: 400 700 kbps (downlink from the network) and 40 80 kbps (uplink to the network). Actual speed depends on the network conditions. Compare to <a href="#">1X</a> .
<b>1X</b>	Single Carrier (1X) Radio Transmission Technology. A high-speed standard for cellular <a href="#">packet</a> data communications. Supports Internet connections with data rates up to 153 kbps (simultaneously in each direction—downlink and uplink). Actual speed depends on the network conditions. Compare to <a href="#">1xEV-DO</a> .
<b>3GPP</b>	3rd Generation Partnership Project
<b>8PSK</b>	Octagonal Phase Shift Keying
<b>AGC</b>	Automatic Gain Control
<b>API</b>	Application Programming Interface
<b>BER</b>	Bit Error Rate—A measure of receive sensitivity
<b>BLER</b>	Block Error Rate
<b>bluetooth</b>	Wireless protocol for data exchange over short distances
<b>CAIT</b>	CDMA Air Interface Tool
<b>CDG</b>	CDMA Development Group—a consortium of companies that develop and promote the products and services for <a href="#">CDMA</a> wireless systems.
<b>CDMA</b>	Code Division Multiple Access. A wideband spread spectrum technique used in digital cellular, personal communications services, and other wireless networks. Wide channels (1.25 MHz) are obtained through spread spectrum transmissions, thus allowing many active users to share the same channel. Each user is assigned a unique digital code, which differentiates the individual conversations on the same channel.
<b>CQI</b>	Channel Quality Indication
<b>COM</b>	Communication port
<b>CS</b>	Circuit-switched
<b>CSA</b>	Canadian Standards Association
<b>CW</b>	Continuous waveform

Table F-1: Acronyms and definitions (Continued)

Acronym or term	Definition
<b>dB</b>	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>
<b>dBm</b>	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).
<b>DCS</b>	Digital Cellular System A cellular communication infrastructure that uses the 1.8 GHz radio spectrum.
<b>DL</b>	Downlink (network to mobile)
<b>DRX</b>	Discontinuous Reception
<b>DSM</b>	Distributed Shared Memory
<b>DUT</b>	Device Under Test
<b>EDGE</b>	Enhanced Data rates for GSM Evolution
<b>eHRPD</b>	Evolved High Rate Packet Data—Enhances traditional <a href="#">1xEV-DO</a> to enable <a href="#">LTE</a> to CDMA handover.
<b>EIRP</b>	Effective (or Equivalent) Isotropic Radiated Power
<b>EMC</b>	Electromagnetic Compatibility
<b>EMI</b>	Electromagnetic Interference
<b>ERP</b>	Effective Radiated Power
<b>ESD</b>	Electrostatic Discharge
<b>FCC</b>	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 <a href="http://www.fcc.gov">www.fcc.gov</a> .
<b>FDMA</b>	Frequency Division Multiple Access
<b>FER</b>	Frame Error Rate—A measure of receive sensitivity.
<b>firmware</b>	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.
<b>FOTA</b>	Firmware Over The Air—Technology used to download firmware upgrades directly from the service provider, over the air.
<b>FOV</b>	Field Of View
<b>FSN</b>	Factory Serial Number—A unique serial number assigned to the mini card during manufacturing.
<b>GCF</b>	Global Certification Forum

Table F-1: Acronyms and definitions (Continued)

Acronym or term	Definition
<b>GLONASS</b>	Global Navigation Satellite System
<b>GMSK</b>	Gaussian Minimum Shift Keying modulation
<b>GND</b>	Ground
<b>GPRS</b>	General Packet Radio Service
<b>GPS</b>	Global Positioning System A system that uses a series of 24 geosynchronous satellites to provide navigational data.
<b>GSM</b>	Global System for Mobile Communications
<b>Host</b>	The device into which an embedded module is integrated
<b>Hz</b>	Hertz = 1 cycle/second
<b>IC</b>	Industry Canada
<b>IF</b>	Intermediate Frequency
<b>IMEI</b>	International Mobile Equipment Identity
<b>IMS</b>	IP Multimedia Subsystem—Architectural framework for delivering IP multimedia services. (MC7750 supports MO/MT SMS over IMS for LTE/eHRPD.)
<b>inrush current</b>	Peak current drawn when a device is connected or powered on
<b>inter-RAT</b>	Radio Access Technology
<b>IOT</b>	Interoperability Testing
<b>IS</b>	Interim Standard. After receiving industry consensus, the TIA forwards the standard to ANSI for approval.
<b>IS-2000</b>	3G radio standards for voice and data (CDMA only)
<b>IS-95</b>	2G radio standards targeted for voice (cdmaONE)
<b>LED</b>	Light Emitting Diode. A semiconductor diode that emits visible or infrared light.
<b>LHCP</b>	Left-Hand Circular Polarized
<b>LNA</b>	Low Noise Amplifier
<b>LPM</b>	Low Power Mode
<b>LPT</b>	Line Print Terminal
<b>LTE</b>	Long Term Evolution—a high-performance air interface for cellular mobile communication systems.
<b>MCS</b>	Modulation and Coding Scheme
<b>MHz</b>	Megahertz = 10e6 Hz

**Table F-1: Acronyms and definitions (Continued)**

<b>Acronym or term</b>	<b>Definition</b>
<b>MEID</b>	Mobile Equipment Identifier—The unique second-generation serial number assigned to the minicard for use on the wireless network.
<b>MIMO</b>	Multiple Input Multiple Output—wireless antenna technology that uses multiple antennas at both transmitter and receiver side. This improves performance.
<b>NAS/AS</b>	Network Access Server
<b>NC</b>	No Connect
<b>NDIS</b>	Network Driver Interface SpecificationSpecification—a programming interface specification for connecting network interface cards in Windows.
<b>NIC</b>	Network Interface Card
<b>NMEA</b>	National Marine Electronics Association
<b>OEM</b>	Original Equipment Manufacturer—a company that manufactures a product and sells it to a reseller.
<b>OFDMA</b>	Orthogonal Frequency Division Multiple Access
<b>OMA DM</b>	Open Mobile Alliance Device Management—A device management protocol.
<b>OTA</b>	‘Over the air’ (or radiated through the antenna)
<b>PA</b>	Power Amplifier
<b>packet</b>	A short, fixed-length block of data, including a header, that is transmitted as a unit in a communications network.
<b>PCB</b>	Printed Circuit Board
<b>PCS</b>	Personal Communication System A cellular communication infrastructure that uses the 1.9 GHz radio spectrum.
<b>PDN</b>	Packet Data Network
<b>PMI</b>	Pre-coding Matrix Index
<b>PSS</b>	Primary synchronisation signal
<b>PST</b>	Product Support Tools
<b>PTCRB</b>	PCS Type Certification Review Board
<b>QAM</b>	Quadrature Amplitude Modulation. This form of modulation uses amplitude, frequency, and phase to transfer data on the carrier wave.
<b>QMI</b>	Qualcomm MSM/Modem Interface
<b>QOS</b>	Quality of Service
<b>QPSK</b>	Quadrature Phase-Shift Keying
<b>QPST</b>	Qualcomm Product Support Tools
<b>RAT</b>	Radio Access Technology

Table F-1: Acronyms and definitions (Continued)

Acronym or term	Definition
<b>RF</b>	Radio Frequency
<b>RI</b>	Ring Indicator
<b>roaming</b>	A cellular subscriber is in an area where service is obtained from a cellular service provider that is not the subscriber's provider.
<b>RSE</b>	Radiated Spurious Emissions
<b>RSSI</b>	Received Signal Strength Indication
<b>SDK</b>	Software Development Kit
<b>SED</b>	Smart Error Detection
<b>Sensitivity (Audio)</b>	Measure of lowest power signal that the receiver can measure.
<b>Sensitivity (RF)</b>	Measure of lowest power signal at the receiver input that can provide a prescribed BER/BLER/SNR value at the receiver output.
<b>SIB</b>	System Information Block
<b>SIM</b>	Subscriber Identity Module. Also referred to as USIM or UICC.
<b>SIMO</b>	Single Input Multiple Output—smart antenna technology that uses a single antenna at the transmitter side and multiple antennas at the receiver side. This improves performance and security.
<b>SISO</b>	Single Input Single Output—antenna technology that uses a single antenna at both the transmitter side and the receiver side.
<b>SKU</b>	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.
<b>SMS</b>	Short Message Service. A feature that allows users of a wireless device on a wireless network to receive or transmit short electronic alphanumeric messages (up to 160 characters, depending on the service provider).
<b>S/N</b>	Signal-to-noise (ratio)
<b>SNR</b>	Signal-to-Noise Ratio
<b>SOF</b>	Start of Frame—A USB function.
<b>SSS</b>	Secondary synchronisation signal.
<b>SUPL</b>	Secure User Plane Location
<b>TIA/EIA</b>	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 <a href="http://www.tiaonline.org">www.tiaonline.org</a> .
<b>TIS</b>	Total Isotropic Sensitivity

**Table F-1: Acronyms and definitions (Continued)**

<b>Acronym or term</b>	<b>Definition</b>
<b>TRP</b>	Total Radiated Power
<b>UDK</b>	Universal Development Kit (for PCI Express Mini Cards)
<b>UE</b>	User Equipment
<b>UICC</b>	Universal Integrated Circuit Card (Also referred to as a SIM card.)
<b>UL</b>	Uplink (mobile to network)
<b>UL</b>	Underwriters Laboratory
<b>UMTS</b>	Universal Mobile Telecommunications System
<b>USB</b>	Universal Serial Bus
<b>USIM</b>	Universal Subscriber Identity Module (UMTS)
<b>VCC</b>	Supply voltage (3.3 V)
<b>VSWR</b>	Voltage Standing Wave Ratio
<b>WAN</b>	Wide Area Network
<b>WCDMA</b>	Wideband Code Division Multiple Access (also referred to as UMTS)
<b>WLAN</b>	Wireless Local Area Network
<b>ZIF</b>	Zero Insertion Force

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