FCC RF Radiation Exposure Statement:

1. This Transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.
2. This equipment complies with FCC RF radiation exposure limits set forth for an uncontrolled environment for body-worn configuration in direct contact to the phantom.

Information to OEM integrator

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user manual of the end product.
The user manual which is provided by OEM integrators for end users must include the following information in a prominent location.
1. To comply with FCC RF exposure compliance requirements, the antenna used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter, except in accordance with FCC multi-transmitter product procedures.
2. Only those antennas with same type and lesser gain filed under this FCC ID number can be used with this device.
3. The regulatory label on the final system must include the statement: "Contains FCC ID：MAU050 or using electronic labeling method as documented in KDB 784748.
4. The final system integrator must ensure there is no instruction provided in the user manual or customer documentation indicating how to install or remove the transmitter module except such device has implemented two-ways authentication between module and the host system.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
-Reorient or relocate the receiving antenna.
-Increase the separation between the equipment and receiver.
-Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
-Consult the dealer or an experienced radio/TV technician for help.

FCC Part 15.21 information for user

You are cautioned that changes or modifications not expressly approved by the party responsible for compliance could void your authority to operate the equipment.

8: Mechanical and Environmental Specifications

8

The LTE7750 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 RF 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 Electrostatic discharge (ESD) on page 55.)	Operational	The RF port (antenna launch and RF connector) complies with the IEC 61000-4-2 standard: • Electrostatic Discharge Immunity: Test: Level3 Contact Discharge: ±6 kV Air Discharge: ±8 kV
	Non-operational	The host connector Interface complies with the following standards only: • +/- 1 kV Human Body Model (JESD22-A114-B) • +/- 125 V Charged Device Model (JESD22-C101)
Thermal considerations		See Thermal considerations 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

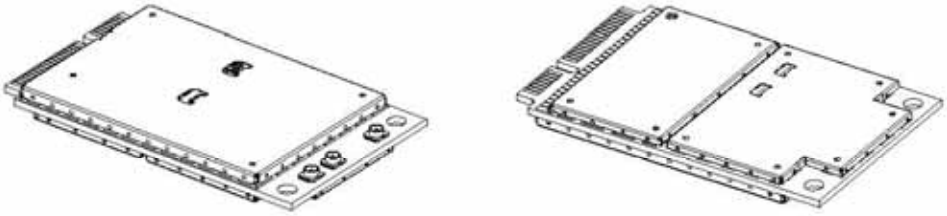


Figure 8-1: Top and bottom views

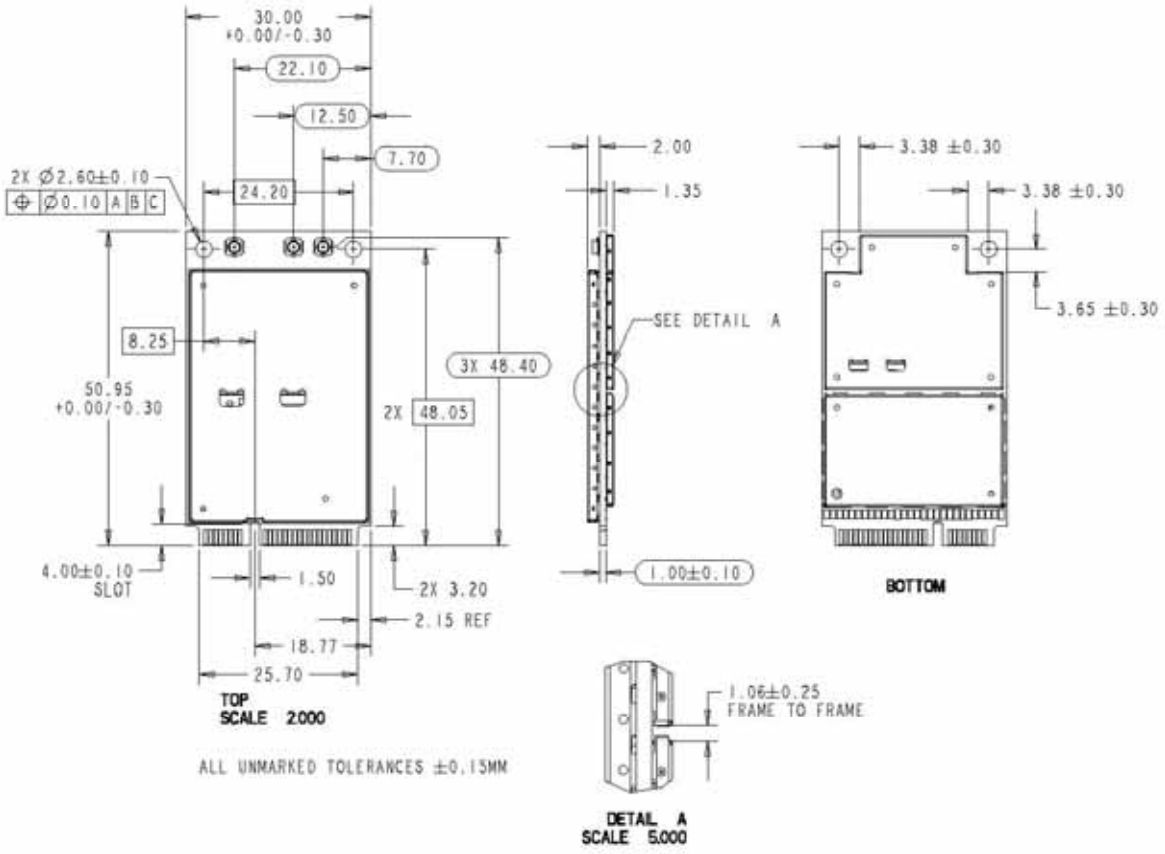


Figure 8-2: Dimensioned view

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.

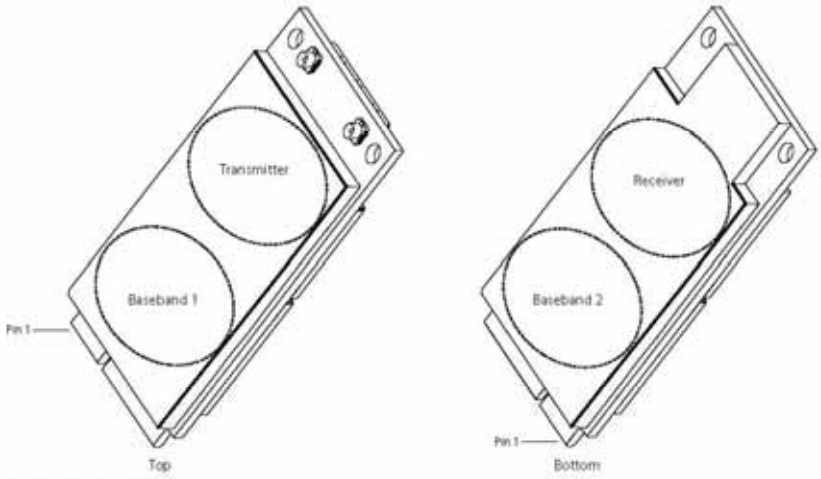


Figure 8-4: Shield locations

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.

Caution: *Thermal putty is not recommended—incorrect application of the material could require exessive 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 LTE7750 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 LTE7750 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 LTE7750 modem **MUST BE**

POWERED OFF. Otherwise, the LTE7750 modem can transmit signals that could interfere with this equipment.

In an aircraft, the LTE7750 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 LTE7750 modem may be used normally at this time.

Important compliance information for North American users

The LTE7750 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 LTE7750 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 LTE7750 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 LTE7750 modem is incorporated, with a statement similar to the following:
  - **This device contains FCC ID: MAU050**

The end product with an embedded LTE7750 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 LTE7750 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 ≥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 ≥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

A

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 [a]

Parameter	Requirements	Comments
Antenna system	External multi-band 2x2 MIMO antenna system (Ant1 / Ant2)[b]	If Ant2 includes GPS, then it must also satisfy requirements in Table A-2 on page 67.
Operating bands of Ant1 and Ant2[c]	700–960 MHz	
	1710–1990 MHz	
	2110–2170 MHz	
	2500–2700 MHz	
VSWR of Ant1 and Ant2	1:1 (ideal) < 2.5:1 (recommended)	On all bands including band edges
Total radiated efficiency of Ant1 and Ant2	> 50% on all bands	• Measured at the RF connector. • Includes mismatch losses, losses in the matching circuit, and antenna losses, excluding cable loss. • 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.
Radiation patterns of Ant1 and Ant2	Nominally Omni-directional radiation pattern in azimuth plane.	

Table A-1: Antenna requirements (Continued)[a]

Parameter	Requirements	Comments
Envelope correlation coefficient between Ant1 and Ant2	< 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	
Mean Effective Gain of Ant1 and Ant2 (MEG1, MEG2)	≥ -3 dBi	
Ant1 and Ant2 Mean Effective Gain Imbalance | MEG1 / MEG2 |	< 2 dB for MIMO operation < 6 dB for diversity operation	
Maximum antenna gain	Must not exceed antenna gains due to RF exposure and ERP/ EIRP limits, as listed in the module's FCC grant.	See Important compliance information for North American users on page 60.
Isolation between Ant1 and Ant2 (S21)	> 10 dB	• If antennas can be moved, test all positions for both antennas. • Make sure all other wireless devices (Bluetooth or WLAN antennas, etc.) are turned OFF to avoid interference.
Power handling	• > 2 W RF power on low bands • > 1 W on high bands	• Measure power endurance over 4 hours (estimated talk time) using a 2 W CW signal—set the CW test signal frequency to the middle of the PCS Tx band (1880 MHz for PCS). • Visually inspect device to ensure there is no damage to the antenna structure and matching components. • VSWR/TIS/TRP measurements taken before and after this test must show similar results.

a. These worst-case VSWR figures for the transmitter bands may not guarantee RSE levels to be within regulatory limits. The device alone meets all regulatory emissions limits when tested into a cabled (conducted) 50 ohm system. With antenna designs with up to 2.5:1 VSWR or worse, the radiated emissions could exceed limits. The antenna system may need to be tuned in order to meet the RSE limits as the complex match between the module and antenna can cause unwanted levels of emissions. Tuning may include antenna pattern changes, 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).
b. Ant1—Primary, Ant2—Secondary (Diversity/MIMO/GPS connector 2)
c. Stated band ranges satisfy requirements for both Ant1 and Ant2.

Recommended GPS antenna specifications

Table A-2: GPS standalone antenna requirements

Parameter	Requirements	Comments
Frequency range	• 1575.42 MHz ±2 MHz minimum • 1565–1606 MHz recommended	
Field of view (FOV)	• Omni-directional in azimuth • -45° to +90° in elevation	
Polarization (average Gv/Gh)	> 0 dB	Vertical linear polarization is sufficient.
Free space average gain (Gv+Gh) over FOV	> -6 dBi (preferably > -3 dBi)	Gv and Gh are measured and averaged over -45° to +90° in elevation, and ±180° in azimuth.
Gain	• Maximum gain and uniform coverage in the high elevation angle and zenith. • Gain in azimuth plane is not desired.	
Average 3D gain	> -5 dBi	
Isolation between GPS and Ant1	> 10 dB in all uplink bands	
Typical VSWR	< 2.5:1	
Polarization	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 Ω 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
Component placement	
Protect the SIM socket so the SIM cannot be removed while the host is powered up.	SIM implementation on page 32
If an ESD suppressor is not used, allow space on the SIM connector for series resistors in layout. (Up to 100 Ω may be used depending on ESD testing requirements).	SIM implementation on page 32
Minimize RF cable losses as these affect performance values listed in product specification documents.	RF connections on page 37
Antennas	
Match the module/antenna coax connections to 50 Ω—mismatched antenna impedance and cable loss negatively affect RF performance.	RF connections on page 37
If installing CDMA and UMTS modules in the same device, consider using separate antennas for maximum performance.	Antenna and cabling on page 38
Power	
Make sure the power supply can handle the maximum current specified for the module type.	Power consumption on page 45
Limit the total impedance of VCC and GND connections to the SIM at the connector to less than 1 Ω (including any trace impedance and lumped element components—inductors, filters, etc.). All other lines must have a trace impedance less than 2 Ω.	SIM implementation on page 32
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.	SIM implementation on page 32
EMI/ESD	
Investigate sources of localized interference early in the design cycle.	Methods to mitigate decreased Rx performance on page 40

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

C: Testing

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 **AT!DAFTMACT**. However, if **AT!DASBAND** 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)
- Industry Canada (www.ic.gc.ca)
- CSA (Canadian Standards Association—www.csa.ca)

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

Production testing

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.

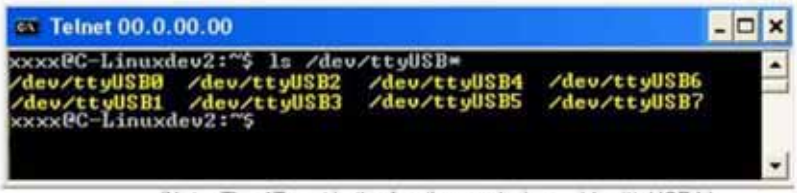
Using an appropriate Dev Kit-based test station, and referring to the appropriate AT command references:

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 ttyUSB*n* 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 ttyUSB*n* 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:



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

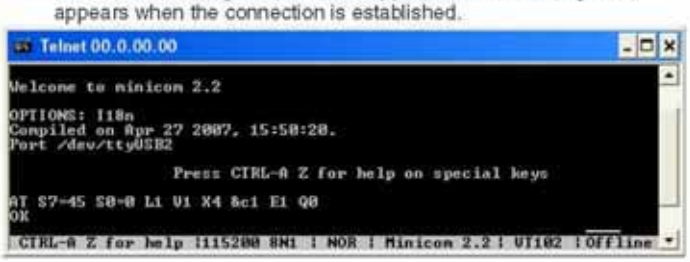
6. Make sure your modem is connected and running, and then establish contact with the module:
   - **Windows systems:** Use a terminal emulation/communications program such as Microsoft HyperTerminal® to connect over the COM port reserved for AT commands (see listings in Step 5):
     a. Start HyperTerminal.
     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.

*Note: If necessary, use **AT E1** to enable echo.*

   - **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.

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:

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

1. Download and install minicom—enter the following command:
   sudo apt-get install minicom
2. When prompted, enter your user password to begin the download and installation. When minicom is installed, the shell prompt appears.
3. Configure minicom to communicate with your modem:
   a. Start minicom with the following command:
      minicom -s
4. Use the down-arrow key to select the **Serial port setup** option.
5. Refer to Step 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.

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

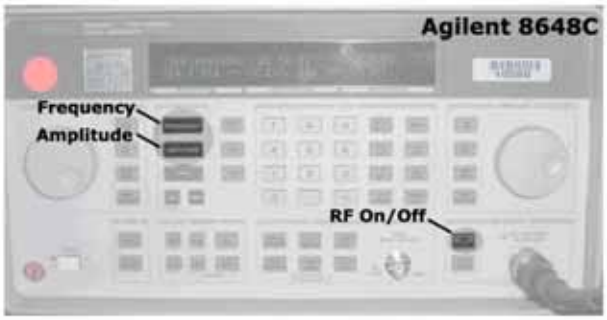
Testing CDMA RF Receive path

Note: This procedure segment is performed in Step 13 of the Production test procedure on page 74.

To test the DUT's receive path:

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:



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. **ATIENTERCND** (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 = 0xFFFFFF33 = -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. **AT!RX2=1** (Turn on diversity receiver.)

g. **AT!RX2AGC?** (Read back the power level, in dBm, from the diversity receiver.)
Response examples:
- RX2AGC = 0xFFFFFF76 = -84 dBm (Signal generator's RF port is OFF)
- RX2AGC = 0xFFFFFFC6 = -69 dBm typical (Signal generator's RF port is ON)

h. **AT!RX=0** (Turn off main receiver.)

i. **AT!RX2=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 ±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

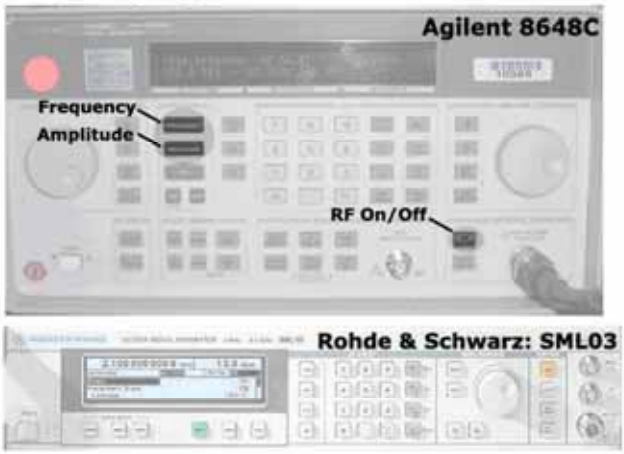
Mode	Test category	Bands		
		B13	B17	B4
LTE	Frequency[a] (MHz)	753.0	742.0	2134.5
	Band	36	37	42
	Channel[b]	23230	23790	20175

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 ±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 LTE7750 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. **AT!ENTERCND** (Unlock extended AT command set.)
   b. **AT!DAFTMACT** (Put modem into factory test mode.)
   c. **AT!DACGPSTESTMODE=1** (Start CGPS diagnostic task.)
   d. **AT!DACGPSSTANDALONE=1** (Enter standalone RF mode.)
   e. **AT!DACGPSMASKON** (Enable log mask.)
   f. **AT!DACGPSCTON** (Return signal-to-noise and frequency measurements.)
   g. Repeat **AT!DACGPSCTON** 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 **!DACGPSCTON** 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 **!DACGPSCTON** readings and use these as a reference for what a marginal/poor signal would be.

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

Table C-2: Extended AT commands (Continued)

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

Table C-2: Extended AT commands (Continued)

Command	Description
!TX	Turn transmitter on/off
!TXAGC	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.

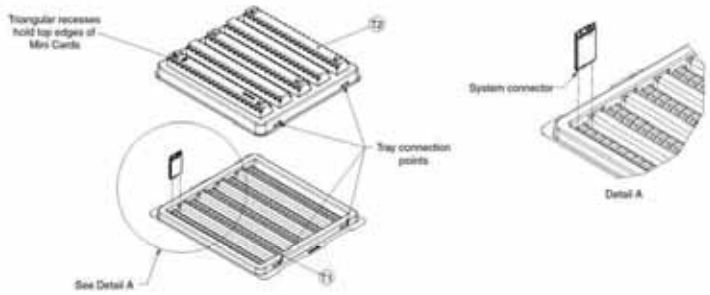


Figure 4-1: Device placement in module tray

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.)

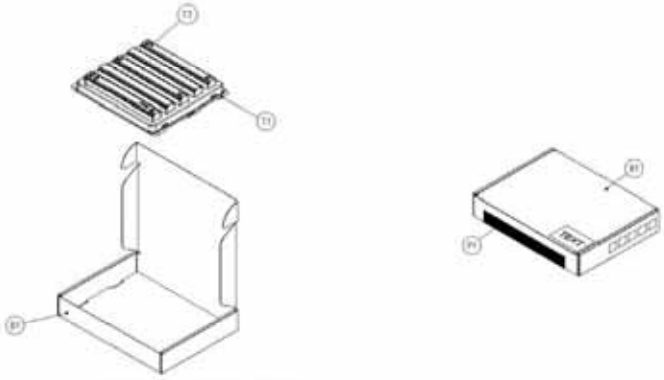


Figure 4-2: Shipping package

E: References

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 www.sierrawireless.com/minicard. To obtain access permission, contact your Sierra Wireless account representative.

Sierra Wireless documents

The following Sierra Wireless documents are available from www.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

F

Table F-1: Acronyms and definitions

Acronym or term	Definition
1xEV-DO	Single Carrier (1X) EVolution – Data Only. A high-speed standard for cellular packet 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 1X.
1X	Single Carrier (1X) Radio Transmission Technology. A high-speed standard for cellular packet 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 1xEV-DO.
3GPP	3rd Generation Partnership Project
8PSK	Octagonal Phase Shift Keying
AGC	Automatic Gain Control
API	Application Programming Interface
BER	Bit Error Rate—A measure of receive sensitivity
BLER	Block Error Rate
bluetooth	Wireless protocol for data exchange over short distances
CAIT	CDMA Air Interface Tool
CDG	CDMA Development Group—a consortium of companies that develop and promote the products and services for CDMA wireless systems.
CDMA	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.
CQI	Channel Quality Indication
COM	Communication port
CS	Circuit-switched
CSA	Canadian Standards Association
CW	Continuous waveform

Table F-1: Acronyms and definitions (Continued)

Acronym or term	Definition
dB	Decibel = 10 x $\log_{10}$ (P1/P2) *P1 is calculated power; P2 is reference power* Decibel = 20 x $\log_{10}$ (V1/V2) *V1 is calculated voltage, V2 is reference voltage*
dBm	A logarithmic (base 10) measure of relative power (dB for decibels); relative to milliwatts (m). A dBm value will be 30 units (1000 times) larger (less negative) than a dBW value, because of the difference in scale (milliwatts vs. watts).
DCS	Digital Cellular System A cellular communication infrastructure that uses the 1.8 GHz radio spectrum.
DL	Downlink (network to mobile)
DRX	Discontinuous Reception
DSM	Distributed Shared Memory
DUT	Device Under Test
EDGE	Enhanced Data rates for GSM Evolution
eHRPD	Evolved High Rate Packet Data—Enhances traditional 1xEV-DO to enable LTE to CDMA handover.
EIRP	Effective (or Equivalent) Isotropic Radiated Power
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ERP	Effective Radiated Power
ESD	Electrostatic Discharge
FCC	Federal Communications Commission The U.S. federal agency that is responsible for interstate and foreign communications. The FCC regulates commercial and private radio spectrum management, sets rates for communications services, determines standards for equipment, and controls broadcast licensing. Consult www.fcc.gov.
FDMA	Frequency Division Multiple Access
FER	Frame Error Rate—A measure of receive sensitivity.
firmware	Software stored in ROM or EEPROM; essential programs that remain even when the system is turned off. Firmware is easier to change than hardware but more permanent than software stored on disk.
FOTA	Firmware Over The Air—Technology used to download firmware upgrades directly from the service provider, over the air.
FOV	Field Of View
FSN	Factory Serial Number—A unique serial number assigned to the mini card during manufacturing.
GCF	Global Certification Forum

Table F-1: Acronyms and definitions (Continued)

Acronym or term	Definition
GLONASS	Global Navigation Satellite System
GMSK	Gaussian Minimum Shift Keying modulation
GND	Ground
GPRS	General Packet Radio Service
GPS	Global Positioning System A system that uses a series of 24 geosynchronous satellites to provide navigational data.
GSM	Global System for Mobile Communications
Host	The device into which an embedded module is integrated
Hz	Hertz = 1 cycle/second
IC	Industry Canada
IF	Intermediate Frequency
IMEI	International Mobile Equipment Identity
IMS	IP Multimedia Subsystem—Architectural framework for delivering IP multimedia services. (LTE7750 supports MO/MT SMS over IMS for LTE/eHRPD.)
inrush current	Peak current drawn when a device is connected or powered on
inter-RAT	Radio Access Technology
IOT	Interoperability Testing
IS	Interim Standard. After receiving industry consensus, the TIA forwards the standard to ANSI for approval.
IS-2000	3G radio standards for voice and data (CDMA only)
IS-95	2G radio standards targeted for voice (cdmaONE)
LED	Light Emitting Diode. A semiconductor diode that emits visible or infrared light.
LHCP	Left-Hand Circular Polarized
LNA	Low Noise Amplifier
LPM	Low Power Mode
LPT	Line Print Terminal
LTE	Long Term Evolution—a high-performance air interface for cellular mobile communication systems.
MCS	Modulation and Coding Scheme
MHz	Megahertz = 10e6 Hz

Table F-1: Acronyms and definitions (Continued)

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

Table F-1: Acronyms and definitions (Continued)

Acronym or term	Definition
RF	Radio Frequency
RI	Ring Indicator
roaming	A cellular subscriber is in an area where service is obtained from a cellular service provider that is not the subscriber's provider.
RSE	Radiated Spurious Emissions
RSSI	Received Signal Strength Indication
SDK	Software Development Kit
SED	Smart Error Detection
Sensitivity (Audio)	Measure of lowest power signal that the receiver can measure.
Sensitivity (RF)	Measure of lowest power signal at the receiver input that can provide a prescribed BER/BLER/SNR value at the receiver output.
SIB	System Information Block
SIM	Subscriber Identity Module. Also referred to as USIM or UICC.
SIMO	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.
SISO	Single Input Single Output—antenna technology that uses a single antenna at both the transmitter side and the receiver side.
SKU	Stock Keeping Unit—identifies an inventory item: a unique code, consisting of numbers or letters and numbers, assigned to a product by a retailer for purposes of identification and inventory control.
SMS	Short Message Service. 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).
S/N	Signal-to-noise (ratio)
SNR	Signal-to-Noise Ratio
SOF	Start of Frame—A USB function.
SSS	Secondary synchronisation signal.
SUPL	Secure User Plane Location
TIA/EIA	Telecommunications Industry Association / Electronics Industry Association. A standards setting trade organization, whose members provide communications and information technology products, systems, distribution services and professional services in the United States and around the world. Consult www.tiaonline.org.
TIS	Total Isotropic Sensitivity

Table F-1: Acronyms and definitions (Continued)

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

Index

Numerics

A

B

C

D

E

F

G

H

I

L

M

N

O

P

Q

R

S

T

U

V

W

Z