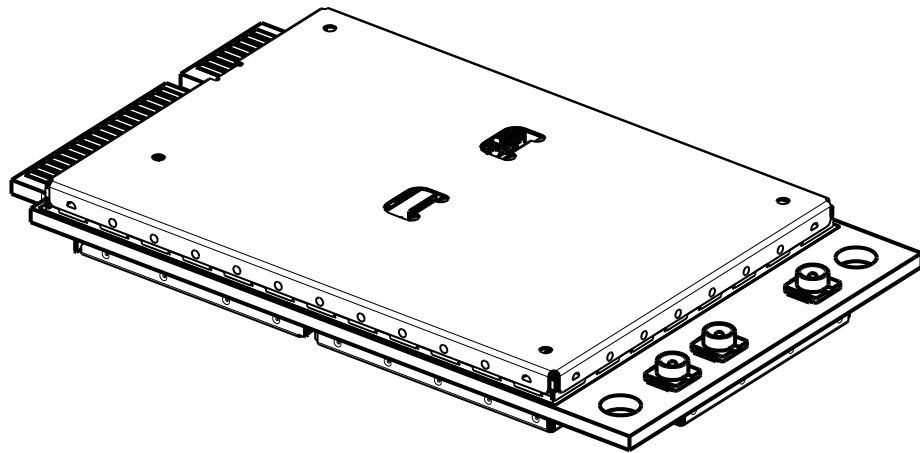




Product Technical Specification & Customer Design Guidelines

AirPrime MC7700



SIERRA
WIRELESS™

2400088

Rev 8

Contents subject to change

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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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Revision History

Revision number	Release date	Changes
1	September 2010	Initial release.
2	November 2010	Updated LTE features, Table 4-1 (GPIOs and pin 20), Table 6-1 , Table 6-2 , Table 6-3
3	March 2011	General review and redraft
4	May 2011	Added LTE Band 1 Changed WAKE_N, GPS_EN_N, W_DISABLE_N, WLAN_LED_N signal names to reflect 'active low'.
5	September 2011	Updated LED table Updated UMTS Tx and Rx test sequences Updated LTE power consumption Added suggested antenna part number
6	January 2013	Updated preface. Added Windows 8 support. Corrected HSDPA data rate category. Corrected GPRS/EDGE class details. Updated current consumption - standby+sleep activated, LPM+sleep deactivated (Table 6-1)
7	February 2013	Updated developer zone URL
8	March 2013	Removed SKU-specific limitations for LTE Band 1 and DC-HSPA+ support

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1: Introduction

The Sierra Wireless MC7700 PCI Express Mini Card is a compact, lightweight, wireless LTE- and UMTS-based modem, designed to be AT&T certified.

The MC7700 provides LTE, DC-HSPA+, HSPA+, HSDPA, HSUPA, WCDMA, GSM, GPRS, EDGE, 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 MDM9200 baseband processor, supports data operation on LTE, DC-HSPA+, HSPA+, EDGE, GPRS, and GSM networks.

Table 1-1: Supported RF bands

Technology	Bands	Diversity
LTE	<ul style="list-style-type: none">Band 1 (2100 MHz)Band 4 (AWS) (1700/2100 MHz)Band 17 (700 MHz)	✓ (MIMO)
UMTS (WCDMA) HSDPA HSUPA HSPA+ DC-HSPA+	<ul style="list-style-type: none">Band 1 (2100 MHz)Band 2 (1900 MHz)Band 5 (850 MHz)Band 6 (800 MHz)	✓
GSM GPRS EDGE	<ul style="list-style-type: none">GSM 850 (850 MHz)GSM 900 (900 MHz)DCS 1800 (1800 MHz)PCS 1900 (1900 MHz)	✗
GPS	<ul style="list-style-type: none">1575.42 MHz	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 and Direct IP)
- **NDIS NIC** interface support for Windows 7, Windows Vista, and Windows XP platforms
- Support for Windows 8 in-box NDIS MBIM driver
- 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)

Packet mode features

- LTE data rates (category 3, MIMO)
 - 100 Mbps **DL** within 20 MHz bandwidth
 - 50 Mbps **UL** within 20 MHz bandwidth
- Circuit-switched data bearers (up to 64 kbps for GSM and UMTS)
- Quad-mode UMTS (WCDMA) / HSDPA / EDGE / GPRS operation
- HSDPA data rates up to category 24
- HSUPA data rates up to category 6
- GPRS multislot class 10
- EDGE multislot class 12

LTE features

- Basic cell selection and system acquisition
 - **PSS/SSS/MIB** decode
 - SIB1–SIB8, SIB10, SIB11 decoding
- NAS/AS security procedures
 - Snow 3G/AES security
- **CQI/RI/PMI** 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

- Detach procedure
 - Network-initiated detach with reattach required
 - Network-initiated detach followed by connection release

Short Message Service (SMS) features

- Mobile-terminated [SMS](#) for UMTS
- Mobile-originated SMS for UMTS
- SMS over SGs (LTE)

Position location ([GPS](#))

- Standalone mode
- A-GPS SUPL1.0
- A-GPS SUPL2.0 (future release)
- GLONASS support on GPS connector 1 (future release)
- DC bias on GPS connector 1 to support external active GPS antenna

Warranty and support

The MC7700 offers the following support features:

- Standard 1-year warranty
- Enabling software (drivers, [SDK](#), etc.) for Android, Linux, Windows 8, 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 91](#).

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 connectors¹

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

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 MC7700 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 63](#).

- **Service provisioning**—Manufacturing process
- **Software**—As discussed in [Software Interface on page 55](#).
- **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/20 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

UMTS

The Universal Mobile Telecommunications System (UMTS) specification is the 3G mobile systems standard based on an evolution of GSM core network components. High-speed 3G systems implementing the UMTS standard enable improved performance for wireless data applications, delivery of enhanced multimedia content, and improved network capacity to support additional subscribers.

HSPA

HSPA is a third generation (3G) evolution of WCDMA that combines two extensions to UMTS—HSDPA (High Speed Downlink Packet Access) and HSUPA (High Speed Uplink Packet Access).

HSPA+

HSPA+ is an enhanced version of HSPA (High Speed Packet Access), as defined by the 3rd Generation Partnership Project (3GPP) Release 7 UMTS Specification for Mobile Terminated Equipment. Using improved modulation schemes and refined data communication protocols, HSPA+ permits increased uplink and downlink data rates.

DC-HSPA+

Dual-Carrier HSPA+ is an enhanced version of HSPA+, as defined by the 3GPP Release 8 UMTS Specification for Mobile Terminated Equipment. DC-HSPA+ uses paired spectrum allocations to double the bandwidth available and, therefore, double downlink data rates.

GPRS / EDGE

GPRS and EDGE are 2G wireless technologies providing end-to-end [packet](#) data services through reuse of existing GSM infrastructure.

Note: The network controls slot assignments based on current network loads and the bandwidth required by the mobile device - users cannot change slot assignments.

GPRS / EDGE packet data rates are determined by the number of timeslots available for downlink (Rx) and uplink (Tx), and the coding scheme used for any given transmission.

The MC7700 supports:

- All standardized coding schemes (CS 1 to CS 4, and MCS1 to MCS9)
- Multislot class 10 (GPRS)
 - 2 Tx slots (maximum); 4 Rx slots (maximum)
 - Up to 5 active slots
 - No backoff
- Multislot class 12 (EDGE)
 - 4 Tx slots (maximum); 4 Rx slots (maximum)
 - Up to 5 active slots
 - For MCS1-4 (GMSK), up to 6dB backoff used for Tx slots 3 and 4

Table 2-1: Supported GPRS / EDGE power classes

Feature	Notes
EGSM 900/GSM 850 Power Class 4	2 W, 33 dBm
GSM 1800 / 1900 Power Class 1	1 W, 30 dBm
EDGE Power Class for 850/900MHz	Class E2 ¹ 27 dBm, 0.5 W
EDGE Power Class for 1800 / 1900MHz	Class E2 ¹ 26 dBm, 0.4 W

1. E2 power class applies to 8PSK modulation.

3: Standards Compliance

The MC7700 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">• 3GPP Release 8
UMTS	<ul style="list-style-type: none">• 3GPP Release 5• 3GPP Release 6• 3GPP Release 7• 3GPP Release 8
GSM/GPRS/EDGE	<ul style="list-style-type: none">• 3GPP Release 99• GERAN Feature Package #1

4: Electrical Specifications

The system block diagram in [Figure 4-1](#) represents the MC7700 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 MC7700 that disables the main RF radio.
- **GPS_EN_N**—Active low input from a hardware switch to the MC7700 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 39](#). 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 MC7700 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.

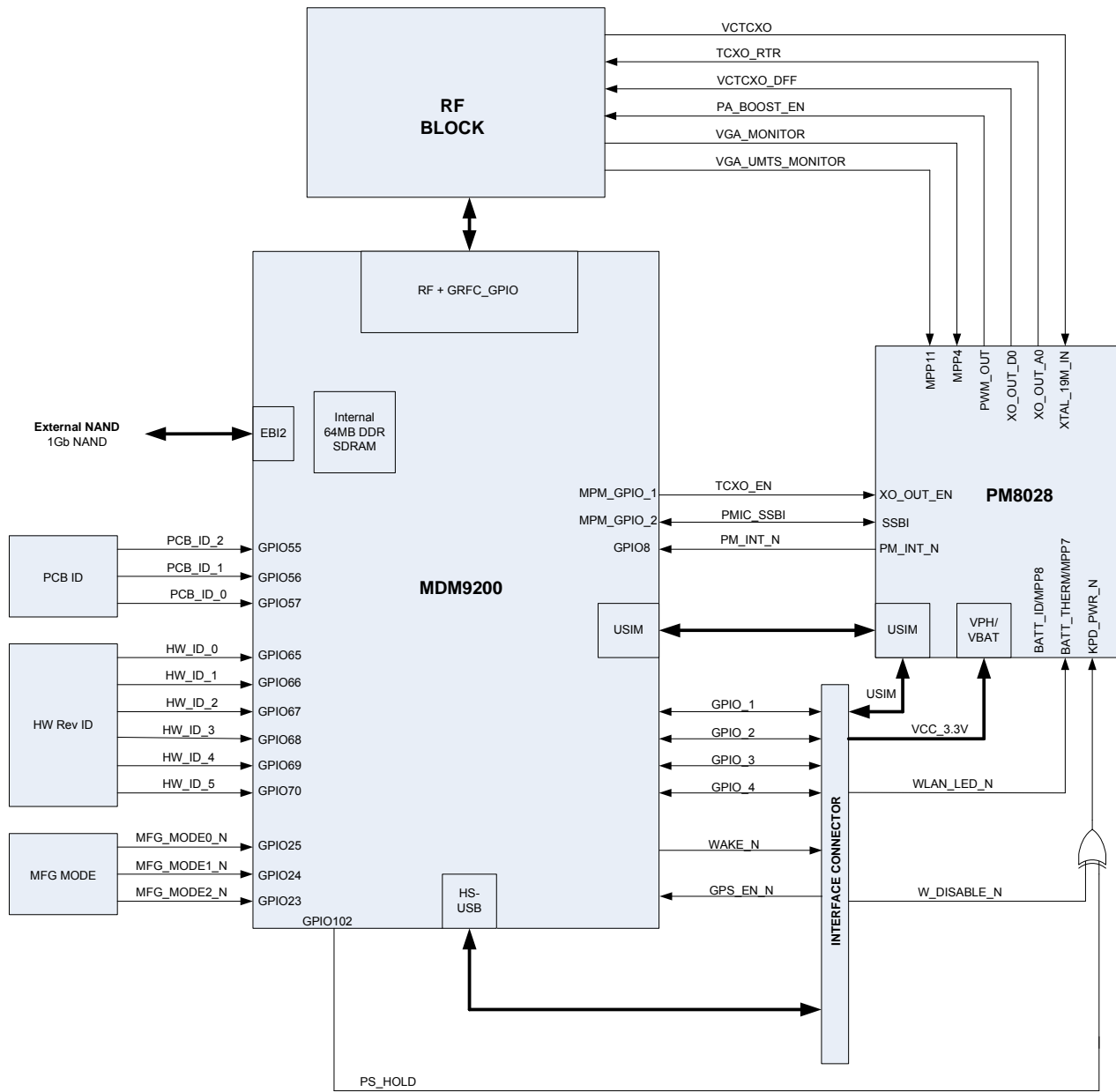


Figure 4-1: System block diagram

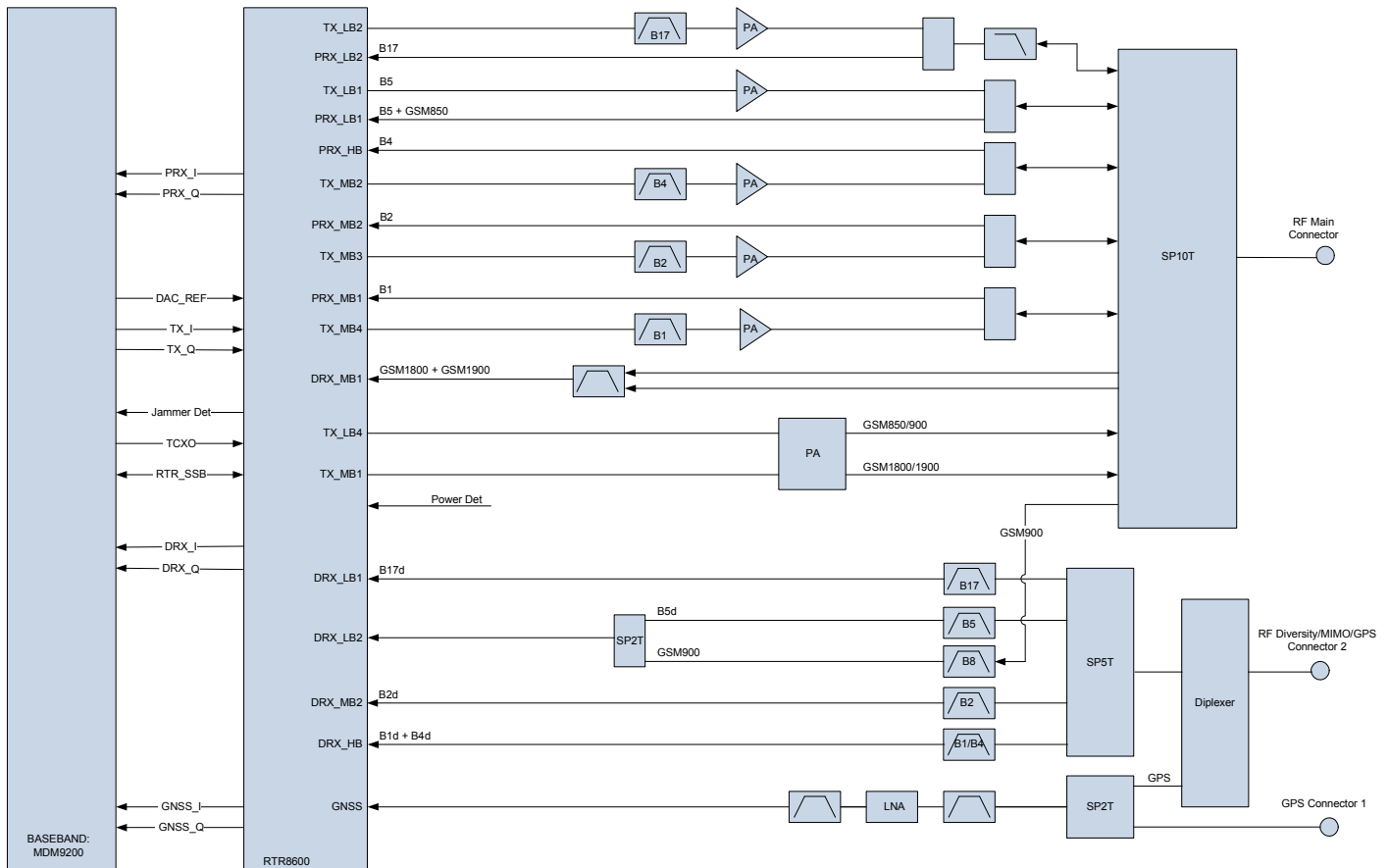


Figure 4-2: Expanded RF block diagram

Host interface pin assignments

The MC7700 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 31
- [Table 4-3, USB interface](#), on page 31
- [Table 4-4, SIM interface signal](#), on page 32
- [Table 4-5, Module control signals](#), on page 35

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 assignments¹

Pin	Signal name	Pin type ²	Description	Direction to module	Active state	Voltage levels (V)		
						Min	Typ	Max
1	WAKE_N ³		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 assignments¹ (Continued)

Pin	Signal name	Pin type ²	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 assignments¹ (Continued)

Pin	Signal name	Pin type ²	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 ³	-	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. 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
3. 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 MC7700 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 Table 4-1 on page 28 .			
		Ripple voltage	-	-	100	mV _{pp}
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 [11] *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 33](#). Voltage levels over this interface comply with 3GPP standards.

Table 4-4: SIM interface signal

Name	Pin	Description	SIM contact number ¹	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 33](#) for SIM card contacts.

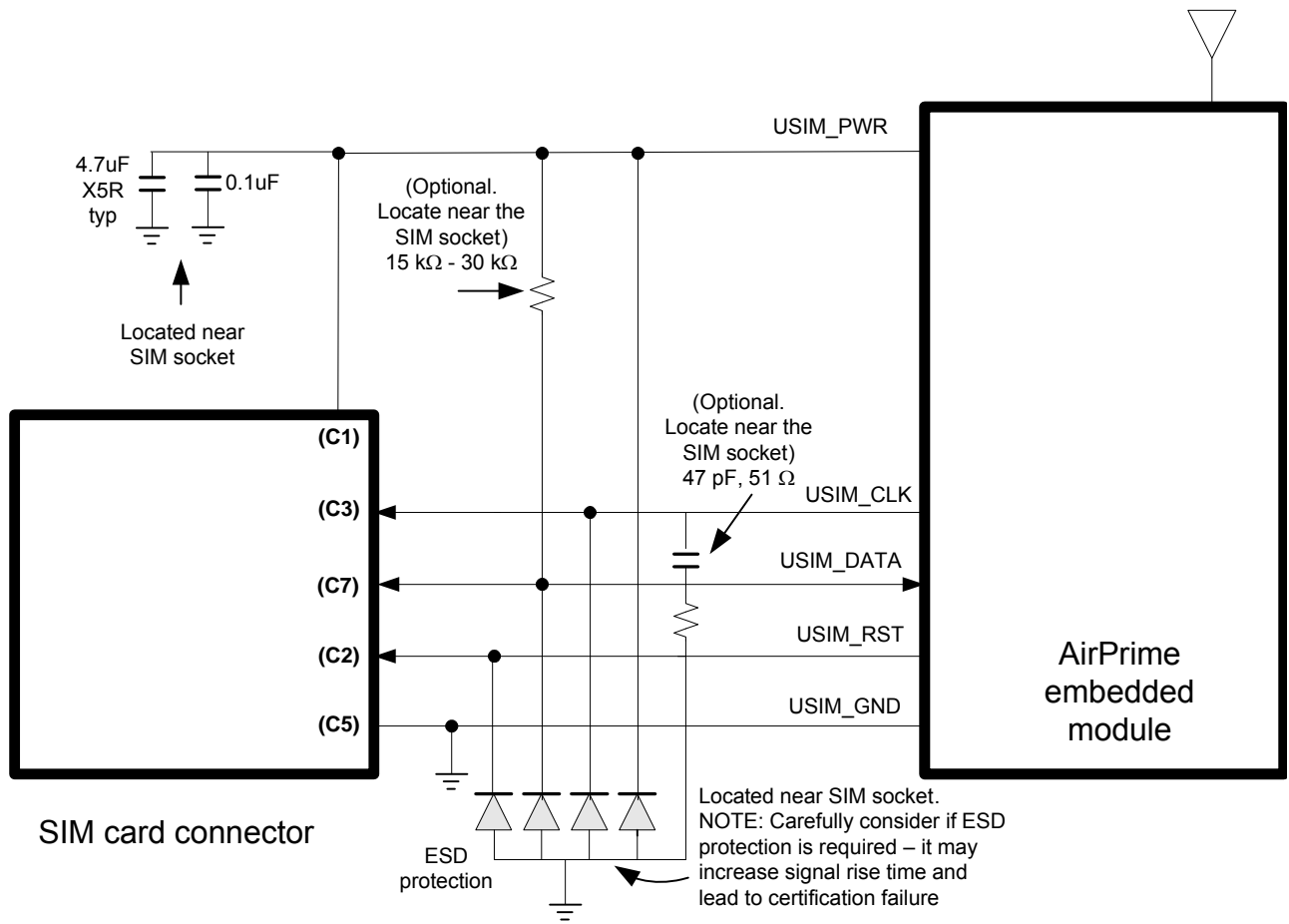


Figure 4-3: SIM application interface

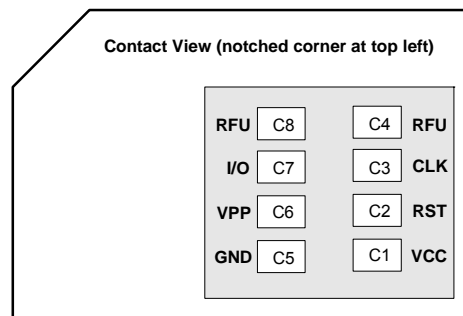


Figure 4-4: SIM card contacts (contact view)

SIM implementation

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

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

Some design recommendations include:

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

Control interface (Signals)

The MC7700 provides signals for:

- Waking the host when specific events occur
- 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 ¹
WAKE_N ²	1	Wake host	O
W_DISABLE_N	20	Wireless disable (Main RF)	PU
WLAN_LED_N	42	LED driver	O
GPS_EN_N ²	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 Ω –100 k Ω 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 35](#) for a recommended implementation.

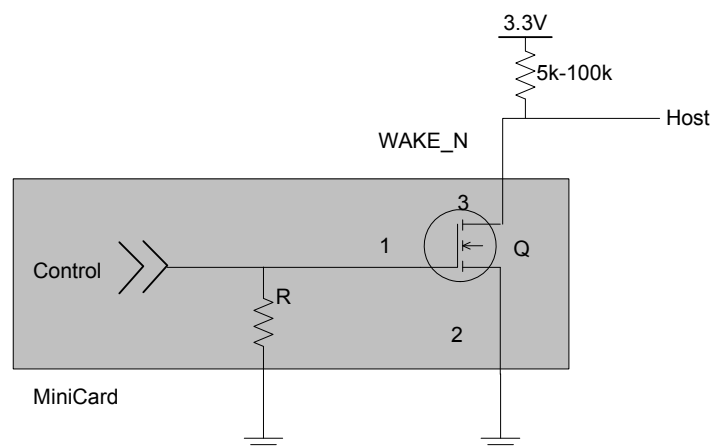


Figure 4-5: Recommended WAKE_N connection

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 [10] *PCI Express Mini Card Electromechanical Specification Revision 1.2*. These pins have 20 kΩ pull-up resistors. See [Figure 4-6 on page 36](#) 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.

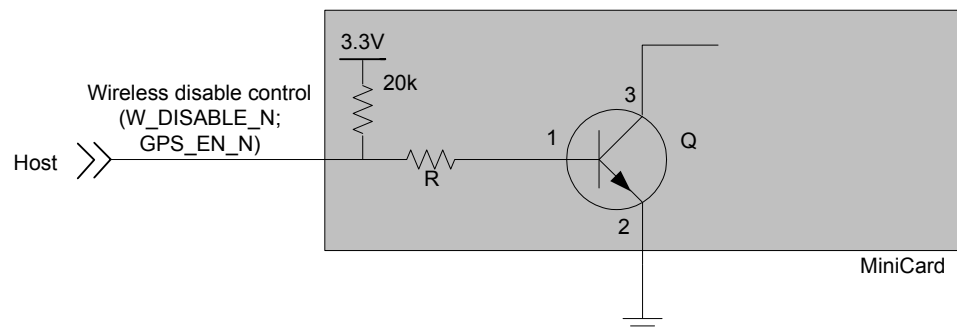


Figure 4-6: Recommended wireless disable connection

WLAN_LED_N—LED output

The module drives the LED output according to [10] *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

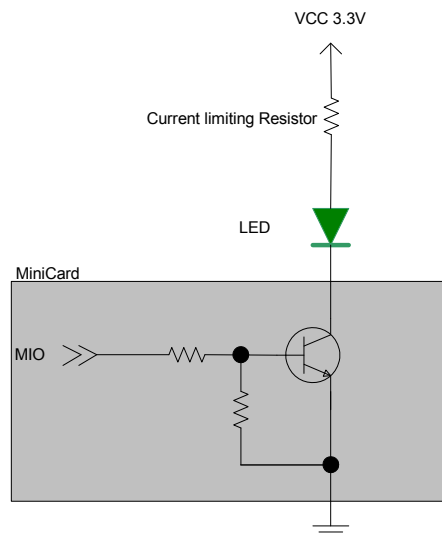


Figure 4-7: Example LED

Digital interface

The MC7700 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 ^{1,2}
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 MC7700 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.

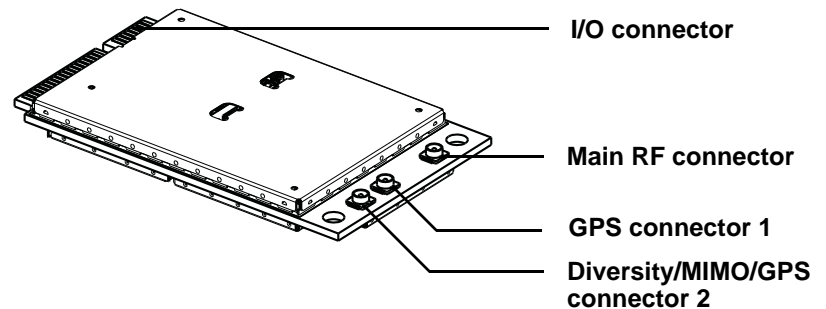


Figure 5-1: Module connectors

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 39](#).
- Match coaxial connections between the module and the antenna to 50 Ω .
- Minimize RF cable losses to the antenna; the recommended maximum cable loss for antenna cabling is 0.5 dB.
- To ensure best thermal performance, if possible use the mounting holes to attach (ground) the device to the main PCB ground or a metal chassis.

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

Shielding

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

*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.*

Antenna and cabling

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

Note: For detailed electrical performance criteria, see [Appendix A: Antenna Specification](#) on page 67.

Choosing the correct antenna and cabling

When matching antennas and cabling:

- The antenna (and associated circuitry) should have a nominal impedance of 50 Ω with a 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 Ω impedance. If the impedance of the module is mismatched, RF performance is reduced significantly.
- Antenna cables should be routed, if possible, away from noise sources (switching power supplies, LCD assemblies, etc.). If the cables are near the noise sources, the noise may be coupled into the RF cable and into the antenna. See [Interference from other wireless devices on page 41](#).

Disabling the diversity antenna

- Use the AT command `IRXDEN=0` to disable receive diversity or `IRXDEN=1` to enable receive diversity.

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

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 39](#)).
- 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 42](#)) and radiated sensitivity measurement ([Radiated sensitivity measurement on page 43](#)).

Note: The MC7700 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.

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:

- CE/ETSI EN 301 908 (WCDMA), test numbers 5.3.1 ('Radiated Emissions (UE)')
- CE/ETSI EN 301 511 (GSM), test 5.2.16 ('Radiated Spurious Emissions - MS allocated a channel'). This test uses the procedure and requirement outlined in 3GPP 51.010 (GSM) section 12.2.1 of the same test name.

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.)

Note: GSM spurious emissions are most likely to have RSE issues, but in general, RSE requirements must be met on all models with user-designed antennas.

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](#)).

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

Sensitivity vs. frequency

Sensitivity is defined as the input power level in dBm that produces a BER (Bit Error Rate) of 2% (GSM) or 0.1% (UMTS). Sensitivity should be measured at all GSM / UMTS frequencies across each band.

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

Supported frequencies

The MC7700 supports:

- Dual-band LTE—See [Table 5-1 on page 44](#).
- Quad-band WCDMA/HSDPA/HSUPA/HSPA+/DC-HSPA+—See [Table 5-3 on page 44](#).
- Quad-band WCDMA receive diversity
- Quad-band GSM/GPRS/EGPRS—See [Table 5-4 on page 44](#).
- 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 1	Tx: 1920–1980 MHz Rx: 2110–2170 MHz
Band 4 (AWS)	Tx: 1710–1755 MHz Rx: 2110–2155 MHz
Band 17	Tx: 704–716 MHz Rx: 734–746 MHz

Table 5-2: LTE bandwidth support¹

Band	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
Band 1	✗	✗	✓	✓	✓	✓
Band 4 (AWS)	✓	✓	✓	✓	✓	✓
Band 17	✗	✗	✓ ²	✓ ²	✗	✗

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: WCDMA frequency band support¹

Band	Frequencies
Band 1 WCDMA 2100	Tx: 1920–1980 MHz Rx: 2110–2170 MHz
Band 2 WCDMA 1900	Tx: 1850–1910 MHz Rx: 1930–1990 MHz
Band 5 WCDMA 850	Tx: 824–849 MHz Rx: 869–894 MHz
Band 6 WCDMA 800	Tx: 830–840 MHz Rx: 875–885 MHz

1. WCDMA channel spacing is 5 MHz, but this can be adjusted to optimize performance in a particular deployment scenario.

Table 5-4: GSM frequency band support

Band	Frequencies
GSM 850	Tx: 824–849 MHz Rx: 869–894 MHz
EGSM 900	Tx: 880–915 MHz Rx: 925–960 MHz

Table 5-4: GSM frequency band support (Continued)

Band	Frequencies
GSM 1800	Tx: 1710–1785 MHz Rx: 1805–1880 MHz
GSM 1900	Tx: 1850–1910 MHz Rx: 1930–1990 MHz

Conducted Rx sensitivity / Tx power

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

LTE bands		Conducted Rx sensitivity (dBm)			
		Primary (Typical)	Secondary (Typical)	SIMO (Typical)	SIMO ¹ (Worst case)
LTE Band 1	Full RB BW: 10 MHz ²	-98.5	-98.5	-101.5	-96.3
LTE Band 4		-97.5	-99.0	-100.0	-96.3
LTE Band 17		-98.0	-98.5	-100.0	-93.3

1. Per 3GPP specification
2. Sensitivity values scale with bandwidth:
 $x_MHz_Sensitivity = 10_MHz_Sensitivity - 10 \cdot \log(10 \text{ MHz}/x_MHz)$
 Note: Bandwidth support is dependent on firmware version.

Table 5-6: Conducted Rx (Receive) sensitivity — UMTS bands

UMTS bands		Conducted Rx sensitivity (dBm)		
		Primary (Typical)	Secondary (Typical)	Primary/Secondary (Worst case)
Band 1 (UMTS 2100)	0.1% BER 12.2 kbps	-111.5	-111.5	-106.7
Band 2 (UMTS 1900)		-111.0	-108.0	-104.7
Band 5 (UMTS 850)		-111.0	-109.0	-106.7
Band 6 (UMTS 800)		-111.0	-109.0	-106.7

Table 5-7: Conducted Rx (Receive) sensitivity — GSM/EDGE bands

GSM/EDGE bands		Conducted Rx sensitivity (dBm)		
		Typical	Worst case	
GSM 850	2% BER	CS ¹	-109	-102
	10% BLER	GMSK (CS1)	-111	-104
		EDGE (MCS5)	-102	-98
EGSM 900	2% BER	CS ¹	-109	-102
	10% BLER	GMSK (CS1)	-111	-104
		EDGE (MCS5)	-102	-98

Table 5-7: Conducted Rx (Receive) sensitivity— GSM/EDGE bands

GSM/EDGE bands			Conducted Rx sensitivity (dBm)	
			Typical	Worst case
DCS 1800	2% BER	CS ¹	-108	-102
	10% BLER	GMSK (CS1)	-111	-104
		EDGE (MCS5)	-101	-98
PCS 1900	2% BER	CS ¹	-108	-102
	10% BLER	GMSK (CS1)	-111	-104
		EDGE (MCS5)	-101	-98

1. CS=Circuit Switched

Table 5-8: Conducted Tx (Transmit) power tolerances

Parameter	Conducted transmit power (dBm)	Notes
LTE		
LTE Band 1	+22 ± 1	
LTE Band 4 LTE Band 17	+23 ± 1	
UMTS		
Band 1 (IMT 2100 12.2 kbps) Band 2 (UMTS 1900 12.2 kbps) Band 5 (UMTS 850 12.2 kbps) Band 6 (UMTS 800 12.2 kbps)	+23 ± 1	Connectorized (Class 3)
GSM / EDGE		
GSM850 CS GSM900 CS	+32 ± 1	GMSK mode, connectorized (Class 4)
	+27 ± 1	8PSK mode, connectorized (Class E2)
DCS1800 CS PCS1900 CS	+29 ± 1	GMSK mode, connectorized (Class 1)
	+26 ± 1	8PSK mode, connectorized (Class E2)

GPS specifications

Note: For detailed electrical performance criteria, see [Recommended GPS antenna specifications on page 69](#).

Table 5-9: GPS specifications ¹

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
Sensitivity	Tracking ² : -161 dBm Acquisition ³ (Assisted): -158 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 MC7700 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 31](#).

Table 6-1: Averaged standby DC power consumption¹

Signal	Description	Bands ²	Current ³			Notes / configuration	
			Typ	Max ⁴	Unit		
VCC	Standby current consumption (Sleep mode activated⁵)						
	LTE	LTE Bands	3.2	7	mA	DRX cycle = 8 (2.56 s)	
	HSDPA / WCDMA	UMTS bands	3.2	7	mA	DRX cycle = 8 (2.56 s)	
	GSM / GPRS / EDGE	GSM bands	3.9	6	mA	MFRM = 5 (1.175 s)	
	Standby current consumption (Sleep mode deactivated⁵)						
	LTE	LTE bands	55	65	mA		
	HSDPA / WCDMA	UMTS bands	55	60	mA	DRX cycle = 8 (2.56 s)	
	GSM / GPRS / EDGE	GSM bands	65	70	mA	MFRM = 5 (1.175 s)	
	Low Power Mode (LPM)/Offline Mode (Sleep mode activated⁵)						
	RF disabled, but module is operational			2.5	3.0	mA	
	Low Power Mode (LPM)/Offline Mode (Sleep mode deactivated⁵)						
	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 44, [Table 5-3, WCDMA frequency band support](#), on page 44, and [Table 5-4, GSM frequency band support](#), on page 44.
3. All measurements are preliminary.
4. Measured at 30°C/nominal voltage.
5. Assumes USB bus is fully suspended during measurements

Table 6-2: Averaged call mode DC power consumption (LTE/WCDMA/HSUPA)¹

Signal	Description	Band ²	Current		Notes / configuration
			Max ³	Unit	
VCC	Data current consumption (includes USB bus current)				
	LTE category 3	LTE bands	1100	mA	<ul style="list-style-type: none"> 100/50 Mbps—23 dBm Tx power Over temperature (worst case measured at upper/lower temperature extreme) Bandwidth ≤ 10 MHz Continuous data traffic
			+150	mA	Additional current draw for 20MHz bandwidth (if supported by band/operator)
	WCDMA	UMTS bands	750	mA	384 kbps at 20 dBm Tx power ⁴
			300	mA	0 dBm Tx power
	HSUPA (1.8/3.6/7.2/21.1 Mbps)	UMTS bands	800	mA	All speeds at 20 dBm Tx power ⁵
450			mA	0 dBm Tx power	

1. All measurements are preliminary values
2. For supported bands, see [Table 5-1, LTE frequency band support](#), on page 44, [Table 5-3, WCDMA frequency band support](#), on page 44, and [Table 5-4, GSM frequency band support](#), on page 44.
3. Measured at 30°C/nominal voltage.
4. Highest current is on Band 2 (PCS1900)
5. Approximate current difference between speeds = 30 mA

Table 6-3: Averaged call mode DC power consumption (GSM/EDGE)¹

Signal	Description	Band	Current		Output power for number of timeslots (dBm)			
			Max ²	Unit	1	2	3	4
VCC	Data current consumption (assumes USB bus current)							
	GSM / GPRS	850/900/ 1800/1900	700	mA	32	32	n/a	n/a
	EDGE	850/900	550	mA	27	27	27	27
		1800/1900			26	26	26	26
Peak current (averaged over 100 μs)	GSM bands	2.75	A	n/a	n/a	n/a	n/a	

1. All measurements are preliminary values.
2. Measured at 30°C/nominal voltage.

Table 6-4: Miscellaneous DC power consumption¹

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 _L = 50 pF on D+ and D- signals
	Inrush current	750	3000	mA	<ul style="list-style-type: none"> Assumes power supply turn on time > 100μs Dependent on host power supply rise time.
GPS signal connector	Active bias on GPS port		3.3 (100 mA)	V	GPS connector 1 in Figure 5-1 on page 39 .

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

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"> Host keeps module powered off by driving W_DISABLE_N low Module draws minimal current See W_DISABLE_N and GPS_EN_N — Wireless disable on page 36 for more information.] 	✓	✗	✗	✗
Disconnected	<ul style="list-style-type: none"> Host power source is disconnected from the module and all voltages associated with the module are at 0 V. 	✗	✗	✗	✗

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 ¹		Notes
	Trigger	v ²	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

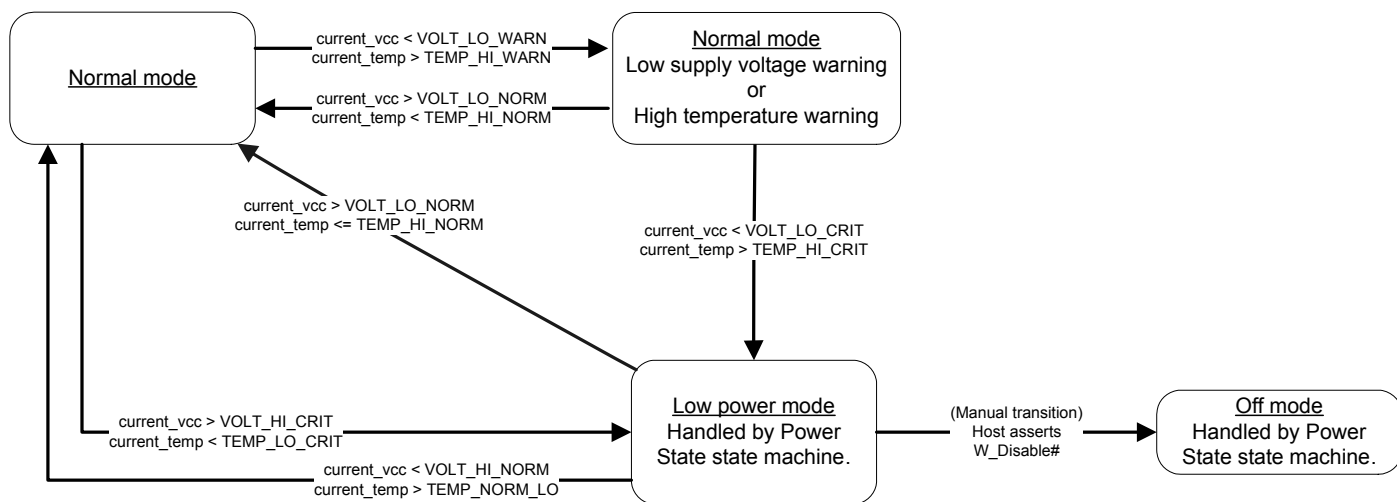


Figure 6-1: Voltage/temperature monitoring state machines

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 53 illustrates the power-up timing sequence.

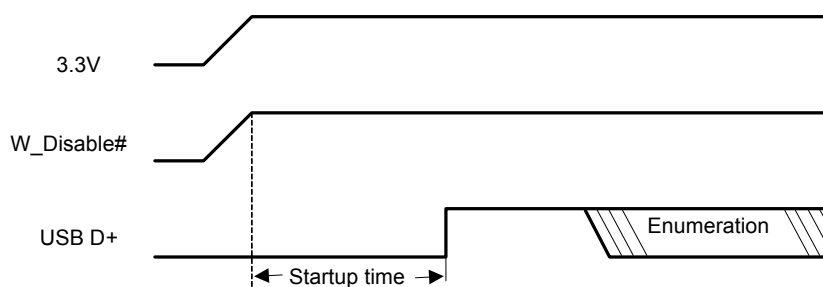


Figure 6-2: Power-up timing diagram

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

Transmit power waveform (GSM)

As shown in [Figure 6-3](#), at maximum GSM transmit power, the input current can remain at 2.4 A for up to 25% of each 4.6 ms GSM cycle (1.15 ms) after reaching an initial peak of 2.75 A (average over 100 μ s, with an instantaneous peak current of 3.5 A). For class 12 operation, the peak could remain for 2.3 ms (four timeslots).

The 2.4 A current draw is for 50 ohm systems (1:1 VSWR). For worst-case antenna designs (3.5:1 VSWR), the current draw could increase to 2.75 A, as shown in the diagram. Beyond 3.5:1 VSWR, the current draw could increase to 3.5 A.

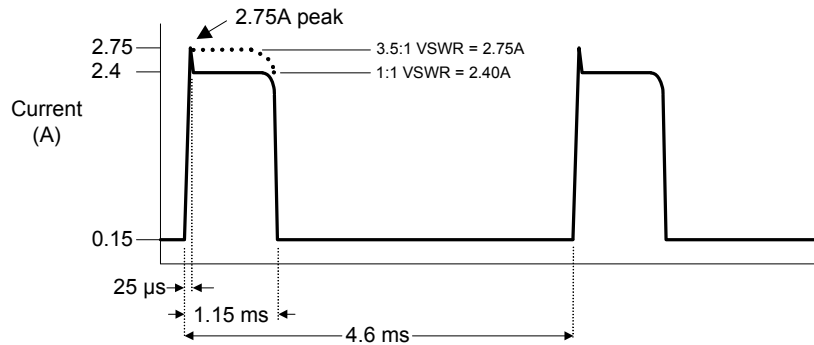


Figure 6-3: GSM transmit power waveform (class 10 operation)

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

Support tools

The MC7700 is compatible with the following support tools from Sierra Wireless and authorized third parties:

- Firmware update utilities from Sierra Wireless
- QXDM from QUALCOMM
- QUALCOMM Product Support Tool (QPST)
- Windows and Linux SDKs (including API and drivers)

USB interface

The device supports two USB interface types—the Sierra Wireless Direct IP high speed interface supported by previous generation minicard devices, and the Qualcomm QMI interface. The interfaces are not supported simultaneously—device configuration changes are required to switch between the interface types.

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

8: Mechanical and Environmental Specifications

The MC7700 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 59.)	Operational	The RF port (antenna launch and RF connector) complies with the IEC 61000-4-2 standard: <ul style="list-style-type: none"> Electrostatic Discharge Immunity: Test: Level3 Contact Discharge: ±6 kV Air Discharge: ±8 kV
	Non-operational	The host connector Interface complies with the following standards only: <ul style="list-style-type: none"> +/- 1 kV Human Body Model (JESD22-A114-B) +/- 125 V Charged Device Model (JESD22-C101)
Thermal considerations		See Thermal considerations on page 60.
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

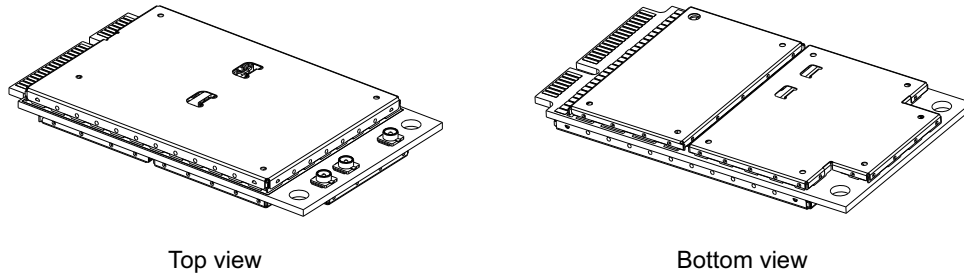


Figure 8-1: Top and bottom views

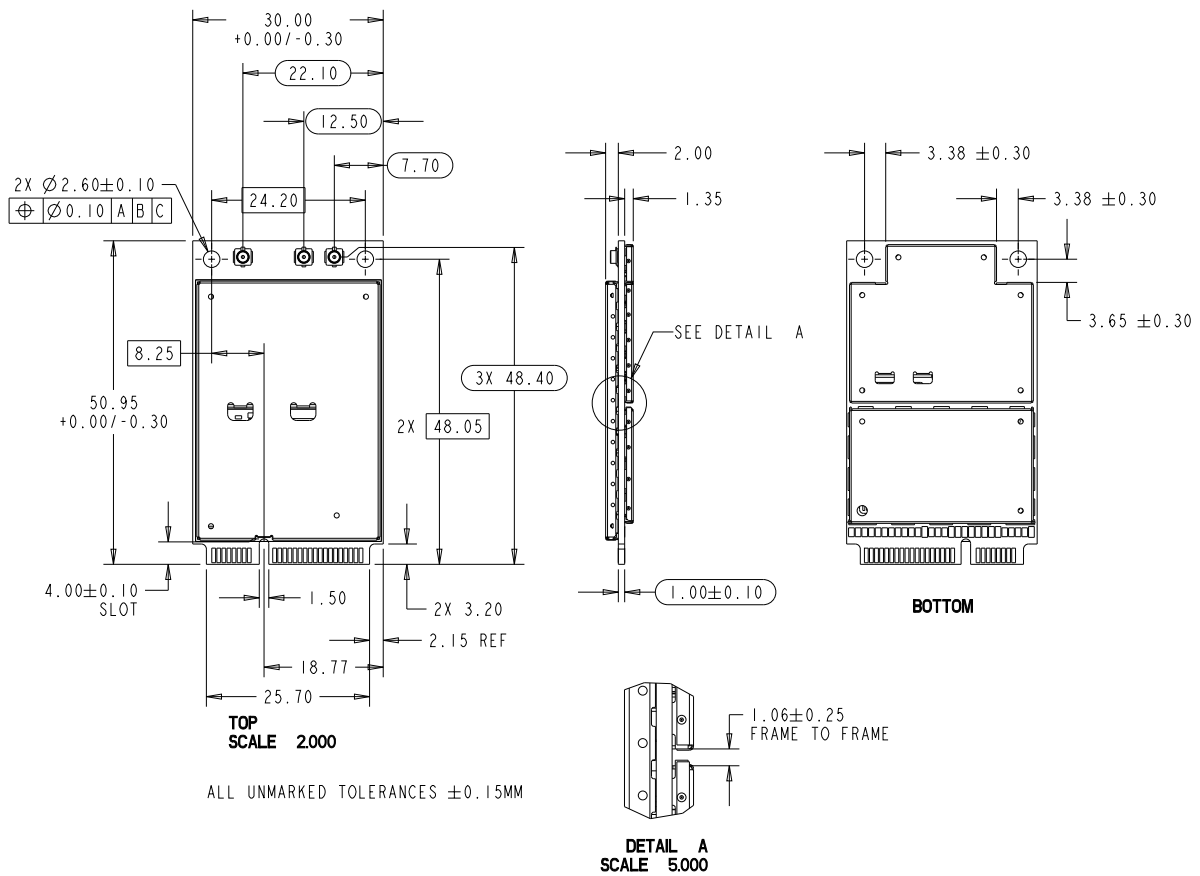


Figure 8-2: Dimensioned view

Labeling



Figure 8-3: Unit label

Note: The displayed label is an example only. The production label will vary by **SKU**.

The MC7700 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 MC7700 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 57](#) 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.

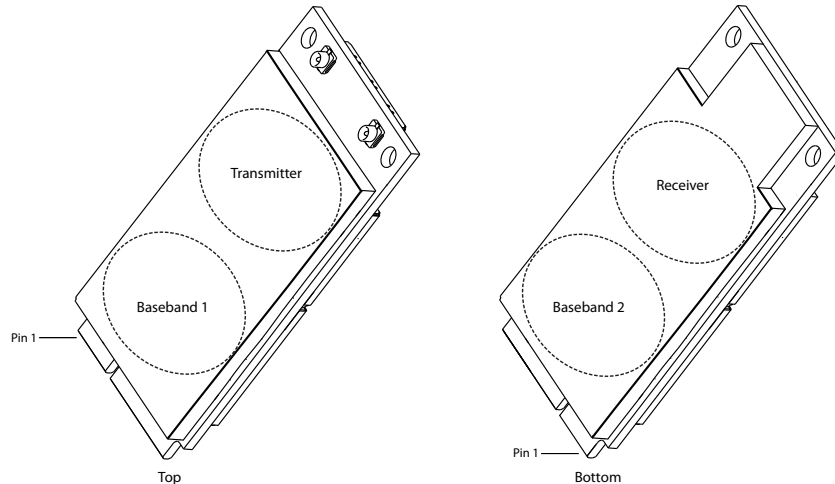


Figure 8-4: Shield locations

The amount of thermal dissipation required depends on:

- Supply voltage—Maximum power dissipation for the module can be up to 3.1 W (or 3.5 W in HSPA+ mode) at voltage supply limits.
- 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 [10] PCI Express Mini Card Electromechanical Specification Revision 1.2.

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 60](#) (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 73](#).)

9: Regulatory and Industry Approvals

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

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:

- PTCRB

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 MC7700 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 MC7700 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 MC7700 modem **MUST BE**

POWERED OFF. Otherwise, the MC7700 modem can transmit signals that could interfere with this equipment.

In an aircraft, the MC7700 modem **MUST BE POWERED OFF.** Otherwise, the MC7700 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 MC7700 modem may be used normally at this time.

Important compliance information for North American users

Note: Details are preliminary and subject to change.

The MC7700 modem has been granted modular approval for mobile applications. Integrators may use the MC7700 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.

1. At least 20 cm separation distance between the antenna and the user's body must be maintained at all times.
2. 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:
 - 7.5 dBi in Cellular band
 - 3 dBi in PCS band
 - 5.5 dBi in LTE Band 4
 - 9 dBi in LTE Band 17 (Note: LTE Band 17 is not permitted in Canada.)
3. The MC7700 modem and its antenna must not be co-located or operating in conjunction with any other transmitter or antenna within a host device.
4. A label must be affixed to the outside of the end product into which the MC7700 modem is incorporated, with a statement similar to the following:
 - **This device contains FCC ID: N7NMC7700**
Contains transmitter module IC: 2417C-MC7700 where 2417C-MC7700 is the module's certification number.
5. A user manual with the end product must clearly indicate the operating requirements and conditions that must be observed to ensure compliance with current FCC / IC RF exposure guidelines.

The end product with an embedded MC7700 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.

»» 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 ^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 69 .
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	<ul style="list-style-type: none"> 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 I MEG1 / MEG2 I	< 2 dB for MIMO operation < 6 dB for diversity operation	
Maximum antenna gain	To be determined by the RF exposure requirements and ERP/ EIRP limits, where applicable.	
Isolation between Ant1 and Ant2 (S21)	> 10 dB	<ul style="list-style-type: none"> • If antennas can be moved, test all positions for both antennas. • Make sure all other wireless devices (Bluetooth or WLAN antennas, etc.) are turned OFF to avoid interference.
Power handling	<ul style="list-style-type: none"> • > 2 W RF power on low bands • > 1 W on high bands 	<ul style="list-style-type: none"> • Measure power endurance over 4 hours (estimated talk time) using a 2 W CW signal—set the CW test signal frequency to the middle of the PCS Tx band (1880 MHz for PCS). • Visually inspect device to ensure there is no damage to the antenna structure and matching components. • VSWR/TIS/TRP measurements taken before and after this test must show similar results.

- a. These worst-case VSWR figures for the transmitter bands may not guarantee RSE levels to be within regulatory limits. The device alone meets all regulatory emissions limits when tested into a cabled (conducted) 50 ohm system. With antenna designs with up to 2.5:1 VSWR or worse, the radiated emissions could exceed limits. The antenna system may need to be tuned in order to meet the RSE limits as the complex match between the module and antenna can cause unwanted levels of emissions. Tuning may include antenna pattern changes, 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	<ul style="list-style-type: none"> 1575.42 MHz \pm2 MHz minimum 1565–1606 MHz recommended 	
Field of view (FOV)	<ul style="list-style-type: none"> Omni-directional in azimuth -45° to +90° in elevation 	
Polarization (average Gv/Gh)	> 0 dB	Vertical linear polarization is sufficient.
Free space average gain (Gv+Gh) over FOV	> -6 dBi (preferably > -3 dBi)	Gv and Gh are measured and averaged over -45° to +90° in elevation, and \pm 180° in azimuth.
Gain	<ul style="list-style-type: none"> Maximum gain and uniform coverage in the high elevation angle and zenith. Gain in azimuth plane is not desired. 	
Average 3D gain	> -5 dBi	
Isolation between 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 67](#) and [Table A-2 on page 69](#):

- 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 34
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 34
Minimize RF cable losses as these affect performance values listed in product specification documents.	RF connections on page 39
Antennas	
Match the module/antenna coax connections to 50 Ω —mismatched antenna impedance and cable loss negatively affect RF performance.	RF connections on page 39
If installing CDMA and UMTS modules in the same device, consider using separate antennas for maximum performance.	Antenna and cabling on page 40
Power	
Make sure the power supply can handle the maximum current specified for the module type.	Power consumption on page 49
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 34
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 34
EMI/ESD	
Investigate sources of localized interference early in the design cycle.	Methods to mitigate decreased Rx performance on page 42

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 34
Keep very low capacitance traces on the USIM_DATA and USIM_CLK signals.	SIM implementation on page 34
To minimize noise leakage, establish a very good ground connection between the module and host.	Ground connection on page 41
Route cables away from noise sources (for example, power supplies, LCD assemblies, etc.).	Methods to mitigate decreased Rx performance on page 42
Shield high RF-emitting components of the host device (for example, main processor, parallel bus, etc.).	Methods to mitigate decreased Rx performance on page 42
Use discrete filtering on low frequency lines to filter out unwanted high-order harmonic energy.	Methods to mitigate decreased Rx performance on page 42
Use multi-layer PCBs to form shielding layers around high-speed clock traces.	Methods to mitigate decreased Rx performance on page 42
Thermal	
Test to worst case operating conditions—temperature, voltage, and operation mode (transmitter on 100% duty cycle, maximum power).	Thermal considerations on page 60
Use appropriate techniques to reduce module temperatures (for example, airflow, heat sinks, heat-relief tape, module placement, etc.).	Thermal considerations on page 60
Host/Modem communication	
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 63](#).

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 74](#) 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 78](#) 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 85](#).
12. Test RF transmission, if desired:
 - (UMTS) See [UMTS RF transmission path test on page 79](#).
 - (LTE) To test the LTE transmission path, use a call box.
13. Test RF reception, if desired:
 - (UMTS) See [UMTS RF receive path test on page 81](#).
 - (LTE) See [LTE RF receive path test on page 83](#).
14. Test standalone GPS functionality—See [GPS standalone connector test on page 84](#).
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 76 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 76).

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

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

UMTS RF transmission path test

Note: This procedure segment is performed in [Step 12](#) of the [Production test procedure on page 76](#).

[Table C-1](#) contains parameters used in the suggested test procedure that follows.

Table C-1: Test settings—Transmission path

Mode	Test category	Bands				
		850	900	1800	1900	2100
WCDMA	Band	22	29	n/a	15 ^a	9
	Channel ^b	4182	2812	n/a	9400	9750
GSM	Band	18	10	11	12	n/a
	Channel ^b	190	65	697	661	n/a

- a. Either 15 (WCDMA1900A) or 16 (WCDMA1900B) may be used for testing.
- b. Channel values shown are at the center of the corresponding bands.

To test the DUT's transmitter path:

1. Set up the power meter:



- a. Make sure the meter has been given sufficient time to warm up, if necessary, to enable it to take accurate measurements.
 - b. Zero-calibrate the meter.
 - c. Enable MAP mode.
2. Prepare the DUT using the following AT commands:
 - a. `ATIINTERCND=<password>` (Unlock extended AT command set.)
 - b. `ATIDAFTMACT` (Enter test mode.)
 - c. `ATIDASBAND=<bandValue>` (Set frequency band.)
 - See [Table C-1](#) for appropriate <bandValue> values

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

- d. **ATIDASCHAN=<channel>** (Set modem channel)
 - See [Table C-1](#) for appropriate <channel> values
 - e. (GSM mode only)
ATIDAGSTXFRAME=0, 1, 3000, 0 (Set Tx frame structure.)
 - f. **ATIDASTXON** (Turns on the transmit path.)
 - g. (WCDMA mode only)
ATIDAWSTXCW=0 (Use a modulated carrier.)
ATIDASPDM=2, 75 (Set the power level. Repeat command with different offsets until desired Tx power is obtained.)
ATIDAWSPARANGE=3 (Set to high PA gain state.)
 - h. Offset the tracking (If necessary, repeat with different offsets until the desired frequency is obtained.)
(WCDMA mode) **AT!DASPDM=4,35100**
(GSM mode) **AT!DASPDM=0,2240**
 - i. Take the measurement.
 - j. **ATIDASTXOFF** (Turn off the transmitter.)
3. Test limits—Run ten or more good DUTs through this test procedure to obtain a nominal output power value.
- Apply a tolerance of ± 5 to 6 dB to each measurement (assuming a good setup design).
 - Monitor these limits during mass-production ramp-up to determine if further adjustments are needed.
 - For GSM mode, the transmit signal is bursted, so the transmit power will appear averaged on the power meter reading.

Note: The module has a nominal output power of +23 dBm ± 1 dB in WCDMA mode. However, the value measured by the power meter is significantly influenced (beyond the stated ± 1 dB output power tolerance) by the test setup (host RF cabling loss, antenna efficiency and pattern, test antenna efficiency and pattern, and choice of shield box).

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

UMTS RF receive path test

Note: This procedure segment is performed in [Step 13](#) of the [Production test procedure on page 76](#).

[Table C-2](#) contains parameters used in the suggested test procedure that follows.

Table C-2: Test settings—Receive path

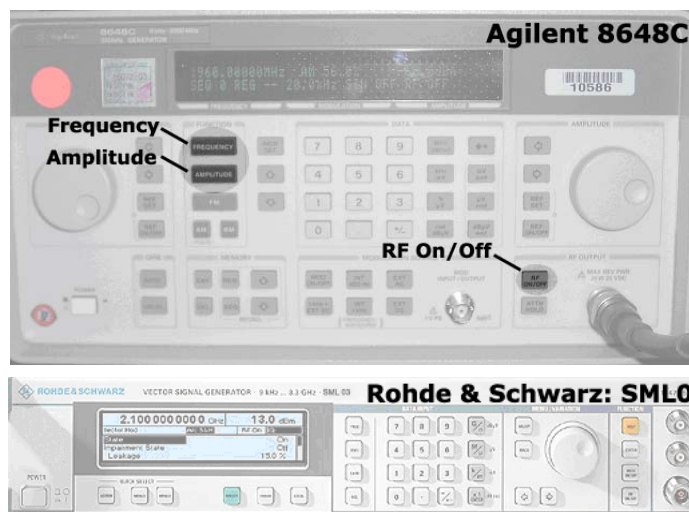
Mode	Test category	Bands				
		850	900	1800	1900	2100
WCDMA	Frequency ^a (MHz)	882.60	948.60	n/a	1961.2	2141.2
	Band	22	29	n/a	15 ^b	9
	Channel ^c	4182	2812	n/a	9400	9750
GSM	Frequency ^d (MHz)	881.667	948.067	1842.267	1960.067	n/a
	Band	18	10	11	12	n/a
	Channel ^c	190	65	697	661	n/a

- All values offset from actual center channel by +1.2 MHz
- Either 15 (WCDMA1900A) or 16 (WCDMA1900B) may be used for testing.
- Channel values shown are at the center of the corresponding bands.
- All values offset from actual center channel by +67 kHz

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.

- Set up the signal generator:



- Set the amplitude to:
 - 80 dBm (WCDMA mode)
 - 60 dBm (GSM mode)
- Set the frequency for the band being tested. See [Table C-2](#) for frequency values.

2. Set up the DUT:
 - a. **ATIINTERCND** (Unlock extended AT command set.)
 - b. **ATIDAFTMACT** (Put modem into factory test mode.)
 - c. **ATIDASBAND=<band>** (Set frequency band.)
 - See [Table C-2 on page 81](#) for <band> values
 - d. **ATIDASCHAN=<channel>** (Set modem channel)
 - See [Table C-2 on page 81](#) for <channel> values
 - e. **ATIDASLNAGAIN=0** (Set the LNA to maximum gain.)
 - f. (WCDMA mode)
 - i. **ATIDAWGAVGAGC=9400,0** (For PCS1900, channel 9400 as an example.)
(GSM mode)
 - ii. **ATIDAGSRXBURST=0** (Set to receive bursted mode.)
 - iii. **ATIDAGGAVGRSSI=190,0** (For channel 190, for example.)The returned value is the RSSI in dBm.
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).

Note: Diversity is not available in GSM mode.

*Note: Setup of the DUT is the same as in [Step 2](#), except for a change to **ATIDAWGAVGAGC** and the addition of **ATIDAWSSCHAIN**.*

4. Test diversity paths:
 - a. Set up the signal generator as in [Step 1](#).
 - b. Set up the DUT:
 - i. **ATIINTERCND** (Unlock extended AT command set.)
 - ii. **ATIDAFTMACT** (Put modem into factory test mode.)
 - iii. **ATIDASBAND=<band>** (Set frequency band.)
 - See [Table C-2 on page 81](#) for <band> values
 - iv. **ATIDAWSSCHAIN=1** (Enable the secondary chain.)
 - v. **ATIDASCHAN=<channel>** (Set modem channel)
 - See [Table C-2 on page 81](#) for <channel> values
 - vi. **ATIDASLNAGAIN=0** (Set the LNA to maximum gain.)
 - vii. **ATIDAWGAVGAGC=9400,0,1** (The '1' indicates the diversity path is used.)
 - c. Test the limits as in [Step 3](#).

LTE RF receive path test

Note: This procedure segment is performed in [Step 13](#) of the [Production test procedure on page 76](#).

[Table C-3](#) contains parameters used in the suggested test procedure that follows.

Table C-3: 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

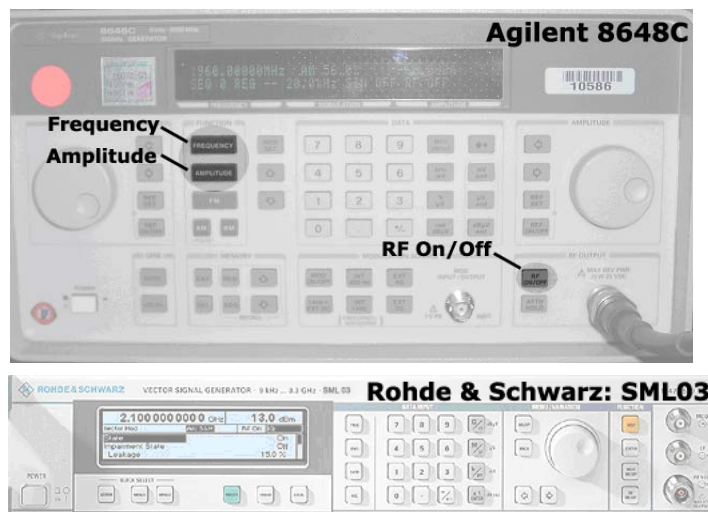
a. All values offset from actual center channel by +2 MHz

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-3](#) 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-3 on page 83](#) for <band> values

- d. **ATIDASCHAN=<channel>** (Set modem channel)
 - See [Table C-3 on page 83](#) for <channel> values
 - e. **ATIDALGAVGAGC=<channel>,0** (Get averaged Rx AGC)
 - See [Table C-3 on page 83](#) 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 MC7700 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 Mini Card 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 **!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
- UMTS:
 - RF sensitivity testing—BER/BLER for different bands and modes
 - Transmitter and receiver tests (based on relevant sections of the 3GPP TS51010 and 3GPP 34121 documents)

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-4 on page 86](#).

Table C-4: 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	
!DAFTMACT	Put the modem into FTM (Factory Test Mode)
!DAFTMDEACT	Put the modem into online mode
!DAGRSSI	Return the RSSI (Received Signal Strength Indicator) in dBm (GSM mode)

Table C-4: Extended AT commands (Continued)

Command	Description
!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
!DAGSTXBURST	Set the GSM transmitter to burst mode
!DAGSTXFRAME	Set the GSM Tx frame structure
!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)
!OSDSM	Display memory usage for DSM (Distributed Shared Memory) buffer pools

»» 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.

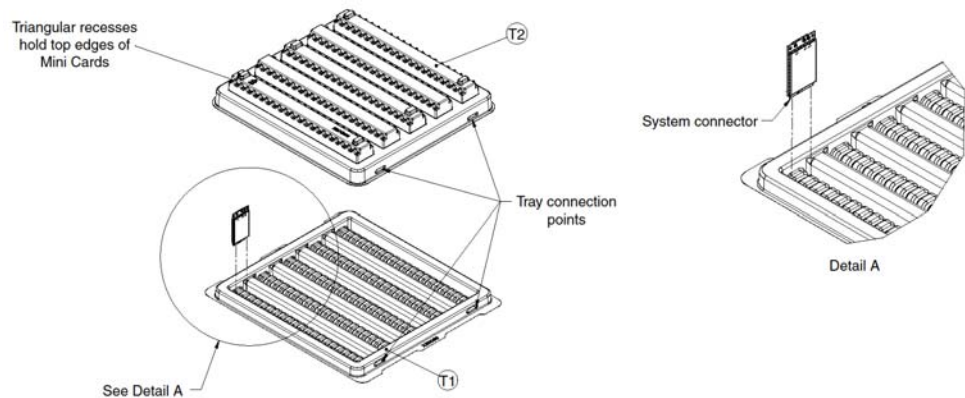


Figure 4-1: Device placement in module tray

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](#).)

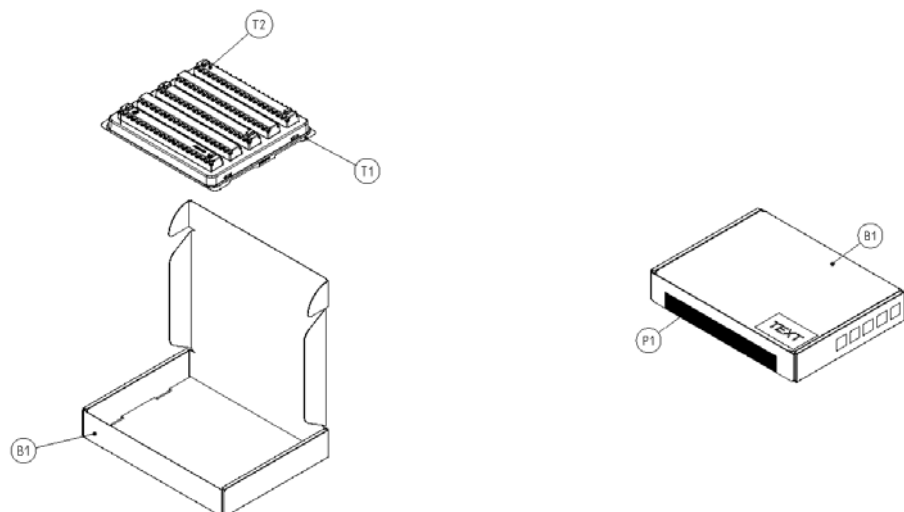


Figure 4-2: Shipping package

»» | 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.

Sierra Wireless documents

The following Sierra Wireless documents are available from 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] FCC Regulations - Part 15 - Radio Frequency Devices
- [7] IEC-61000-4-2 level 3
- [8] IEC-61000-4-2 level (Electrostatic Discharge Immunity Test)
- [9] Mobile Station (MS) Conformance Specification; Part 4:
Subscriber Interface Module (Doc# 3GPP TS 11.10-4)
- [10] PCI Express Mini Card Electromechanical Specification Revision
1.2
- [11] Universal Serial Bus Specification, Rev 2.0

[12] JESD22-A114-B

[13] JESD22-C101

»» F: Acronyms



Table F-1: Acronyms and definitions

Acronym or term	Definition
3GPP	3rd Generation Partnership Project
8PSK	Octagonal Phase Shift Keying
AGC	Automatic Gain Control
A-GPS	Assisted GPS
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
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
dB	Decibel = $10 \times \log_{10} (P1/P2)$ <i>P1 is calculated power; P2 is reference power</i> Decibel = $20 \times \log_{10} (V1/V2)$ <i>V1 is calculated voltage, V2 is reference voltage</i>
dBm	A logarithmic (base 10) measure of relative power (dB for decibels); relative to milliwatts (m). A dBm value will be 30 units (1000 times) larger (less negative) than a dBW value, because of the difference in scale (milliwatts vs. watts).
DC-HSPA+	Dual Carrier HSPA+
DCS	Digital Cellular System A cellular communication infrastructure that uses the 1.8 GHz radio spectrum.
DL	Downlink (network to mobile)
DRX	Discontinuous Reception

Table F-1: Acronyms and definitions (Continued)

Acronym or term	Definition
DSM	Distributed Shared Memory
DUT	Device Under Test
EDGE	Enhanced Data rates for GSM Evolution
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.
FOV	Field Of View
FSN	Factory Serial Number—A unique serial number assigned to the mini card during manufacturing.
GCF	Global Certification Forum
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
HSDPA	High Speed Downlink Packet Access
HSPA+	Enhanced HSPA, as defined in 3GPP Release 7 and beyond
HSUPA	High Speed Uplink Packet Access

Table F-1: Acronyms and definitions (Continued)

Acronym or term	Definition
Hz	Hertz = 1 cycle/second
IC	Industry Canada
IF	Intermediate Frequency
IMEI	International Mobile Equipment Identity
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-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
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
OTA	'Over the air' (or radiated through the antenna)

Table F-1: Acronyms and definitions (Continued)

Acronym or term	Definition
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
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
RF	Radio Frequency
RI	Ring Indicator
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.
SG	An LTE signaling interface for SMS (“SMS over SGs”)
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.

Table F-1: Acronyms and definitions (Continued)

Acronym or term	Definition
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
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

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