



AirPrime Intelligent Embedded Modules

Hardware Integration Guide



SIERRA
WIRELESS

2130114
Rev 2.0

Important Notice

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

Safety and Hazards

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

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

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

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

Limitation of Liability

The information in this manual is subject to change without notice and does not represent a commitment on the part of Sierra Wireless. SIERRA WIRELESS AND ITS AFFILIATES SPECIFICALLY DISCLAIM LIABILITY FOR ANY AND ALL DIRECT, INDIRECT, SPECIAL, GENERAL, INCIDENTAL, CONSEQUENTIAL, PUNITIVE OR EXEMPLARY DAMAGES INCLUDING, BUT NOT LIMITED TO, LOSS OF PROFITS OR REVENUE OR ANTICIPATED PROFITS OR REVENUE ARISING OUT OF THE USE OR INABILITY TO USE ANY SIERRA WIRELESS PRODUCT, EVEN IF SIERRA WIRELESS AND/OR ITS AFFILIATES HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES OR THEY ARE FORESEEABLE OR FOR CLAIMS BY ANY THIRD PARTY.

Notwithstanding the foregoing, in no event shall Sierra Wireless and/or its affiliates aggregate liability arising under or in connection with the Sierra Wireless product, regardless of the number of events, occurrences, or claims giving rise to liability, be in excess of the price paid by the purchaser for the Sierra Wireless product.

Patents

Portions of this product may be covered by some or all of the following US patents:

| | | | | | |
|-----------|-----------|-----------|-----------|-----------|-----------|
| 5,515,013 | 5,629,960 | 5,845,216 | 5,847,553 | 5,878,234 | 5,890,057 |
| 5,929,815 | 6,169,884 | 6,191,741 | 6,199,168 | 6,339,405 | 6,359,591 |
| 6,400,336 | 6,516,204 | 6,561,851 | 6,643,501 | 6,653,979 | 6,697,030 |
| 6,785,830 | 6,845,249 | 6,847,830 | 6,876,697 | 6,879,585 | 6,886,049 |
| 6,968,171 | 6,985,757 | 7,023,878 | 7,053,843 | 7,106,569 | 7,145,267 |
| 7,200,512 | 7,295,171 | 7,287,162 | D442,170 | D459,303 | D599,256 |
| D560,911 | | | | | |

and other patents pending.

This product includes technology licensed from QUALCOMM® 3G

Manufactured or sold by Sierra Wireless or its licensees under one or more patents licensed from InterDigital Group.

Copyright

©2010 Sierra Wireless. All rights reserved.

Trademarks

AirCard® and Watcher® are registered trademarks of Sierra Wireless. Sierra Wireless™, AirPrime™, AirLink™, AirVantage™ and the Sierra Wireless logo are trademarks of Sierra Wireless.

Windows® and Windows Vista® are registered trademarks of Microsoft Corporation.

Macintosh and Mac OS are registered trademarks of Apple Inc., registered in the U.S. and other countries.

QUALCOMM® is a registered trademark of QUALCOMM Incorporated. Used under license.

Other trademarks are the property of their respective owners.

Contact Information

| | | |
|-------------|---|---------------------------------|
| Sales Desk: | Phone: | 1-604-232-1488 |
| | Hours: | 8:00 AM to 5:00 PM Pacific Time |
| | E-mail: | sales@sierrawireless.com |
| Post: | Sierra Wireless 13811 Wireless Way Richmond, BC Canada V6V 3A4 | |
| Fax: | 1-604-231-1109 | |
| Web: | www.sierrawireless.com | |

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

www.sierrawireless.com

Revision History

| Revision number | Release date | Changes |
|-----------------|----------------|---|
| 1.5 | July 2007 | <ul style="list-style-type: none"> Added 8780/81 content Added SED description Fixed details about capacitance Added connector pin details |
| 1.6 | Unreleased | |
| 1.7 | April 2008 | <ul style="list-style-type: none"> Removed references to RUIM (MC57xx products) Removed "Diversity antenna must fold down" (Diversity antenna design requirements on page 93). Removed references to MC5720, MC8755, MC8755V, and MC8765. Corrected LED characteristics (Faster blink on page 58) Added content for MC5725, MC5725V, and MC8785V |
| 1.8 | September 2008 | <ul style="list-style-type: none"> Added content for MC8790, MC8790V, MC8791V, and MC8792V |
| 1.9 | October 2008 | <ul style="list-style-type: none"> Added AT command entry timing note and Linux content to testing chapter Corrected range for external pull up resistor in Figure 5-2 on page 60 |
| 1.10 | February 2009 | <ul style="list-style-type: none"> Added MC5728V Added AUX (HAC) and TTY to supported operating modes |
| 1.11 | July 2009 | <ul style="list-style-type: none"> Added Brazil regulatory details Added MC8700 Removed MC8785V |
| 1.12 | Unreleased | |
| 1.13 | December 2009 | <ul style="list-style-type: none"> Added MC8795V Removed GPS from MC8700 |
| 1.14 | March 2010 | <ul style="list-style-type: none"> Added MC5728V Important Signal Considerations - Application Note on page 103. Updated the MC5728V info: Electrostatic discharge (ESD) on page 18; CDMA transmitting and shutdown numbers (Table 2-3, Current specifications (MC57xx), on page 27). Updated Figure 4-2, MC5728V Audio system block, on page 50. Uses new template (layout/formatting changes) |
| 2.0 | April 2010 | <ul style="list-style-type: none"> Added MC8201 Additional branding/formatting changes Removed MC5725/25V Removed sensitivity graphs for UMTS devices (portrayed data already found in Table 5-2 on page 56) Improved presentation of UMTS device RF Parameters (Table 3-2 on page 37) |



Contents

| | |
|--|-----------|
| Introduction | 11 |
| The Universal Development Kit | 12 |
| Required connectors | 12 |
| Guide organization | 12 |
| Related documents | 13 |
| | |
| Power Interface | 17 |
| Overview of operation | 17 |
| Power signals | 17 |
| Electrostatic discharge (ESD) | 18 |
| Module power states | 18 |
| Disconnected state | 19 |
| Off state | 19 |
| Normal state | 19 |
| Low power state | 19 |
| Voltage monitoring state machine | 20 |
| Temperature monitoring state machine | 22 |
| Inrush currents | 24 |
| Timing requirements | 25 |
| Power ramp-up | 25 |
| Power-up timing | 25 |
| Transmit power wave form (GSM) | 26 |
| Current consumption | 26 |
| Current consumption overview | 27 |
| Modes | 35 |
| SED (Smart Error Detection) | 35 |
| Usage models | 36 |
| | |
| RF Integration | 37 |
| RF connection | 39 |

| | |
|--|-----------|
| Ground connection | 40 |
| Shielding | 40 |
| Antenna and cabling | 40 |
| Interference and sensitivity | 41 |
| Power supply noise | 41 |
| Interference from other wireless devices | 42 |
| Device-generated RF | 42 |
| Methods to mitigate decreased Rx performance | 43 |
| Radiated sensitivity measurement. | 43 |
| Sierra Wireless' sensitivity testing and desensitization investigation . . . | 43 |
| OTA test chamber configuration | 43 |
| Path loss calculation | 44 |
| Positioning the DUT (Device Under Test) | 45 |
| Sensitivity vs. frequency | 45 |
| Audio Interface | 47 |
| System block diagrams | 48 |
| MC5727V system block | 48 |
| MC5728V system block | 49 |
| MC8775V/MC8790V/MC8791V/MC8792V/MC8795V system block . . . | 50 |
| Modes of operation | 51 |
| Sidetone support | 51 |
| Gain distribution. | 52 |
| Echo cancellation support | 52 |
| Audio signal interface | 53 |
| Audio function partitioning | 54 |
| Host/Module Interfaces | 55 |
| Host interface pin details | 55 |

| | |
|--|-----------|
| USB interface | 56 |
| USB handshaking | 57 |
| LED output | 58 |
| USIM interface | 59 |
| USIM operation | 61 |
| Extended AT commands | 62 |
| Thermal Considerations | 65 |
| Design Checklist | 67 |
| Testing | 69 |
| AT command entry timing requirement | 69 |
| Acceptance testing | 69 |
| Acceptance test requirements | 70 |
| Acceptance test procedure | 70 |
| Certification testing | 70 |
| Production testing | 71 |
| Suggested manual functional test procedure | 71 |
| Suggested production test plan procedure | 72 |
| Testing RF transmission path—MC57xx | 76 |
| Testing RF transmission path—MC8xxx | 77 |
| Testing RF Receive path—MC57xx | 79 |
| Testing RF Receive path—MC8xxx | 81 |
| Testing GPS Receiver—MC8775V | 83 |
| Test Audio Loop-back—MC5727V/MC5728V/MC8775V/MC8790V/ MC8791V/MC8792V/MC8795V | 84 |
| Quality assurance testing | 86 |
| Suggested testing equipment | 87 |
| Antenna Specification | 91 |
| Required antennas | 91 |
| Frequency bands | 92 |

| | |
|---|------------|
| Antenna design | 93 |
| General antenna design requirements | 93 |
| Main antenna design requirements | 93 |
| Diversity antenna design requirements | 93 |
| GPS antenna design requirements | 94 |
| Testing | 94 |
| Voltage Standing Wave Ratio (VSWR) | 95 |
| Radiated efficiency | 96 |
| Antenna-to-antenna isolation | 96 |
| Peak gain and radiation patterns | 97 |
| Fading correlation coefficient | 97 |
| Regulatory Information. | 99 |
| Important notice | 99 |
| Safety and hazards | 99 |
| Important compliance information for North American users. | 100 |
| EU regulatory conformity | 101 |
| Brazil ANATEL homologation | 102 |
| MC5728V Important Signal Considerations - Application Note | 103 |
| MDL_RESET_N — Module reset input | 103 |
| W_Disable# — Wireless disable | 104 |
| Acronyms and Definitions | 105 |
| Index. | 107 |

1: Introduction

Sierra Wireless' AirPrime Intelligent Embedded Modules form the radio component for the products in which they are embedded. [Table 1-1](#) identifies embedded modules that are available for use on CDMA and GSM networks.

Table 1-1: CDMA and UMTS AirPrime Intelligent Embedded Modules

| Device | Networks | Network standards | GPS features | | | | | |
|--|----------|--|--------------|--------|-------------|-------|--------|----------------|
| | | | Stand-alone | gpsOne | gpsOne XTRA | A-GPS | Nav2.0 | NMEA sentences |
| MC5727 MC5727V MC5728V | CDMA | CDMA IS-95 1X 1xEV-DO (IS-856) | ✓ | ✓ | | ✓ | ✓ | ✓ |
| MC8201 | GSM | GSM, GPRS, EDGE, UMTS, HSDPA | | | | | | |
| MC8700 | GSM | GSM, GPRS, EDGE, UMTS, HSDPA, HSUPA, HSPA+ | | | | | | |
| MC8775 MC8775V | GSM | GSM, GPRS, EDGE, UMTS, HSDPA | ✓ | | | | | |
| MC8780 MC8781 MC8790 MC8790V MC8791V MC8792V MC8795V | GSM | GSM, GPRS, EDGE, UMTS, HSDPA, HSUPA | ✓ | | ✓ | ✓ | ✓ | ✓ (5) |

Note: Throughout this document, MC57xx and MC8xxx refer to the entire suites (as listed in [Table 1-1](#)) of CDMA and UMTS AirPrime embedded modules respectively.

Note: An understanding of network technology, and experience in integrating hardware components into electronic equipment is assumed.

Purpose of this guide

This guide addresses issues that affect the integration of AirPrime embedded modules into host products, and includes design recommendations for the host products.

The Universal Development Kit

Sierra Wireless manufactures a Universal Development Kit (UDK) that facilitates all phases of the integration process.

This kit is a hardware development platform that is designed to support the AirPrime embedded modules listed in [Table 1-1](#) on page 11. It contains the hardware components that are typically necessary for evaluating and developing with the module, including:

- Development board
- Cables
- Antennas
- Other accessories

For instructions on setting up the UDK, see *PCI Express Mini Card Dev Kit Quick Start Guide (Document 2130705)*.

Required connectors

Note: Contact vendors before choosing your connectors—the numbers included here are for reference only. Choose connectors that are appropriate to your design.

When integrating AirPrime embedded modules into your host device, you need the following connector types:

- RF cables that mate with Hirose U.FL connectors (model U.FL #CL331-0471-0-10). Modules include one or two connector jacks depending on individual module support for diversity or GPS functionality.
- Industry-standard mating connector for 52-pin EDGE—some manufacturers include Tyco, Foxconn, and Molex. For example, the connector used on the Mini Card Dev Kit board is a Molex 67910-0001.
- Industry-standard USIM connector (MC8xxx only)—the actual connector you use depends on how your device exposes the USIM socket. For example, the USIM connector used on the Mini Card Dev Kit board is an ITT CCM03-3518.

Guide organization

This guide includes the following sections:

1. **Introduction** (this section)
2. [Power Interface](#) on page 17
Describes power control signals used by the module and discusses design issues related to power supply integration.
3. [RF Integration](#) on page 37
Describes antenna connection methods and grounding issues, RF interference and desense issues.
4. [Audio Interface](#) on page 47
Describes supported audio modes and related details.
5. [Host/Module Interfaces](#) on page 55
Describes the USB interface for host/module communication, and the USIM interface for host/module integration.

6. [Thermal Considerations](#) on page 65
Describes thermal characteristics of the module and provides suggestions for testing and addressing thermal issues.
7. [Design Checklist](#) on page 67
Summarizes design considerations for integration of AirPrime embedded modules in your host devices.
8. [Testing](#) on page 69
Describes suggested acceptance, certification, production, and quality assurance tests.
9. [Antenna Specification](#) on page 91
Describes antenna requirements and testing details.
10. [Regulatory Information](#) on page 99
Describes regulatory approvals and regulatory information requirements.
11. [MC5728V Important Signal Considerations - Application Note](#) on page 103
Describes important signal considerations regarding MDL_RESET_N and W_DISABLE# signals of the MC5728V module.
12. [Acronyms and Definitions](#) on page 105
Lists acronyms and definitions used throughout this guide.
13. [Index](#) on page 107

Note: The term "host" always refers to the host device.

Related documents

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

[Table 1-2](#) lists other documents referenced in this guide.

Table 1-2: Related documentation

| Document title | Description |
|---|--|
| AT Command Set for User Equipment (UE) (Release 6) (3GPP TS 27.007) | Standard AT commands for GSM/UMTS devices. |
| CDMA 1X Standard (CDMA 200 Series Release A (2000) - Document #TIA/EIA/IS-2000 Series, Release A) | Technical requirements for CDMA systems, including details on sleep cycle index (SCI) values. |
| CDMA CnS Reference (Document 2130754) | CnS (Control and Status) messages supported by AirPrime CDMA embedded modules. |
| CDMA AT Command Reference (Document 2130620) | Proprietary, basic AT commands for AirPrime CDMA embedded modules. For UMTS-specific commands, see <i>AirCard/AirPrime UMTS devices Supported AT Command Reference (Document 2130617)</i> . |

Table 1-2: Related documentation (Continued)

| Document title | Description |
|---|--|
| CDMA Extended AT Command Reference (Document 2130621) | Proprietary AT commands for AirPrime CDMA embedded modules. For UMTS-specific commands, see <i>AirPrime MC8xxx Embedded Modules Extended AT Command Reference (Document 2130616)</i> . |
| FCC Regulations - Part 15 - Radio Frequency Devices | This section of the FCC Code of Federal Regulations, Title 47 deals with radio frequency devices, including shielding requirements for embedded modules. |
| IEC-61000-4-2 level 3 | Techniques for testing and measuring electrostatic discharge (ESD) immunity. |
| MC5727 Mini Card Product Specification (Document 2130958) | Features, mechanical and electrical specifications, and standards compliance of the MC5727. |
| MC5727V Mini Card Product Specification (Document 2131023) | Features, mechanical and electrical specifications, and standards compliance of the MC5727V. |
| MC5728V Mini Card Product Specification (Document 2111350) | Features, mechanical and electrical specifications, and standards compliance of the MC5728V. |
| MC8201 PCI Express Mini Card Product Specification (Document 2131362) | Features, mechanical and electrical specifications, and standards compliance of the MC8201. |
| MC8700 PCI Express Mini Card Product Specification (Document 2131202) | Features, mechanical and electrical specifications, and standards compliance of the MC8700. |
| MC8775 PCI Express Mini Card Product Specification (Document 2130697) | Features, mechanical and electrical specifications, and standards compliance of the MC8775. |
| MC8775V with Audio PCI Express Mini Card Product Specification (Document 2130700) | Features, mechanical and electrical specifications, and standards compliance of the MC8775V. |
| MC8780 / MC8781 PCI Express Mini Card Product Specification (Document 2130782) | Features, mechanical and electrical specifications, and standards compliance of the MC8780/MC8781. |
| MC8790 PCI Express Mini Card Product Specification (Document 2111279) | Features, mechanical and electrical specifications, and standards compliance of the MC8790. |
| MC8790V PCI Express Mini Card Product Specification (Document 2111280) | Features, mechanical and electrical specifications, and standards compliance of the MC8790V. |
| MC8791V PCI Express Mini Card Product Specification (Document 2131032) | Features, mechanical and electrical specifications, and standards compliance of the MC8791V. |
| MC8792V PCI Express Mini Card Product Specification (Document 2131033) | Features, mechanical and electrical specifications, and standards compliance of the MC8792V. |
| MC8795V PCI Express Mini Card Product Specification (Document 2131276) | Features, mechanical and electrical specifications, and standards compliance of the MC8795V. |
| MC87XX Modem CnS Reference (Document 2130602) | CnS (Control and Status) messages supported by AirPrime UMTS embedded modules. |
| MC87xx Modem CnS Reference (Voice) (Document 2130817) | Voice-related CnS (Control and Status) messages supported by voice-enabled AirPrime UMTS embedded modules (MC8775V, MC8790V, MC8791V, MC8792V, and MC8795V). |
| AirCard/AirPrime UMTS devices Supported AT Command Reference (Document 2130617) | Proprietary, basic AT commands for UMTS AirCard and AirPrime devices. For CDMA-specific commands, see the <i>CDMA AT Command Reference (Document 2130620)</i> . |

Table 1-2: Related documentation (Continued)

| Document title | Description |
|--|--|
| AirPrime MC8xxx Embedded Modules Extended AT Command Reference (Document 2130616) | Proprietary AT commands for UMTS AirPrime embedded modules. For CDMA-specific commands, see the <i>CDMA Extended AT Command Reference (Document 2130621)</i> . |
| Mobile Station (MS) Conformance Specification; Part 4: Subscriber Interface Module (3GPP TS 11.10-4) | SIM testing methods. |
| PCI Express Mini Card Dev Kit Quick Start Guide (Document 2130705) | Setup and configuration of modules. |
| PCI Express Mini Card Electromechanical Specification Revision 1.1 | |
| Universal Serial Bus Specification, Rev 2.0 | |

Overview of operation

*Note: This chapter contains information for both CDMA (MC57xx) and GSM (MC8xxx) AirPrime embedded modules.
Information that is **unique** to specific module types is clearly identified.*

AirPrime embedded modules are designed to use a 3.3V (nominal) power supply (3.8V for the MC8201) provided by the host. It is the host's responsibility to provide safe and continuous power to the module at all times; the module does NOT have an independent power supply, or protection circuits to guard against electrical issues.

The host controls the module's power state using the `W_Disable#` signal as shown in [Figure 2-1](#). The signal is driven low by the host to power off the module, or left floating (high impedance) to power on the module. The module also monitors its supply voltage and requests shutdown if the supply is insufficient (see [Voltage monitoring state machine](#) on page 20).

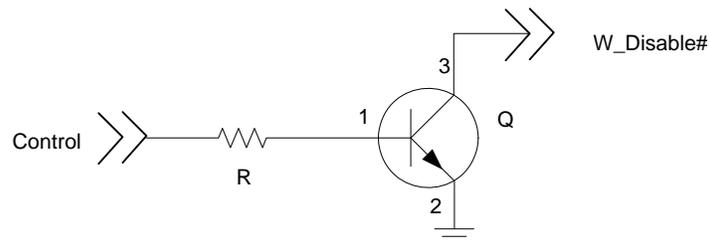


Figure 2-1: Recommended `W_Disable#` connection (open drain circuit)

Power signals

The module must be connected to a 3.3V power supply (3.8V for the MC8201), as described in *PCI Express Mini Card Electromechanical Specification Revision 1.1*.

The MC8xxx has more power pins than the MC57xx due to higher peak current requirements for GSM devices.

For detailed pinout and voltage/current requirements of these modules, see the Product Specification Document for your AirPrime embedded module (see [Table 1-2](#) on page 13).

*Note: The Product Specification Document's pin connection table describes the **internal** structure of the module. For example, a Mini Card standard-compliant host platform provides +3.3Vaux on pin 24, but this pin is not connected internally on the MC8775V. Thus, the pin is flagged as 'No connect'.*

Electrostatic discharge (ESD)

You are responsible for ensuring that the host has adequate ESD protection on digital circuits and antenna ports as described by the following specifications:

- (Operational) RF port (antenna launch and RF connector): *IEC-61000-4-2—Level (Electrostatic Discharge Immunity Test)*
- (Non-operational) Host connector interface: *JESD22-A114-B +/- 1kV Human Body Model* and *JESD22-C101 +/- 125 V Charged Device Model*
- MC5728V only: (Non-operational) Host connector interface: *JESD22-A114-B +/- 125V Human Body Model* and *JESD22-C101 +/- 100 V Charged Device Model*

MC5728V has placeholders for additional ESD devices, for cases where the device must, per customer requirements, meet the higher Human Body Model (+/-1kV) ESD rating.

This guide provides specific recommendations where needed, however, the level of protection required depends on your application.

Note: ESD protection is highly recommended for the USIM 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.

Module power states

Note: The module unit defaults to the Normal state when VCC is first applied in the absence of W_Disable# control.

The module has four power states:

- Disconnected
No power to the module.
- Off
Power to the module, but the module is powered off.
- Normal
The module is active. Several modes are possible (Receive, Transmit, Sleep, Shutdown).
- Low power (“airplane mode”)
The module is active, but RF is disabled.

State machines are implemented in the module to monitor the power supply and operating temperature.

Disconnected state

Note: The difference between the Disconnected and Off states is that, in the Off state, the module is still connected to the power source and draws minimal current.

This state occurs when there is no power to the module—the host power source is disconnected from the module and all voltages associated with the module are at 0 V.

Whether the host device is also powered off depends on the power rail design:

- If the connection between the power rail and the module is controlled by the host, the host can stay powered on and cut the power to put the module into the disconnected state.
- If the power rail is shared between the host device and the module, the host is powered off when the module is powered off.

Off state

In this state, the host is powered up and the module is powered down (but still connected to the power source).

The host keeps the module powered off by driving the `W_Disable#` signal low. In this state, the module draws minimal current.

The module enters the Off state if `W_Disable#` is driven low and power (VCC) is applied to the module, or if the module is in a powered state and `W_Disable#` is driven low for a module-dependent minimum period. See [State change: Power off/on](#) on page 23 for details.

For additional MC5728V information, see [W_Disable# — Wireless disable](#) on page 104.

Normal state

This is the active state of the module. In this state:

- The module is fully powered.
- The module is capable of placing/receiving calls or establishing data connections on the wireless network.
- The USB interface is fully active.

Low power state

In this state (also called “airplane mode”), RF (both Rx and Tx) is disabled in the module, but the USB interface is still active. This state is controlled through the host interface by the following software commands:

- `+CFUN=0` command (*AT Command Set for User Equipment (UE) (Release 6)*)
- `CNS_RADIO_POWER [0x1075]` (*CDMA CnS Reference (Document 2130754)*)
- Disable Modem command (*MC87XX Modem CnS Reference (Document 2130602)*).

Note: This is the default state when VCC is first applied in the absence of `W_Disable#` control.

Voltage monitoring state machine

Figure 2-2 illustrates the state machine used to monitor the VCC supply, and Table 2-1 details the voltage conditions that trigger state changes.

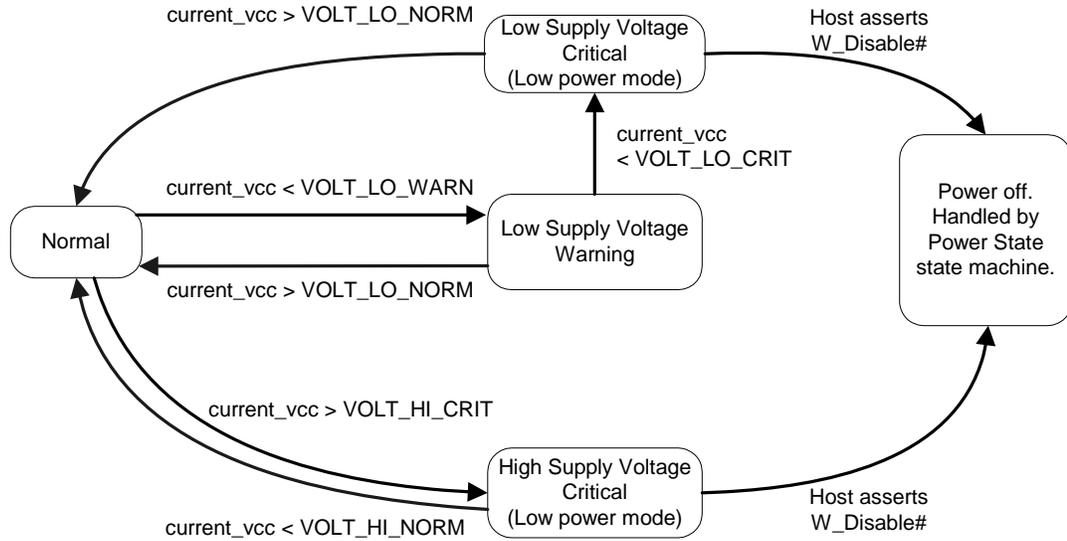


Figure 2-2: Voltage monitoring state machine

Table 2-1: Voltage trigger levels

| Condition | Voltage (V) | | | |
|--------------|----------------------|--------------------------------|---|------------------|
| | VCC3.3 (3.0 V–3.6 V) | | | VCC3.8 (3.4–4.2) |
| | MC57xx | MC8775/75V MC8780 MC8781 | MC8700 MC8790/90V MC8791V MC8792V MC8795V | MC8201 |
| VOLT_HI_CRIT | 3.6 | 3.6 | 3.8 | 4.4 |
| VOLT_HI_NORM | 3.5 | 3.5 | 3.5 | 4.2 |
| VOLT_LO_NORM | 3.1 | 3.1 | 3.1 | 3.4 |
| VOLT_LO_WARN | 3.0 | 3.0 | 3.05 | 3.2 |
| VOLT_LO_CRIT | 2.9 | 2.9 | 3.00 | 3.1 |

State change: Normal mode to Low Power mode

This state change causes the module to suspend RF activity. It occurs when the module's supply voltage exceeds either the high (VOLT_HI_CRIT) or low (VOLT_LO_CRIT) limits detailed in [Table 2-1](#) on page 20.

When this state change occurs, the CnS notification CNS_RADIO_POWER is issued, if enabled. For a detailed description of this notification, see *CDMA CnS Reference (Document 2130754)* or *MC87XX Modem CnS Reference (Document 2130602)* as appropriate.

State change: Low Power mode to Normal mode

This state change causes the module to resume RF activity. It occurs when the module's supply voltage returns from critical to normal limits as described in [Table 2-1](#) on page 20 (VOLT_HI_NORM and VOLT_LO_NORM).

When this state change occurs, the CnS notification CNS_RADIO_POWER is issued, if enabled. For a detailed description of this notification, see *CDMA CnS Reference (Document 2130754)* or *MC87XX Modem CnS Reference (Document 2130602)* as appropriate.

State change: Power off/on

Note: The module is still connected to the power source in this state, drawing minimal power.

The module begins a shutdown sequence and powers off if it has been in a powered-on state for more than 10.5 seconds and the host device drives the `W_Disable#` signal low for:

- ≥ 50 ms (MC8775/MC8775V)
- ≥ 500 ms (MC5727/MC5727V/ MC5728V/MC8201/MC8700/MC8780/MC8781/MC8790/MC8790V/MC8791V/MC8792V/MC8795V)

Note: The module ignores changes in the `W_Disable#` line for the first 10.5 seconds after it enters a powered-on state.

The module powers on when the host device leaves the `W_Disable#` signal floating (high impedance) as shown in [Figure 2-1](#) on page 17.

[Figure 2-2](#) on page 20 shows the transition from 'Low Supply Voltage Critical' or 'High Supply Voltage Critical' to 'Power off':

1. The module enters low power mode because it detects that the supply voltage level is critically low (VOLT_LO_CRIT) or critically high (VOLT_HI_CRIT).
2. The module sends a CnS notification (Return Radio Voltage—0x0009) to the host indicating that it is now in low power mode.
3. The host has the option, at this point, of driving `W_Disable#` low (forcing the module to power off) to prevent damage to the unit.

Temperature monitoring state machine

Figure 2-3 illustrates the state machine used to monitor the embedded module’s temperature, and Table 2-2 details the temperature conditions that trigger state changes.

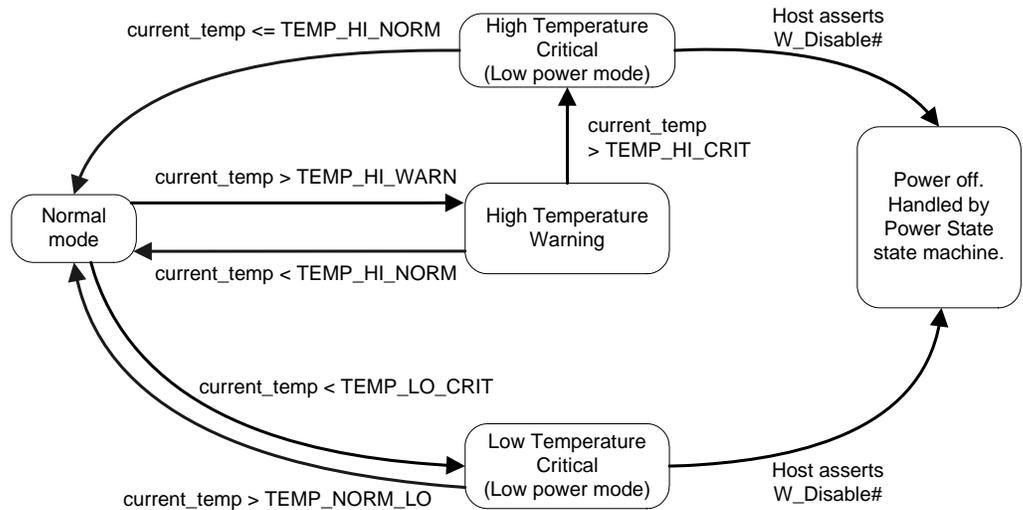


Figure 2-3: Temperature monitoring state machine

Table 2-2: Temperature trigger levels^a

| Condition | MC57xx Temp (°C) | MC8xxx Temp (°C) |
|--------------|------------------|------------------|
| TEMP_LO_CRIT | -30 | -25 |
| TEMP_NORM_LO | -20 | -15 |
| TEMP_HI_NORM | 85 | 85 |
| TEMP_HI_WARN | 95 | 95 |
| TEMP_HI_CRIT | 108 | 108 |

a. Module-reported temperatures at the printed circuit board. Temperature decreases from 10°C–18°C between the PCB and the module shield, and a further 10°C–18°C between the shield and host environment (ambient), depending on the efficiency of heat-dissipation in the host device.

State change: Normal mode to Low Power mode

This state change causes the module to suspend RF activity. It occurs when the module temperature exceeds either the high (TEMP_HI_CRIT) or low (TEMP_LO_CRIT) limits detailed in Table 2-2.

When this state change occurs, the CnS notification `CNS_RADIO_POWER` is issued, if enabled. For a detailed description of this notification, see *CDMA CnS Reference (Document 2130754)* or *MC87XX Modem CnS Reference (Document 2130602)* as appropriate. As well, the MC57xx issues the CnS notification `Modem Too Hot [0x4500]` if it has to drop a call when shifting to low power mode.

State change: Low Power mode to Normal mode

This state change causes the module to resume RF activity. It occurs when the module temperature returns from critical to normal limits as described in [Table 2-2](#) on page 22 (`TEMP_HI_NORM` and `TEMP_LO_NORM`).

When this state change occurs, the CnS notification `CNS_RADIO_POWER` is issued, if enabled. For a detailed description of this notification, see *CDMA CnS Reference (Document 2130754)* or *MC87XX Modem CnS Reference (Document 2130602)* as appropriate.

State change: Power off/on

The module begins a shutdown sequence and powers off if it has been in a powered-on state for more than 10.5 seconds and the host device drives the `W_Disable#` signal low for:

- ≥ 50 ms (MC8775/MC8775V)
- ≥ 500 ms (MC5727/MC5727V/ MC5728V/MC8201/MC8700/MC8780/ MC8781/MC8790/MC8790V/MC8791V/MC8792V/MC8795V)

Note: The module ignores changes in the `W_Disable#` line for the first 10.5 seconds after it enters a powered-on state.

The module powers on when the host device leaves the `W_Disable#` signal floating (high impedance) as shown in [Figure 2-1](#) on page 17.

[Figure 2-3](#) on page 22 shows the transition from 'Low Temperature Critical' or 'High Temperature Critical' to 'Power off'.

1. The module enters low power mode because it detects that the operating temperature is critically low (`TEMP_LO_CRIT`) or critically high (`TEMP_HI_CRIT`).
2. The module sends a CnS notification (`Return Radio Temperature—0x0008`) to the host indicating that it is now in low power mode.
3. The host has the option, at this point, of driving `W_Disable#` low (forcing the module to power off) to prevent damage to the unit.

Note: (MC57xx only) If the ambient temperature of the module exceeds 60°C, the RF level is automatically lowered for max power transmission.

Inrush currents

The following power events can cause large inrush currents from the host supply to the module on the power pins:

- Application of the host’s power supply
- Host leaves `W_Disable#` floating (high impedance) to power up the module (as shown in [Figure 2-1](#) on page 17).

[Figure 2-4](#) and [Figure 2-5](#) show the inrush models for the MC57xx and MC8xxx. Application of the host’s power supply typically occurs when the switch is open; `W_Disable#` is left floating (high impedance) when the switch is closed.

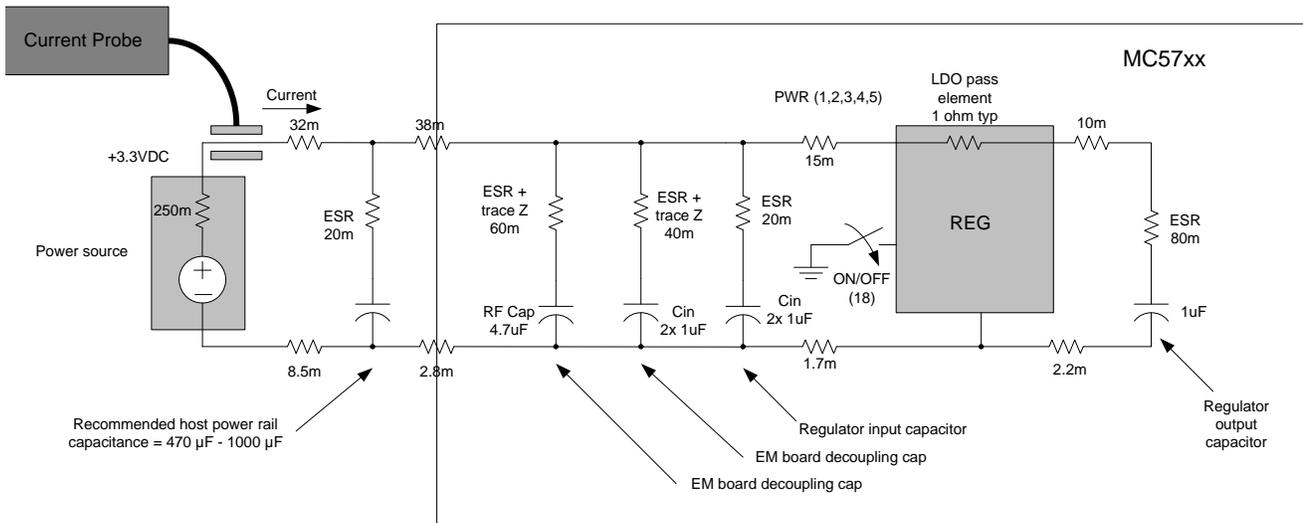


Figure 2-4: Inrush model - MC57xx

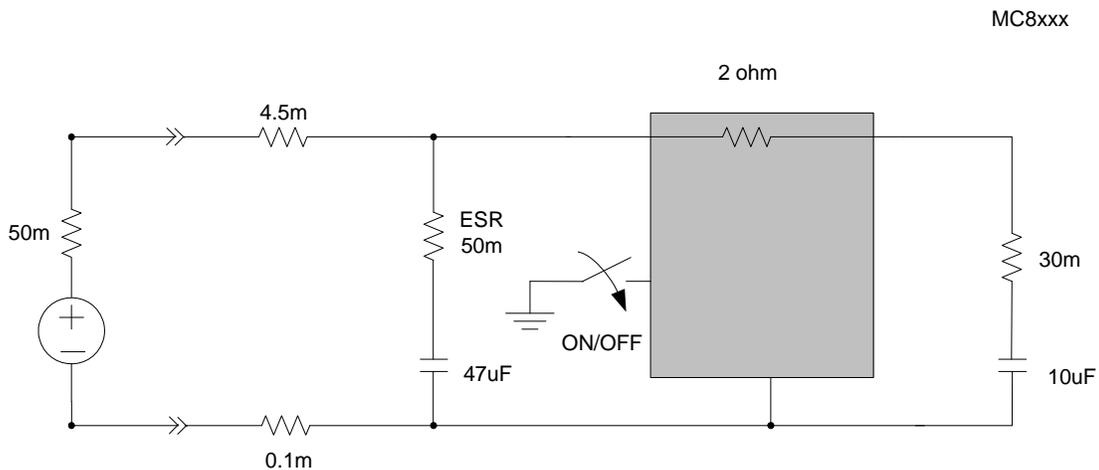


Figure 2-5: Inrush model - MC8xxx

Inrush current via application of host power supply

This event occurs when the host's supply is enabled, charging the input capacitors on the embedded module's power rail. The switches shown in [Figure 2-4](#) on page 24 and [Figure 2-5](#) on page 24 are open (typically) when this event occurs.

Note: In some circumstances, depending on temperature and the components in use, two or more regulators may switch on at the same time. The host power system must be designed to handle this possibility.

To limit the inrush current and stabilize the supply of power to the module, sufficient capacitance must be added to the host power rail. The recommended capacitance range is 470–1000 μF .

Peak current (IPEAK) is calculated using:

$$I_{PEAK} = V_{CC} / R_{SERIES}$$

$$R_{SERIES} = \text{impedance from power source (+ive) through to the Regulator output capacitor} \\ + \text{(impedance from power source (-ive) through to GND pins of the EM regulator)}$$

Inrush current via floating W_Disable#

The second event type occurs when the host leaves the W_Disable# signal floating (high impedance) to power up the module. The switches shown in [Figure 2-4](#) on page 24 and [Figure 2-5](#) on page 24 are closed when this event occurs. This enables the power management system of the module, charging several internal regulator output capacitors.

When W_Disable# is left floating (high impedance), the peak current is less than 500 mA (with a 30 μs rise time).

Timing requirements

Power ramp-up

During the first 0.5 seconds, as the internal voltage regulators are activated in sequence, several current transients of up to 500 mA with a 30 μs rise time may occur.

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 5.1 seconds (depending on module type) after power-up. (Most modules enumerate within 4 seconds.) [Figure 2-6](#) on page 26 illustrates the power-up timing sequence.

Note: The actual startup time may vary between the different module types (for example, MC5727 versus MC8775).

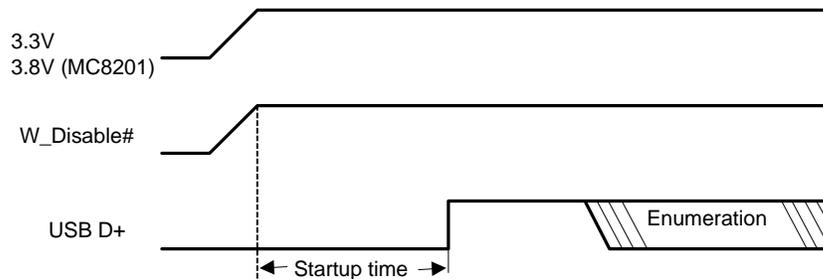


Figure 2-6: Power-up timing diagram

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

Transmit power wave form (GSM)

As shown in Figure 2-7, 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). 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, such as 3.5:1 VSWR (as stated in Table 2-7 on page 31), this current draw could increase from 2.4 A to 2.75 A, as shown in the diagram. Beyond the 3.5:1 VSWR as recommended to be worst-case in Table 1-4 on page 95, the current draw could increase beyond 2.75 A to 3.5 A.

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 initially reaching a peak of 2.75 A average over 100 μ s and with an instantaneous peak current of 3.5 A.

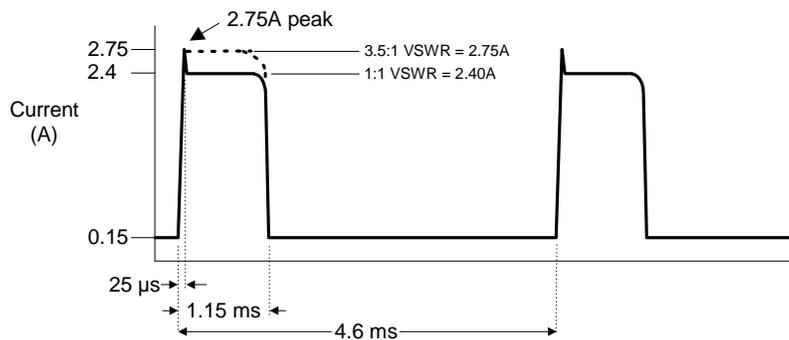


Figure 2-7: GSM transmit power wave form

Current consumption

Current consumption depends on the module's operating mode at any given time.

This section describes:

- Current consumption for both module types (MC57xx and MC8xxx)
- Operating modes

Current consumption overview

Note: Values in this guide are taken from the appropriate product specification documents (PSDs) (listed in Table 1-2 on page 13)—in the case of a discrepancy between this document and the relevant PSD, use the value listed in the PSD.

Electrical requirements and current specifications are listed in the following tables:

- [Table 2-3](#) on page 27 (MC57xx)
- [Table 2-4](#) on page 28 (MC8201)
- [Table 2-5](#) on page 29 (MC8700)
- [Table 2-6](#) on page 30 (MC8775/MC8775V)
- [Table 2-7](#) on page 31 (MC8780/MC8781)
- [Table 2-8](#) on page 32 (MC8790/MC8790V/MC8791V/MC8792V)
- [Table 2-9](#) on page 33 (MC8795V)

These specifications identify minimum, typical, and maximum current drain for each operating mode (while in the Normal state):

- Transmit
- Receive
- Sleep
- Deep sleep
- Shutdown

The current consumption values in these tables were measured using a supply voltage of 3.3 V (3.8 V for MC8201). The device's supply voltage is 3.0–3.6 V with a typical voltage of 3.3 V (3.4–4.2 V with a typical voltage of 3.8 V for MC8201).

*Note: For sleep modes, the values shown are for the **actual** sleep state. The module wakes at intervals to control timing and check for traffic—at these moments the current consumption is higher.*

Table 2-3: Current specifications (MC57xx)

| Condition | Current consumption (mA) | | |
|--|--------------------------|---------|------|
| | Min | Typical | Max |
| CDMA Transmitting (MC5727/MC5727V) | 250 | 300 | 950 |
| CDMA Transmitting (MC5728V) Current depends on the radio band in use and the network's control of the module's output power. The 'Typical' value is based on: <ul style="list-style-type: none"> • 40% full rate, and • 60% 1/8th rate over -35 to +23.5 dBm. | 300 | 380 | 1000 |
| CDMA Receiving (MC5727/MC5727V/MC5728V) | 90 | 100 | 120 |

Table 2-3: Current specifications (MC57xx) (Continued)

| Condition | Current consumption (mA) | | |
|--|--------------------------|---------|------|
| | Min | Typical | Max |
| CDMA Sleep, default slot cycle = 2 (MC5727/MC5727V) | 1.4 | 1.7 | 1.75 |
| CDMA Sleep, default slot cycle = 2 (MC5728V) The module supports slotted mode operation and Quick Paging Channel (both enable reduced sleep current). The values shown are the <i>lowest</i> power consumption during the sleep cycle. The default Slot Cycle Index (SCI) for slotted mode operation is determined by the PRI setting (usually 1). | 1.9 | 2.1 | 5.6 |
| Deep Sleep Average (MC5727/MC5727V/MC5728V) | 0.5 | 0.7 | 1.5 |
| Shutdown (MC5727/MC5727V) | 0.25 | 0.30 | 0.35 |
| Shutdown (MC5728V) | 0.24 | 0.27 | 0.30 |

Table 2-4: Current specifications (MC8201)^a

| Description | Band | Typ | Max | Units | Notes / Configuration |
|---|-------------------|-----|-----|-------|---|
| Averaged standby DC current consumption | | | | | |
| With Sleep mode activated (assumes USB bus is fully suspended during measurements) | | | | | |
| HSDPA/WCDMA | Bands II, V | 4 | 5 | mA | DRX cycle = 8 (2.56 s) |
| GSM/GPRS/EDGE | GSM 850, GSM 1900 | 4 | 5 | mA | MFRM = 5 (1.175 s) |
| With Sleep mode deactivated (assumes USB bus is fully suspended during measurements) | | | | | |
| HSDPA/WCDMA | Bands II, V | 40 | 50 | mA | DRX cycle = 8 (2.56 s) |
| GSM/GPRS/EDGE | GSM 850, GSM 1900 | 40 | 50 | mA | MFRM = 5 (1.175 s) |
| Low Power Mode (LPM)/Offline Mode | | | | | |
| RF disabled, but module is operational | | 4 | 5 | mA | This state is entered when Watcher (or other application) shuts down/turns off the radio. |
| Averaged Call Mode WCDMA/HSPA/HSPA+ data DC power consumption | | | | | |
| WCDMA | Bands II, V | 700 | | mA | 384 kbps at 20 dBm Tx power ^b |
| | | 300 | | mA | 0 dBm Tx power |
| HSDPA (1.8 Mbps/3.6 Mbps) | Bands II, V | 800 | | mA | All speeds at 20 dBm Tx power ^c |
| | | 370 | | mA | 0 dBm Tx power |
| Peak current (averaged over 100 μ s) | Bands II, V | 720 | | mA | |

Table 2-4: Current specifications (MC8201)^a (Continued)

| Description | Band | Typ | Max | Units | Notes / Configuration |
|--|----------------------|------|-----|-------|------------------------------------|
| Averaged Call Mode GSM/EDGE data DC power consumption (with 4 time slots) | | | | | |
| GSM/GPRS | GSM 850, GSM 1900 | 650 | | mA | Max PCL for each band ^d |
| | | 300 | | mA | 10 dBm Tx |
| EDGE | | 620 | | mA | Class 12 ^d |
| Peak current (averaged over 100 μ s) | | 2.60 | | A | Worst case on 850. |

- All measurements are preliminary values
- Highest current is on Band II (PCS1900)
- Approximate current difference between speeds = 30 mA
- Highest current is on 850 band Class 10 (Class 12 implements power backoff).

Table 2-5: Current specifications (MC8700)^{a, b}

| Description | Band | Typ | Max | Units | Notes / Configuration |
|---|-----------------------------|------|-----|-------|--|
| Averaged standby DC current consumption | | | | | |
| With Sleep mode activated (assumes USB bus is fully suspended during measurements) | | | | | |
| Not supported by this product. | | | | | |
| With Sleep mode deactivated (assumes USB bus is fully suspended during measurements) | | | | | |
| Not supported by this product. | | | | | |
| Low Power Mode (LPM)/Offline Mode | | | | | |
| Not supported by this product. | | | | | |
| Averaged Call Mode WCDMA/HSPA/HSPA+ data DC power consumption | | | | | |
| WCDMA | Bands I, II, V, VI, VIII | 700 | | mA | 384 kbps at 20 dBm Tx power ^c |
| | | 360 | | mA | 0 dBm Tx power |
| HSUPA | | 760 | | mA | 2 Mbps at 20 dBm Tx power |
| | | 470 | | mA | 0 dBm Tx power |
| HSDPA (1.8 Mbps/3.6 Mbps/ 7.2 Mbps) | | 820 | | mA | All speeds at 20 dBm Tx power ^d |
| | | 450 | | mA | 0 dBm Tx power |
| HSPA+ (21.1 Mbps) | | 850 | | mA | 20 dBm Tx power |
| | | 500 | | mA | 0 dBm Tx power |
| Peak current (averaged over 100 μ s) | | 1000 | | mA | |

Table 2-5: Current specifications (MC8700)^{a,b} (Continued)

| Description | Band | Typ | Max | Units | Notes / Configuration |
|--|----------|------|-----|-------|------------------------------------|
| Averaged Call Mode GSM/EDGE data DC power consumption (with 4 time slots) | | | | | |
| GSM/GPRS | Quad GSM | 700 | | mA | Max PCL for each band ^e |
| | | 400 | | mA | 10 dBm Tx |
| EDGE | | 720 | | mA | Class 12 ^e |
| Peak current (averaged over 100 μ s) | | 2.70 | | A | Worst case on 850/900 band. |

- a. All measurements are preliminary values
b. Measurements are for MDM8200 MDM2.0. Consumption levels for MDM8200 MDM1.1 will be slightly higher.
c. Highest current is on Band II (PCS1900)
d. Approximate current difference between speeds = 30 mA
e. Highest current is on 850/900 band Class 10 (Class 12 implements power backoff). Current on 1800/900 bands is typically 100–200 mA less.

Table 2-6: Current specifications (MC8775/MC8775V)

| Description | Band | Typ | Max | Units | Notes / Configuration |
|---|----------------|-----|-----|-------|--|
| Averaged standby DC current consumption | | | | | |
| With Sleep mode activated (assumes USB bus is fully suspended during measurements) | | | | | |
| HSDPA/WCDMA | Bands I, II, V | 2.9 | 4 | mA | DRX cycle = 8 (2.56 s) |
| GSM/GPRS/EDGE | Quad GSM | 2.8 | 4 | mA | MFRM = 5 (1.175 s) |
| With Sleep mode deactivated (assumes USB bus is fully suspended during measurements) | | | | | |
| HSDPA/WCDMA | Bands I, II, V | 73 | 80 | mA | DRX cycle = 8 (2.56 s) |
| GSM/GPRS/EDGE | Quad GSM | 46 | 55 | mA | MFRM = 5 (1.175 s) |
| Low Power Mode (LPM)/Offline Mode | | | | | |
| RF disabled, but module is operational | | 2.5 | 4 | mA | This state is entered when Watcher [®] (or other application) shuts down/turns off the radio. |
| Averaged WCDMA/HSDPA DC current consumption | | | | | |
| WCDMA talk current (AMR 12.2 kbps vocoder) | Bands I, II, V | 300 | - | mA | 0 dBm Tx power |
| | | 480 | - | mA | +15 dBm Tx power |
| | | 650 | - | mA | +21 dBm Tx power |
| WCDMA data current | | 330 | - | mA | 64 kbps UL/384 kbps DL, +0 dBm Tx power |
| WCDMA searching channels | | | 180 | mA | 320 mA peak |
| HSDPA current | | 340 | - | mA | 0 dBm Tx power |
| Maximum peak talk current | | - | 1.2 | A | Max RF output power, full rate, full operating temperature range |

Table 2-6: Current specifications (MC8775/MC8775V) (Continued)

| Description | Band | Typ | Max | Units | Notes / Configuration |
|---|-----------------|-----|------|-------|---|
| Averaged GSM/EDGE DC current consumption | | | | | |
| GSM Talk current (Full rate GSM vocoder, averaged over multiple Tx frames) | Quad GSM | 300 | - | mA | +5 dBm Tx power |
| | | 210 | - | mA | +13 dBm Tx power |
| | | 300 | - | mA | +29 dBm Tx power |
| | GSM850 & GSM900 | 360 | - | mA | +33 dBm Tx power |
| GPRS current (+13 dBm Tx power, GPRS CS2, averaged over multiple Tx frames) | Quad GSM | 180 | - | mA | 1 Rx/1 Tx slot |
| | | 180 | - | mA | 2 Rx/1 Tx slot |
| | | 240 | - | mA | 4 Rx/2 Tx slot |
| GSM/GPRS searching channels | Quad GSM | | 163 | mA | 489 mA peak |
| EDGE current (14 dBm Tx Power, averaged over multiple Tx frames) | Quad GSM | 180 | - | mA | 1 Rx/1 Tx slot |
| | | 180 | - | mA | 2 Rx/1 Tx slot |
| | | 240 | - | mA | 4 Rx/2 Tx slot |
| Maximum Peak Talk current | Quad GSM | 2.3 | 2.75 | A | Max RF output power, Tx pulse current, full operating temperature range |
| Miscellaneous DC current consumption | | | | | |
| Module OFF leakage current | All | 310 | 600 | μA | Full operating temperature range |
| USB transmit current | All | - | 10 | mA | Full speed USB connection, C _L = 50 pF on D+ and D- signals |

Table 2-7: Current specifications (MC8780/MC8781)

| Description | Band | Typ | Max | Units | Notes / Configuration |
|---|----------------|-----|-----|-------|---|
| Averaged standby DC current consumption | | | | | |
| With Sleep mode activated (assumes USB bus is fully suspended during measurements) | | | | | |
| HSDPA/WCDMA | Bands I, II, V | 3 | 4 | mA | DRX cycle = 8 (2.56 s) |
| GSM/GPRS/EDGE | Quad GSM | 3 | 4 | mA | MFRM = 5 (1.175 s) |
| With Sleep mode deactivated (assumes USB bus is fully suspended during measurements) | | | | | |
| HSDPA/WCDMA | Bands I, II, V | 46 | 50 | mA | DRX cycle = 8 (2.56 s) |
| GSM/GPRS/EDGE | Quad GSM | 50 | 55 | mA | MFRM = 5 (1.175 s) |
| Low Power Mode (LPM)/Offline Mode | | | | | |
| RF disabled, but module is operational | | 3 | 4 | mA | This state is entered when Watcher (or other application) shuts down/turns off the radio. |

Table 2-7: Current specifications (MC8780/MC8781) (Continued)

| Description | Band | Typ | Max | Units | Notes/Configuration |
|---|----------------|------|-----|-------|--|
| (Maximum power) Averaged WCDMA/HSDPA data current consumption (includes USB bus current) | | | | | |
| WCDMA | Bands I, II, V | 800 | | mA | 384 kbps at 20 dBm Tx power ^a |
| | | 300 | | mA | 0 dBm Tx power |
| HSUPA | | 850 | | mA | 2 Mbps at 20 dBm Tx power |
| | | 400 | | mA | 0 dBm Tx power |
| HSDPA (1.8 Mbps/3.6 Mbps/ 7.2 Mbps) | | 850 | | mA | All speeds at 20 dBm Tx power ^b |
| | | 450 | | mA | 0 dBm Tx power |
| (Maximum power) Averaged GSM/EDGE data current consumption (includes USB bus current) | | | | | |
| GSM/GPRS | Quad GSM | 560 | | mA | Max PCL for each band ^c |
| | | 230 | | mA | 10 dBm Tx |
| EDGE | | 520 | | mA | Class 12 ^c |
| Peak current (averaged over 100 μs) | | 2.75 | | A | Worst case on 850/900 band. |

a. Highest current is on Band II (PCS1900)

b. Approximate current difference between speeds = 20 mA

Example: Current(7.2 Mbps) = Current(3.6 Mbps) + 20 mA = Current(1.8 Mbps) + 40 mA

c. Highest current is on 850/900 band Class 10 (Class 12 implements power backoff). Current on 1800/900 bands is typically 100–200 mA less.

Table 2-8: Current specifications (MC8790/MC8790V/MC8791V/MC8792V)

| Description | Band | Typ | Max | Units | Notes/Configuration |
|---|---|-----|-----|-------|------------------------|
| Averaged standby DC current consumption | | | | | |
| With Sleep mode activated (assumes USB bus is fully suspended during measurements) | | | | | |
| HSDPA/WCDMA | MC8790/90V: Bands I, II, V, VI MC8791V: Band I MC8792V: Band I, II, VIII | 4 | 5 | mA | DRX cycle = 8 (2.56 s) |
| GSM/GPRS/EDGE | Quad GSM | 4 | 5 | mA | MFRM = 5 (1.175 s) |
| With Sleep mode deactivated (assumes USB bus is fully suspended during measurements) | | | | | |
| HSDPA/WCDMA | MC8790/90V: Bands I, II, V, VI MC8791V: Band I MC8792V: Band I, II, VIII | 40 | 50 | mA | DRX cycle = 8 (2.56 s) |
| GSM/GPRS/EDGE | Quad GSM | 40 | 50 | mA | MFRM = 5 (1.175 s) |

Table 2-8: Current specifications (MC8790/MC8790V/MC8791V/MC8792V) (Continued)

| Description | Band | Typ | Max | Units | Notes / Configuration |
|--|-----------------------------------|-----|-----|-------|--|
| Low Power Mode (LPM)/Offline Mode | | | | | |
| RF disabled, but module is operational | | 4 | 5 | mA | State is entered when Watcher (or other application) shuts down/turns off the radio. |
| Averaged Call Mode WCDMA/HSPA data DC power consumption | | | | | |
| WCDMA | MC8790/90V: Bands I, II, V, VI | 700 | | mA | 384 kbps at 20 dBm Tx power ^a |
| | | 300 | | mA | 0 dBm Tx power |
| HSUPA | MC8791V: Band I | 800 | | mA | 2 Mbps at 20 dBm Tx power |
| | | 350 | | mA | 0 dBm Tx power |
| HSDPA (1.8 Mbps/3.6 Mbps/ 7.2 Mbps) | MC8792V: Band I, II, VIII | 800 | | mA | All speeds at 20 dBm Tx power ^b |
| | | 370 | | mA | 0 dBm Tx power |
| Peak current (averaged over 100 μ s) | | 720 | | mA | |
| Averaged Call Mode GSM/EDGE data DC power consumption (with 4 time slots) | | | | | |
| GSM/GPRS | Quad GSM | 650 | | mA | Max PCL for each band ^c |
| | | 300 | | mA | 10 dBm Tx |
| EDGE | | 620 | | mA | Class 12 ^c |
| Peak current (averaged over 100 μ s) | | 2.6 | | A | Worst case on 850/900 band. |

a. Highest current is on Band II (PCS1900)

b. Approximate current difference between speeds = 30 mA

c. Highest current is on 850/900 band Class 10 (Class 12 implements power backoff). Current on 1800/900 bands is typically 100–200 mA less.

Table 2-9: Current specifications (MC8795V)

| Description | Band | Typ | Max | Units | Notes / Configuration |
|---|--------------------------|-----|-----|-------|---|
| Averaged standby DC current consumption | | | | | |
| With Sleep mode activated (assumes USB bus is fully suspended during measurements) | | | | | |
| HSDPA/WCDMA | Bands I, II, V, VI, VIII | 4 | 5 | mA | DRX cycle = 8 (2.56 s) |
| GSM/GPRS/EDGE | Quad GSM | 4 | 5 | mA | MFRM = 5 (1.175 s) |
| With Sleep mode deactivated (assumes USB bus is fully suspended during measurements) | | | | | |
| HSDPA/WCDMA | Band I, II, V, VI, VIII | 40 | 50 | mA | DRX cycle = 8 (2.56 s) |
| GSM/GPRS/EDGE | Quad GSM | 40 | 50 | mA | MFRM = 5 (1.175 s) |
| Low Power Mode (LPM)/Offline Mode | | | | | |
| RF disabled, but module is operational | | 4 | 5 | mA | This state is entered when Watcher (or other application) shuts down/turns off the radio. |

Table 2-9: Current specifications (MC8795V) (Continued)

| Description | Band | Typ | Max | Units | Notes/Configuration |
|--|--------------------------|-----|-----|-------|--|
| Averaged Call Mode WCDMA/HSPA data DC power consumption | | | | | |
| WCDMA | Bands I, II, V, VI, VIII | 700 | | mA | 384 kbps at 20 dBm Tx power ^a |
| | | 350 | | mA | 0 dBm Tx power |
| HSUPA | | 750 | | mA | 2 Mbps at 20 dBm Tx power |
| | | 420 | | mA | 0 dBm Tx power |
| HSDPA (1.8 Mbps/3.6 Mbps/ 7.2 Mbps) | | 750 | | mA | All speeds at 20 dBm Tx power ^b |
| | | 410 | | mA | 0 dBm Tx power |
| Peak current (averaged over 100 μ s) | | 770 | | mA | |
| Averaged Call Mode GSM/EDGE data DC power consumption (with 4 time slots) | | | | | |
| GSM/GPRS | Quad GSM | 650 | | mA | Max PCL for each band ^c |
| | | 300 | | mA | 10 dBm Tx |
| EDGE | | 640 | | mA | Class 12 ^c |
| Peak current (averaged over 100 μ s) | | 2.6 | | A | Worst case on 850/900 band. |

a. Highest current is on Band II (PCS1900)

b. Approximate current difference between speeds = 30 mA

c. Highest current is on 850/900 band Class 10 (Class 12 implements power backoff). Current on 1800/900 bands is typically 100–200 mA less.

Table 2-10: Miscellaneous DC power consumption (MC8xxx except MC8775/MC8775V)

| Signal | Description | Band | Module | Typ | Max | Units | Notes/Configuration |
|--------|-------------------------------|-----------|---------------------|-----|-----|---------|---|
| VCC | Module OFF leakage current | All bands | All (except MC8700) | 400 | 600 | μ A | Full operating temperature range |
| | | | MC8700 | 200 | 700 | μ A | |
| | USB transmit current | All bands | All (except MC8700) | 10 | 10 | mA | Full speed USB connection, $C_L = 50$ pF on D+ and D- signals |
| | | | MC8700 | 10 | 10 | mA | |

Modes

Transmit and Receive modes

Current consumption in transmit or receive mode (in a call or data connection) is affected by several factors, such as:

- Radio band being used
- Transmit power
- Receive gain settings
- Data rate
- Number of active Transmit time slots (for transmit mode)

Sleep mode

Sleep mode is the normal state of the module between calls or data connections. In this reduced power mode, the module cycles between wake (polling the network) and sleep, at an interval determined by the network provider.

Deep sleep

Deep sleep mode is a reduced power, out-of-network-coverage mode, that the module enters when it cannot acquire network service after several minutes.

The module then exits deep sleep periodically to try to acquire service, and if successful, attempts to register.

Shutdown mode

While in shutdown mode, the module is powered off, but still draws a minimal current from the host power supply.

SED (Smart Error Detection)

(MC8xxx only)

The MC8xxx modules use a form of SED to track recurrent premature modem resets. In such cases, the module automatically forces a pause in boot-and-hold mode at power-on to accept an expected firmware download to resolve the problem.

The SED process is implemented as follows:

- The module tracks consecutive resets within 30 seconds of power-on.
- After a third consecutive reset occurs, the module automatically waits up to 30 seconds in boot-and-hold mode, waiting for a firmware download to resolve the power-cycle problem.
- If no firmware download begins within 30 seconds, the module continues to power-on.
- If the module resets again within 30 seconds of power-on, it again waits in boot-and-hold mode.

This process continues until the unexpected power-cycle issue is resolved—either a firmware download occurs, or the module doesn't reset spontaneously within 30 seconds of power-on.

Usage models

Usage models can be used to calculate expected current consumption. A sample usage model is provided in [Table 2-11](#), based on the values in [Table 2-3](#) on page 27 for a CDMA module.

Table 2-11: Power consumption of sample application

| | Used by a field worker (data only) | Used for remote data logging |
|------------------------------------|---|-------------------------------------|
| Upload (module Tx) | 1000 kB/day | 40 kB/h |
| Download (module Rx) | 500 kB/day | 100 kB/day |
| Coverage/data rate | 1X/80 kbps | IS-95/14.4 kbps |
| Hours of operation | 8 hrs/day (off 16 hrs/day) | 24/day |
| Total power consumed over 24 hours | 60 mAh | 200 mAh |

This example model applies to a battery-operated device. In practice, because the module is isolated from the battery (the host device manages the power source), the mAh ratings depend on the module's supply efficiency.

The module automatically enters slotted sleep mode when there is no transmission or reception occurring (SCI = 2).

Transmit power is assumed to be +3 dBm.

3: RF Integration

This chapter provides information related to RF (Radio Frequency) integration of AirPrime embedded modules with host devices. The frequencies of operation and performance specifications vary depending on the module model used. RF performance parameters for typical modules are listed in [Table 3-1](#) and [Table 3-2](#).

Note: Values in this guide are taken from the appropriate product specification documents (PSDs) (listed in [Related documents](#) on page 13)—in the case of a discrepancy between this document and the relevant PSD, use the value listed in the PSD.

Table 3-1: Typical RF parameters (MC57xx)

| Band | Tx Band (MHz) | Tx Power (dBm) | Rx Band (MHz) | Rx Sensitivity (dBm) |
|-----------------|---------------|----------------|---------------|-----------------------------|
| PCS | 1851–1910 | +23 to +25 | 1930–1990 | < -106 |
| Cellular | 824–849 | +23 to +25 | 869–894 | < -106 |
| GPS | | | 1575.42 | SA Off: -148 SA On: -152 |

Table 3-2: RF Parameters (MC8xxx)

| Module/Frequencies (MHz) | UMTS AirPrime embedded module (MC8xxx) | | | | | | | | | | | |
|---|--|------|------|-------|------|------|------|-------|-------|-------|-------|---|
| | 8201 | 8700 | 8775 | 8775V | 8780 | 8781 | 8790 | 9890v | 8791V | 8792V | 8795V | |
| GSM 850^a Tx: 824–849 Rx: 869–894 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Conducted Rx sensitivity (dBm) ^b Worst case: -106 Typical: -108 | | | | | | | | | | | |
| | Conducted Tx Power (dBm) +32 ± 1 (GMSK) +27 ± 1 (8PSK) | | | | | | | | | | | |
| EGSM_900^a Tx: 880–915 Rx: 925–960 | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Conducted Rx sensitivity (dBm) ^b Worst case: -106 Typical: -108 | | | | | | | | | | | |
| | Conducted Tx Power (dBm) +32 ± 1 (GMSK) +27 ± 1 (8PSK) | | | | | | | | | | | |
| DCS 1800^a Tx: 1710–1785 Rx: 1805–1880 | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Conducted Rx sensitivity (dBm) ^b Worst case: -105 Typical: -107 | | | | | | | | | | | |
| | Conducted Tx Power (dBm) +29 ± 1 (GMSK) +26 ± 1 (8PSK) | | | | | | | | | | | |

Table 3-2: RF Parameters (MC8xxx) (Continued)

| Module/Frequencies (MHz) | UMTS AirPrime embedded module (MC8xxx) | | | | | | | | | | | |
|--|--|------|------|-------|------|------|------|-------|-------|-------|-------|---|
| | 8201 | 8700 | 8775 | 8775V | 8780 | 8781 | 8790 | 9890v | 8791V | 8792V | 8795V | |
| PCS 1900^a Tx: 1850–1910 Rx: 1930–1990 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Conducted Rx sensitivity (dBm) ^b Worst case: -105 Typical: -107 | | | | | | | | | | | |
| | Conducted Tx Power (dBm) +29 ± 1 (GMSK) +26 ± 1 (8PSK) | | | | | | | | | | | |
| Band I^c (UMTS 2100) Tx: 1920–1980 Rx: 2110–2170 | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Conducted Rx sensitivity (dBm) ^b Worst case: -108 Typical: -110 | | | | | | | | | | | |
| | Conducted Tx Power (dBm) +23 ± 1 | | | | | | | | | | | |
| Band II^b (UMTS 1900) Tx: 1850–1910 Rx: 1930–1990 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ |
| | Conducted Rx sensitivity (dBm) ^b Worst case: -108 Typical: -110 | | | | | | | | | | | |
| | Conducted Tx Power (dBm) +23 ± 1 | | | | | | | | | | | |
| Band V^{b,d} (UMTS 850) Tx: 824–849 Rx: 869–894 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✗ | ✓ | ✓ |
| | Conducted Rx sensitivity (dBm) ^b Worst case: -108 Typical: -110 | | | | | | | | | | | |
| | Conducted Tx Power (dBm) +23 ± 1 | | | | | | | | | | | |
| Band VI^b (UMTS 800) Tx: 830–840 Rx: 875–885 | ✗ | ✓ | ✗ | ✗ | ✗ | ✗ | ✓ | ✓ | ✗ | ✗ | ✓ | ✓ |
| | Conducted Rx sensitivity (dBm) ^b Worst case: -108 Typical: -110 | | | | | | | | | | | |
| | Conducted Tx Power (dBm) +23 ± 1 | | | | | | | | | | | |
| Band VIII^b (UMTS 900) Tx: 880–915 Rx: 925–960 | ✗ | ✓ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ |
| | Conducted Rx sensitivity (dBm) ^b Worst case: -108 Typical: -110 | | | | | | | | | | | |
| | Conducted Tx Power (dBm) +23 ± 1 | | | | | | | | | | | |
| GPS 1575.42 | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | GPS conducted sensitivity (dBm): -154 | | | | | | | | | | | |

- a. (2%) CS
- b. All MC8xxx modules will conform to these limits. Individual models (as specified in their PSDs) may have stricter limits.
- c. (0.1%) 12.2 kbps
- d. Band VI is included as a subset of Band V.

RF connection

When attaching an antenna to the module:

*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.*

- Use a Hirose U.FL connector (model U.FL #CL331-0471-0-10) to attach an antenna to a connection point on the module, as shown in [Figure 3-1](#) (main RF connector or diversity RF/GPS connector).
- 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.

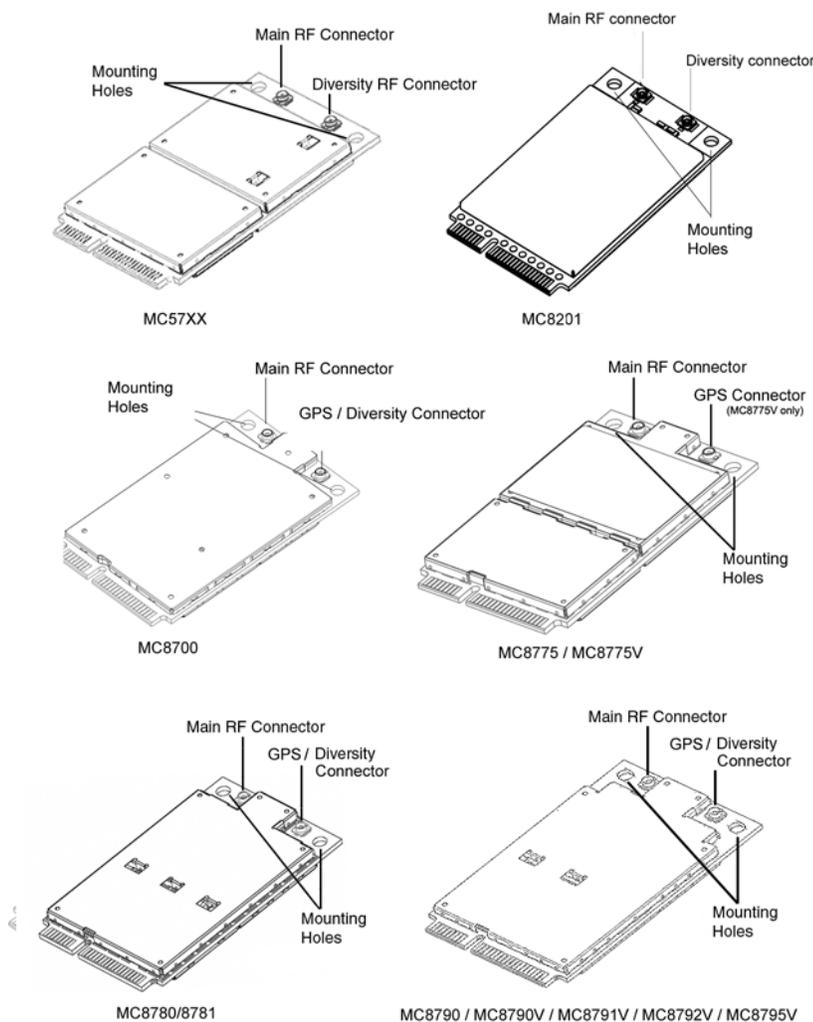


Figure 3-1: Antenna connection points and mounting holes

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 3-1](#) 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.

Shielding

The module is fully shielded to protect against EMI and to ensure compliance with FCC Part 15 - “Radio Frequency Devices” (or equivalent regulations in other jurisdictions).

Note: The module shields must NOT be removed.

Note: Values in this guide are taken from the appropriate product specification documents (PSDs) (listed in [Related documents](#) on page 13)—in the case of a discrepancy between this document and the relevant PSD, use the value listed in the PSD.

Antenna and cabling

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

Choosing the correct antenna and cabling

Consider the following points for proper matching of 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.

Developing custom antennas

Consider the following points when developing custom-designed antennas:

- A skilled RF engineer should do the development to ensure that the RF performance is maintained.
- Identify the bands that need to be supported, particularly when both CDMA (MC57xx) and UMTS (MC8xxx) modules will be installed in the same platform. In this case, you may want to develop separate antennas for maximum performance.

Note: For detailed electrical performance criteria, see [Appendix A: Antenna Specification](#) on page 91.

Determining the antenna's location

Consider the following points when deciding where to put the antenna:

- 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.

Disabling the diversity antenna

- MC57xx—If your host device is not designed to use the MC57xx module's diversity antenna, terminate the interface with a 50 Ω load.
- MC8201/MC8700/MC8780/MC8781/MC8790/MC8790V/MC8791V/MC8792V/MC8795V —Use the AT command **!RXDEN=0** to disable receive diversity or **!RXDEN=1** to enable receive diversity.

Interference and sensitivity

Note: These modules are 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.

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

RF desense can be addressed through a combination of mitigation techniques and radiated sensitivity measurement.

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.

Note: Values in this guide are taken from the appropriate product specification documents (PSDs) (listed in [Related documents](#) on page 13)—in the case of a discrepancy between this document and the relevant PSD, use the value listed in the PSD.

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.

Device-generated RF

Note: The module can cause interference with other devices such as hearing aids and on-board speakers.

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.

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

The 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

These and other high-speed devices (in particular, the processor) can decrease Rx performance because they run at frequencies of tens of MHz. The rapid rise and fall of these clock signals generates higher-order harmonics that often fall within the operating frequency band of the module, affecting the module's receive sensitivity.

Example

On a sub-system running at 40 MHz, the 22nd harmonic falls at 880 MHz, which is within the cellular receive frequency band.

Note: In practice, there are usually numerous interfering frequencies and harmonics. The net effect can be a series of desensitized receive channels.

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 sensitivity measurement

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

To determine the extent of any desensitization of receiver performance 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

Most carriers require a certain level of receiver performance to ensure proper functioning of the device on their networks. Although AirPrime embedded modules have been designed to meet these carrier requirements, 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 [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.

OTA test chamber configuration

To make OTA measurements, a test chamber is required. A full-size anechoic chamber is not necessarily required. [Figure 3-2](#) on page 44 shows a small anechoic chamber manufactured by Lindgren. This does not provide power to the

same accuracy as a full-size anechoic chamber, but is sufficient for this application. A base station simulator, such as an Agilent 8960 (shown) or Rohde & Schwarz CMU200, is used to provide FER (Frame Error Rate) measurements.

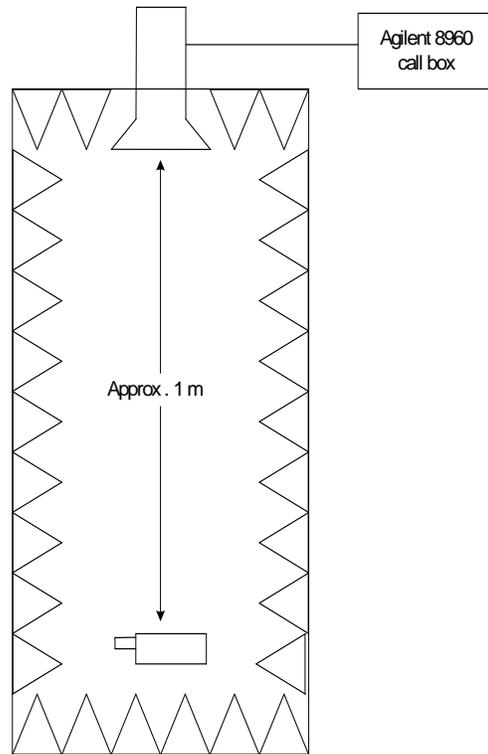


Figure 3-2: Anechoic chamber

Path loss calculation

The chamber is calibrated for path loss using a reference antenna with known gain that is feeding a spectrum analyzer or power meter. This makes it possible to determine the radiated power available to the receiving antenna and the path loss:

$$\begin{aligned} \text{Radiated Power} = & \text{Measured received power} \\ & + \text{Any cable losses} \\ & - \text{Reference receive antenna gain} \end{aligned}$$

$$\begin{aligned} \text{Path Loss} = & \text{Radiated power} \\ & - \text{Input power} \end{aligned}$$

Note: It is not necessary to know the gain of the transmitting antenna; it is included in the path loss.

Positioning the DUT (Device Under Test)

To achieve meaningful results, the device must be positioned such that the peak of the receive antenna pattern is pointed toward the source antenna. Theoretically, the best way to accomplish this is to modify the DUT so that antenna output is through coaxial cable. The device is then rotated until the receive power is maximized.

Alternate path loss calculation method

Path loss can also be calculated, without modifying the DUT, by using the transmit capabilities of the unit. This method of calculation is possible because the position that maximizes transmitter power provides a sufficiently accurate location for receiver desense measurements.

The unit is placed in a call and set to generate peak output power, either through a test mode, or by configuring the base station simulator to issue the appropriate command.

The unit is then positioned for maximum power as determined by the call box.

Sensitivity vs. frequency

For the MC57xx, sensitivity is defined as the input power level in dBm that produces a FER (Frame Error Rate) of 0.5%. Sensitivity should be measured at all CDMA frequencies across each band. For example, [Figure 3-3](#) on page 46 illustrates sensitivity in the US PCS band. There are 25 physical channels with a spacing of 50 KHz; the first CDMA channel is CH25.

For the MC8xxx, 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.

Sensitivity test results—MC57xx

Figure 3-3 shows typical test results for the US PCS band for both conducted and over-the-air connections. The conducted (or "connectorized") measurements were made using an RF coaxial cable connection. The over-the-air measurements were made using both an external antenna and a typical device antenna.

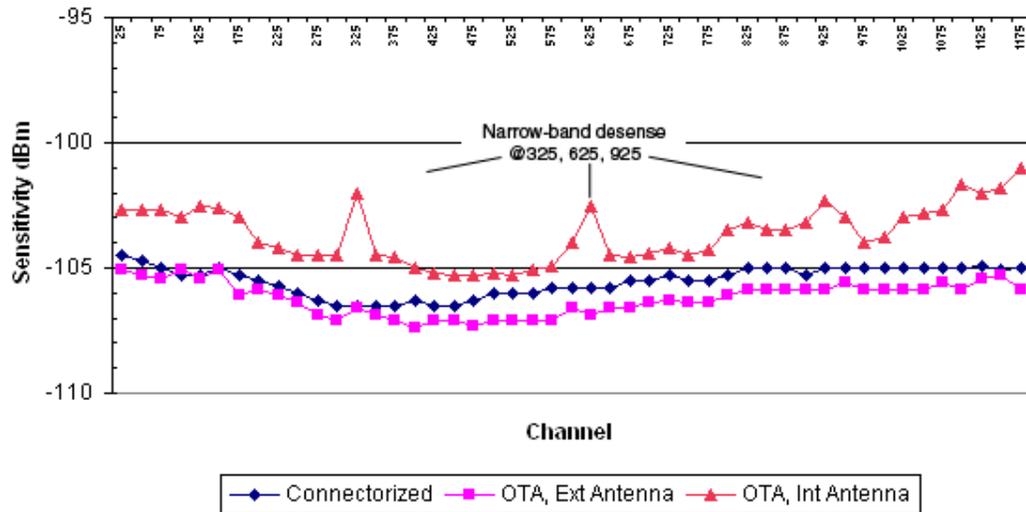


Figure 3-3: US PCS sensitivity measurements

In this test, the external antenna performed best—the expected result if a high efficiency antenna with some gain is used. The internal antenna has less gain than the external antenna, so the internal antenna's performance is offset above the external antenna. The antenna gain must be known to determine whether the offset is strictly the result of antenna gain or if broadband desense is present. Narrowband desense can be seen at channels 325, 625, and 925.

4: Audio Interface

Note: Values in this guide are taken from the appropriate product specification documents (PSDs) (listed in [Related documents](#) on page 13)—in the case of a discrepancy between this document and the relevant PSD, use the value listed in the PSD.

AirPrime embedded modules that support voice (MC5727V / MC5728V / MC8775V / MC8790V / MC8791V / MC8792V / MC8795V) support the following audio modes that may be required by a host audio system:

- Handset
- Headset
- Car kit
- Speakerphone
- AUX (MC5727V / MC5728V modules are preconfigured for HAC [Hearing Aid Compatibility])
- TTY

The modules support both a differential analog interface and PCM digital audio, and allow dynamic run-time selection of the appropriate mode.

[Table 4-1](#) summarizes the key audio features of these modules.

Table 4-1: Embedded module audio features

| Feature | Transmit | Receive |
|--|---|------------------|
| Gain (adjustable) | MC5727V: <ul style="list-style-type: none"> • MIC_AMP1: Programmable to 0 dB or +24 dB. • MIC_AMP2: Programmable from -6 dB to +25.5 dB in steps of 1.5 dB. MC5728V: <ul style="list-style-type: none"> • Programmable to 0 dB or +24 dB. MC8775V / MC8790V / MC8791V / MC8792V / MC8795V: <ul style="list-style-type: none"> • Up to +48.5 dB analog gain available (when the analog interface is selected). | Up to +12 dB |
| Filtering stages | Several adjustable high-pass and slope filters | High-pass filter |
| Noise suppression | Supported | n/a |
| Echo cancellation | Configurable for each audio mode (headset, handset, speakerphone, and car kit) | n/a |
| Output driver stage | n/a | Supported |
| FIR (Finite Impulse Response) filtering | MC8xxx: <ul style="list-style-type: none"> • Option of providing 13 tap FIR filtering for receive and transmit paths to equalize the acoustic response of the speaker and microphone elements. | |
| Audio pass band | 300 Hz–3.4 kHz | |

These modules are intended to serve as an integral component of a more complex audio system—for example, a PDA with a separate codec interfaced to the Host Application processor.

Usually, the interface between the module and the host audio system is set to line-level amplitudes with no transducer considerations. The responsibility of the module codec or host codec for special functions is detailed in [Table 4-2](#) on page 48.

Table 4-2: Codecs responsible for special functions

| Function | Responsible Codec |
|--|-------------------|
| Phone oriented (e.g., echo cancellation, FIR filtering) | Module codec |
| Path-switching | Host codec |
| Transducer interfaces | Host codec |
| Adjustable gain/volume settings | Either |
| DTMF/ringer tone generation | Either |
| Mixing | Host codec |

System block diagrams

Note: When integrating the module into your host platform, make sure the module has sufficient shielding to prevent RF interference.

MC5727V system block

[Figure 4-1](#) on page 49 represents the MC5727V module's audio system block, and includes the following features:

- Module interconnects are shown on the left side of the diagram. The audio interface uses the signals:
 - MIC_P/MIC_N
 - SPK_P/SPK_N
- Dynamic ranges for each programmable gain stage are listed, with the following constraints:
 - MIC_AMP1 is programmable in discrete steps only
 - MIC_AMP2 (MC5727V only) is programmable in discrete steps only
 - CodecSTGain, when set to the minimum setting, effectively mutes sidetone in the module codec

Note: Make sure the host device includes DC blocking capacitors on the Audio In lines – the module does not include series capacitors.

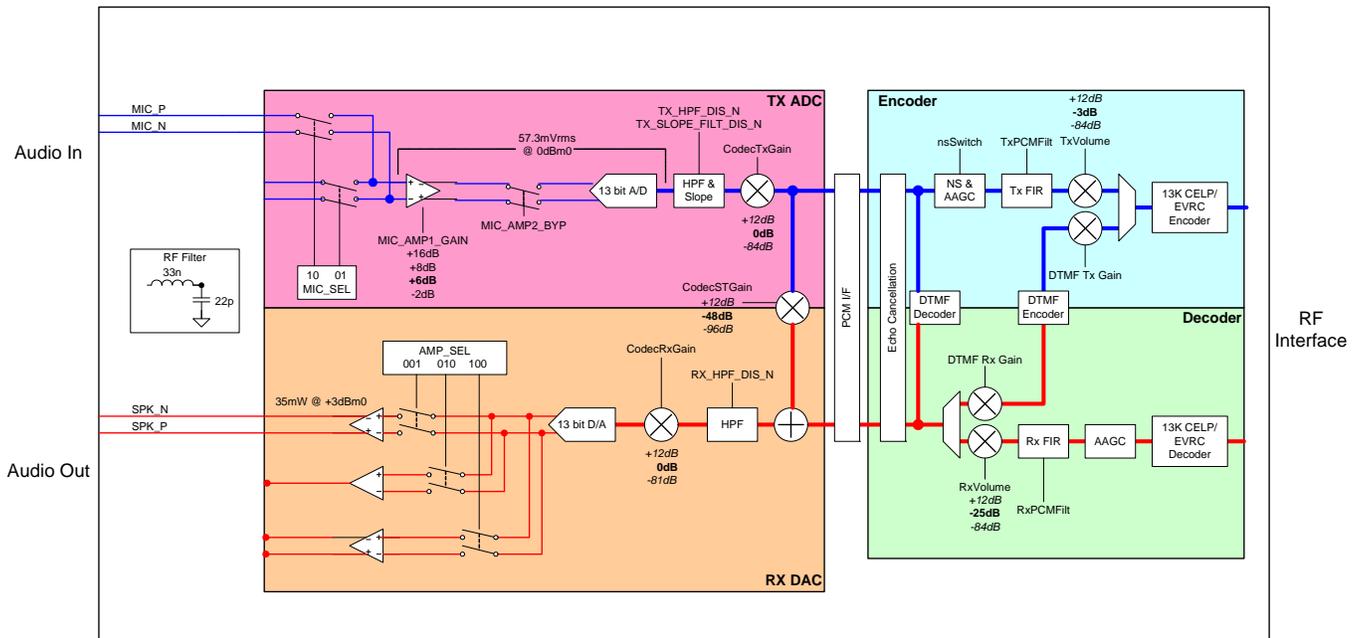


Figure 4-1: MC5727V Audio system block

MC5728V system block

Figure 4-2 on page 50 represents the MC5728V module's audio system block, and includes the following features:

- Module interconnects are shown on the left side of the diagram. The audio interface uses the signals:
 - MIC_P/MIC_N
 - SPK_P/SPK_N
- Dynamic ranges for each programmable gain stage are listed, with the following constraints:
 - MIC_AMP1 is programmable to 0 dB or +24 dB only
 - CodecSTGain, when set to the minimum setting, effectively mutes sidetone in the module codec

Note: Make sure the host device includes DC blocking capacitors on the Audio In lines – the module does not include series capacitors.

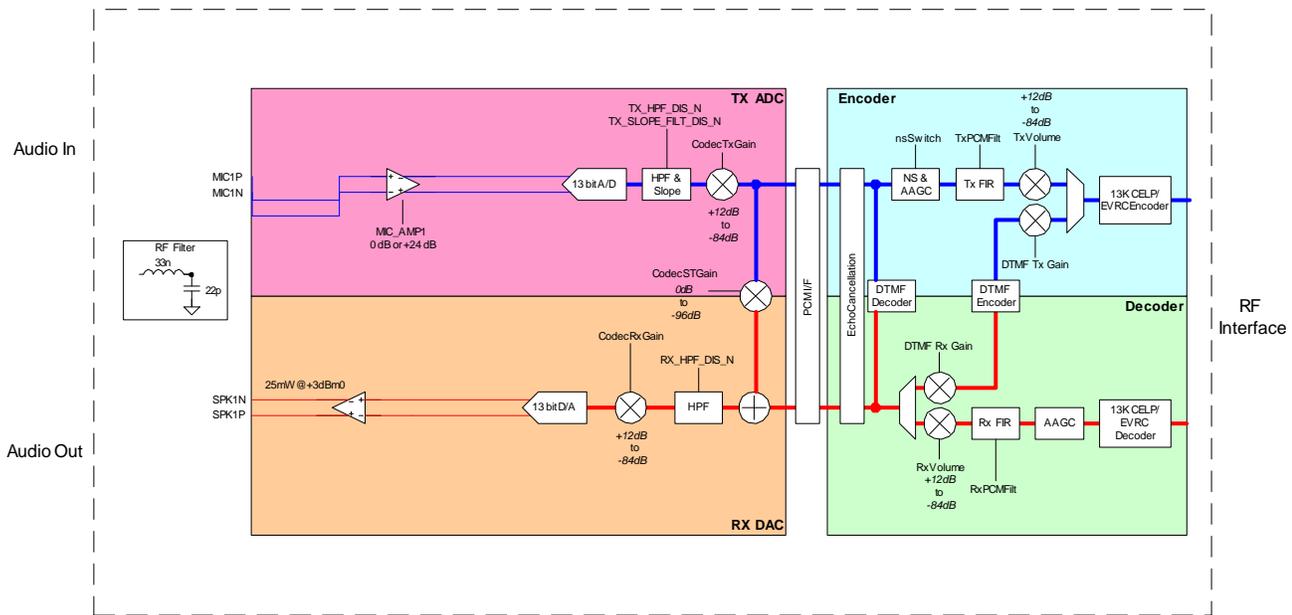


Figure 4-2: MC5728V Audio system block

MC8775V/MC8790V/MC8791V/MC8792V/ MC8795V system block

Figure 4-3 on page 51 represents the MC8775V/MC8790V/MC8791V/MC8792V/MC8795V module’s audio system block, and includes the following features:

- Module interconnects are shown on the left side of the diagram. The analog audio interface uses the signals:
 - MIC_P/MIC_N
 - SPK_P/SPK_N
- The digital PCM audio interface uses the signals:
 - PCM_CLK
 - PCM_DIN
 - PCM_DOUT
 - PCM_SYNC
- Dynamic ranges for each programmable gain stage are listed, with the following constraints:
 - MIC_AMP1 is programmable in 1.5 dB steps
 - CodecSTGain, when set to the minimum setting, effectively mutes sidetone in the module codec
- When PCM audio is selected, the RX DAC and TX ADC blocks are bypassed—the external PCM codec controls transmit gain, receive gain, and sidetone gain.

Note: Make sure the host device includes DC blocking capacitors on the analog Audio In lines – the module does not include series capacitors.

Note: Data mixing is not supported. If mixing of voice signal is required, it must be done by the host processor.

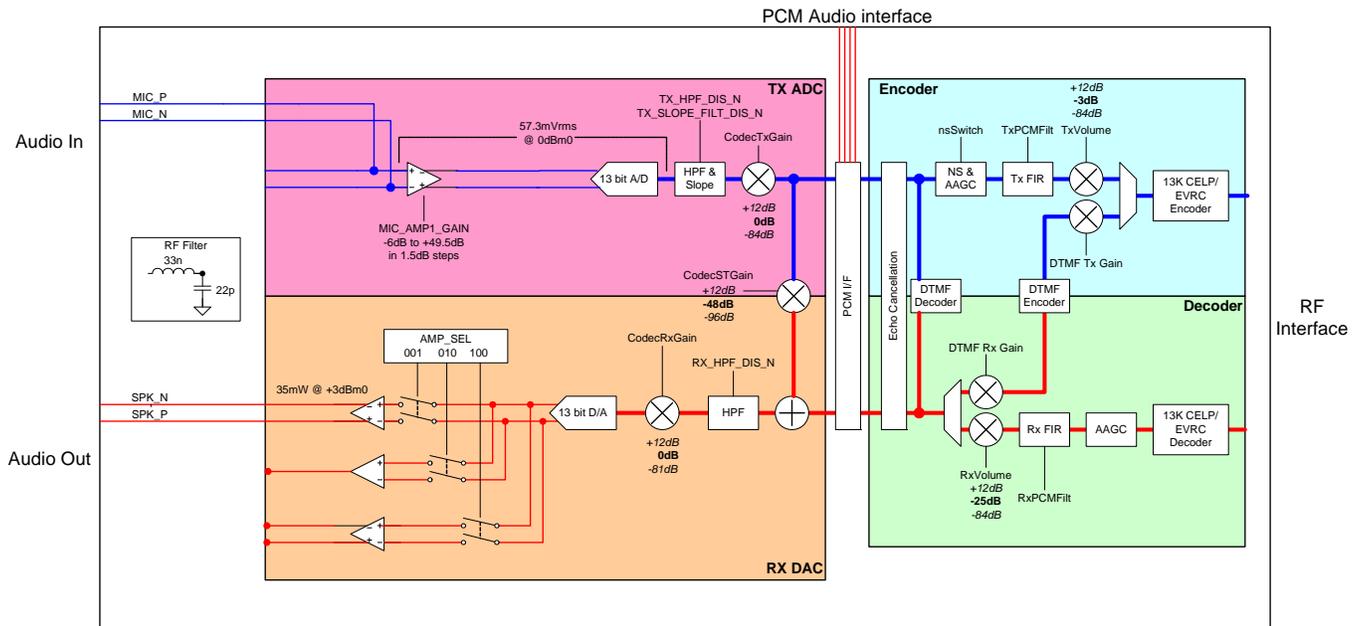


Figure 4-3: MC8775V/MC8790V/MC8791V/MC8792V/MC8795V Audio system block

Modes of operation

These modules support the following operational modes: headset, handset, car kit, speakerphone, AUX¹, and TTY—end products can use any combination of these modes.

The host device must use host-modem messaging to tell the module which mode to use for each call.

Sidetone support

The sidetone path mixes the near-end transmit voice to the near-end receive. This gives the near-end user some feedback that indicates that the call is up and that the audio system is functioning.

The sidetone path can be enabled in either the PDA codec or the embedded module—each path is equally valid. It should *not* be added to both devices, and for speakerphone or car kit applications, *both* sidetone paths should be disabled.

The typical handset sidetone is 12 dB below transmit voice levels.

1. MC5727V/MC5728V modules are preconfigured for HAC [Hearing Aid Compatibility].

Gain distribution

Table 4-3: System gain values^a

| Mode | Modem TX gain (dB) | Modem RX gain (dB) | Typical system TX gain (dB) | Typical system RX gain (dB) |
|---------------------|--------------------|--------------------|-----------------------------|-----------------------------|
| Handset | +8 | +8 | +28 | +32 |
| Headset | +8 | +8 | +28 | +24 |
| Car Kit | +16 | +8 | +36 | +32 |
| Speakerphone | +16 | +8 | +36 | +32 |

a. Typical system gains are estimates only and vary from system to system depending upon transducer sensitivity.

For Handset and Headset mode, the threshold of pain (+120 dBSPL) *must not* be exceeded at the maximum volume setting. A good target for the medium volume setting is +94 dBSPL, as this is a typical level for conversational speech.

Most audio gain should be added to the host audio front end (within the PDA style codec gain blocks or amplifiers between the host codec and transducers). Refer to the appropriate Product Specification Document for reference levels on the modem receive and transmit side.

Echo cancellation support

AirPrime embedded modules offer four modes of echo cancellation to support unique end-unit audio capabilities (echo cancellation can also be turned off completely). All echo cancellation is near-end (mobile TX) cancellation only. The network provides some level of far-end echo cancellation.

Table 4-4: Echo cancellation details

| Mode | Details |
|----------------|---|
| Handset | <ul style="list-style-type: none"> • Short echo path (<16 ms travel time from speaker to microphone) • Handset design requires good isolation between speaker and microphone • Echo canceller allows full-duplex conversation with absolute minimum echo |
| Headset | <ul style="list-style-type: none"> • Short echo path (<16 ms travel time from speaker to microphone) • Headset design may allow higher echo than handset mode—microphone and speaker are physically closer • More aggressive echo canceller algorithm allows full-duplex conversation on headsets with good isolation |

Table 4-4: Echo cancellation details (Continued)

| Mode | Details |
|---------------------|---|
| Car kit | <ul style="list-style-type: none"> • Long echo path (<64 ms travel time from speaker to microphone) • Loud echo • For use with hands-free car kit or speakerphone applications with mild distortion |
| Speakerphone | <ul style="list-style-type: none"> • Long echo path (<64 ms travel time from speaker to microphone) • Loud echo • For use with speakerphone applications with high distortion • Half-duplex algorithm, very aggressive in near-end Tx muting to eliminate transmitted echo |
| Off | |

Audio signal interface

The differential microphone input offers superior noise rejection performance to the single-ended approach. The termination of the differential pair rejects common signals (such as noise). The pair should be routed together for optimal noise rejection. Since MIC_P and MIC_N are high impedance inputs, it is important to isolate these from possible noise sources (toggling digital lines with fast edges).

The speaker interface can be single-ended or differential depending on product. Single-ended speaker outputs rely on modem ground as an audio reference.

The audio passband for both receive and transmit paths (speaker and microphone) extends from 300 Hz to 3.4 kHz. A programmable sidetone with a range from mute to unity gain is available for both headset and main audio paths. Sidetone should be muted for speakerphone use.

Note that certain carriers now require use of hearing-aid compatible transducers in a handset design. The Primary audio path can be interfaced directly to such devices. Refer to ANSI C63.19 for details regarding reduced RF emissions ("U3 rating") and inductive/telecoil coupling ("U3T" rating) devices.

Table 4-5: Primary audio signal interface

| Signal | Pin # | Type | Direction | Description |
|--------------|-------|--------|-----------|-----------------------------------|
| MIC_P | 1 | Analog | Input | Non-inverted microphone input (+) |
| MIC_N | 3 | Analog | Input | Inverted microphone input (-) |
| SPK_P | 5 | Analog | Output | Non-inverted speaker output (+) |
| SPK_N | 7 | Analog | Output | Inverted speaker output (-) |

Table 4-6: PCM digital audio signal interface

| Signal | Pin # | Type | Direction | Description |
|-----------------|-------|---------|----------------------------|--------------|
| PCM_CLK | 45 | Digital | Output | PCM clock |
| PCM_DIN | 47 | Digital | Input (internal pull-down) | PCM data in |
| PCM_DOUT | 49 | Digital | Output | PCM data out |
| PCM_SYNC | 51 | Digital | Input (internal pull-down) | PCM sync |

Audio function partitioning

The following phone-oriented functions are usually under module control:

- FIR filters—Transmit and receive paths
- Noise suppression—Required due to high sensitivity and gain in transmit path
- Echo cancellation—Different for each audio path and environment (handset, headset, car kit, speakerphone)
- High pass filtering/slope filtering functions—Required per phone acoustic requirements
- AGC (Automatic Gain Control)—Normalizes audio volumes in varying acoustic environments
- DTMF tones—Generation and detection of DTMF tones is required in both directions of the phone interface
- Comfort noise—Low level noise injected into receiver path for user "connection" experience
- Simple ringers—Digital and analog tones, melody ringers, MIDI with limited memory storage

The following functions are typically performed in the host codec:

- Voice Memo—Performed by the host if significant memory storage is required
- Polyphonic ringtone—Host often supports WAV, MIDI formats with significant memory storage
- Audio path switching—Turn on audio path depending on user interface selection, or headset detection
- Audio path mixing—Required for voice memo recording and playback via multiple audio paths
- Transducer interface—Host provides acoustic drivers, must occur outside of path switching and mixing

These functions can be performed in either the host or module codec, depending on balance of component selection and engineering resources:

- Volume settings—Adjustable gain settings based on user interface selections
- Sidetone—Careful placement of sidetone gain control is required to prevent the need to adjust sidetone gain with varying volume settings

5: Host/Module Interfaces

5

This chapter provides information about specific host interface pin assignments, the host-module communication interface (USB interface), LED outputs, USIM interface, and lists extended AT commands that may be useful for hardware integration testing.

Host interface pin details

Detailed connector pin information is available in the product specification documents for each module—refer to these documents when integrating modules into your host devices.

The following are specific integration considerations relating to the host interface connector pins:

- On any given interface (USB, USIM, etc.), leave unused inputs and outputs as no-connects.
- [Table 5-1](#) and [Table 5-2](#) on page 56 describe MC8775V and MC8790V/MC8791V/MC8792V/MC8795V-specific pins that are rated for 2.6 V. Reference these pins to the MSM_2.6 V rail (pin 11) as the maximum limit.

Table 5-1: MC8775V 2.6 V connector pins^a

| Pin | Signal name | Description |
|-----|---------------|--|
| 1 | MIC_P | Microphone Positive |
| 3 | MIC_N | Microphone Negative |
| 6 | GPIO_1 | General Purpose I/O ^b |
| 16 | GPIO_2 | General Purpose I/O ^a |
| 22 | AUXV1 | Auxiliary Voltage 1 (ADC input, 0–2.6Vmax) |
| 28 | GPIO_3 | General Purpose I/O ^a |
| 33 | MDL_RESET_N | Reset |
| 44 | GPIO_4 | General Purpose I/O ^a |
| 45 | CTS1/PCM_CLK | UART Clear To Send <i>or</i> PCM Clock |
| 46 | GPIO_5 | General Purpose I/O ^a |
| 47 | RTS1/PCM_DIN | UART Request To Send <i>or</i> PCM Data In |
| 48 | GPIO_6 | General Purpose I/O ^a |
| 49 | RXD1/PCM_DOUT | UART Receive Data <i>or</i> PCM Data Out |
| 51 | TXD1/PCM_SYNC | UART Transmit Data <i>or</i> PCM Sync |

a. This table is abstracted from the PSD—the PSD takes precedence

b. No defined function—reserved for future use

Table 5-2: MC8790V/MC8791V/MC8792V/MC8795V 2.6 V connector pins^a

| Pin | Signal name | Description |
|-----|-------------|--|
| 1 | MIC_P | Microphone Positive |
| 3 | MIC_N | Microphone Negative |
| 6 | GPIO_1 | General Purpose I/O ^b |
| 16 | GPIO_2 | General Purpose I/O ^b |
| 22 | AUXV1 | Auxiliary Voltage 1 (ADC input, 0–2.6V/max) |
| 28 | GPIO_3 | General Purpose I/O ^b |
| 30 | GPIO_4 | General Purpose I/O ^b |
| 32 | RI | UART Ring Indicator |
| 33 | MDL_RESET_N | Reset |
| 44 | DCD | UART Data Carrier Detect |
| 45 | CTS/PCM_CLK | UART Clear To Send <i>or</i> PCM Clock |
| 46 | DSR | UART Data Set Ready |
| 47 | RTS/PCM_DIN | UART Request To Send <i>or</i> PCM Data In |
| 48 | DTR | UART Data Terminal Ready |
| 49 | RD/PCM_DOUT | UART Receive Data <i>or</i> PCM Data Out |
| 51 | TD/PCM_SYNC | UART Transmit Data <i>or</i> PCM Sync Out |

- a. This table is abstracted from the device PSDs—the PSDs takes precedence
b. No defined function—reserved for future use

USB interface

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

The interface complies with the *Universal Serial Bus Specification, Rev 2.0*.

Features of the USB interface include:

- Support for *full-speed (12 Mbps)* data rate
- (MC8201/MC8700/MC8790/MC8790V/MC8791V/MC8792V/MC8795V)
Support for *high-speed (480 Mbps)* data rate
- Transfer of general, phone diagnostic, and over-the-air data between the module and the host
- Enumeration of the module as a set of Modem (MC57xx) or COM (MC57xx and MC8xxx) ports, using host Windows drivers

- Enumeration of the module as a set of /dev/ttyUSBn devices for Linux systems with the Sierra Wireless driver installed
- USB-compliant transceivers

USB handshaking

Note: If you are using Sierra Wireless drivers, you can skip this section—it is intended for developers who are creating their own USB drivers.

The host must act as a USB host device to interface with the module.

The module uses the USB standard Suspend and Resume functions (described further) to control the sleep and wakeup states. For detailed specifications of Resume and Suspend, refer to *Universal Serial Bus Specification, Rev 2.0*.

Suspending

The module supports USB Suspend mode.

When the module enters suspend mode, it shuts down the USB clock to save power.

While in the suspend state:

- The module provides power to the D+/- interface to signal its current state to the host device.
- The host must maintain the VCC_3V3 voltage (VCC_3V8 for MC8201)

Refer to *Universal Serial Bus Specification, Rev 2.0* for critical timing parameters for the suspend state.

Resume

USB activity may be resumed by either the USB host or by the module.

If the host initiates USB activity:

1. The USB transceiver detects the change in bus activity and triggers the USB_RESUME interrupt to the module's processor.
2. The module then enables its USB clock and responds to the host.

If the module initiates USB communication (Remote Wakeup):

1. The module enables its USB clock.
2. The module enables the USB transceiver.
3. The module sends the resume signal for at least 20 ms.

Refer to *Universal Serial Bus Specification, Rev 2.0* for critical timing parameters for the resume state.

Host USB driver requirements

The USB driver on the host device must meet these critical requirements:

- The host USB driver must support remote wakeup, resume, and suspend operations as described in *Universal Serial Bus Specification, Rev 2.0*.
- The host USB driver must support serial port emulation. The module implements both 27.010 multiplexing and USB-CDC.
- When the host doesn't have any valid data to send, the host USB driver should NOT send any SOF tokens (start-of-frames) to the module. These tokens keep the module awake and cause unnecessary power consumption.

LED output

The module drives the LED output according to the *PCI-Express Mini Card specification* (summarized in [Table 5-3](#)).

Table 5-3: LED states

| State | Indicates | Characteristics |
|---------------------|---|---|
| Off | Module is not powered. | Light is off. |
| On | Module is powered and connected, but not transmitting or receiving. | Light is on. |
| Slow blink | Module is powered and searching for a connection. | LED is flashing at a steady, slow rate. <ul style="list-style-type: none"> • 250 ms ± 25% ON period • 0.2 Hz ± 25% blink rate |
| Faster blink | Module is transmitting or receiving. | LED is flashing at a steady, faster rate. <ul style="list-style-type: none"> • Approximately 3 Hz blink rate |

Note: MC572x modules support customer-defined LED controls.

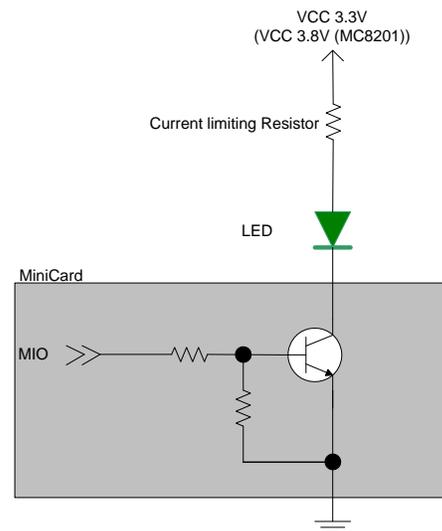


Figure 5-1: Example LED

USIM interface

Note: This section applies only to UMTS (MC8xxx) modules.

The module is designed to support one USIM (Universal Subscriber Identity Module). The USIM holds account information, allowing users to use their account on multiple devices.

The USIM interface has four signals (plus Ground). These are defined in [Table 5-4](#) with an example circuit shown in [Figure 5-2](#) on page 60. (For USIM card contacts, see [Figure 5-3](#) on page 60.)

Table 5-4: USIM pins

| Pin name | USIM contact number | Function |
|-----------|---------------------|-------------------------------|
| XIM_VCC | 1 | USIM VCC |
| XIM_RESET | 2 | Active low USIM reset |
| XIM_CLK | 3 | Serial clock for USIM data |
| XIM_DATA | 7 | Bi-directional USIM data line |
| XIM_GND | 5 | Ground |

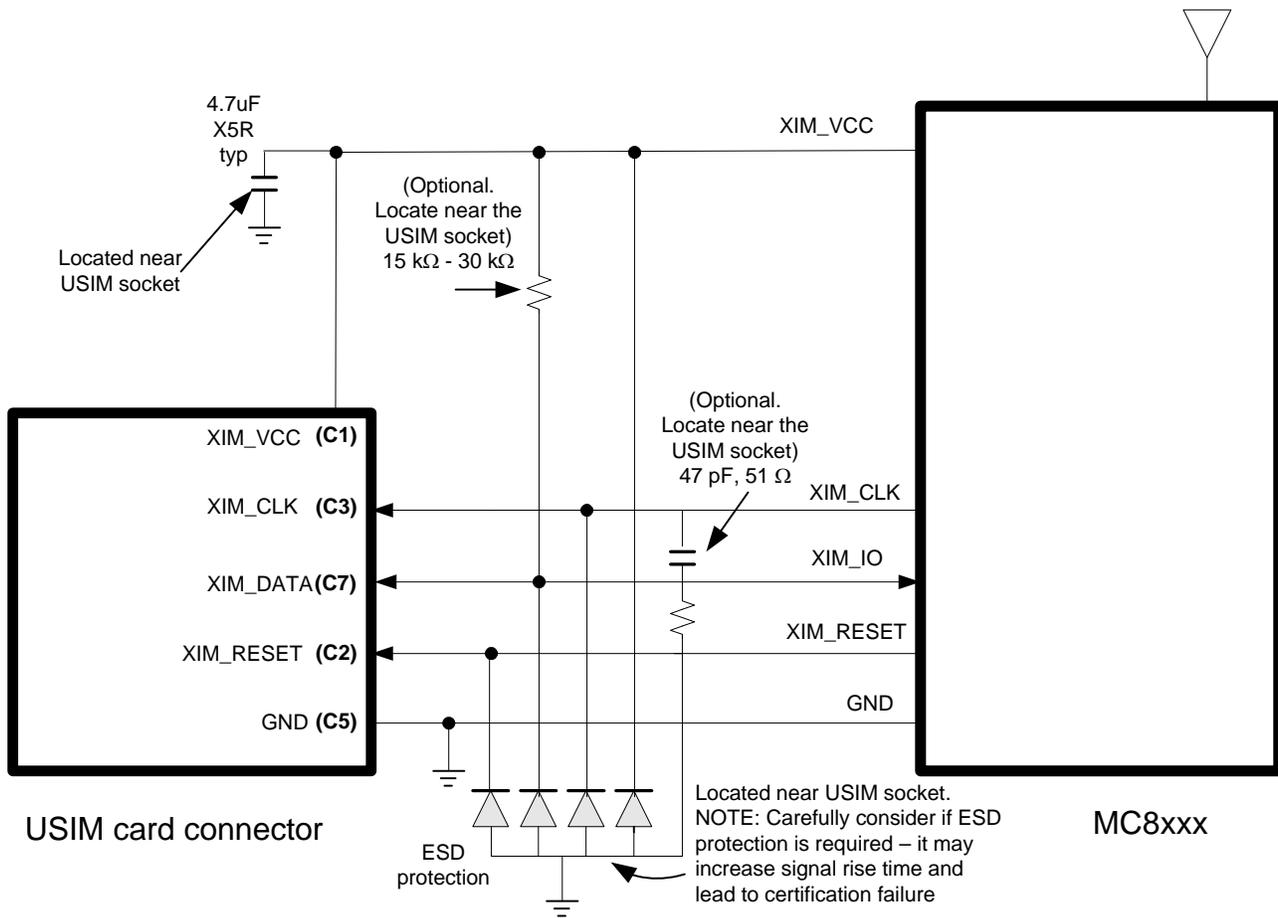


Figure 5-2: USIM application interface

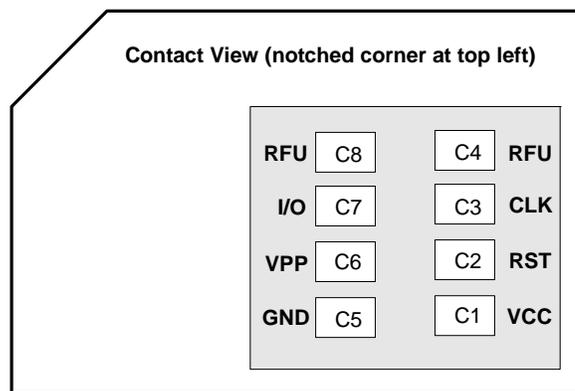


Figure 5-3: USIM card contacts (contact view)

USIM operation

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 USIM interface, you *must* make sure that the USIM signal integrity is not compromised.

Some design recommendations include:

- Total impedance of the VCC and GND connections to the USIM, measured at the module connector, should be less than $1\ \Omega$ to minimize voltage drop (includes any trace impedance and lumped element components—inductors, filters, etc.).

Note: The MC8xxx is designed for use with either a 1.8 V or 3 V USIM.

- Position the USIM connector no more than 10 cm from the module. If a longer distance is required because of the design of the host device, a shielded wire assembly is recommended—connect one end as close as possible to the USIM connector and the other end as close as possible to the module connector. The shielded assembly may help shield the USIM interface from system noise.
- Reduce crosstalk on the XIM_data line to reduce the risk of failures during GCF approval testing.
- Avoid routing the XIM_CLK and XIM_DATA lines in parallel over distances greater than 2 cm—cross-coupling of these lines can cause failures.
- Keep USIM signals as short as possible, and keep very low capacitance traces on the XIM_DATA and XIM_CLK signals to minimize signal rise time—signal rise time must be $<1\ \mu\text{s}$. High capacitance increases signal rise time, potentially causing your device to fail certification tests.
- Add external pull-up resistors ($15\ \text{k}\Omega$ – $30\ \text{k}\Omega$), if required, between the SIM_IO and SIM_VCC lines to optimize the signal rise time.
- 3GPP has stringent requirements for I/O rise time ($<1\ \mu\text{s}$), signal level limits, and noise immunity—consider this carefully when developing your PCB layout.
- VCC line should be decoupled close to the USIM socket.
- USIM is specified to run up to 5 MHz (USIM clock rate). Take note of this speed in the placement and routing of the USIM signals and connectors.
- You must decide if, **and how much**, additional ESD protection and series resistors are suitable for your product. The MC8xxx already includes additional ESD protection. Adding more protection (additional circuits) than is necessary could decrease signal rise time, increase load impedance, and cause USIM certification failure.
- Putting an optional decoupling capacitor at XIM_VCC near the USIM 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 XIM_CLK at the USIM socket to reduce EMI and increase signal integrity is recommended if the trace length between the USIM socket and module is long— $47\ \text{pF}$ and $50\ \Omega$ resistor are recommended.

- Protect the USIM socket to make sure that the USIM cannot be removed while the module/host device is powered up. For example, you could place the socket under the battery (for portable devices); consider similar options for other device types.
- Test your first prototype host hardware with a Compton IT³ USIM test device at a suitable testing facility.

Extended AT commands

Several proprietary AT commands are available for AirPrime embedded modules to use in hardware integration design and testing (these commands are *NOT* intended for use by end users). For a list of all available commands and descriptions of their functionality, refer to *CDMA Extended AT Command Reference (Document 2130621)* for the MC57xx, or *AirPrime MC8xxx Embedded Modules Extended AT Command Reference (Document 2130616)* and *AirCard/AirPrime UMTS devices Supported AT Command Reference (Document 2130617)* for the MC8xxx.

Some useful commands for use in hardware integration are listed in [Table 5-5](#) (MC57xx) and [Table 5-6](#) on page 63 (MC8xxx).

Table 5-5: MC57xx Extended AT commands

| Command | Description |
|-----------------------------|--|
| Internal commands | |
| !OEM | Unlock OEM protected commands |
| Modem state commands | |
| !DIAG | Set diagnostic mode |
| !BOOTHOLD | Resets modem and wait in boot loader |
| RF AT commands | |
| !CHAN | Set RF band and channel |
| !RX | Turn on/off the first receiver |
| !RX2 | Turn on/off the second receiver |
| !RXAGC | Read Rx AGC |
| !RX2AGC | Read second Rx AGC |
| !TX | Enable Tx chain |
| !TXAGC | Set Tx AGC |
| !KEYON | Turn on transmitter |
| !KEYOFF | Turn off transmitter |
| !ALLUP | Turn on transmitter in all ups condition |

Table 5-5: MC57xx Extended AT commands (Continued)

| Command | Description |
|-------------------------------|------------------------------------|
| Provisioning commands | |
| !CARRIERID | Display the carrier ID |
| CDMA commands | |
| !STATUS | Display the status of the modem |
| !SCI | Get slot cycle index |
| Power control commands | |
| !PCSTATE | Power control state |
| !PCINFO | Read the power control information |
| !PCTEMP | Read the power control temperature |
| !PCVOLT | Read the power control voltage |

Table 5-6: MC8xxx Extended AT commands

| Command | Password-protected | 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 |
| !DAGGRSSI | ✓ | Return the RSSI (Received Signal Strength Indicator) in dBm (GSM mode) |
| !DAGGAVGRSSI | ✓ | Return an averaged RSSI (Received Signal Strength Indicator) in dBm (GSM mode) |

Table 5-6: MC8xxx Extended AT commands (Continued)

| Command | Password-protected | Description |
|----------------------|--------------------|---|
| !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 |

6: Thermal Considerations

6

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

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

- Supply voltage—Maximum power dissipation for these modules can be up to 3.1 W (or 3.5 W for the MC8700 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 include the following four shield cases indicated in [Figure 6-1](#) on page 66:

- Transmitter—Top shield (next to RF connectors). This is likely to be the hottest area.
- Baseband 1—Bottom shield, below the transmitter
- Receiver—Top shield, other side of module from the transmitter
- Baseband 2—Bottom shield, below the receiver

You can enhance heat dissipation by:

- Maximizing airflow over/around the module
- Locating the module away from other hot components

Note: Adequate dissipation of heat is necessary to ensure that the module functions properly, and to comply with the thermal requirements in PCI Express Mini Card Electromechanical Specification Revision 1.1.

Module 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 each shield indicated in [Figure 6-1](#) on page 66.

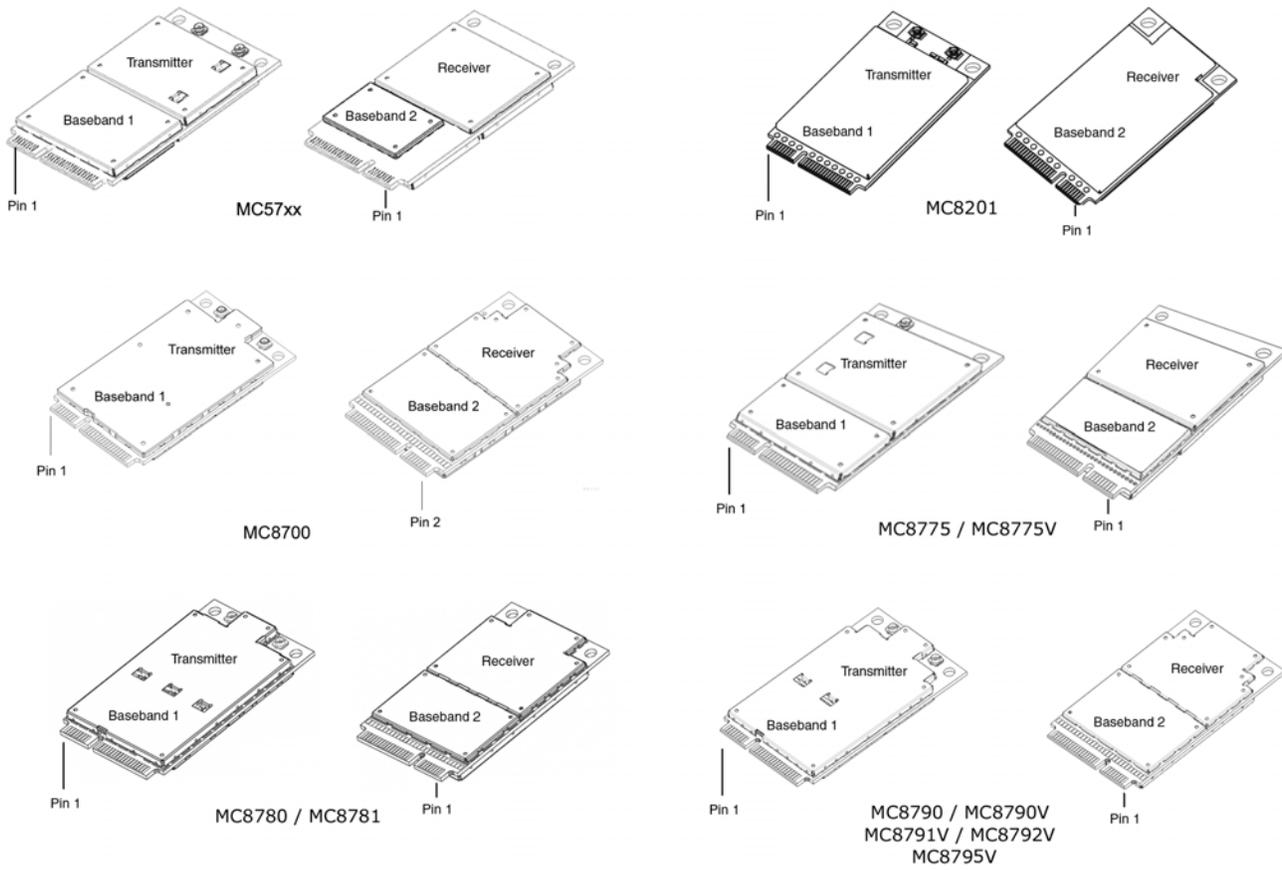


Figure 6-1: Shield locations

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

7: Design Checklist

7

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 7-1: Hardware integration design considerations

| Suggestion | Section where discussed |
|--|---|
| Component placement | |
| Protect the USIM socket so the USIM cannot be removed while the host is powered up. | USIM operation on page 61 |
| If an ESD suppressor is not used, allow space on the USIM connector for series resistors in layout. (Up to 100 Ω may be used depending on ESD testing requirements). | USIM operation on page 61 |
| Minimize RF cable losses as these affect performance values listed in product specification documents. | RF connection on page 39 |
| Antennas | |
| Match the module/antenna coax connections to 50 Ω —mismatched antenna impedance and cable loss negatively affect RF performance. | RF connection on page 39 |
| If installing both the MC57xx and MC8xxx in the same device, consider using separate antennas for maximum performance. | Antenna and cabling on page 40 |
| Power | |
| Limit host power rail dips caused by module inrush current by adding sufficient capacitance to the host power rail. | Inrush currents on page 24 |
| Make sure the power supply can handle the maximum current specified for the module type. | Current consumption overview on page 27 |
| Limit the total impedance of VCC and GND connections to the USIM 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 . | USIM operation on page 61 |
| Decouple the VCC line close to the USIM socket. The longer the trace length (impedance) from socket to module, the greater the capacitance requirement to meet compliance tests. | USIM operation on page 61 |

Table 7-1: Hardware integration design considerations (Continued)

| Suggestion | Section where discussed |
|--|---|
| EMI/ESD | |
| Investigate sources of localized interference early in the design cycle. | Methods to mitigate decreased Rx performance on page 43 |
| Provide ESD protection for the USIM connector at the exposed contact point (in particular, the CLK, VCC, IO, and RESET lines). | USIM operation on page 61 |
| Keep very low capacitance traces on the XIM_DATA and XIM_CLK signals. | |
| To minimize noise leakage, establish a very good ground connection between the module and host. | Ground connection on page 40 |
| Route cables away from noise sources (for example, power supplies, LCD assemblies, etc.). | Methods to mitigate decreased Rx performance on page 43 |
| Shield high RF-emitting components of the host device (for example, main processor, parallel bus, etc.). | Methods to mitigate decreased Rx performance on page 43 |
| Use discrete filtering on low frequency lines to filter out unwanted high-order harmonic energy. | Methods to mitigate decreased Rx performance on page 43 |
| Use multi-layer PCBs to form shielding layers around high-speed clock traces. | Methods to mitigate decreased Rx performance on page 43 |
| Thermal | |
| Test to worst case operating conditions—temperature, voltage, and operation mode (transmitter on 100% duty cycle, maximum power). | Thermal Considerations on page 65 |
| Use appropriate techniques to reduce module temperatures (for example, airflow, heat sinks, heat-relief tape, module placement, etc.). | Thermal Considerations on page 65 |
| Host/Modem communication | |
| Make sure the host USB driver supports remote wakeup, resume, and suspend operations, and serial port emulation. | USB handshaking on page 57 |
| When no valid data is being sent, do not send SOF tokens from the host (causes unnecessary power consumption). | USB handshaking on page 57 |

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:

- The units are operational
- The 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, you need to pass certification testing of your device with the integrated module one time only.

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.

Note: The module itself (MC57xx, MC8xxx) has been certified already—only the integrated device needs certification.

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)
- (MC57xx only) CDG (CDMA Development Group—www.cdg.org)
- (MC8xxx only) GCF (Global Certification Forum—www.globalcertificationforum.org) outside of North America
- (MC8xxx only) 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.

Each assembled device should be tested to make sure the module is installed correctly and is functioning within normal operating parameters.

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

In general, production testing ensures that 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, the RF assembly (Tx and/or Rx, as appropriate), and the audio assembly (for voice-enabled modules).

*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—this may include, for example, testing network availability, any host device configuration issues, baseband testing (GPIO/Audio, host/module connectors) and appropriate RF testing (Tx and/or Rx).*

Use an appropriate test station for your testing environment (see [Acceptance test requirements](#) on page 70 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 as shown in the suggested test equipment—local government regulations may prohibit unauthorized transmissions.

Suggested manual functional test procedure

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 MC57xx and/or MC8xxx installed.

- Visual check of the module's connectors, RF assemblies, and audio assemblies (if applicable)
- Module is operational
- USB connection is functional
- LED is functional
- W_Disable# (module power down)
- Firmware revision check
- Rx tests on main and auxiliary paths
- Tx test
- Audio (microphone and speaker) tests (for voice-enabled modules)

Suggested production test plan procedure

Note: The following is a suggested outline for a relatively comprehensive test plan—you must decide which tests are appropriate for your product.

*This is **not** an exhaustive list of tests—you may wish to add additional tests that more fully exercise the capabilities of your product.*

You may choose to create and run a test program that automates portions of the test procedure.

Using an appropriate Dev Kit-based test station (a suggested setup is described in [Suggested testing equipment](#) on page 87), 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—Set W_Disable# 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#—Turn on the module by letting W_Disable# float (high impedance). Depending on your device, this may just require powering up the device. Refer to the *PCI Express Mini Card Dev Kit Quick Start Guide (Document 2130705)* for more details.

Note: To power-off the module, drive W_Disable# low for the required minimum period. See [State change: Power off/on](#) on page 23 for details.

5. Test USB functionality—Check for USB enumeration.

- (Windows systems) The Device Manager shows Sierra Wireless items under the Ports - (COM & LPT) entry. The devices shown depend on the module type. For example:

- MC8xxx



- MC57xx



- (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 three or seven new devices, depending on the module type.) For example:
 - MC8775/MC8775V/MC8780/MC8781/MC8700 (with no other USB devices connected):

```

C:\ Telnet 00.0.00.00
xxxx@C-Linuxdev2:~$ ls /dev/ttyUSB*
/dev/ttyUSB0 /dev/ttyUSB1 /dev/ttyUSB2
xxxx@C-Linuxdev2:~$

```

(The AT port is the third new enumerated device—`/dev/ttyUSB2`.)

- MC5727/MC5727V/MC5728V/MC8201/MC8700/MC8790/MC8790V/MC8791V/MC8792V/MC8795V (with one other USB device already connected and assigned to `ttyUSB1`):

```

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

```

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

6. Some modules cause a Sierra Wireless Network Adapter to appear in Device Manager, as shown below for MC57xx. Disable the adapter to allow entry of AT commands when performing diagnostic tests:

- a. Right-click the Sierra Wireless Network Adapter to display the context menu.
- b. Click **Disable**.

MC57xx



7. Make sure your modem is connected and running, and then establish contact with the module:

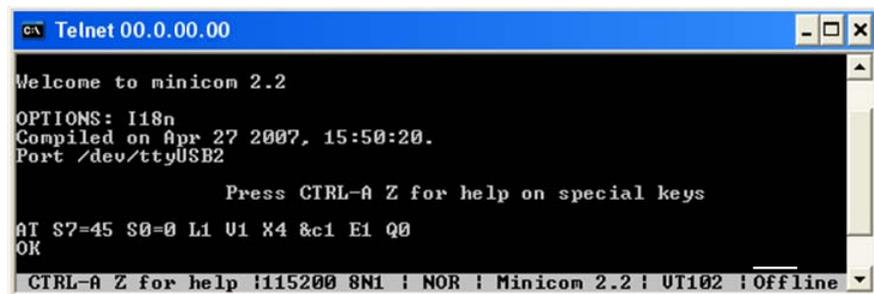
Windows systems: Use a terminal emulation/communications program such as Microsoft HyperTerminal[®] to connect over the COM port reserved for AT commands (see listings in [Step 5](#)):

- a. Start HyperTerminal.
- b. Select **File > Connection Description**. The Connection Description dialog box appears.
- c. Type Sierra in the Name box and click **OK**. The Connect To dialog box appears.
- d. Click **OK** without changing any of the displayed information. The Connect dialog box appears.
- e. Click **Cancel**.
- f. 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](#)):

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

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



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

Note: If the command "minicom" is not found, then use a different program, or download minicom and repeat this step. See [Downloading and configuring minicom for Linux systems](#) on page 76 for details.

8. Display the firmware version:
 - MC57xx: **AT+GMR**
 - MC8xxx: **AT!GVER**
 Example response:
 - p2005000,0 [Aug 09, 2006 14:28:24],, VID: PID:
 Characters 5–6 are the firmware version (50 in this example).
9. Test the LED—Set the LED in blinking mode using this command, then visually verify that the LED turns off and on:
 - MC57xx: **AT!LED=0,1**
 - MC8xxx: **AT!DLED** or **AT!LEDCTRL**
10. Unlock the extended AT command set:
 - MC57xx: **AT!OEM=176**
 - MC8xxx: **AT!ENTERCND**
11. Put the module in diagnostic/factory test mode:
 - MC57xx: **AT!DIAG**
 - MC8xxx: **AT!DAFTMACT**
12. (MC8xxx only) Communicate with the USIM using **+CPIN** or **+CIMI**.
13. Test RF transmission, if desired:
 - MC57xx—See [Testing RF transmission path—MC57xx](#) on page 76.
 - MC8xxx—See [Testing RF transmission path—MC8xxx](#) on page 77.
14. Test RF reception, if desired:
 - MC57xx—See [Testing RF Receive path—MC57xx](#) on page 79.
 - MC8xxx— See [Testing RF Receive path—MC8xxx](#) on page 81.
15. (MC8775V only) Test the GPS receiver, if desired. See [Testing GPS Receiver—MC8775V](#) on page 83.
16. Test Audio loop-back. See [Test Audio Loop-back—MC5727V/MC5728V/MC8775V/MC8790V/MC8791V/MC8792V/MC8795V](#) on page 84.
17. Finish testing
 - a. If the network adapter was disabled in [Step 6](#), re-enable it (same instructions, except click **Enable** instead of **Disable**).
 - b. Set the `w_Disable#` signal 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.

Note: When performing RF tests, use a test platform similar to those shown in [Figure 8-2](#) on page 88 and [Figure 8-3](#) on page 89.

Note: The GPS receiver does not need to be tested for UMTS (MC8xxx) or CDMA (MC57xx) modules supporting diversity because RF connectivity is validated by testing the diversity receiver in [Step 14](#).

Note: To power-off the module, drive `W_Disable#` low for the required minimum period. See [State change: Power off/on](#) on page 23 for details.

Downloading and configuring minicom for Linux systems

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

To download and configure minicom in a Ubuntu system:

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

1. Download and install minicom—enter the following command:

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

```
minicom -s
```
4. Use the down-arrow key to select the **Serial port setup** option.
5. Refer to [Step 5](#) on page 73 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 for an MC8792V as shown in the example in [Step 5](#) on page 73).
7. Press **Enter** twice.
8. Use the down-arrow key to select **Save setup as dfl**.
9. Select **Exit**.

Testing RF transmission path—MC57xx

Note: This procedure segment is performed in [Step 13](#) of the [Suggested production test plan procedure](#) on page 72.

To test the DUT's transmitter path:

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

1. Set up the power meter:



- a. Make sure the meter has been given sufficient time to warm up, if necessary, to enable it to take accurate measurements.

Note: These AT commands generate a modulated test signal.

- b. Zero-calibrate the meter.
 - c. Enable MAP mode.
2. Prepare the DUT using the following AT commands:
 - a. **ATIOEM=176** (Unlock the extended AT command set)
 - b. **ATIDIAG** (Set modem in diagnostic mode)
 - c. **ATICHAN=600,1** (PCS band, channel 600)
or
ATICHAN=384,0 (Cellular band, channel 384)

The power meter should read -100 dBm, indicating no signal.

- d. **ATITX=1** (Turn on transmitter)
 - e. **ATIALUP=1** (Enable “all ups” condition)
The power meter should read from 0–24 dBm, depending on your setup.
 - f. **ATITX=0** (Turn off transmitter)
3. Test limits—Run ten or more good DUTs through this test procedure to obtain a nominal output power value.
 - Apply a tolerance of ± 5 to 6 dB to each measurement (assuming a good setup design).
 - Monitor these limits during mass-production ramp-up to determine if further adjustments are needed.

Note: The MC57xx has a nominal output power of +24 dBm ± 1 dB. However, the value measured by the power meter depends on the test setup (RF cable loss, couplers, splitters) and the DUT design.

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

Testing RF transmission path—MC8xxx

Note: This procedure segment is performed in [Step 13](#) of the [Suggested production test plan procedure](#) on page 72.

Table 8-1 contains parameters used in the suggested test procedure that follows.

Table 8-1: Test settings—MC8xxx transmission path

| Mode | Test category | Bands | | | | |
|-------|---------------|-------|------|------|------|------|
| | | 850 | 900 | 1800 | 1900 | 2100 |
| WCDMA | Band | 22 | 29 | | 15 | 9 |
| | Channel | 4182 | 2812 | | 9400 | 9750 |

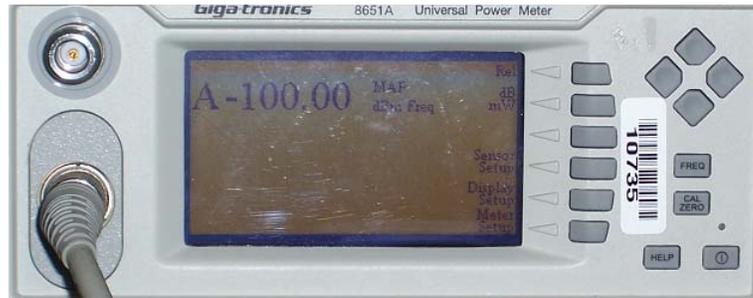
Table 8-1: Test settings—MC8xxx transmission path (Continued)

| Mode | Test category | Bands | | | | |
|------|---------------|-------|-----|------|------|------|
| | | 850 | 900 | 1800 | 1900 | 2100 |
| GSM | Band | 18 | 10 | 11 | 12 | |
| | Channel | 190 | 65 | 697 | 661 | |

To test the DUT's transmitter path:

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

1. Set up the power meter:



- a. Make sure the meter has been given sufficient time to warm up, if necessary, to enable it to take accurate measurements.
 - b. Zero-calibrate the meter.
 - c. Enable MAP mode.
- 2. Prepare the DUT using the following AT commands:**
- a. `ATIUNLOCK=<lockCode>` (Unlock extended AT command set.)
or
`ATIINTERCND`
 - b. `ATIDAFTMACT` (Enter test mode.)
 - c. `ATIDASBAND=<bandValue>` (Set frequency band.)
· See [Table 8-1](#) for appropriate <bandValue> values
 - d. `ATIDASCHAN=<channel>` (Set modem channel)
· See [Table 8-1](#) 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.)
 - h. (WCDMA mode only)
`ATIDASPDM=2, 455` (Set the power level, tunable from 0 to 511.)
 - i. (WCDMA mode only)
`ATIDAWSPARANGE=3` (Set to high PA gain state.)
 - j. Take the measurement.
 - k. `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 MC8xxx 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.

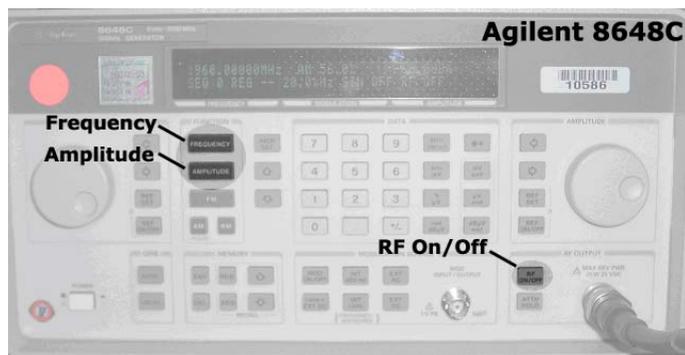
Testing RF Receive path—MC57xx

Note: This procedure segment is performed in [Step 14](#) of the [Suggested production test plan procedure](#) on page 72.

To test the DUT's receive path:

1. Set up the signal generator:

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



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

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

- a. Press the **Frequency** button to set the frequency to 1960.200 MHz for PCS band, Channel 600, or 881.720 MHz for Cellular band, Channel 384
 - b. Press the **Amplitude** button to set the amplitude to -55.0 dBm.
 - c. Press the **RF ON/OFF** button to enable or disable the RF port of the signal generator.
2. Read back the power level from the main receiver:
 - a. **ATIOEM=176** (Unlock the extended AT command set.)
 - b. **ATIDIAG** (Set the modem in Diagnostic mode.)
 - c. **ATICHAN=600,1** (PCS band, channel 600)
or
ATICHAN=384,0 (Cellular band, channel 384)
 - d. **ATIRX=1** (Turn on the main receiver.)
 - e. **ATIRXAGC?** (Read back the power level, in dBm, from the main receiver.)
Response examples:
 - RXAGC = 0xFFFFFFFF33 = -77 dBm (Signal generator's RF port is OFF)
 - RXAGC = 0x0021 = -60 dBm typical (Signal generator's RF port is ON)

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

- f. **ATIRX2=1** (Turn on diversity receiver.)
 - g. **ATIRX2AGC?** (Read back the power level, in dBm, from the diversity receiver.)
Response examples:
 - RX2AGC = 0xFFFFFFFF76 = -84 dBm (Signal generator's RF port is OFF)
 - RX2AGC = 0xFFFFFFFFC6 = -69 dBm typical (Signal generator's RF port is ON)
 - h. **ATIRX=0** (Turn off main receiver.)
 - i. **ATIRX2=0** (Turn off diversity receiver.)
3. Test limits—Run ten or more good DUTs through this test procedure to obtain a nominal received power value.
 - Apply a tolerance of ± 5 to 6 dB to each measurement (assuming a good setup design).
 - Make sure the measurement is made at a high enough level that it is not influenced by DUT-generated and ambient noise.
 - The Signal Generator power level should be at least -50 dBm.
 - Monitor these limits during mass-production ramp-up to determine if further adjustments are needed.

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

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

Testing RF Receive path—MC8xxx

Note: This procedure segment is performed in [Step 14](#) of the [Suggested production test plan procedure](#) on page 72.

[Table 8-2](#) contains parameters used in the suggested test procedure that follows.

Table 8-2: Test settings—MC8xxx Receive path

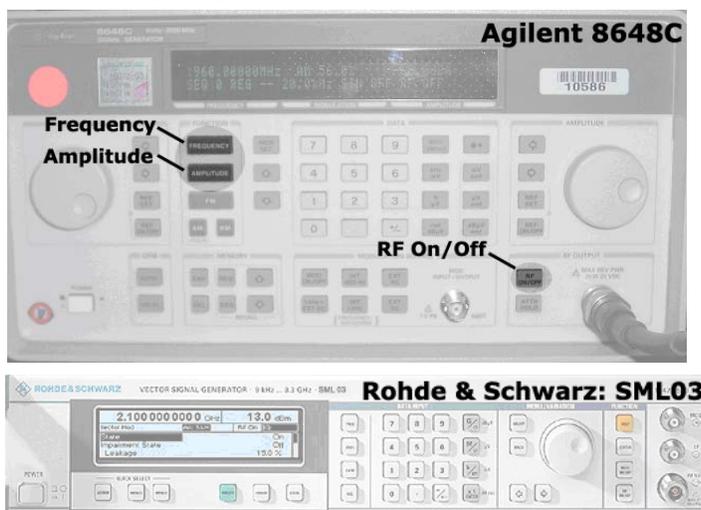
| Mode | Test category | Bands | | | | |
|-------|------------------------------|---------|---------|----------|----------|--------|
| | | 850 | 900 | 1800 | 1900 | 2100 |
| WCDMA | Frequency ^a (MHz) | 882.60 | 948.60 | | 1961.2 | 2141.2 |
| | Band | 22 | 29 | | 15 | 9 |
| | Channel | 4182 | 2812 |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

- a. All values offset from actual center channel by +1.2 MHz
 b. All values offset from actual center channel by +67 kHz

To test the DUT's receive path:

- Set up the signal generator:

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



- Set the amplitude to:
 - 80 dBm (WCDMA mode)
 - 60 dBm (GSM mode)
- Set the frequency for the band being tested. See [Table 8-2](#) for frequency values.

2. Set up the DUT:
 - a. `ATIUNLOCK=<customerCode>` (Unlock extended AT command set.)
or
`ATIENTERCND` (Unlock extended AT command set.)
 - b. `ATIDAFTMACT` (Put modem into factory test mode.)
 - c. `ATIDASBAND=<band>` (Set frequency band.)
· See [Table 8-2](#) on page 81 for <band> values
 - d. `ATIDASCHAN=<channel>` (Set modem channel)
· See [Table 8-2](#) 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.

4. Test diversity paths:
 - MC8201 (WCDMA 850/WCDMA 1900)
 - MC8780 (WCDMA 850/WCDMA 2100)
 - MC8781 (WCDMA 850/WCDMA 1900)
 - MC8790/MC8790V (WCDMA 850/WCDMA 1900/WCDMA 2100)
 - MC8700/MC8795V (WCDMA 850/WCDMA 900/WCDMA 1900/WCDMA 2100):
 - a. Set up the signal generator as in [Step 1](#).
 - b. Set up the DUT:
 - i. `ATIUNLOCK=<customerCode>` (Unlock extended AT command set.)
or
`ATIENTERCND`
 - ii. `ATIDAFTMACT` (Put modem into factory test mode.)

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

- iii. ATIDASBAND=<band> (Set frequency band.)
 - See [Table 8-2](#) on page 81 for <band> values
 - iv. ATIDAWSSCHAIN=1 (Enable the secondary chain.)
 - v. ATIDASCHAN=<channel> (Set modem channel)
 - See [Table 8-2](#) 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](#).

Testing GPS Receiver—MC8775V

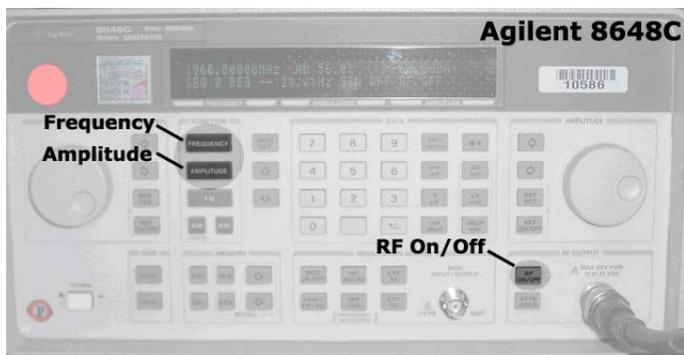
Note: The GPS receiver does not need to be tested for other UMTS or CDMA modules supporting diversity because RF connectivity is validated by testing the diversity receiver in [Step 14](#) of the [Suggested production test plan procedure](#) on page 72.

Note: This procedure segment is performed in [Step 15](#) of the [Suggested production test plan procedure](#) on page 72.

To test the carrier-to-noise level for the GPS receive path:

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

1. Set up the signal generator:



- a. Set the amplitude to -110 dBm.
- b. Set the frequency to 1575.52 MHz. This is 100 kHz above the center frequency for GPS and is needed to accurately measure the carrier-to-noise (C/N) level.

2. Set up the DUT using the following commands:
 - a. `ATIUNLOCK=<customerCode>` (Unlock extended AT command set.)
 - b. `ATIDAFTMACT` (Put modem into factory test mode.)
 - c. `ATIDAAGCTON` (Query power difference between carrier signal and receiver.)
3. Test limits—Run ten or more good DUTs through this test procedure to obtain averaged C/N readings.
 - The GPS receiver responds to signal levels from -130 dBm to -80 dBm.
 - Measure C/N five times for each DUT to obtain an average reading at -110 dB.
 - Make sure the C/N is less than 15 dB when the signal generator is off.
 - Allow for ± 5 dB of C/N variation to identify any problems in the GPS receive path.

Test Audio Loop-back—MC5727V/MC5728V/ MC8775V/MC8790V/MC8791V/MC8792V/ MC8795V

Note: This procedure segment is performed in [Step 16](#) of the [Suggested production test plan procedure](#) on page 72.

The microphone and speaker audio paths for voice-enable modules can be tested by using an audio quantity that is suited to identify known assembly issues, and applying limits to detect any problems.

To test the audio paths:

1. Set up the audio analyzer to generate a constant tone:

Note: This procedure describes steps using the Keithley Audio Analyzing DMM, 2016-P.



- a. Connect a BNC cable to the “Source Output” port at the rear panel.
- b. Press the **Source** button on the front panel, and then set the generator to:
 - Ampl = 0.20 V
 - Impedance = 50 Ω
 - Freq = 1.000 kHz

- c. If using a Sierra Wireless Mini Card Dev Kit, connect the signals as follows:
 - i. Connect the generator output signal to the MIC1_P (positive) and MIC1_N (negative) header pins located at CN18 on the Dev Kit.
 - ii. Connect the analyzer input signal to the SPK1_P (positive) and SPK1_N (negative) header pins located at CN18 on the Dev Kit (see [Figure 8-1](#) on page 85). For additional details concerning use of the Dev Kit, see the *PCI Express Mini Card Dev Kit Quick Start Guide (Document 2130705)*.
- d. If using a custom host platform:
 - i. Connect the generator output to the microphone input (MIC, positive and negative) in the host.
 - ii. Connect the analyzer input to the Speaker output (SPK, positive and negative) in the host.

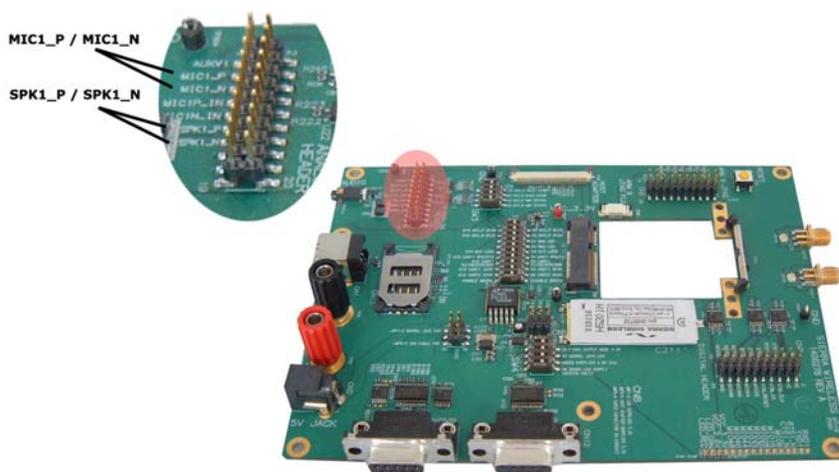


Figure 8-1: Mini Card Dev Kit showing MIC/SPK pins.

2. Set up the DUT using the following commands:

(MC5727V/MC5728V)

 - a. **AT!OEM=176** (Unlock the extended AT command set.)
 - b. **AT!DIAG** (Set modem in Diagnostic mode.)
 - c. **AT!AUAUDIOLPBK=1** (Enable audio loop-back mode.)
 - d. **AT!CODECGAIN=8000,8000,8000** (Set codec gains in the loopback path to +6 dB (Tx), +6 dB (Rx) and -6dB (SideTone).)
 - Total loopback gain = $\sum(\text{codec gains}) - 2 \text{ dB}$
 - For this example, total loopback gain = +4 dB

(MC8775V/MC8790V/MC8791V/MC8792V/MC8795V)

 - a. **AT!UNLOCK="<lockCode>"** (Unlock extended AT command set.)
 - b. **AT!AVSETDEV=0,0,0** (Unmute speaker and microphone for audio profile 0.)
 - c. **AT!AVCODECSTG=0,FFFF** (Set sidetone gain for audio profile 0.)

Note: Actual measured results will vary, depending on your testing setup.

3. Take measurements using the following commands (Note that the module has a gain of 4 dB in audio loopback mode.):
 - a. Press the **ACV** button to measure the AC level.
 - Expected range: 1–2.5 VAC
 - b. Press the **FREQ** button to measure the frequency.
 - Expected value: 1 kHz
 - c. Press the **Shift** and **THD** buttons at the same time to measure the total harmonic distortion.
 - Expected value: < 1%
 - d. Reset the audio parameters:
 - (MC5727V/MC5728V)
ATI_AVAUDIOLPBK=0 (Disables audio loop-back mode)
 - (MC8775V/MC8790V/MC8791V/MC8792V/MC8795V)
ATI_AVDEF (Set configurable audio parameters to default values.)

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
- MC57xx-specific:
 - Waveform quality tests (calculating the “rho” parameter) to compare the CDMA signal’s power distribution against the ideal distribution—rho must be >0.97 with max freq error of 0.5 to pass.
 - FER testing—Test receiver sensitivity for conditions of minimum cell power. FER can be measured for the specified receiver sensitivity of -104 dBm. The objective of this test is to determine if the FER measured is within the acceptable limits for the specified receiver sensitivity of the module. Unlike the FER tests performed during production testing, this test determines the receiver performance without the influence of the noise factor (AWGN), but with extremely low cell power. The reported FER and the confidence level must be <1% and >95% respectively for the test to be considered a pass.
- MC8xxx-specific:
 - 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 require appropriate testing equipment.

[Figure 8-2](#) on page 88 shows a suggested test station for use with devices incorporating AirPrime embedded modules, and [Recommended Dev Kit test setup](#) on page 89 shows a supported Dev kit setup.

In the test station as shown, a test computer coordinates testing between the host device with an integrated module and the measurement equipment. If the test computer does not have direct access to the module, then the host device must have custom software to forward instructions from the test computer to the module.

This suggested station setup includes:

- Audio analyzer—Evaluate Tx.
- Power meter—Evaluate current consumption for Tx and Rx in various modes.
- Signal generator—Evaluate Rx.

When using this setup, you can allow the signal generator to run continuously throughout the production testing procedure.

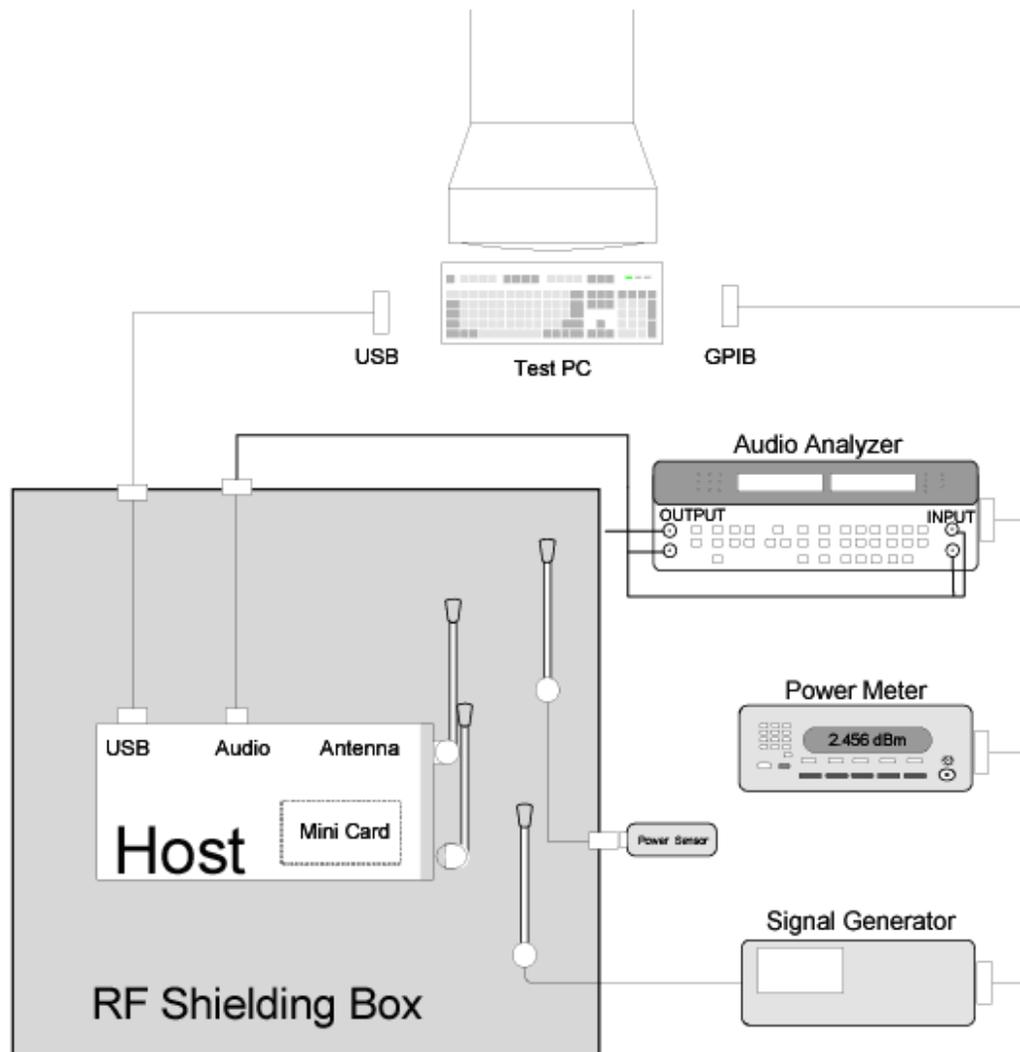


Figure 8-2: Recommended production test setup

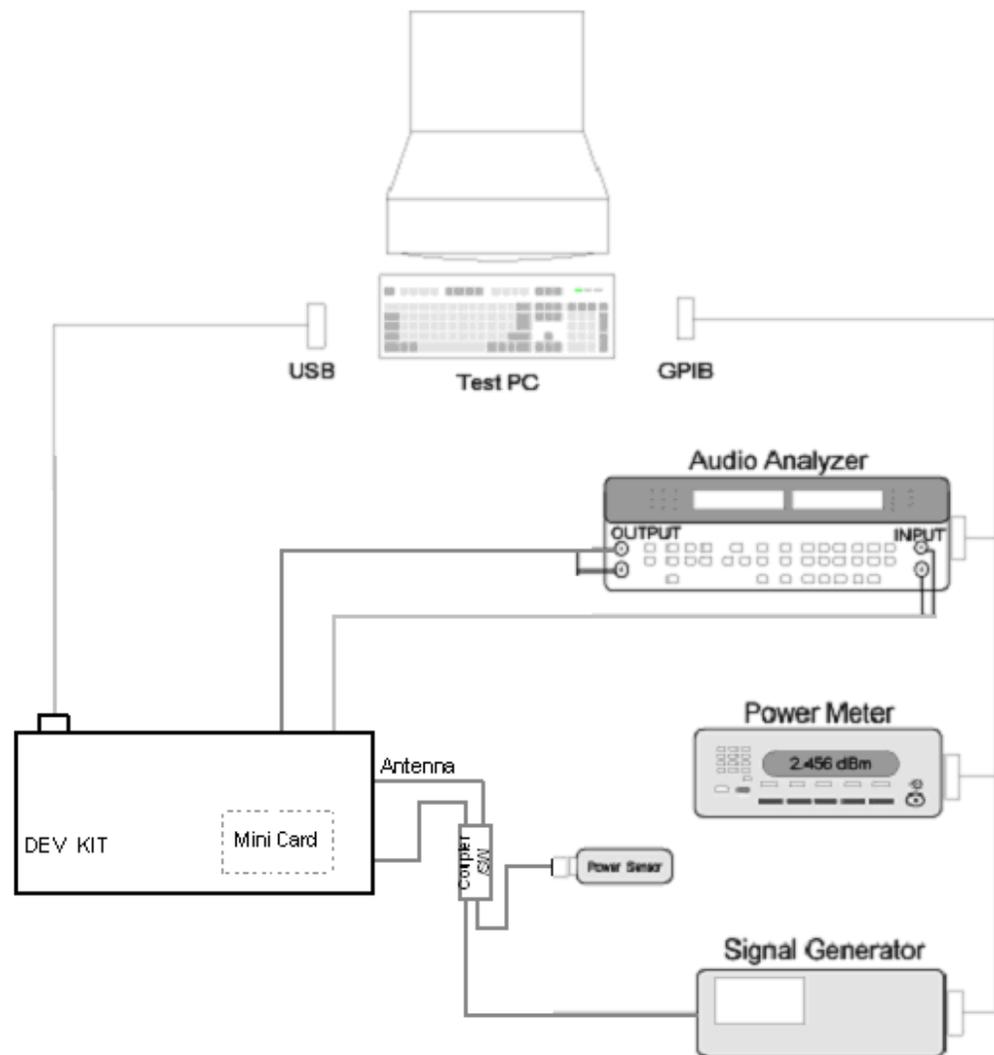


Figure 8-3: Recommended Dev Kit test setup

»» A: Antenna Specification

A

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

Required antennas

Table A-1 lists minimum required antenna types for each module and the maximum antenna gain, including cable loss, in a mobile-only exposure condition.

Note: If your system uses both the MC8xxx and MC57xx, the five-band antenna can be used for both modules. However, improved antenna performance may be attained if a dual-band main-path antenna is designed and optimized specifically for the MC57xx.

Table A-1: Required antennas and maximum antenna gain by module

| Module | Antenna type (minimum) | | Maximum antenna gain ^a | |
|---|---|---|-----------------------------------|----------------|
| | Main | Diversity/GPS | Cellular band (dBi) | PCS band (dBi) |
| MC5727 MC5727V MC5728V | 2-band (Cellular/PCS) | 3-band (Cellular/PCS/GPS) | 5.1 | 4.15 |
| MC8201 | N.America: 2-band (Cellular/PCS) | 2-band (Cellular/PCS) | 5 | 4 |
| MC8700 | N.America: 2-band (Cellular/PCS) Eur/Asia: 3-band World: 5-band | N.America: 2-band (Cell/PCS) Eur/Asia: 2-band (Cell/IMT) World: 4-band (Cell/IMT/PCS) | 8.22 | 3.5 |
| MC8775 | N.America: 2-band (Cellular/PCS) Eur/Asia: 3-band World: 5-band | n/a | 5 | 4 |
| MC8775V | N.America: 2-band (Cellular/PCS) Eur/Asia: 3-band World: 5-band | 1-band (GPS) | 5 | 4 |
| MC8780 | Eur/Asia: 3-band | 3-band (Cellular/IMT/GPS) | 5 | 4 |
| MC8781 | N.America: 2-band (Cellular/PCS) | 3-band (Cellular/PCS/GPS) | 5 | 4 |
| MC8790 MC8790V MC8791V MC8792V MC8795V | N.America: 2-band (Cellular/PCS) Eur/Asia: 3-band World: 5-band | N.America: 3-band (Cell/PCS/GPS) Eur/Asia: 3-band (Cell/IMT/GPS) World: 4-band (Cell/IMT/PCS/GPS) | 5 | 4 |

a. Gain limits in this table are as reported on FCC grants for each module, for consideration against RF exposure and ERP/EIRP limits.

Frequency bands

Table 1-2 and Table 1-3 summarize the frequency bands that must be supported by main, diversity, and GPS antennas for CDMA and UMTS modules.

Table 1-2: Supported CDMA frequency bands

| Module | Band | Antenna | Mode | Frequency range |
|--------|------|-----------------------------------|------|-----------------|
| MC57xx | Cell | Main/Diversity (Rx) | Tx | 824–849 |
| | | | Rx | 869–894 |
| | PCS | Main/ Diversity (Rx) | Tx | 1850–1910 |
| | | | Rx | 1930–1990 |
| | GPS | Diversity or separate GPS antenna | Rx | 1574–1576 |

Table 1-3: Supported UMTS frequency bands^a

| Frequency band | Frequency range (MHz) | Network types supported, by module ^b | | | | | | | | | |
|---|--------------------------------|---|------|------|-------|------|------|---------------|-------|-------|-------|
| | | 8201 | 8700 | 8775 | 8775V | 8780 | 8781 | 8790 8790V | 8791V | 8792V | 8795V |
| Main antenna | | | | | | | | | | | |
| 850 ^c (North Am.) | Tx: 824–849 Rx: 869–894 | G,U | G,U | G,U | G,U | G,U | G,U | G,U | G | G | G,U |
| 900 (Europe) | Tx: 880–915 Rx: 925–960 | | G,U | G | G | G | G | G | G | G,U | G,U |
| 1800 (Europe) | Tx: 1710–1785 Rx: 1805–1880 | | G | G | G | G | G | G | G | G | G |
| 1900 (North Am.) | Tx: 1850–1910 Rx: 1930–1990 | G,U | G,U | G,U | G,U | G,U | G,U | G,U | G | G,U | G,U |
| 2100 (Europe) | Tx: 1920–1980 Rx: 2110–2170 | | U | U | U | U | U | U | U | U | U |
| Diversity antenna (or Diversity/GPS antenna if GPS is enabled) | | | | | | | | | | | |
| UMTS 850 (North Am.) | Rx: 869–894 | Y | Y | | | Y | Y | Y | | | Y |
| UMTS 900 (Europe) | Rx: 925–960 | | Y | | | | | | Y | Y | Y |
| UMTS 1900 (PCS N.Am.) | Rx: 1930–1990 | Y | Y | | | | Y | Y | Y | Y | Y |
| UMTS 2100 (IMT Europe) | Rx: 2110–2170 | | Y | | | Y | | Y | Y | Y | Y |
| GPS (World) | Rx: 1574–1576 | | | | | Y | Y | Y | Y | Y | Y |
| Separate GPS antenna | | | | | | | | | | | |
| GPS (World) | Rx: 1574–1576 | | | | Y | | | | | | |

- a. Table entries show which bands are supported by each module. The actual bands used depend on the device location (North America, Europe, etc.). See Table A-1 on page 91 for antenna requirements by region.
- b. G—GSM/GPRS/EDGE; U—UMTS; Y—Yes
- c. UMTS 800 (Band VI) is a subset of UMTS 850 (Band V)—An antenna supporting UMTS 850 therefore also supports UMTS 800.

Antenna design

Design of main path, diversity path, and GPS antennas is determined by the host device OEM and their designated antenna designer.

Note: Modems that support diversity and GPS can use the same secondary (diversity) antenna for both.

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

General antenna design requirements

In addition to passing the specific tests described in [Testing](#) on page 94, the main path and diversity/GPS path antennas should satisfy the following requirements:

- Antenna impedance at feeding terminal = 50 Ω (A simple matching circuit with six or fewer components is acceptable at the feeding terminal.)
- Nominally omni-directional radiation pattern in the azimuth plane

Main antenna design requirements

In addition to passing the specific tests described in [Testing](#) on page 94, the main path antenna should satisfy the following requirement:

- Must handle 2 W RF power on low bands and 1 W on high bands.

Measure the power using the following criteria:

- Measure power endurance over a period of 4 hours (estimated talk time) using a 2 W CW signal—Set the frequency of the CW test signal to the middle of the PCS Tx band (1880 MHz for PCS).
- Visual inspection must prove 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.

Diversity antenna design requirements

(MC57xx/MC8201/MC8700/MC8780/MC8781/MC8790/MC8790V/MC8791V/MC8792V/MC8795V)

Antenna diversity is required for end user performance and enhanced coverage on:

- CDMA networks (800 MHz/1900 MHz) for MC57xx. (See [Table 1-2](#) on page 92 for details.)
- UMTS networks (800 MHz/850 MHz/900 MHz/1900 MHz/2100 MHz) for MC8201/MC8700/MC8780/MC8781/MC8790/MC8790V/MC8791V/MC8792V/MC8795V. (See [Table 1-3](#) on page 92 for details.)

In addition to passing the specific tests described in [Testing](#) on page 94, the diversity path antenna should satisfy the following requirement:

- Receive performance, measured by forward link throughput, must be 0 to 3 dB better than a single antenna

Performance goals

When designing the antenna system, consider the following performance goals:

- 0 dB gain antenna (or better)
- Diversity antenna receive performance to be similar to primary antenna
- Separation distance or polarity separation to achieve diversity antenna isolation of 10 dB (minimum). Otherwise the receive antenna picks up too much power radiating from the primary antenna

GPS antenna design requirements

(MC57xx/MC8775V/MC878x/MC879x)

A second antenna is required to access GPS functionality—if the modem also supports diversity, the same antenna can be used.

In addition to passing the specific tests described in [Testing](#) on page 94, the diversity path antenna should satisfy the following requirements:

- Field of view (FOV): Omni-directional in azimuth, -45° to $+90^{\circ}$ in elevation
- Polarization (average G_v/G_h): > 0 dB. Vertical linear polarization is sufficient (no need to optimize for circular polarization)
- Free space average gain (G_v+G_h) over FOV: > -6 dBi (preferably > -3 dBi). Note: Average gain is the sum of average values ($G_v + G_h$) where both G_v and G_h are measured (and averaged) over -45° to $+90^{\circ}$ in elevation and $\pm 180^{\circ}$ in azimuth.
- Maximum gain and uniform coverage in the high elevation angle and zenith. Gain in the azimuth plane is not desired.
- Average 3D gain: > -5 dBi
- Typical VSWR: $< 2:1$
- Polarization: Any other than LHCP (left-hand circular polarized) is acceptable.

The same design procedures outlined in [Interference and sensitivity on page 41](#) apply to the GPS path as well.

Testing

The performance specifications described in this section are valid while the antenna is mounted in the host device with the antenna feed cable routed in its final application configuration.

The following guidelines apply to the tests in this section:

- Perform electrical measurements at room temperature ($+20^{\circ}\text{C}$ to $+26^{\circ}\text{C}$) 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 the frequency bands in [Table 1-3](#) on page 92.
- 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.

Voltage Standing Wave Ratio (VSWR)

Measure VSWR for each antenna (main, diversity) using the following criteria:

- Measure VSWR in free space at the antenna's coaxial connector (feeding terminal) when the antenna is installed in the host device with the cable routed to the Mini Card slot.
- Use an HP8753E network analyzer (or equivalent).

Table 1-4: VSWR (Voltage Standing Wave Ratio)

| Frequency (MHz) | Typical VSWR | Worst-case VSWR at band edges | Notes |
|---------------------|--------------|-------------------------------|---|
| Main antenna | | | |
| 824–849 | | 2.5:1 | 850-band Tx |
| 869–880 | | 3.5:1 | 850-band Rx excluding part inside 900-band Tx |
| 880–915 | | 2.5:1 | 900-band Tx |
| 925–960 | | 3.5:1 | 900-band Rx |
| 1710–1785 | | 2.5:1 | 1800-band Tx |
| 1805–1850 | | 3.5:1 | 1800-band Rx excluding part inside 1900-band Tx |
| 1850–1910 | | 2.5:1 | 1900-band Tx |
| 1920–1980 | | 2.5:1 | 2100-band Tx and part of 1900-band Rx |
| 1980–1990 | | 3.5:1 | Part of 1900-band Rx outside of 2100-band Tx |
| 2110–2170 | | 3.5:1 | 2100-band Rx |

Table 1-4: VSWR (Voltage Standing Wave Ratio) (Continued)

| Frequency (MHz) | Typical VSWR | Worst-case VSWR at band edges | Notes |
|------------------------------|--------------|-------------------------------|-------------------------------------|
| Diversity/GPS antenna | | | |
| 869–894 | < 3:1 | <3.5:1 | Preferable to have input VSWR < 2:1 |
| 925–960 | < 3:1 | <3.5:1 | |
| 1930–1990 | < 3:1 | <3.5:1 | |
| 2110–2170 | < 3:1 | <3.5:1 | |

Radiated efficiency

[Table 1-5](#) details the minimum total radiated efficiency for main and, if supported, diversity antennas.

Table 1-5: Minimum total radiated efficiency^a

| Mode | Main | Diversity |
|----------------------|------|-----------|
| Transmit (Tx) | 50% | n/a |
| Receive (Rx) | 30% | 25% |

a. Total efficiency is measured at the RF connector. It includes mismatch losses, losses in the matching circuit, and antenna losses.

Antenna-to-antenna isolation

(MC57xx/MC8201/MC8700/MC8775V/MC878x/MC879x)

Use a network analyzer to measure isolation between the main and secondary antenna pairs over the operating Tx/Rx frequency bands described in [Table 1-3](#) on page 92.

[Table 1-6](#) details the minimum isolation allowed over the various frequency bands for the applicable antenna pairs.

Table 1-6: Minimum Main–Secondary antenna isolation

| Antenna pair | Isolation (dB) | | |
|-----------------------------------|----------------|----------|-------------------|
| | 850/900 band | GPS band | DCS/PCS/UMTS band |
| Main/Diversity (Tx and Rx) | 8 (cell) | | 8 (PCS/UMTS) |
| Main (Tx)/GPS | 15 | 15 | 15 |

When you perform these tests:

- If the antennas can be moved, test all positions for both the main and secondary antennas.
- Collect worst-case isolation data.

- Make sure all other wireless devices (Bluetooth or WLAN antennas, etc.) are turned OFF to avoid interference. For details, see [Interference from other wireless devices on page 42](#).

Note: System performance below the minimum isolation specification could cause damage to the module, resulting in below-average system performance.

Peak gain and radiation patterns

[Table 1-7](#) describes the peak and average antenna gain limits for the main path and diversity path antennas.

*Note: 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 performance can be affected by parameters such as antenna size, location, design type, etc. The antenna gain patterns remain fixed unless one or more of these parameters change.*

Table 1-7: Peak and average antenna gain

| Antenna | Peak gain ^a | Average gain ^b |
|------------------|------------------------|---------------------------|
| Main | > +1 dBi | > -3 dBi |
| Diversity | > -3 dBi | > -6 dBi |

a. Vertical/horizontal polarizations

b. Vertical/horizontal polarizations combined, over $\pm 45^\circ$ in elevation and $\pm 180^\circ$ in azimuth

Fading correlation coefficient

(MC57xx/MC8201/MC8700/MC878x/MC879x)

Measure the fading (envelope) correlation coefficient between the main and diversity antennas over the operating Rx frequency bands described in [Table 1-3](#) on page 92.

The maximum allowed fading correlation coefficient over any of the bands is 0.5.

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 MC57xx/MC8xxx 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 MC57xx/MC8xxx modem **MUST BE POWERED OFF**. Otherwise, the MC57xx/MC8xxx modem can transmit signals that could interfere with this equipment.

In an aircraft, the MC57xx/MC8xxx modem **MUST BE POWERED OFF**. Otherwise, the MC57xx/MC8xxx 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 MC57xx/MC8xxx modem may be used normally at this time.

Important compliance information for North American users

The MC57xx/MC8xxx modem has been granted modular approval for mobile applications. Integrators may use the MC57xx/MC8xxx 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 the levels detailed in [Table A-1, Required antennas and maximum antenna gain by module, on page 91](#).
3. The MC57xx/MC8xxx 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 MC57xx/MC8xxx modem is incorporated, with a statement similar to the following:
 - For MC5727/MC5727V:
This device contains FCC ID: N7N-MC5727
This equipment contains equipment certified under IC: 2417C-MC5727
 - For MC5728V:
This device contains FCC ID: N7N-MC5728
This equipment contains equipment certified under IC: 2417C-MC5728
 - For MC8201:
This device contains FCC ID: N7NMC8201
This equipment contains equipment certified under IC: 2417C-MC8201
 - For MC8700:
This device contains FCC ID: N7NMC8700
This equipment contains equipment certified under IC: 2417C-MC8700
 - For MC8775/MC8775V:
This device contains FCC ID: N7NMC8775
This equipment contains equipment certified under IC: 2417C-MC8775
 - For MC8780:
This device contains FCC ID: N7NMC8780
 - For MC8781:
This device contains FCC ID: N7NMC8781
This equipment contains equipment certified under IC: 2417C-MC8781
 - For MC8790/MC8790V:
This device contains FCC ID: N7NMC8790
This equipment contains equipment certified under IC: 2417C-MC8790
 - For MC8792V:
This device contains FCC ID: N7NMC8792
This equipment contains equipment certified under IC: 2417C-MC8792

-
- For MC8795V:

This device contains FCC ID: N7NMC8795

This equipment contains equipment certified under IC: 2417C-MC8795

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 MC57xx/MC8xxx 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.

EU regulatory conformity

Sierra Wireless hereby declares that the MC8700, MC8775, MC8775V, MC8780, MC8790, MC8790V, MC8791V, MC8792V, and MC8795V modems conform with all essential requirements of Directive 1999/5/EC.

MC8775, MC8775V, MC8780, MC8790, MC8790V, MC8791V, MC8792V:

CE 0682

MC8795V:

CE 0168

MC8700:

CE 0678

The Declaration of Conformity made under Directive 1999/5/EC is available for viewing at the following location in the EU community:

Sierra Wireless (UK), Limited
Lakeside House
1 Furzeground Way, Stockley Park East
Uxbridge, Middlesex
UB11 1BD
England

Brazil ANATEL homologation

(MC8790 somente) Este produto está homologado pela ANATEL, de acordo com os procedimentos regulamentados pela Resolução 242/2000, e atende aos requisitos técnicos aplicados.

Para maiores informações, consulte o site da ANATEL www.anatel.gov.br.

Modelo: MC8790



0688-09-1568



(01)07898912207166

➤➤ | C: MC5728V Important Signal Considerations - Application Note

C

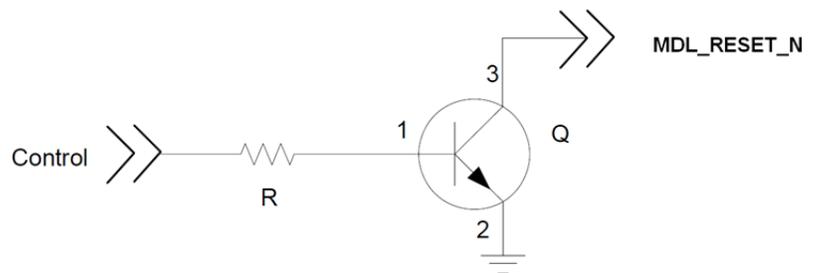
MDL_RESET_N — Module reset input

The MDL_RESET_N signal (pin 33) is an input to the MC5728V module from the host device to initiate a reset of the module.

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

- This signal is an input to the module and should be driven LOW only for its active state (RESET); otherwise it should be floating or (High impedance). It should never be driven to a logic high level. At module power-up, the Baseband processor holds this signal LOW for a pre-determined time; the host must not interfere with this sequence (by attempting to drive the signal HIGH). If the host does not comply with this, unwanted behavior and an unknown state of the module may occur.
- If the host never needs to assert a reset to the MC5728V module, leave this signal unconnected from the host interface. The figure below shows good design practice for connecting the MDL_RESET_N signal. This allows for open collector output when not being asserted by the host device.

Figure C-1: Recommended MDL_RESET_N connection



W_Disable# — Wireless disable

The W_Disable# signal (pin 20) is an input to the module from the host device to control the Power state (power on and shutdown of the MC5728V module, depending on the state of the signal).

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

- This 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 MC5728V 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.
- If the host never needs to assert this power state control to the MC5728V module, leave this signal unconnected from the host interface. [Figure 2-1 on page 17](#) shows good design practice for connecting the W_DISABLE# signal. This allows for open collector output when not being asserted by the host device.

»» D: Acronyms and Definitions

D

Table D-1: Acronyms and definitions

| Acronym or term | Definition |
|----------------------------|--|
| AGC | Automatic Gain Control |
| BER | Bit Error Rate - a measure of receive sensitivity |
| BLER | Block Error Rate |
| Call Box | Base Station Simulator - Agilent E8285A or 8960, Rohde & Schwarz CMU200 |
| CDMA | Code Division Multiple Access |
| 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 | Decibels, relative to 1 mW - Decibel(mW) = $10 \times \log_{10} (Pwr (mW)/1mW)$ |
| DUT | Device Under Test |
| EDGE | Enhanced Data rates for GSM Evolution |
| EM | Embedded Module |
| ESD | ElectroStatic Discharge |
| FER | Frame Error Rate - a measure of receive sensitivity |
| GPRS | General Packet Radio Services |
| GPS | Global Positioning System |
| GSM | Global System for Mobile communications |
| Hz | Hertz = 1 cycle/second |
| inrush current | Peak current drawn when a device is connected or powered on |
| IS-2000 | 3G radio standards for voice and data (CDMA only) |
| IS-95 | 2G radio standards targeted for voice (cdmaONE) |
| LDO | Low Drop Out - refers to linear regulator |
| MC5727/MC5727V/ MC5728V | Sierra Wireless AirPrime embedded modules used on CDMA networks |
| MC57xx | Any of the following CDMA AirPrime embedded modules: MC5727/ MC5727V/MC5728V |

Table D-1: Acronyms and definitions

| Acronym or term | Definition |
|--|--|
| MC8201/MC8700/ MC8775/MC8775V / MC8780/MC8781/ MC8790/MC8790V/ MC8791V/MC8792V/ MC8795V | Sierra Wireless AirPrime embedded modules used on GSM/UMTS networks |
| MC8xxx | Any of the following GSM/UMTS AirPrime embedded modules: MC8201/ MC8700/MC8775/MC8775V/MC8780/MC8781/MC8790/MC8790V/ MC8791V/MC8792V/MC8795V |
| MHz | MegaHertz = 10E6 Hertz (Hertz = 1 cycle/second) |
| MIO | Module Input/Output |
| MPE | Maximum Permissible Exposure—the level of radiation to which a person may be exposed without hazardous effect or adverse biological changes |
| OTA | Over-The-Air or Radiated through the antenna |
| PCS | Personal Communication System - PCS spans the 1.9 GHz radio spectrum |
| RF | Radio Frequency |
| RMS | Root Mean Square |
| SA | Selective Availability |
| Sensitivity (Audio) | Measure of lowest power signal that the receiver can measure |
| Sensitivity (RF) | Measure of lowest power signal at the receiver input that can provide a prescribed BER/BLER/SNR value at the receiver output. |
| SIM | Subscriber Identity Module |
| SNR | Signal to Noise Ratio |
| SOF | Start of Frame - a USB function |
| UART | Universal Asynchronous Receiver Transmitter |
| UDK | Universal Development Kit (PCI Express Mini Card Dev Kit) |
| UMTS | Universal Mobile Telecommunications System |
| USB | Universal Serial Bus |
| USIM | Universal Subscriber Identity Module |
| VCC | Supply voltage (3.8 V for MC8201, 3.3 V for all others) |
| WCDMA | Wideband Code Division Multiple Access—In this document, the term “UMTS” is used instead of “WCDMA”. |
| XIM | In this document, XIM is used as part of the contact identifiers for the USIM interface (XIM_VCC, XIM_CLK, etc.). |

Index

Numerics

- 1X
 - CDMA Standard, 13

A

- acceptance tests, 69
- acronyms and definitions, 105–106
- airplane mode, 19
- anechoic chamber, OTA testing, 43
- antenna
 - connection and mounting points, 39
 - connection considerations, 39
 - custom, considerations, 40
 - design requirements, diversity antenna, 93
 - design requirements, general, 93
 - design requirements, GPS, 94
 - design requirements, main antenna, 93
 - diversity antenna, disabling, 41
 - diversity, MC57xx, 93
 - diversity, MC8xxx, 93
 - frequency bands, supported, 92
 - GPS, MC57xx / MC8775V / MC878x / MC879x / MC8700, 94
 - limit, matching coaxial connections, 39
 - location, considerations, 41
 - matching, considerations, 40
 - maximum cable loss, 39
 - specification, 91–97
 - testing, 94
- antennas
 - design checklist, 67
 - frequency bands supported, MC57xx, 92
 - required, by module type and gain, 91
- AT commands
 - 3GPP specification, details, 13
 - extended, MC57xx, 62
 - extended, MC8xxx, 63
 - extended, overview, 62
 - low power mode, setting, 19
 - standard, MC57xx (reference document), 13
 - standard, MC8xxx (reference document), 14
- AT commands, extended
 - MC57xx, reference, 14
 - MC8xxx, reference, 15
- AT commands, standard
 - MC57xx, reference, 13
 - MC8xxx, reference, 14

- audio
 - features, summary, 47
 - functions, host-controlled, 54
 - functions, module-controlled, 54
 - functions, responsible codecs, 48
 - interface, 47–54
 - path mixing, host-controlled, 54
 - path switching, host-controlled, 54
 - PCM digital, signal interface, 54
 - primary, signal interface, 53
 - signal interface, 53
 - system block diagram, MC5728V, 49
 - system block diagram, MC87xxV, 50
 - audio modes, supported, 51
 - audio pass band, 47
 - audio passband, Rx and Tx, 53
 - automatic gain control (AGC)
 - module-controlled, 54
- ## B
- BER (Bit Error Rate), 45
 - bit error rate (BER)
 - measure of sensitivity, MC8xxx, 45
- ## C
- cable loss
 - antenna, maximum, 39
 - capacitance
 - inrush current, effect on, 25
 - capacitors
 - with USIM, 61
 - with XIM_DATA / XIM_CLK, 61
 - car kit audio mode, 47
 - car kit mode
 - echo cancellation, 53
 - CDMA
 - 1X Standard, 13
 - cellular band
 - RF parameters, MC57xx, 37
 - certification tests, 70
 - checklist, design, 67
 - CnS
 - MC57xx reference, 13
 - MC87xx reference, 14
 - notification issued, state change
 - temperature, 23
 - voltage, 21
 - voice reference, 14
 - CnS commands
 - low power mode, setting, 19
 - codec
 - for audio functions, 48
 - comfort noise
 - module-controlled, 54

- communications, host to modem
 - design checklist, [68](#)
- connection
 - grounding, [40](#)
- connectors, required
 - EDGE mating (52-pin), [12](#)
 - host-module, [12](#)
 - RF, Hirose, [12](#)
 - USIM, [12](#)
- current
 - consumption, [26–36](#)
 - consumption, usage models, [36](#)
 - peak inrush current, calculation, [25](#)
 - specifications, MC57xx, [27–28](#)
 - specifications, MC8201, [28–29](#)
 - specifications, MC8700, [29–30](#)
 - specifications, MC8775/75V, [30–31](#)
 - specifications, MC8780/81, [31–32](#)
 - specifications, MC8790/90V/91V/92V/95V, [32–33](#)
 - specifications, MC8795V, [33–34](#)
- current, consumption, [27](#)

D

- desense. See RF
- design checklist
 - antennas, [67](#)
 - component placement, [67](#)
 - EMI/ESD, [68](#)
 - host/modem communications, [68](#)
 - power, [67](#)
 - thermal, [68](#)
- device
 - positioning, sensitivity testing, [45](#)
- disconnected, module power state, [19](#)
- diversity antenna
 - disabling, [41](#)
- DTMF
 - codec, [48](#)
 - module-controlled, [54](#)

E

- echo cancellation
 - audio feature, [47](#)
 - codec, [48](#)
 - details, [52](#)
 - module-controlled, [54](#)
 - support, all modes, [52](#)
- EDGE connector, manufacturers, [12](#)
- efficiency
 - test criteria, [96](#)
- electrostatic discharge. See ESD
- ESD
 - design checklist, [68](#)
 - protection requirements, [18](#)
 - testing techniques document (IEC-61000-4-2), [14](#)

F

- fading correlation coefficient
 - test criteria, [97](#)
- FCC
 - regulations, relevant section, [14](#)
- FER (Frame Error Rate), [45](#)
- filtering
 - high pass / slope filtering, module-controlled, [54](#)
- filtering stages, audio, [47](#)
- filtering, RF desense, [43](#)
- FIR filtering
 - audio feature, [47](#)
 - codec, [48](#)
 - module-controlled, [54](#)
- frame error rate (FER)
 - measure of sensitivity, MC57xx, [45](#)
- frequency bands, supported, [92](#)

G

- gain
 - codec, [48](#)
 - distribution, audio, [52](#)
 - limits, adjustable, [47](#)
- gain, antenna
 - test criteria, [97](#)
- GPS band
 - RF parameters, MC57xx, [37](#)
- grounding
 - connection considerations, [40](#)

H

- handset audio mode, [47](#)
- handset mode
 - echo cancellation, [52](#)
- handshaking
 - USB, [57](#)
- headset audio mode, [47](#)
- headset mode
 - echo cancellation, [52](#)
- Host-Module interface, [55–64](#)

I

- I/O rise time requirements, [61](#)
- impedance
 - module-antenna, [41](#)
 - USIM, [61](#)
- inrush currents
 - description, [24](#)
 - host power supply applied, [25](#)
 - model, MC57xx, [24](#)
 - model, MC8xxx, [24](#)
 - W_Disable# deasserted, [25](#)
- interface
 - audio signal, [53](#)

- interference
 - device generated, 42
 - power supply noise, 41
 - wireless devices, 42
- isolation
 - test criteria, 96
- L**
- LED
 - example, 58
 - states, 58
- low power mode
 - setting, AT commands, 19
 - setting, CnS commands, 19
 - state change from normal, temperature, 22
 - state change from normal, voltage, 21
 - state change to normal, temperature, 23
 - state change to normal, voltage, 21
- low power, module power state, 19
- M**
- MC5727
 - AT commands, extended, 62
 - AT reference (extended), 14
 - AT reference (standard), 13
 - CnS reference, 13
 - networks supported, 11
 - product specification, 14
- MC5727V
 - AT commands, extended, 62
 - AT reference (extended), 14
 - AT reference (standard), 13
 - audio interface, supported, 47
 - CnS reference, 13
 - networks supported, 11
 - product specification, 14
- MC5728V
 - AT commands, extended, 62
 - AT reference (extended), 14
 - AT reference (standard), 13
 - audio interface, supported, 47
 - CnS reference, 13
 - important signal considerations, 103
 - networks supported, 11
 - product specification, 14
- MC57xx
 - current specifications, 27–28
 - sensitivity test results, 46
 - sensitivity, defined, 45
- MC8201
 - current specifications, 28–29
 - networks supported, 11
 - product specification, 14
- MC8700
 - AT reference (extended), 15
 - AT reference (standard), 14
 - CnS reference, and MC87xx, 14
 - current specifications, 29–30
 - networks supported, 11
 - product specification, 14
- MC8775
 - AT reference (extended), 15
 - AT reference (standard), 14
 - CnS reference, and MC87xx, 14
 - current specifications, 30–31
 - networks supported, 11
 - product specification, 14
- MC8775V
 - AT reference (extended), 15
 - AT reference (standard), 14
 - audio interface, supported, 47
 - CnS reference, and MC87xx, 14
 - CnS voice reference, and MC87xxV, 14
 - current specifications, 30–31
 - networks supported, 11
 - product specification, 14
- MC8780
 - AT reference (extended), 15
 - AT reference (standard), 14
 - CnS reference, and MC87xx, 14
 - current specifications, 31–32
 - networks supported, 11
 - product specification, 14
- MC8781
 - AT reference (extended), 15
 - AT reference (standard), 14
 - CnS reference, and MC87xx, 14
 - current specifications, 31–32
 - networks supported, 11
 - product specification, 14
- MC8790
 - AT reference (extended), 15
 - AT reference (standard), 14
 - CnS reference, and MC87xx, 14
 - current specifications, 32–33
 - networks supported, 11
 - product specification, 14
- MC8790V
 - AT reference (extended), 15
 - AT reference (standard), 14
 - audio interface, supported, 47
 - CnS reference, and MC87xx, 14
 - CnS voice reference, and MC87xxV, 14
 - current specifications, 32–33
 - networks supported, 11
 - product specification, 14

MC8791V

- AT reference (extended), [15](#)
- AT reference (standard), [14](#)
- audio interface, supported, [47](#)
- CnS reference, and MC87xx, [14](#)
- CnS voice reference, and MC87xxV, [14](#)
- current specifications, [32–33](#)
- networks supported, [11](#)
- product specification, [14](#)

MC8792V

- AT reference (extended), [15](#)
- AT reference (standard), [14](#)
- audio interface, supported, [47](#)
- CnS reference, and MC87xx, [14](#)
- CnS voice reference, and MC87xxV, [14](#)
- current specifications, [32–33](#)
- networks supported, [11](#)
- product specification, [14](#)

MC8795V

- AT reference (extended), [15](#)
- AT reference (standard), [14](#)
- audio interface, supported, [47](#)
- CnS reference, and MC87xx, [14](#)
- CnS voice reference, and MC87xxV, [14](#)
- current specifications, [33–34](#)
- networks supported, [11](#)
- product specification, [14](#)

MC87xxV

- pins, connector (2.6V), [55, 56](#)

MC8xxx

- AT commands, extended, [63](#)
- sensitivity, defined, [45](#)

MDL_RESET_N (MC5728V), [103](#)

Mini Card

- Dev Kit Quick Start Guide, [15](#)
- PCI Express Specification, [15](#)
- See also MC5727, MC5727V, MC5728V, MC8201, MC8700, MC8775, MC8775V, MC8780, MC8780, MC8781, MC8790, MC8790V, MC8791V, MC8792V, MC8795V

minicom

- downloading and installing, [76](#)

mixing

- codec, [48](#)

modes

- deep sleep, description, [35](#)
- operating, [35](#)
- shutdown, description, [35](#)
- sleep, description, [35](#)
- transmit / receive, description, [35](#)

module

- power states, [18–23](#)

N

noise

- leakage, minimizing, [40](#)
- RF interference, power supply, [41](#)

noise suppression

- audio feature, [47](#)
- module-controlled, [54](#)

normal mode

- state change from low power, temperature, [23](#)
- state change from low power, voltage, [21](#)
- state change to low power, temperature, [22](#)
- state change to low power, voltage, [21](#)

normal, module power state, [19](#)**O**off, module power state, [19](#)output driver stage, audio feature, [47](#)**P**path loss, OTA testing, [44](#)

path switching

- codec, [48](#)

PCB

- multi-layer, shielding for RF desense, [43](#)

PCI Express

- Mini Card specification, [15](#)

PCM digital audio, signal interface, [54](#)

PCS band

- RF parameters, MC57xx, [37](#)

pins

- connector (2.6V), MC87xxV, [55, 56](#)

polyphonic ringtone

- host-controlled, [54](#)

power

- consumption, MC8xxx, [34](#)
- current consumption, overview, [27](#)
- default state, [19](#)
- design checklist, [67](#)
- disconnected, characteristics, [19](#)
- normal, characteristics, [19](#)
- off, characteristics, [19](#)
- off, state change, temperature, [23](#)
- off, state change, voltage, [21](#)
- power-up timing, [25](#)
- ramp-up timing, [25](#)
- required supply voltage, [17](#)
- signals, overview, [17](#)
- state machine, temperature monitoring, [22–23](#)
- state machine, voltage monitoring, [20–21](#)
- state, disconnected, [19](#)
- state, low power, [19](#)
- state, normal, [19](#)
- state, off, [19](#)
- states, module, [18–23](#)
- supply, RF interference, [41](#)
- supply, ripple limit, [41](#)
- transmit, wave form, [26](#)

power interface, [17–36](#)product specification (PSD), [14](#)production tests, [71](#)

PSD (Product Specification Document), 14

Q

quality assurance tests, 86

R

regulatory information, 99–102

Brazil, 102

EU, 101

FCC, 100

limitation of liability, 99

safety and hazards, 99

reset module, input (MC5728V), 103

resistors, external pull-up, 61

resume

mode, USB, 57

RF

antenna cable loss, maximum, 39

antenna connection, considerations, 39

cable type, required, 12

desense

device-generated, 42

harmonic energy, filtering, 43

mitigation suggestions, 43

shielding suggestions, 43

integration, 37–46

interference

other devices, 42

power supply, 41

wireless devices, 42

level lowered automatically, high temperature, 23

parameters

cellular band, MC57xx, 37

GPS, MC57xx, 37

PCS band, MC57xx, 37

ringer tone

codec, 48

ringers

module-controlled, 54

ringtone, polyphonic

host-controlled, 54

Rx band

RF parameters, MC57xx, 37

Rx sensitivity

RF parameter, MC57xx, 37

RF parameter, MC8xxx, 37

S

SCI (Slot Cycle Index), 28

SED

see Smart Error Detection

sensitivity

defined, MC57xx and MC87xx, 45

MC57xx, defined (frame error rate), 45

MC8xxx, defined (bit error rate), 45

radiated measurement, overview, 43

RF parameter, MC57xx, 37

RF parameter, MC8xxx, 37

test results

MC57xx, 46

testing

device under test, positioning, 45

testing, overview, 43

testing, path loss calculation, 44

sensitivity, OTA test chamber configuration, 43

shielding

module, compliance, 40

reducing RF desense, 43

sidetone

responsible codec, 54

support, 51

SIM

testing methods, MS conformance specification, 15

See also USIM

Slot Cycle Index, 28

Smart Error Detection

detecting module reset, 35

speakerphone audio mode, 47

speakerphone mode

echo cancellation, 53

state machine

temperature monitoring, 22–23

voltage monitoring, 20–21

suspend

mode, USB, 57

system block, audio

MC5728V, 49

MC87xxV, 50

T

temperature, module. See thermal

test

efficiency, 96

fading correlation coefficient, 97

gain, antenna, 97

isolation, 96

VSWR (Voltage Standing Wave Ratio), 95

testing

overview, 69

acceptance tests, 69

audio loop-back, MC5727V / MC5728V / MC8775V /
MC8790V / MC8791V / MC8792V / MC8795V,

84

- certification tests, 70
- equipment, suggested, 87
- ESD immunity, techniques document (IEC-61000-4-2), 14
- GPS receiver, MC8775V, 83
- manual functional test, suggested, 71
- production tests, 71
- quality assurance tests, 86
- RF receive path, MC57xx, 79
- RF receive path, MC87xx, 81
- RF transmission path, MC57xx, 76
- RF transmission path, MC87xx, 77
- sensitivity, OTA test chamber configuration, 43
- suggestions, 69–89
- testing, path loss calculation, 45
- thermal
 - considerations, 65–66
 - design checklist, 68
 - dissipation, factors affecting, 65
 - dissipation, suggestions, 65
 - RF shield temperature, maximum, 66
 - testing, module, 65–66
- timing
 - power ramp-up, 25
 - power-up, 25
- transducer interface
 - host-controlled, 54
- transducer interfaces
 - codec, 48
- transmit power wave form, 26
- Tx band
 - RF parameters, MC57xx, 37
- Tx power
 - RF parameters, MC57xx, 37

U

- UDK (Universal Development Kit)
 - components, included, 12
- Universal Development Kit (UDK)
 - components, included, 12
- Universal Serial Bus. See USB.
- usage models
 - current consumption, 36

USB

- enumeration, power-up, 25
- handshaking, 57
- host driver requirements, 58
- interface
 - host-module communication, 56–58
 - overview, 56
- resume mode, 57
- specification, 15
- suspend mode, 57

USIM

- capacitor recommendations, 61
- card contacts, 60
- clock rate, 61
- connector type, required, 12
- electrical specifications, 61
- impedance, connectors, 61
- interface diagram, 60
- interface, overview, 59
- operation, 61–62
- pin assignments, 59
- socket placement, 62

V

- voice memo
 - host-controlled, 54
- Voltage Standing Wave Ratio (VSWR)
 - test criteria, 95
- volume, setting
 - responsible codec, 54
- VSWR (Voltage Standing Wave Ratio)
 - test criteria, 95

W

- W_Disable#
 - deasserted, causes inrush current event, 25
 - de-asserted, peak current, 25
 - inrush currents, 24
 - MC5728V information, 104
 - module, powering off, 21, 23
 - Normal state, 19
 - off state, 19

Z

- ZIF (Zero Intermediate Frequency), 41



SIERRA
WIRELESS