



AirPrime EM7565

Product Technical Specification



SIERRA
WIRELESS®

41110788

Rev 8

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Contents subject to change

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

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Revision History

| Revision number | Release date | Changes |
|-----------------|--------------|--|
| 1 | April 2017 | Initial release |
| 2 | June 2017 | Added Power On/Off Timing for the USB section |
| 3 | June 2017 | Updated notes indicating how long host must wait to drive signals at power-on (in Host Interface Pin Assignments , Power On/Off Timing for the USB , and Power On Timing for PCIe Port) |
| 4 | June 2017 | Corrected appendix table/figure numbering and TOC formatting |
| 5 | July 2017 | Added uplink carrier aggregation combinations Removed Bands 252/255 |

| Revision number | Release date | Changes |
|-----------------|---------------|--|
| 6 | February 2018 | Added Carrier Aggregation tables Added max values for ClassA / ClassB operating temperatures Updated 3GPP LTE Release # Updated Table 3-1 —VCC typical value, pin 8 voltages, PCIE pin voltages Removed PCIe Interface section and Power-on Timing for PCIe Added Recommended Capacitor Placement details for USB3.0 Updated USB Throughput Performance details Updated LTE Conducted Rx Sensitivity table Updated Conducted Tx Power Tolerances table—LTE B30 Updated Averaged Standby DC Power Consumption table Updated Averaged Call Mode DC Power Consumption table Updated Miscellaneous DC Power Consumption table Updated Power State Transition Trigger Levels (Temperature values) Updated USB timing parameters Updated USB Enumeration description Updated Product Marking (Labeling) example Updated Regulatory Compliance chapter—Antenna gain table, FCC/IC IDs Updated Test Settings for UMTS and LTE Rx and Tx |
| 7 | April 2018 | Added Required Shutdown Sequence on page 54 Updated Electrical Specifications WAN_LED_N description to not include GNSS Added GPS_DISABLE# Input high voltage detail Marked LTE B42/B43/B48 as disabled Removed B42C from UL CA list Removed WCDMA Band 3 Updated RESET# usage in Table 3-7, Full_Card_Power_Off# and RESET# Usage , on page 35 |
| 8 | October 2018 | Updated PTCRB Carrier Aggregation Download Combinations Updated Power-on signal timing graphic and host signals note Updated PCI_PERST_N voltage levels LTE B30 noted as downlink only Replaced references to !RXDEN with !LTERXCONTROL Updated envelope correlation coefficient values Updated topic Disabling the Diversity Antenna Updated TEMP_HI_CRIT value |

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>> 1: Introduction

The Sierra Wireless EM7565 Embedded Module is an M.2 module that provides LTE, UMTS, and GNSS connectivity for notebook, ultrabook, tablet computers, and M2M applications over several radio frequency bands.

Supported RF bands

The modem, based on Qualcomm's MDM9250 baseband processor, supports data operation on LTE and UMTS networks over the bands described in Table 1-1, with LTE carrier aggregation (CA) as described in Table 1-2 and Table 1-3.

Table 1-1: Supported RF Bands

| RAT | Bands | | | | | | | | | | | | | | | | | | | | | | | | |
|-------------------|--|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----------------|----------------|----------------|-----|----------------|----------------|----------------|----------------|----|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 12 | 13 | 18 | 19 | 20 | 26 | 28 | 29 | 30 | 32 | 41 | 42 | 43 | 46 | 48 | 66 |
| LTE ^a | F | F | F | F | F | | F | F | F | F | F | F | F | F | F | F | F ^b | F ^b | F ^b | T | T ^c | T ^c | T ^b | T ^c | F |
| UMTS ^d | Y | Y | | Y | Y | Y | | Y | Y | | | | Y | | | | N/A | | | N/A | | | | | |
| GNSS | <ul style="list-style-type: none"> • GPS: 1575.42 MHz • GLONASS: 1602 MHz • BeiDou: 1561.098 MHz • Galileo: 1575.42 MHz • QZSS: 1575.42 MHz | | | | | | | | | | | | | | | | | | | | | | | | |

- (LTE) Downlink MIMO support (2x2; 4x2)
F=FDD; T=TDD
Data rates: Downlink (Cat 12 with 3CA, 256QAM=600 Mbps; Cat 9 with 3CA, 64QAM=450 Mbps), Uplink (Cat 13 with 2CA contiguous, 64QAM=150 Mbps)
- Downlink only
- B42/B43/B48 disabled as of publication date, support pending regulatory approval
- UMTS (DC-HSPA+, HSPA+, HSPA, UMTS)
Diversity support
Data rates: Downlink (Cat 24, up to 42 Mbps), Uplink (Cat 6, up to 11 Mbps)

Table 1-2: PTCRB Carrier Aggregation Downlink Combinations^a

| 1 Band/2CC | 1 Band/3CC | 2 Bands/2CC | 2 Bands/3CC | 3 Bands/3CC |
|------------|------------|-------------|---------------|---------------|
| | | CA_1A-3A | CA_1A-7A-7A | CA_1A-3A-5A |
| | | CA_1A-5A | | CA_1A-3A-7A |
| | | CA_1A-7A | | CA_1A-3A-8A |
| | | CA_1A-18A | | CA_1A-3A-19A |
| | | CA_1A-19A | | CA_1A-3A-20A |
| | | CA_1A-20A | | CA_1A-5A-7A |
| | | CA_1A-26A | | CA_1A-7A-20A |
| | | CA_1A-41A | | |
| CA_2A-2A | | CA_2A-4A | CA_2A-2A-5A | CA_2A-4A-5A |
| CA_2C | | CA_2A-7A | CA_2A-2A-12A | CA_2A-4A-7A |
| | | CA_2A-12A | CA_2A-2A-13A | CA_2A-4A-12A |
| | | CA_2A-13A | CA_2A-7A-7A | CA_2A-4A-13A |
| | | CA_2A-29A | CA_2A-66A-66A | CA_2A-4A-29A |
| | | CA_2A-30A | CA_2A-66B | CA_2A-12A-30A |
| | | CA_2A-46A | CA_2A-66C | CA_2A-13A-66A |
| | | CA_2A-66A | | CA_2A-29A-30A |
| CA_3A-3A | | CA_3A-5A | CA_3A-3A-7A | CA_3A-7A-20A |
| CA_3C | | CA_3A-7A | CA_3C-5A | |
| | | CA_3A-8A | CA_3A-7B | |
| | | CA_3A-19A | CA_3A-7C | |
| | | CA_3A-20A | CA_3A-7A-7A | |
| | | CA_3A-41A | CA_3C-7A | |
| | | | CA_3C-20A | |
| | | | CA_3A-41C | |
| CA_4A-4A | | CA_4A-5A | CA_4A-4A-5A | CA_4A-5A-30A |
| | | CA_4A-7A | CA_4A-4A-12A | CA_4A-7A-12A |
| | | CA_4A-12A | CA_4A-4A-13A | CA_4A-12A-30A |
| | | CA_4A-13A | CA_4A-4A-30A | CA_4A-29A-30A |
| | | CA_4A-29A | CA_4A-7A-7A | |
| | | CA_4A-30A | | |
| | | CA_4A-46A | | |
| | | CA_5A-30A | CA_5A-66C | CA_5A-30A-66A |
| | | CA_5A-66A | CA_5A-66A-66A | |

Table 1-2: PTCRB Carrier Aggregation Downlink Combinations^a (Continued)

| 1 Band / 2CC | 1 Band / 3CC | 2 Bands / 2CC | 2 Bands / 3CC | 3 Bands / 3CC |
|--------------|--------------|---------------|----------------|----------------|
| CA_7B | | CA_7A-12A | | |
| CA_7C | | CA_7A-20A | | |
| | | CA_12A-30A | | CA_12A-30A-66A |
| | | CA_12A-66A | | |
| | | CA_13A-66A | CA_13A-66A-66A | |
| | | | CA_13A-66B [2] | |
| | | CA_20A-32A | | |
| | | CA_29A-30A | | CA_29A-30A-66A |
| | | CA_29A-66A | | |
| | | CA_30A-66A | | |
| | CA_41D | | | |
| CA_66B | CA_66A-66B | | | |
| CA_66C | CA_66A-66C | | | |

a. Supported CA DL combinations outside of North America are carrier-dependent.

Table 1-3: Carrier Aggregation Uplink Combinations

| |
|--------|
| CA_3C |
| CA_7C |
| CA_41C |

Physical Features

- M.2 form factor—WWAN Type 3042-S3-B (in WWAN—USB 3.0 Port Configuration 2), as specified in [8] *PCI Express NGFF (M.2) Electromechanical Specification Revision 1.0*. (Note: Any variations from the specification are detailed in this document.)
- Ambient operating temperature range with appropriate heatsinking:
 - Class A (3GPP compliant): -30°C to +70°C
 - Class B (operational, non-3GPP compliant): -40°C to +85°C (reduced operating parameters required)

Important: *The internal module temperature (reported by AT!PCTEMP) must be kept below 90°C. For best performance, the internal module temperature should be kept below 80°C. Proper mounting, heat sinks, and active cooling may be required, depending on the integrated application.*

Application Interface Features

- USB interface (QMI) for Linux and Android
- MBIM for Windows 8.1, Windows 10, and Linux
- AT command interface ([1] *AT Command Set for User Equipment (UE) (Release 6) (Doc# 3GPP TS 27.007)*, plus proprietary extended AT commands) in [2] *AirPrime EM75xx AT Command Reference (Doc# 41111748)*
- Software Development Kits (SDK), including API (Application Program Interface) functions:
 - Windows 8.1, Windows 10
 - Linux
- Support for active antenna control via dedicated antenna control signals (ANTCTL0:3)
- Dynamic power reduction support via software and dedicated GPIO (DPR)
- OMA DM (Open Mobile Alliance Device Management)
- FOTA (Firmware Over The Air)

Note: OMA DM and FOTA support is operator-dependent.

Modem Features

- LTE / DC-HSPA+ / HSPA+ / HSPA / UMTS (WCDMA) operation
- Multiple (up to 16) cellular packet data profiles
- Traditional modem COM port support for AT commands
- USB suspend / resume
- Sleep mode for minimum idle power draw
- SIM application tool kit with proactive SIM commands
- Enhanced Operator Name String (EONS)
- Mobile-originated PDP context activation / deactivation
- Support QoS QCI (3GPP Release 12)
- Static and Dynamic IP address. The network may assign a fixed IP address or dynamically assign one using DHCP (Dynamic Host Configuration Protocol).
- PAP and CHAP support
- PDP context type (IPv4, IPv6, or IPv4v6)
- RFC1144 TCP/IP header compression

LTE Features

- Carrier aggregation:
 - DL LTE-FDD—60 MHz
 - DL LTE-TDD—60 MHz
 - UL LTE—40 MHz intraband contiguous
- CSG support (LTE Femto)
- LTE Advanced receivers (NLIC, eICIC, feICIC)
- Basic cell selection and system acquisition
 - [PSS/SSS](#)/MIB decode
 - [SIB1](#)–SIB16 decoding
- NAS/AS security procedures
 - Snow 3G/AES/ZUC security
- [CQI](#)/RI/PMI reporting

- Paging procedures
 - Paging in Idle and Connected mode
- Dedicated bearer
 - Network-initiated dedicated bearer
 - [UE](#)-initiated dedicated bearer
- Multiple PDN connections (IPv4 and IPv6 combinations), subject to operating system support.
- Connected mode intra-LTE mobility
- Idle mode intra-LTE mobility
- iRAT between LTE/3G for idle and connection release with redirection
- Detach procedure
 - Network-initiated detach with reattach required
 - Network-initiated detach followed by connection release

Short Message Service (SMS) Features

- Mobile-originated and mobile-terminated SMS over [IMS](#)
- Mobile-originated and mobile-terminated SMS over SGs

Position Location (GNSS)

- Customizable tracking session
- Automatic tracking session on startup
- Concurrent standalone GPS, GLONASS, Galileo, BeiDou, and QZSS
- Assisted GPS ([A-GPS](#)) SUPL1.0
- Assisted GPS/GLONASS SUPL2.0
- gpsOneXTRA 1.0/2.0/3.0/3.1
- GNSS reception on dedicated connector or diversity connector

Supporting Documents

Several additional documents describe module design, usage, integration, and other features. See [References on page 95](#).

Accessories

A hardware development kit is available for AirPrime M.2 modules. The kit contains hardware components for evaluating and developing with the module, including:

- Development board
- Cables
- Antennas
- Other accessories

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

Required Connectors

[Table 1-4](#) describes the connectors used to integrate the EM7565 Embedded Module into your host device.

Table 1-4: Required Host-Module Connectors^a

| Connector type | Description |
|---------------------|---|
| RF cables | <ul style="list-style-type: none"> Mate with M.2-spec connectors Three connector jacks (I-PEX 20448-001R-081 or equivalent) |
| EDGE (67 pin) | <ul style="list-style-type: none"> Slot B compatible—Per the M.2 standard (<i>[8] PCI Express NGFF (M.2) Electromechanical Specification Revision 1.0</i>), a generic 75 pin position EDGE connector on the motherboard uses a mechanical key to mate with the 67 pin notched module connector. Manufacturers include LOTES (part #APCI0018-P001A01), Kyocera, JAE, Tyco, and Longwell. |
| SIM | <ul style="list-style-type: none"> Industry-standard connector. See SIM Interface on page 29 for details. |

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

Ordering Information

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

Integration Requirements

Sierra Wireless provides, in the documentation suite, guidelines for successful module integration and offers integration support services as necessary.

When integrating the EM7565 Embedded Module, the following items must be addressed:

- Mounting**—Effect on temperature, shock, and vibration performance
- Power supply**—Impact on battery drain and possible [RF](#) interference
- Antenna location and type**—Impact on RF performance
- Regulatory approvals**—As discussed in [Regulatory Compliance and Industry Certifications on page 62](#).
- Service provisioning**—Manufacturing process
- Software**—As discussed in [Software Interface on page 56](#).
- Host interface**—Compliance with interface voltage levels

>> 2: Standards Compliance

The EM7565 Embedded Module complies with the mandatory requirements described in the following standards. The exact set of requirements supported is network operator-dependent.

Table 2-1: Standards Compliance

| Technology | Standards |
|------------|---|
| LTE | <ul style="list-style-type: none">• 3GPP Release 11^a |
| UMTS | <ul style="list-style-type: none">• 3GPP Release 9 |

a. Some auxiliary functions support Release 12 or Release 13.

>> 3: Electrical Specifications

The system block diagram in [Figure 3-1](#) represents the EM7565 module integrated into a host system. The module includes the following interfaces to the host:

- Full_Card_Power_Off#—Input supplied to the module by the host—active-low to turn the unit off, or active-high to turn the unit on.
- W_DISABLE#—Active low input from the host to the EM7565 disables the main RF radio.
- GPS_DISABLE#—Active low input from the host to the EM7565 disables the GNSS radio receiver.
- WAKE_ON_WAN#—Active low output used to wake the host when specific events occur.
- WWAN_LED#—Active-low LED drive signal provides an indication of WAN radio ON state.
- RESET#—Active low input from the host used to reset the module.
- Antenna—Three RF connectors (main (Rx/Tx), GNSS, and auxiliary (diversity/MIMO/GNSS)). For details, see [RF Specifications on page 37](#).
- Antenna control—Four signals that can be used to control external antenna switches.
- Dynamic power control—Signal used to adjust Tx power to meet FCC SAR requirements. For details, see [Tx Power Control on page 55](#).
- Dual SIM—Supported through the interface connector. The SIM cavities / connectors must be placed on the host device for this feature.
- SIM detect—Internal pullup on the module detects whether a SIM is present or not:
 - If a SIM is not inserted, the pin must be shorted to ground.
 - If a SIM is present, the pin will be an open circuit.
- USB—USB 2.0 and USB 3.0 interfaces to the host for data, control, and status information.
- PCIe port—Reserved for future use.

The EM7565 has two main interface areas—the host I/O connector and the RF ports. Details of these interfaces are described in the sections that follow.

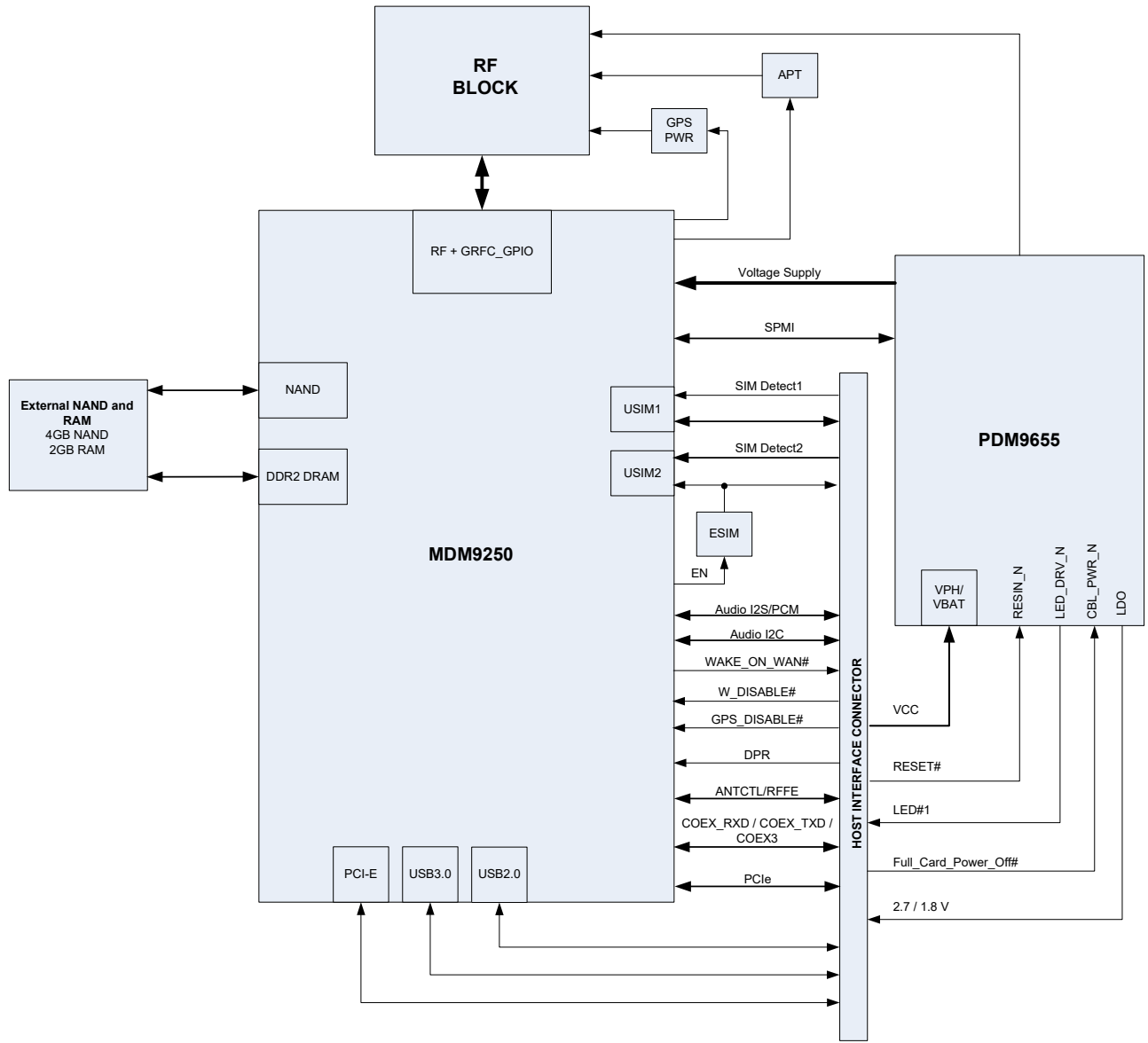
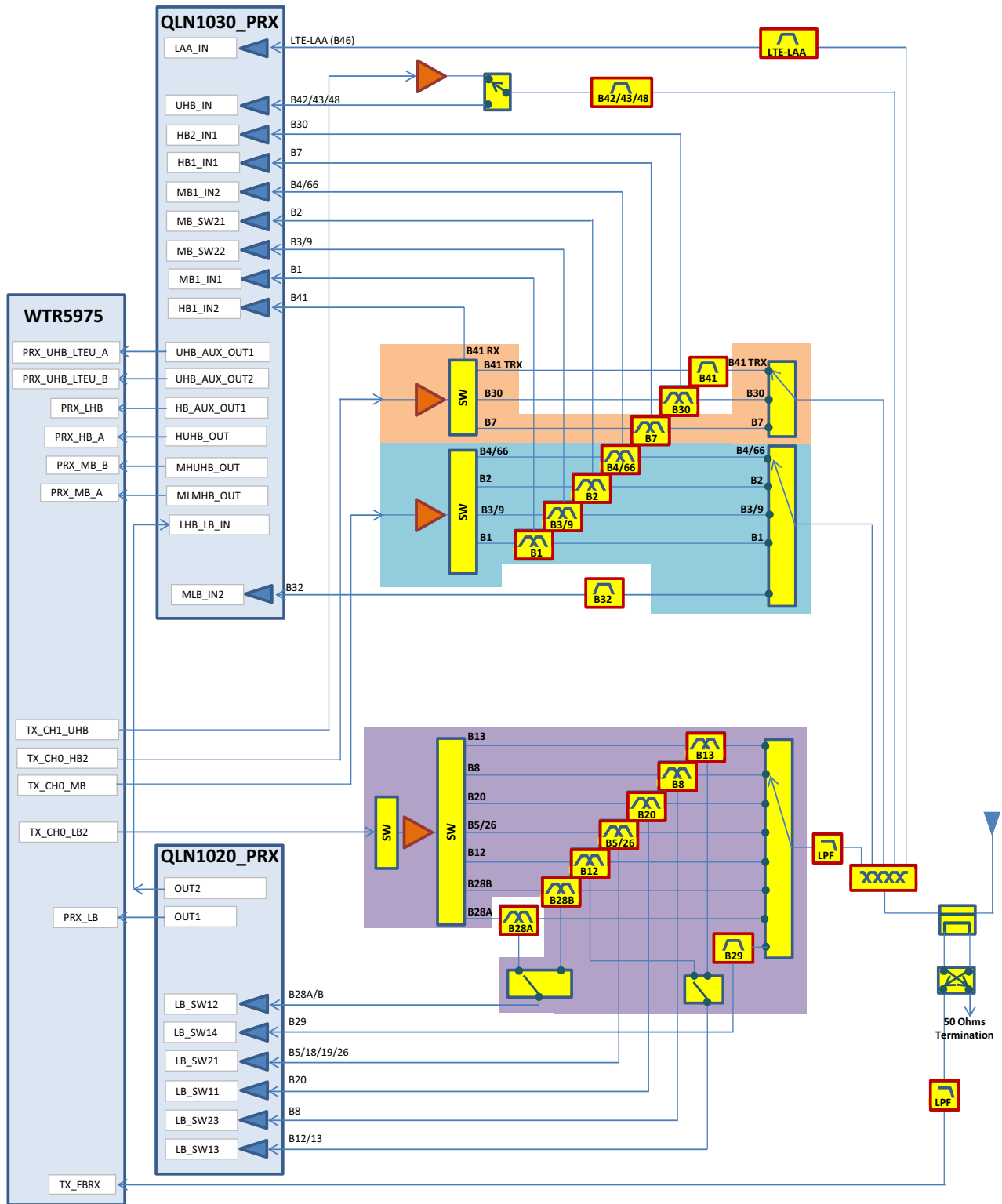


Figure 3-1: System Block Diagram



Note: B42/B43/B48 disabled as of publication date, support pending regulatory approval.

Figure 3-2: Expanded RF (Transmit) Block Diagram

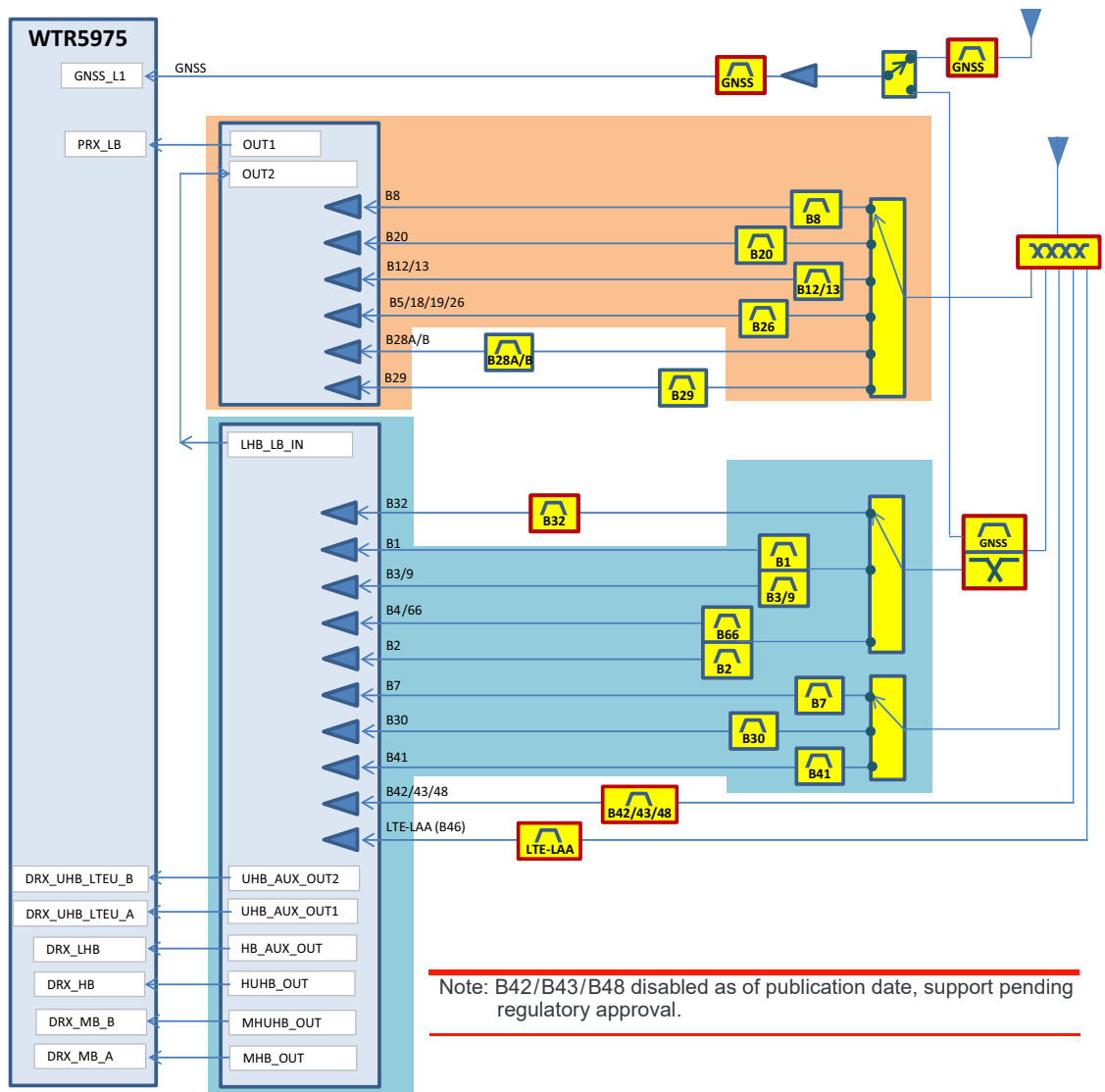


Figure 3-3: Expanded RF (Receive/GNSS) Block Diagram

Host Interface Pin Assignments

The EM7565 host I/O connector provides pins for power, serial communications, and control. Pin assignments are listed in [Table 3-1](#).

Refer to the following tables for pin details based on interface types:

- [Table 3-2, Power and Ground Specifications](#), on page 28
- [Table 3-3, USB Interfaces](#), on page 28
- [Table 3-4, SIM Interface Signals](#), on page 30
- [Table 3-5, Module Control Signals](#), on page 33

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

Note: The host should not drive any signals to the module until > 100 ms from the start of the power-on sequence.

Table 3-1: Host Interface (75-pin) Connections — Module View^a

| Pin | Signal name | Pin type ^b | Description | Direction ^c | Active state | Voltage levels (V) | | |
|-----|---|-----------------------|--|------------------------|--------------|--------------------|-----|------|
| | | | | | | Min | Typ | Max |
| 1 | CONFIG_3 (NC in default module configuration) | | Reserved—Host must not repurpose this pin. | | | | | |
| 2 | VCC | V | Power source | Input | Power | 3.135 | 3.3 | 4.4 |
| 3 | GND | V | Ground | Input | Power | - | 0 | - |
| 4 | VCC | V | Power source | Input | Power | 3.135 | 3.3 | 4.4 |
| 5 | GND | V | Ground | Input | Power | - | 0 | - |
| 6 | Full_Card_Power_Off## ^d | PD | Turn modem on | Input | High | 0.7 | - | 4.4 |
| | | | Turn modem off | Input | Low | -0.3 | - | 0.5 |
| 7 | USB_D+ ^d | - | USB data positive | Input/Output | Differential | - | - | - |
| 8 | W_DISABLE# ^e | PU | Wireless Disable (main RF radio) | Input | Low | - | - | 0.4 |
| | | | | Input | High | 0.7 | - | 4.4 |
| 9 | USB_D- ^d | - | USB data negative | Input/Output | Differential | - | - | - |
| 10 | WWAN_LED# | OC | LED Driver | Output | Low | 0 | - | 0.15 |
| 11 | GND | V | Ground | Input | Power | - | 0 | - |
| 12 | Key | Notch location | | | | | | |
| 13 | Key | Notch location | | | | | | |
| 14 | Key | Notch location | | | | | | |
| 15 | Key | Notch location | | | | | | |
| 16 | Key | Notch location | | | | | | |
| 17 | Key | Notch location | | | | | | |
| 18 | Key | Notch location | | | | | | |
| 19 | Key | Notch location | | | | | | |
| 20 | NC (For audio interface pin usage, see Audio Support on page 65.) | | Reserved—Host must not repurpose this pin. | | | | | |

Table 3-1: Host Interface (75-pin) Connections — Module View^a (Continued)

| Pin | Signal name | Pin type ^b | Description | Direction ^c | Active state | Voltage levels (V) | | |
|-----|---|-----------------------|--|------------------------|--------------|----------------------------------|----------------------------------|----------------------------------|
| | | | | | | Min | Typ | Max |
| 21 | CONFIG_0 (GND in default module configuration) | | Reserved—Host must not repurpose this pin. | Output | - | | 0 | |
| 22 | NC (For audio interface pin usage, see Audio Support on page 65.) | | Reserved—Host must not repurpose this pin. | | | | | |
| 23 | WAKE_ON_WAN# ^d | OC | Wake Host | Output | Low | 0 | | 0.1 |
| 24 | NC (For audio interface pin usage, see Audio Support on page 65.) | | Reserved—Host must not repurpose this pin. | | | | | |
| 25 | DPR | - | Dynamic power control | Input | High | 1.17 | 1.80 | 2.10 |
| | | | | Input | Low | -0.3 | - | 0.63 |
| 26 | GPS_DISABLE# ^e | PU | Wireless disable (GNSS radio) | Input | Low | - | - | 0.4 |
| | | | | Input | High | 0.7 | - | 4.4 |
| 27 | GND | V | Ground | Input | Power | - | 0 | - |
| 28 | NC (For audio interface pin usage, see Audio Support on page 65.) | | Reserved—Host must not repurpose this pin. | | | | | |
| 29 | USB3.0_TX- | | USB 3.0 Transmit Data negative | Output | Differential | - | - | - |
| 30 | UIM1_RESET ^d | O | SIM Reset | Output | Low | 0 | - | 0.45 |
| | | | | Output | High | 2.55 (3V SIM) 1.35 (1.8V SIM) | 3.00 (3V SIM) 1.80 (1.8V SIM) | 3.10 (3V SIM) 1.90 (1.8V SIM) |
| 31 | USB3.0_TX+ | | USB 3.0 Transmit Data positive | Output | Differential | - | - | - |
| 32 | UIM1_CLK ^d | O | SIM Clock | Output | Low | 0 | - | 0.45 |
| | | | | Output | High | 2.55 (3V SIM) 1.35 (1.8V SIM) | 3.00 (3V SIM) 1.80 (1.8V SIM) | 3.10 (3V SIM) 1.90 (1.8V SIM) |
| 33 | GND | V | Ground | Input | Power | - | 0 | - |

Table 3-1: Host Interface (75-pin) Connections — Module View^a (Continued)

| Pin | Signal name | Pin type ^b | Description | Direction ^c | Active state | Voltage levels (V) | | |
|-----|------------------------|-----------------------|-------------------------------|------------------------|--------------|---|--|--|
| | | | | | | Min | Typ | Max |
| 34 | UIM1_DATA ^d | - | SIM IO pin | Input | Low | -0.30 (3V SIM) -0.30 (1.8V SIM) | - | 0.60 (3V SIM) 0.35 (1.8V SIM) |
| | | | | | High | 2.10 (3V SIM) 1.17 (1.8V SIM) | 3.00 (3V SIM) 1.80 (1.8V SIM) | 3.30 (3V SIM) 2.10 (1.8V SIM) |
| | | | | Output | Low | 0 | - | 0.40 |
| | | | | | High | 2.55 (3V SIM) 1.35 (1.8V SIM) | 3.00 (3V SIM) 1.80 (1.8V SIM) | 3.10 (3V SIM) 1.90 (1.8V SIM) |
| 35 | USB3.0_RX- | | USB 3.0 Receive Data negative | Input | Differential | - | - | - |
| 36 | UIM1_PWR ^d | V | SIM VCC supply | Output | Power | 2.90 (3V SIM) 1.75 (1.8V SIM) | 3.00 (3V SIM) 1.80 (1.8V SIM) | 3.10 (3V SIM) 1.85 (1.8V SIM) |
| 37 | USB3.0_RX+ | | USB 3.0 Receive Data positive | Input | Differential | - | - | - |
| 38 | NC | | Reserved | | | | | |
| 39 | GND | V | Ground | Input | Power | - | 0 | - |
| 40 | SIM_DETECT_2 | | SIM2 indication | Input | | 0 V—SIM not present Open circuit—SIM present | | |
| 41 | PCIE_TXM | | PCIe Negative Transmit Data | Output | Differential | - | - | - |
| 42 | UIM2_DATA ^d | - | SIM2 IO pin | Input | Low | -0.30 (3V SIM) -0.30 (1.8V SIM) | - | 0.60 (3V SIM) 0.35 (1.8V SIM) |
| | | | | | High | 2.10 (3V SIM) 1.17 (1.8V SIM) | 3.00 (3V SIM) 1.80 (1.8V SIM) | 3.30 (3V SIM) 2.10 (1.8V SIM) |
| | | | | Output | Low | 0 | - | 0.40 |
| | | | | | High | 2.55 (3V SIM) 1.35 (1.8V SIM) | 3.00 (3V SIM) 1.80 (1.8V SIM) | 3.10 (3V SIM) 1.90 (1.8V SIM) |
| 43 | PCIE_TXP | | PCIe Positive Transmit Data | Output | Differential | - | - | - |

Table 3-1: Host Interface (75-pin) Connections — Module View^a (Continued)

| Pin | Signal name | Pin type ^b | Description | Direction ^c | Active state | Voltage levels (V) | | |
|-----|---|-----------------------|--|------------------------|--------------|--|--|--|
| | | | | | | Min | Typ | Max |
| 44 | UIM2_CLK ^d | O | SIM2 Clock | Output | Low | 0 | - | 0.45 |
| | | | | | High | 2.55 (3V SIM) 1.35 (1.8V SIM) | 3.00 (3V SIM) 1.80 (1.8V SIM) | 3.10 (3V SIM) 1.90 (1.8V SIM) |
| 45 | GND | V | Ground | Input | Power | - | 0 | - |
| 46 | UIM2_RESET ^d | O | SIM2 Reset | Output | Low | 0 | - | 0.45 |
| | | | | | High | 2.55 (3V SIM) 1.35 (1.8V SIM) | - | 3.10 (3V SIM) 1.90 (1.8V SIM) |
| 47 | PCIE_RXM | | PCIe Negative Receive Data | Input | Differential | - | - | - |
| 48 | UIM2_PWR ^d | V | SIM2 VCC supply | Output | Power | 2.90 (3V SIM) 1.75 (1.8V SIM) | 3.00 (3V SIM) 1.80 (1.8V SIM) | 3.10 (3V SIM) 1.85 (1.8V SIM) |
| | | | | | | | | |
| 49 | PCIE_RXP | | PCIe Positive Receive Data | Input | Differential | - | - | - |
| 50 | PCIE_PERST_N | | PCIe Reset | Input | Low | 0 | - | 0.7 |
| | | | | Input | High | 1.5 | - | VCC |
| 51 | GND | V | Ground | Input | Power | - | 0 | - |
| 52 | PCIE_CLKREQ_N | OC | PCIe Clock Request | Output | Low | 0 | - | 0.35 |
| 53 | PCIE_REFCLKM | | PCIe Negative Reference Clock | Input | Differential | - | - | - |
| 54 | PCIE_PEWAKE_N | OC | PCIe Wake | Output | Low | 0 | - | 0.35 |
| 55 | PCIE_REFCLKP | | PCIe Positive Reference Clock | Input | Differential | - | - | - |
| 56 | NC (For audio interface pin usage, see Audio Support on page 65.) | | Reserved—Host must not repurpose this pin. | | | | | |
| 57 | GND | V | Ground | Input | Power | - | 0 | - |
| 58 | NC (For audio interface pin usage, see Audio Support on page 65.) | | Reserved—Host must not repurpose this pin. | | | | | |
| 59 | ANTCTL0 (GPIO1) | | Customer-defined external switch control for multiple antennas | Output | High | 1.35 | - | 1.80 |
| | | | | Output | Low | 0 | - | 0.45 |
| 60 | Reserved—Host must not repurpose this pin and should leave it not connected. | | | | | | | |

Table 3-1: Host Interface (75-pin) Connections — Module View^a (Continued)

| Pin | Signal name | Pin type ^b | Description | Direction ^c | Active state | Voltage levels (V) | | |
|-----|--|-----------------------|--|------------------------|--------------|---|-----|------|
| | | | | | | Min | Typ | Max |
| 61 | ANTCTL1 (GPIO2) | | Customer-defined external switch control for multiple antennas | Output | High | 1.35 | - | 1.80 |
| | | | | Output | Low | 0 | - | 0.45 |
| 62 | Reserved—Host must not repurpose this pin and should leave it not connected. | | | | | | | |
| 63 | ANTCTL2 (GPIO3) | | Customer-defined external switch control for multiple antennas | Output | High | 1.35 | - | 1.80 |
| | | | | Output | Low | 0 | - | 0.45 |
| 64 | Reserved—Host must not repurpose this pin and should leave it not connected. | | | | | | | |
| 65 | ANTCTL3 (GPIO4) | | Customer-defined external switch control for multiple antennas | Output | High | 1.35 | - | 1.80 |
| | | | | Output | Low | 0 | - | 0.45 |
| 66 | SIM_DETECT ^d | PU | SIM indication | Input | | 0 V—SIM not present Open circuit—SIM present | | |
| 67 | RESET# | PU | Reset module | Input | Low | -0.3 | | 0.63 |
| 68 | NC | | Reserved | | | | | |
| 69 | CONFIG_1 (GND in default module configuration) | | Reserved—Host must not repurpose this pin. | Output | - | | 0 | |
| 70 | VCC | V | Power source | Input | Power | 3.135 | 3.3 | 4.4 |
| 71 | GND | V | Ground | Input | Power | - | 0 | - |
| 72 | VCC | V | Power source | Input | Power | 3.135 | 3.3 | 4.4 |
| 73 | GND | V | Ground | Input | Power | - | 0 | - |
| 74 | VCC | V | Power source | Input | Power | 3.135 | 3.3 | 4.4 |
| 75 | CONFIG_2 (NC in default module configuration) | V | Reserved | Output | - | - | | - |

a. All values are preliminary and subject to change.

b. I—Input; O—Digital output; OC—Open Collector output; PU—Digital input (internal pull up); PD—Digital input (internal pull down); V—Power or ground

c. Signal directions are from module's point of view (e.g. 'Output' from module to host, 'Input' to module from host.)

d. Required signal

e. Sierra Wireless recommends that the host implement an open collector driver where a Low signal will turn the module off or enter low power mode, and a high signal will turn the module on or leave low power mode.

Power Supply

The host provides power to the EM7565 through multiple power and ground pins as summarized in [Table 3-2](#).

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

Table 3-2: Power and Ground Specifications

| Name | Pins | Specification | Min | Typ | Max | Units |
|------------|--|----------------|--|-----|-----|------------------|
| VCC (3.3V) | 2, 4, 70, 72, 74 | Voltage range | See Table 3-1 on page 23 . | | | |
| | | Ripple voltage | - | - | 100 | mV _{pp} |
| GND | 3, 5, 11, 27, 33, 39, 45, 51, 57, 71, 73 | - | - | 0 | - | V |

USB Interface

Important: *Host support for USB 2.0 or USB 3.0 signals is required.*

The device supports USB 2.0 and USB 3.0 interfaces for communication between the host and module.

The interfaces comply with the [9] *Universal Serial Bus Specification, Rev 2.0* and [10] *Universal Serial Bus Specification, Rev 3.0* (subject to limitations described below), and the host device must be designed to the same standards.

Table 3-3: USB Interfaces

| | Name | Pin | Description |
|---------|-------------------------|-----|------------------------|
| USB 2.0 | USB_D+ | 7 | Data positive |
| | USB_D- | 9 | Data negative |
| USB 3.0 | USB3.0-TX ^{-a} | 29 | Transmit data negative |
| | USB3.0-TX ^{+a} | 31 | Transmit data positive |
| | USB3.0-RX ^{-a} | 35 | Receive data negative |
| | USB3.0-RX ^{+a} | 37 | Receive data positive |

a. Signal directions (Tx/Rx) are from module's point of view.

Host-side Recommendation

Note: When designing the host device, careful PCB layout practices must be followed.

Sierra Wireless recommends the host platform include series capacitors on the USB3.0 Rx signals (no capacitors required for the Tx signals), as shown below.

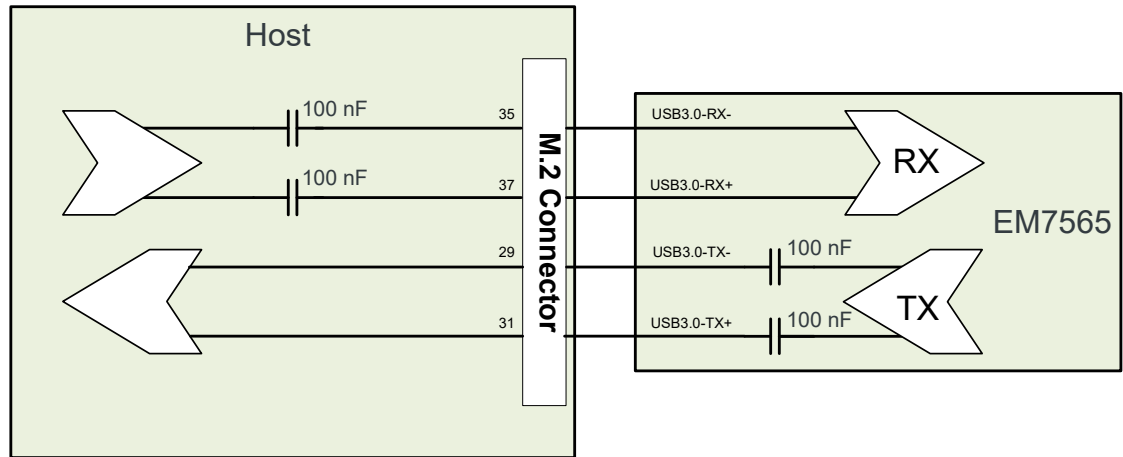


Figure 3-4: Recommended Capacitor Placement for USB3.0 Signals

USB Throughput Performance

This device has been designed to achieve optimal performance and maximum throughput using USB superspeed mode (USB 3.0). Although the device may operate with a high speed host, throughput performance will be on an “as is” basis and needs to be characterized by the [OEM](#). Note that throughput will be reduced and may vary significantly based on [packet](#) size, host interface, and [firmware](#) revision.

User-developed Drivers

Details for user-developed USB drivers are described in [4] *AirCard/AirPrime USB Driver Developer’s Guide (Doc# 2130634)*.

SIM Interface

Note: Host support for SIM interface signals is required.

The module supports up to two SIMs (Subscriber Identity Module) (1.8 V or 3 V). Each SIM holds information for a unique account, allowing users to optimize their use of each account on multiple devices.

The [SIM](#) pins ([Table 3-4 on page 30](#)) provide the connections necessary to interface to SIM sockets located on the host device as shown in [Figure 3-5 on page 31](#). Voltage levels over this interface comply with 3GPP standards.

The types of SIM connectors used depends on how the host device exposes the SIM sockets.

Table 3-4: SIM Interface Signals

| SIM | Name | Pin | Description | SIM contact ^a | Notes |
|-----------|--------------|-----|----------------|--------------------------|--|
| Primary | UIM1_RESET | 30 | Reset | 2 | Active low SIM reset |
| | UIM1_CLK | 32 | Serial clock | 3 | Serial clock for SIM data |
| | UIM1_DATA | 34 | Data I/O | 7 | Bi-directional SIM data line |
| | UIM1_PWR | 36 | SIM voltage | 1 | Power supply for SIM |
| | SIM_DETECT | 66 | SIM indication | - | Input from host indicating whether SIM is present or not <ul style="list-style-type: none"> • Grounded if no SIM is present • No-connect (floating) if SIM is inserted |
| | UIM_GND | | Ground | 5 | Ground reference UIM_GND is common to module ground |
| Secondary | UIM2_RESET | 46 | Reset | 2 | Active low SIM reset |
| | UIM2_CLK | 44 | Serial clock | 3 | Serial clock for SIM data |
| | UIM2_DATA | 42 | Data I/O | 7 | Bi-directional SIM data line |
| | UIM2_PWR | 48 | SIM voltage | 1 | Power supply for SIM |
| | SIM_DETECT_2 | 40 | SIM indication | - | Input from host indicating whether SIM is present or not <ul style="list-style-type: none"> • Grounded if no SIM is present • No-connect (floating) if SIM is inserted |
| | UIM2_GND | | SIM indication | - | Ground reference UIM2_GND is common to module ground |

a. See [Figure 3-6 on page 31](#) for SIM card contacts.

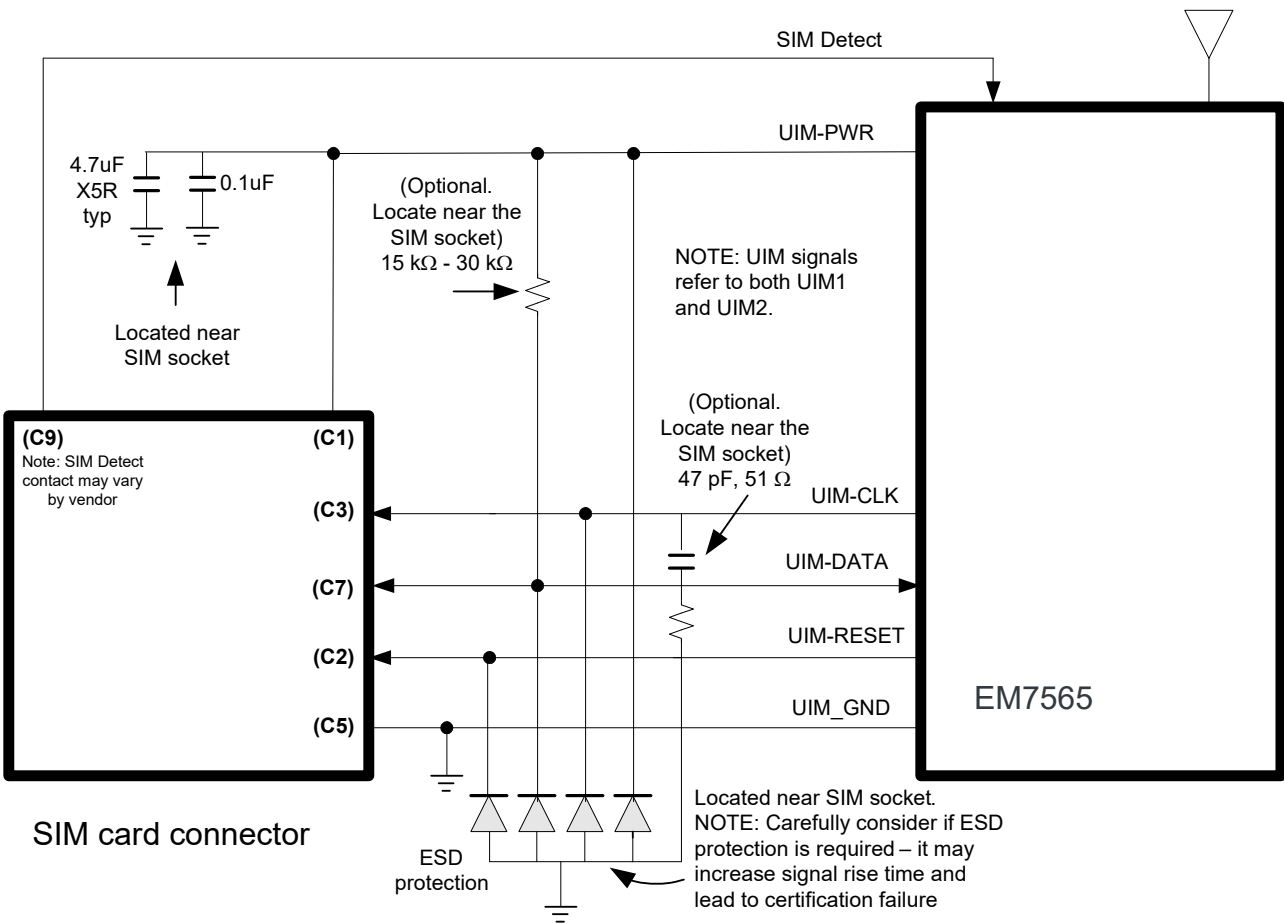


Figure 3-5: SIM Application Interface (applies to both SIM interfaces)

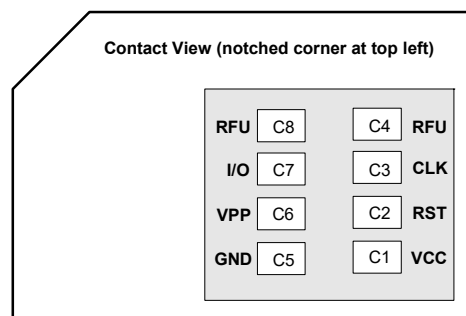


Figure 3-6: SIM Card Contacts (Contact View)

SIM Implementation

Note: For interface design requirements, refer to ETSI TS 102 230 V5.5.0, section 5.2.

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

Some design recommendations include:

- Total impedance of the VCC and GND connections to the SIM, measured at the module connector, should be less than 1 Ω to minimize voltage drop (includes any trace impedance and lumped element components—inductors, filters, etc.).
- Position the SIM connector ≤ 10 cm from the module. If a longer distance is required because of the host device design, use a shielded wire assembly—connect one end as close as possible to the SIM connector and the other end as close as possible to the module connector. The shielded assembly may help shield the SIM interface from system noise.
- Reduce crosstalk on the UIM1_DATA and UIM2_DATA lines to reduce the risk of failures during GCF approval testing.
- Avoid routing the clock and data lines for each SIM (UIM1_CLK/UIM1_DATA, UIM2_CLK/UIM2_DATA) in parallel over distances >2 cm—cross-coupling of a clock and data line pair can cause failures.
- 3GPP has stringent requirements for I/O rise time (<1 μ s), signal level limits, and noise immunity—consider this carefully when developing your PCB layout.
 - Keep signal rise time <1 μ s—keep SIM signals as short as possible, and keep very low capacitance traces on the data and clock signals (UIM1_CLK, UIM1_DATA, UIM2_CLK, UIM2_DATA). High capacitance increases signal rise time, potentially causing your device to fail certification tests.
- Add external pull-up resistors (15 k Ω –30 k Ω), if required, between the data and power lines for each SIM (UIM1_DATA/UIM1_PWR, UIM2_DATA/UIM2_PWR) to optimize the signal rise time.
- VCC line should be decoupled close to the SIM socket.
- SIM is specified to run up to 5 MHz (SIM clock rate). Take note of this speed in the placement and routing of the SIM signals and connectors.
- You must decide whether additional ESD protection is required for your product, as it is dependent on the application, mechanical enclosure, and SIM connector design. The SIM pins will require additional ESD protection if they are exposed to high ESD levels (i.e. can be touched by a user).
- Putting optional decoupling capacitors on the SIM power lines (UIM1_PWR, UIM2_PWR) near the SIM sockets 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) on the clock lines (UIM1_CLK, UIM2_CLK) at the SIM sockets to reduce EMI and increase signal integrity is recommended if the trace length between the SIM socket and module is long—47 pF and 50 Ω resistor are recommended.
- Test your first prototype host hardware with a Comprion IT³ SIM test device at a suitable testing facility.

Control Interface (Signals)

The EM7565 provides signals for:

- Waking the host when specific events occur

- Host control of the module's radios
- Host control of module power
- LED driver output

Note: Host support for Full_Card_Power_Off# is required, and support for other signals in Table 3-5 is optional.

These signals are summarized in Table 3-5 and paragraphs that follow.

Table 3-5: Module Control Signals

| Name | Pin | Description | Type ^a |
|----------------------|-----|----------------------------|-------------------|
| Full_Card_Power_Off# | 6 | On/off signal | PD |
| W_DISABLE# | 8 | Wireless disable (Main RF) | PU |
| WWAN_LED# | 10 | LED driver | OC |
| WAKE_ON_WAN# | 23 | Wake host | O |
| GPS_DISABLE# | 26 | Wireless disable (GNSS) | PU |
| RESET# | 67 | Reset module | PU |

a. O—Digital pin Output; OC—Open Collector output; PD—Digital pin Input, internal pull down; PU—Digital pin Input, internal pull up

WAKE_ON_WAN# — Wake Host

Note: Host support for WAKE_ON_WAN# is optional.

The EM7565 uses WAKE_ON_WAN# to wake the host when specific events occur.

The host must provide a 5 k Ω –100 k Ω pullup resistor that considers total line capacitance (including parasitic capacitance) such that when WAKE_ON_WAN# is deasserted, the line will rise to 3.3 V (Host power rail) in < 100 ns.

See Figure 3-7 on page 33 for a recommended implementation.

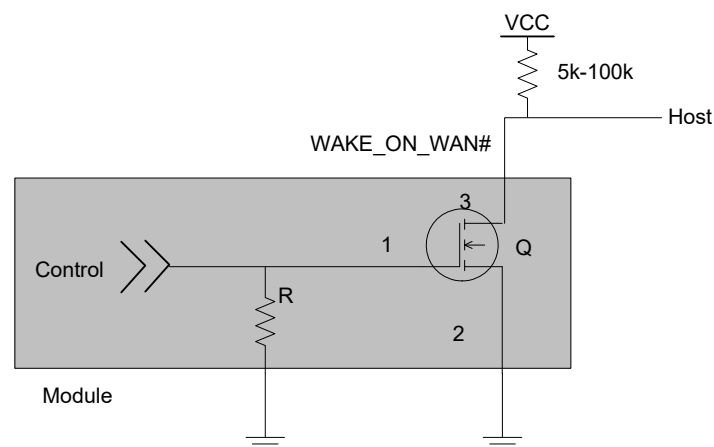


Figure 3-7: Recommended WAKE_ON_WAN# Connection

W_DISABLE# (Wireless Disable) and GPS_DISABLE# (GNSS Disable)

Note: Host support for wireless/GNSS disable signals is optional.

The host device uses W_DISABLE# to enable/disable the WWAN or radio modem, and GPS_DISABLE# to enable/disable GNSS functionality.

Letting these signals float high allows the module to operate normally. These pins have 100 kΩ pull-up resistors. See [Figure 3-8 on page 34](#) for a recommended implementation.

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

- The signal is an input to the module and should be driven LOW to turn the radio off, or HIGH or floating to keep it on.
- If the host never needs to assert this power state control to the module, leave this signal unconnected from the host interface.

Table 3-6: W_DISABLE#/GPS_DISABLE# Usage

| Name | Pin | Description / notes |
|---------------------|-----|---|
| W_DISABLE# | 8 | Enable/disable the WWAN or radio modem ^a . When disabled, the modem cannot transmit or receive. <ul style="list-style-type: none"> • Leave as not connected or drive HIGH to keep the modem always on. • Drive LOW to turn the modem off. |
| GPS_DISABLE# | 26 | Enable/disable GNSS functionality ^a <ul style="list-style-type: none"> • Leave as not connected or drive HIGH to enable GNSS functionality. • Drive LOW to disable GNSS functionality. • For details on enabling / disabling GNSS functionality, see the AT!CUSTOM="GPSENABLE" command in [2] <i>AirPrime EM75xx AT Command Reference</i> (Doc# 4111748). |

a. Sierra Wireless recommends that the host implement an open collector driver where a Low signal turns off the modem or disables GNSS functionality, and a high signal turns on the modem or enables GNSS functionality.

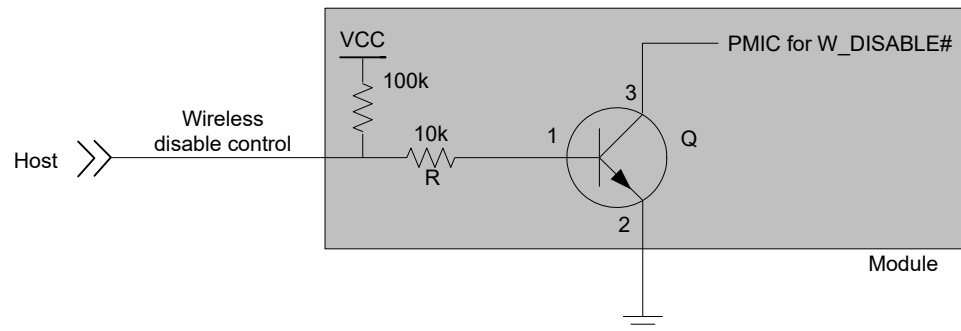


Figure 3-8: Recommended Wireless Disable Connection

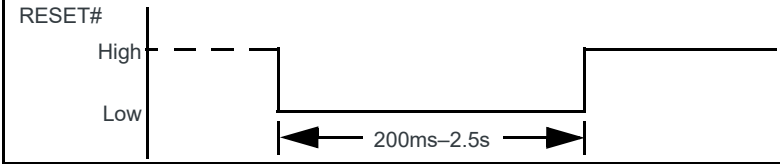
Full_Card_Power_Off# and RESET#

Note: Host support for Full_Card_Power_Off# is required, and support for RESET# is optional.

Full_Card_Power_Off# and RESET# are inputs to the module that the host uses as described in [Table 3-7](#).

For timing details, see [Power On/Off Timing for the USB on page 53](#).

Table 3-7: Full_Card_Power_Off# and RESET# Usage

| Name | Pin | Description/ notes |
|----------------------|-----|---|
| Full_Card_Power_Off# | 6 | <p>Powers the module on/off.</p> <ul style="list-style-type: none"> Signal is required. Pull HIGH to keep the module on. To keep the module always on: <ul style="list-style-type: none"> Tie the pin directly to a host GPIO (1.8V), or Use an external pull-up to pull signal high (10k–20k for 1.8V, 75–100k for VCC rail). Note that a larger-value resistor will reduce leakage current. To power off the module, see Required Shutdown Sequence on page 54. |
| RESET# | 67 | <p>Resets the module.</p> <ul style="list-style-type: none"> Signal is optional. The module will operate correctly if the pin is left disconnected on the host. To reset the module, pulse the RESET# pin with a logic low signal for 200 ms (min) to 2.5 seconds (max)—if the signal is held low for more than 2.5 seconds, the reset cycle restarts, and if it is held low through several cycles, the module will not fully boot. Otherwise, leave the signal floating or high impedance (the module will remain operational because the module has a pull-up resistor to an internal reference voltage (1.8V) in place.).  <p>The diagram shows a signal labeled 'RESET#' with two levels: 'High' and 'Low'. A horizontal line at the 'High' level transitions to a horizontal line at the 'Low' level. A double-headed arrow below the 'Low' pulse indicates its duration is between 200ms and 2.5s. The signal then returns to the 'High' level.</p> <ul style="list-style-type: none"> The signal requires an open collector input from the host. This is a 'hard' reset, which should be used only if the host cannot communicate with the module via the USB port. (If the port is not working, the module may have locked up or crashed.) <p>Caution: RESET# should not be driven or pulled to a logic high level by the host, as this may cause damage to the module.</p> |

WWAN_LED#—LED Output

Note: Host support for WWAN_LED# is optional.

The configuration for the LED shown in Figure 3-9 is customizable. Contact your Sierra Wireless account representative for details.

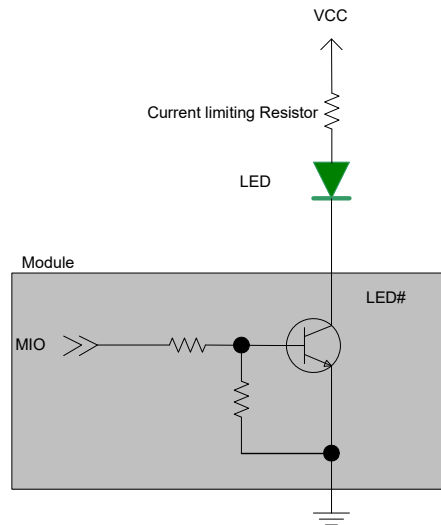


Figure 3-9: Example LED

Antenna Control

Note: Host support for antenna control signals is optional.

The EM7565 provides four output signals (listed in [Table 3-8](#)) that may be used for host designs that incorporate tunable antennas. Customers can configure these signals as appropriate for the operating band(s) using the command AT!ANTSEL. (See [2] *AirPrime EM75xx AT Command Reference (Doc# 41111748)* for details.)

Note: To avoid detuning the PCC band, customers must make sure there are no GPIO state conflicts between the PCC and SCC for all supported CA combinations.

Table 3-8: Antenna Control Signals

| Name | Pin | Description |
|---------|-----|--|
| ANTCTL0 | 59 | Customer-defined external switch controls for tunable antennas |
| ANTCTL1 | 61 | |
| ANTCTL2 | 63 | |
| ANTCTL3 | 65 | |

>> 4: RF Specifications

The EM7565 includes three RF connectors for use with host-supplied antennas:

- Main RF connector—Tx/Rx path
- GNSS RF connector—Dedicated GPS, GLONASS, BeiDou, Galileo, and QZSS
- Auxiliary RF connector—Diversity, MIMO, GPS, GLONASS, BeiDou, Galileo, and QZSS

The module does not have integrated antennas.

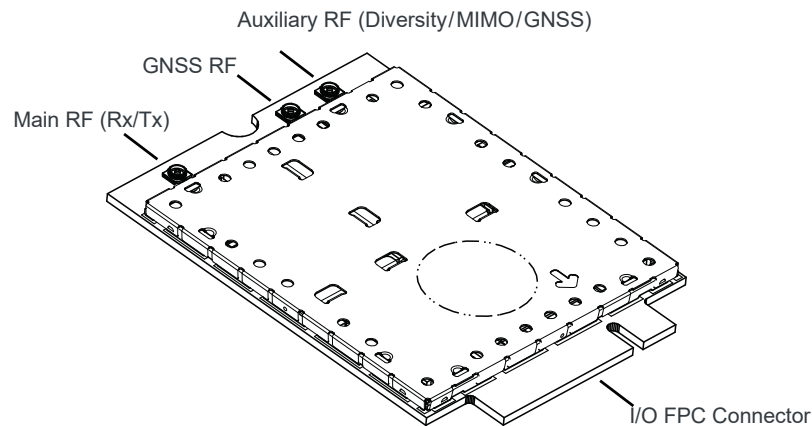


Figure 4-1: Module Connectors

RF Connections

When attaching antennas to the module:

- Use RF plug connectors that are compatible with the following RF receptacle connectors: Foxconn (KK12011-02-7H), Longwell (911-002-0006R), Speedtech (C87P101-00001-H), Murata (MM4829-2702RA4 (HSC)), IPEX (20449-001E (MHF4)).
- Match coaxial connections between the module and the antenna to 50 Ω .
- Minimize RF cable losses to the antenna; the recommended maximum cable loss for antenna cabling is 0.5 dB.
- To ensure best thermal performance, use the mounting hole (if possible) to attach (ground) the device to a metal chassis.

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

Shielding

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

Antenna and Cabling

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

Note: For detailed electrical performance criteria, see [Appendix B: Antenna Specification](#) on page 69.

Choosing the Correct Antenna and Cabling

When matching antennas and cabling:

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

Designing Custom Antennas

Consider the following points when designing custom antennas:

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

Determining the Antenna's Location

When deciding where to put the antennas:

- Antenna location may affect RF performance. Although the module is shielded to prevent interference in most applications, the placement of the antenna is still very important—if the host device is insufficiently shielded, high levels of broadband or spurious noise can degrade the module's performance.
- Connecting cables between the module and the antenna must have 50 Ω impedance. If the impedance of the module is mismatched, RF performance is reduced significantly.
- Antenna cables should be routed, if possible, away from noise sources (switching power supplies, LCD assemblies, etc.). If the cables are near the noise sources, the noise may be coupled into the RF cable and into the antenna. See [Interference from Other Wireless Devices](#) on page 39.

Disabling the Diversity Antenna

Certification testing of a device with an integrated EM7565 may require the module's main and diversity antennas to be tested separately.

To facilitate this testing, receive diversity can be enabled/disabled using AT commands:

- !RXDEN—Used to enable/disable diversity for single-cell call (no carrier aggregation).
- !LTERXCONTROL—Used to enable/disable paths (in carrier aggregation scenarios) after a call is set up.

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

For details, see [2] *AirPrime EM75xx AT Command Reference (Doc# 41111748)*.

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

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 mounting hole shown in [Figure 4-1 on page 37](#).
- Minimize ground noise leakage into the RF.
Depending on the host board design, noise could *potentially* be coupled to the module from the host board. This is mainly an issue for host designs that have signals traveling along the length of the module, or circuitry operating at both ends of the module interconnects.

Interference and Sensitivity

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

RF desense can be addressed through a combination of mitigation techniques ([Methods to Mitigate Decreased Rx Performance on page 40](#)) and radiated sensitivity measurement ([Radiated Sensitivity Measurement on page 41](#)).

Note: The EM7565 is based on ZIF (Zero Intermediate Frequency) technologies. When performing EMC (Electromagnetic Compatibility) tests, there are no IF (Intermediate Frequency) components from the module to consider.

Interference from Other Wireless Devices

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

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

- Any harmonics, sub-harmonics, or cross-products of signals generated by wireless devices that fall in the module's Rx range may cause spurious response, resulting in decreased Rx performance.

- The Tx power and corresponding broadband noise of other wireless devices may overload or increase the noise floor of the module's receiver, resulting in Rx desense.

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

Host-generated RF Interference

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

Proximity of host electronics to the antenna in wireless devices can contribute to decreased Rx performance. Components that are most likely to cause this include:

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

Device-generated RF Interference

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

Methods to Mitigate Decreased Rx Performance

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

- Put the antenna as far as possible from sources of interference. The drawback is that the module may be less convenient to use.
- Shield the host device. The module itself is well shielded to avoid external interference. However, the antenna cannot be shielded for obvious reasons. In most instances, it is necessary to employ shielding on the components of the host device (such as the main processor and parallel bus) that have the highest RF emissions.
- Filter out unwanted high-order harmonic energy by using discrete filtering on low frequency lines.
- Form shielding layers around high-speed clock traces by using multi-layer PCBs.
- Route antenna cables away from noise sources.

Radiated Spurious Emissions (RSE)

When designing an antenna for use with AirPrime embedded modules, the host device with an AirPrime embedded module must satisfy any applicable standards/local regulatory bodies for radiated spurious emission (RSE) for receive-only mode and for transmit mode (transmitter is operating).

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

Radiated Sensitivity Measurement

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

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

Sierra Wireless' Sensitivity Testing and Desensitization Investigation

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

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

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

Sensitivity vs. Frequency

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

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

Supported Frequencies

The EM7565 supports:

- Multiple-band LTE—See [Table 4-1 on page 42](#) (supported bands) and [Table 4-2 on page 42](#) (LTE bandwidth support).
- LTE Advanced carrier aggregation—See [Table 1-1 on page 12](#), [Table 1-2 on page 13](#) and [Table 1-3 on page 14](#) for details.
- Multiple-band WCDMA/HSPA/HSPA+/DC-HSPA+—See [Table 4-3 on page 43](#).
- Multiple-band WCDMA receive diversity
- GPS, GLONASS, BeiDou, Galileo, QZSS—See [Table 4-7 on page 47](#).
- Inter-RAT and inter-frequency cell reselection and handover between supported frequency bands

Table 4-1: LTE Frequency Bands

| Band | Frequency (Tx) | Frequency (Rx) |
|------------------|---|---------------------|
| B1 | 1920–1980 MHz | 2110–2170 MHz |
| B2 | 1850–1910 MHz | 1930–1990 MHz |
| B3 | 1710–1785 | 1805–1880 MHz |
| B4 | 1710–1755 | 2110–2155 MHz |
| B5 | 824–849 MHz | 869–894 MHz |
| B7 | 2500–2570 MHz | 2620–2690 MHz |
| B8 | 880–915 MHz | 925–960 MHz |
| B9 | 1749.9–1784.9 MHz | 1844.9–1879.9 MHz |
| B12 | 699–716 MHz | 729–746 MHz |
| B13 | 777–787 MHz | 746–756 MHz |
| B18 | 815–830 MHz | 860–875 MHz |
| B19 | 830–845 MHz | 875–890 MHz |
| B20 | 832–862 MHz | 791–821 MHz |
| B26 | 814–849 MHz | 859–894 MHz |
| B28 | 703–748 MHz | 758–803 MHz |
| B29 | n/a | 717–728 MHz |
| B30 | 2305–2315 MHz <i>Note: B30 Tx is disabled.</i> | 2350–2360 MHz |
| B32 | n/a | 1452–1496 MHz |
| B41 | 2496–2690 MHz (TDD) | |
| B42 ^a | 3400–3600 MHz (TDD) | |
| B43 ^a | 3600–3800 MHz (TDD) | |
| B46 | n/a | 5150–5925 MHz (TDD) |
| B48 ^a | 3550–3700 MHz (TDD) | |
| B66 | 1710–1780 MHz | 2110–2200 MHz |

a. B42/B43/B48 disabled as of publication date, support pending regulatory approval

Table 4-2: LTE Bandwidth Support^a

| Band | 1.4 MHz | 3 MHz | 5 MHz | 10 MHz | 15 MHz | 20 MHz |
|------|---------|-------|-------|--------|----------------|----------------|
| B1 | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ |
| B2 | ✓ | ✓ | ✓ | ✓ | ✓ ^b | ✓ ^b |

Table 4-2: LTE Bandwidth Support^a (Continued)

| Band | 1.4 MHz | 3 MHz | 5 MHz | 10 MHz | 15 MHz | 20 MHz |
|------------------|---------|-------|----------------|----------------|----------------|------------------|
| B3 | ✓ | ✓ | ✓ | ✓ | ✓ ^b | ✓ ^b |
| B4 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| B5 | ✓ | ✓ | ✓ | ✓ ^b | ✗ | ✗ |
| B7 | ✗ | ✗ | ✓ | ✓ | ✓ ^c | ✓ ^{b,c} |
| B8 | ✓ | ✓ | ✓ | ✓ ^b | ✗ | ✗ |
| B9 | ✗ | ✗ | ✓ | ✓ | ✓ ^b | ✓ ^b |
| B12 | ✓ | ✓ | ✓ ^b | ✓ ^b | ✗ | ✗ |
| B13 | ✗ | ✗ | ✓ ^b | ✓ ^b | ✗ | ✗ |
| B18 | ✗ | ✗ | ✓ | ✓ ^b | ✓ ^b | ✗ |
| B19 | ✗ | ✗ | ✓ | ✓ ^b | ✓ ^b | ✗ |
| B20 | ✗ | ✗ | ✓ | ✓ ^b | ✓ ^b | ✓ ^b |
| B26 | ✓ | ✓ | ✓ | ✓ ^b | ✓ ^b | ✗ |
| B28 | ✗ | ✓ | ✓ | ✓ ^b | ✓ ^b | ✓ ^{b,c} |
| B30 | ✗ | ✗ | ✓ | ✓ ^b | ✗ | ✗ |
| B32 | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ |
| B41 | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ |
| B42 ^d | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ |
| B43 ^d | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ |
| B46 | ✗ | ✗ | ✗ | ✓ | ✗ | ✓ |
| B48 ^d | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ |
| B66 | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ |

- a. Table contents are derived from 3GPP TS 36.521-1 v12.6.0, table 5.4.2.1-1.
b. Bandwidth for which a relaxation of the specified UE receiver sensitivity requirement (Clause 7.3 of 3GPP TS 36.521-1 v12.6.0) is allowed.
c. Bandwidth for which uplink transmission bandwidth can be restricted by the network for some channel assignments in FDD/TDD co-existence scenarios in order to meet unwanted emissions requirements (Clause 6.6.3.2 of 3GPP TS 36.521-1 v12.6.0).
d. B42/B43/B48 disabled as of publication date, support pending regulatory approval

Table 4-3: WCDMA Frequency Bands Support

| Band | Frequency (Tx) | Frequency (Rx) |
|--------|----------------|----------------|
| Band 1 | 1920–1980 MHz | 2110–2170 MHz |
| Band 2 | 1850–1910 MHz | 1930–1990 MHz |
| Band 4 | 1710–1755 MHz | 2110–2155 MHz |
| Band 5 | 824–849 MHz | 869–894 MHz |

Table 4-3: WCDMA Frequency Bands Support (Continued)

| Band | Frequency (Tx) | Frequency (Rx) |
|-------------|-----------------------|-----------------------|
| Band 6 | 830–840 MHz | 875–885 MHz |
| Band 8 | 880–915 MHz | 925–960 MHz |
| Band 9 | 1749.9–1784.9 MHz | 1844.9–1879.9 MHz |
| Band 19 | 830–845 MHz | 875–890 MHz |

Conducted Rx Sensitivity / Tx Power

Note: Values in the following tables are preliminary, pending transceiver matching/testing.

Table 4-4: Conducted Rx (Receive) Sensitivity — LTE Bands

| LTE bands | | Conducted Rx sensitivity (dBm) | | | |
|------------------|---|--------------------------------|-----------------|------------|--------------------------------|
| | | Primary (Typ) | Secondary (Typ) | SIMO (Typ) | SIMO ^a (Worst case) |
| B1 | Full RB on downlink; BW: 10 MHz ^b | -97.5 | -97.5 | -100.0 | -96.3 |
| B2 | | -98.0 | -97.5 | -100.5 | -94.3 |
| B3 | | -97.0 | -98.0 | -100.5 | -93.3 |
| B4 | | -97.0 | -98.0 | -100.0 | -96.3 |
| B5 | | -99.0 | -100.5 | -102.5 | -94.3 |
| B7 | | -97.0 | -99.0 | -101.0 | -94.3 |
| B8 | | -98.5 | -100.5 | -102.5 | -93.3 |
| B9 | | -97.0 | -98.5 | -100.5 | -95.3 |
| B12 | | -98.0 | -101.0 | -102.5 | -93.3 |
| B13 | | -98.0 | -101.0 | -103.0 | -93.3 |
| B18 | | -99.0 | -101.0 | -103.0 | -96.3 |
| B19 | | -98.5 | -100.5 | -102.5 | -96.3 |
| B20 | | -98.5 | -101.0 | -103.5 | -93.3 |
| B26 | | -99.0 | -100.5 | -102.5 | -93.8 |
| B28 | | -98.5 | -100.5 | -102.5 | -94.8 |
| B29 | | -97.0 | -101.0 | -102.5 | -93.3 |
| B30 | | -97.0 | -99.0 | -101.0 | -95.3 |
| B32 | | -99.5 | -98.0 | -101.5 | -96.3 |
| B41 | | -96.5 | -98.0 | -100.5 | -94.3 |
| B42 ^c | | -97.0 | -98.5 | -101.0 | -95.0 |
| B43 ^c | -97.0 | -97.5 | -101.0 | -95.0 | |
| B48 ^c | -97.0 | -98.0 | -101.0 | -95.3 | |
| B66 | -97.0 | -98.0 | -100.0 | -95.8 | |
| B46 | Full RB on downlink; BW: 20 MHz | -96.5 | -97.0 | -99.0 | -88.5 |

a. Per 3GPP specification

b. Sensitivity values scale with bandwidth:

$$x_MHz_Sensitivity = 10_MHz_Sensitivity - 10 \cdot \log(10 \text{ MHz}/x_MHz)$$

Note: Bandwidth support is dependent on firmware version.

c. B42/B43/B48 disabled as of publication date, support pending regulatory approval

Table 4-5: Conducted Rx (Receive) Sensitivity — UMTS Bands

| UMTS bands | | Conducted Rx sensitivity (dBm) | | |
|------------|-----------------------|--------------------------------|---------------------|---|
| | | Primary (Typical) | Secondary (Typical) | Primary/Secondary (Worst case) ^a |
| Band 1 | 0.1% BER 12.2 kbps | -110.6 | -110.5 | -106.7 |
| Band 2 | | -111.2 | -110.4 | -104.7 |
| Band 4 | | -110.1 | -110.6 | -106.7 |
| Band 5 | | -111.4 | -113.5 | -104.7 |
| Band 6 | | -111.2 | -113.5 | -106.7 |
| Band 8 | | -111.4 | -113.4 | -103.7 |
| Band 9 | | -110.1 | -111.3 | -105.7 |
| Band 19 | | -111.1 | -113.4 | -106.7 |

a. Per 3GPP specification

Table 4-6: Conducted Tx (Transmit) Power Tolerances

| Bands | Conducted Tx power | Notes |
|--|--------------------|-------------------------|
| LTE | | |
| LTE bands 1,2,3,4,5,8,9,12,13,18,19,20,26,28,66 | +23 dBm ± 1 dB | |
| LTE bands 7,41,42 ^a ,43 ^a , 48 ^a | +22 dBm ± 1 dB | |
| UMTS | | |
| Band 1 (IMT 2100 12.2 kbps) Band 2 (UMTS 1900 12.2 kbps) Band 4 (AWS 1700/2100 12.2 kbps) Band 5 (UMTS 850 12.2 kbps) Band 6 (UMTS 800 12.2 kbps) Band 8 (UMTS 900 12.2 kbps) Band 9 (UMTS 1700 12.2 kbps) Band 19 (UMTS 800 12.2 kbps) | +23 dBm ± 1 dB | Connectorized (Class 3) |

a. B42/B43/B48 disabled as of publication date, support pending regulatory approval

GNSS Specifications

Note: For detailed electrical performance criteria, see [Recommended GNSS Antenna Specifications on page 71](#).

Table 4-7: GNSS Specifications

| Parameter/feature | Description |
|-------------------------------|---|
| Satellite channels | Maximum 30 channels (16 GPS, 14 GLONASS), simultaneous tracking |
| Protocols | NMEA 0183 V3.0 |
| Acquisition time ^a | Hot start: 1 s Warm start: 29 s Cold start: 32 s |
| Accuracy | Horizontal: < 2 m (50%); < 5 m (90%) Altitude: < 4 m (50%); < 8 m (90%) Velocity: < 0.2 m/s |
| Sensitivity | Tracking ^b : -160 dBm Acquisition ^c (Assisted): -158 dBm Acquisition (Standalone): -145 dBm |
| Operational limits | Altitude <6000 m or velocity <100 m/s (Either limit may be exceeded, but not both.) |

- a. Acquisition times measured with signal strength = -135 dBm
- b. Tracking sensitivity is the lowest GNSS signal level for which the device can still detect an in-view satellite 50% of the time when in sequential tracking mode.
- c. Acquisition sensitivity is the lowest GNSS signal level for which the device can still detect an in-view satellite 50% of the time.

The module includes an internal GNSS LNA, as shown in [Figure 3-3 on page 22](#).

>> 5: Power

Power Consumption

Power consumption measurements in the tables below are for the EM7565 connected to the host PC via USB.

The module does not have its own power source and depends on the host device for power. For a description of input voltage requirements, see [Power Supply on page 28](#).

Table 5-1: Averaged Standby DC Power Consumption^a

| Signal | Description | Bands ^b | Current | | | Notes / configuration | |
|--------|---|--------------------|---------|------------------|------|------------------------|--|
| | | | Typ | Max ^c | Unit | | |
| VCC | Standby current consumption (Sleep mode activated^d) | | | | | | |
| | LTE | LTE bands | 2.8 | 3.3 | mA | DRX cycle = 8 (2.56 s) | |
| | HSPA / WCDMA | UMTS bands | 2.8 | 3.3 | mA | DRX cycle = 8 (2.56 s) | |
| | Standby current consumption^e (Sleep mode deactivated^d) | | | | | | |
| | LTE | LTE bands | 37 | 42 | mA | DRX cycle = 8 (2.56 s) | |
| | HSPA / WCDMA | UMTS bands | 37 | 42 | mA | DRX cycle = 8 (2.56 s) | |
| | Low Power Mode (LPM)/Offline Mode^e (Sleep mode activated^d) | | | | | | |
| | RF disabled, but module is operational | | | 2.1 | 2.6 | mA | |
| | Low Power Mode (LPM)/Offline Mode^e (Sleep mode deactivated^d) | | | | | | |
| | RF disabled, but module is operational | | | 37 | 40 | mA | |
| | Leakage current | | | | | | |
| | Module powered off— Full_Card_Power_Off# is Low, and VCC is supplied | | | 70 | 120 | μA | |

- Preliminary, subject to change.
- For supported bands, see [Table 4-1, LTE Frequency Bands](#), on page 42 and [Table 4-3, WCDMA Frequency Bands Support](#), on page 43.
- Measured at 25°C/nominal 3.3 V voltage.
- Assumes USB bus is fully suspended during measurements
- LPM and standby power consumption will increase when LEDs are enabled. To reduce power consumption, configure LEDs to remain off while in standby and LPM modes.

Table 5-2: Averaged Call Mode DC Power Consumption

| Description | Tx power | Current ^a | | Notes |
|-------------------------------------|----------|----------------------|------|-------------------------------|
| | | Typ | Unit | |
| LTE | 0 dBm | 510 | mA | 3 CA, 20 MHz+20 MHz+20 MHz BW |
| | | 420 | mA | 3 CA, 10 MHz+10 MHz+10 MHz BW |
| | | 382 | mA | 2 CA, 20 MHz+20 MHz BW |
| | | 310 | mA | 2 CA, 10 MHz+10 MHz BW |
| | | 300 | mA | Single Carrier, 20 MHz BW |
| | | 250 | mA | Single Carrier, 10 MHz BW |
| | 20 dBm | 820 | mA | 3 CA, 20 MHz+20 MHz+20 MHz BW |
| | | 710 | mA | 3 CA, 10 MHz+10 MHz+10 MHz BW |
| | | 690 | mA | 2 CA, 20 MHz+20 MHz BW |
| | | 590 | mA | 2 CA, 10 MHz+10 MHz BW |
| | | 610 | mA | Single Carrier, 20 MHz BW |
| | | 530 | mA | Single Carrier, 10 MHz BW |
| | 23 dBm | 1030 | mA | 3 CA, 20 MHz+20 MHz+20 MHz BW |
| | | 900 | mA | 3 CA, 10 MHz+10 MHz+10 MHz BW |
| | | 880 | mA | 2 CA, 20 MHz+20 MHz BW |
| | | 750 | mA | 2 CA, 10 MHz+10 MHz BW |
| | | 780 | mA | Single Carrier, 20 MHz BW |
| | | 690 | mA | Single Carrier, 10 MHz BW |
| DC-HSPA/HSPA | 0 dBm | 220 | mA | All speeds |
| | 20 dBm | 460 | mA | All speeds |
| | 23 dBm | 540 | mA | Worst case |
| Peak current (averaged over 100 μs) | | 1.3 | A | All LTE/WCDMA bands |

a. Measured at 25°C/nominal 3.3 V voltage

Table 5-3: Miscellaneous DC Power Consumption

| Signal | Description | Current / Voltage | | | Unit | Notes / configuration |
|-----------------------|--------------------------|-------------------|------|------|------|---|
| | | Min | Typ | Max | | |
| VCC | USB active current | — | 15 | 20 | mA | High speed USB connection, C _L = 50 pF on D+ and D- signals |
| | Inrush current | — | 2.2 | 2.5 | A | <ul style="list-style-type: none"> Assumes power supply turn on time > 100µs Dependent on host power supply rise time. |
| | Maximum current | — | — | 1.5 | A | <ul style="list-style-type: none"> Across all bands, all temperature ranges 3.3 V supply |
| GNSS Signal connector | Active bias on GNSS port | — | — | 100 | mA | Voltage applied to the GNSS antenna to power electronics inside the antenna (GNSS RF connector in Figure 4-1 on page 37). |
| | | 3.05 | 3.15 | 3.25 | V | |

Warning: The maximum RF power level allowable on any RF port is +10dBm—damage may occur if this level is exceeded.

Module Power States

The module has five power states, as described in [Table 5-4](#).

Table 5-4: Module Power States

| State | Details | Host is powered | USB interface active | RF enabled |
|-------------------------------|--|-----------------|----------------------|------------|
| Normal (Default state) | <ul style="list-style-type: none"> Module is active Default state. Occurs when VCC is first applied, Full_Card_Power_Off# is deasserted (pulled high), and W_DISABLE# is deasserted Module is capable of placing/receiving calls, or establishing data connections on the wireless network Current consumption is affected by several factors, including: <ul style="list-style-type: none"> Radio band being used Transmit power Receive gain settings Data rate | ✓ | ✓ | ✓ |

Table 5-4: Module Power States (Continued)

| State | Details | Host is powered | USB interface active | RF enabled |
|-----------------------------|--|-----------------|----------------------|------------|
| Low power ('Airplane mode') | <ul style="list-style-type: none"> Module is active Module enters this state: <ul style="list-style-type: none"> Under host interface control: <ul style="list-style-type: none"> Host issues AT+CFUN=0 ([1] AT Command Set for User Equipment (UE) (Release 6) (Doc# 3GPP TS 27.007)), or Host asserts W_DISABLE#, after AT!PCOFFEN=0 has been issued. Automatically, when critical temperature or voltage trigger limits have been reached)) | ✓ | ✓ | ✗ |
| Sleep | <ul style="list-style-type: none"> Normal state of module between calls or data connections Module cycles between wake (polling the network) and sleep, at network provider-determined interval. | ✓ | ✗ | ✗ |
| Off | <ul style="list-style-type: none"> Host keeps module powered off by asserting Full_Card_Power_Off# (signal pulled low or left floating) Module draws minimal current See Full_Card_Power_Off# and RESET# on page 35 for more information. | ✓ | ✗ | ✗ |
| Disconnected | <ul style="list-style-type: none"> Host power source is disconnected from the module and all voltages associated with the module are at 0 V. | ✗ | ✗ | ✗ |

Power State Transitions

The module uses state machines to monitor supply voltage and operating temperature, and notifies the host when critical threshold limits are exceeded. (See [Table 5-5](#) for trigger details and [Figure 5-1](#) for state machine behavior.)

Power state transitions may occur:

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

Table 5-5: Power State Transition Trigger Levels

| Transition | Voltage | | Temperature ^a | | Notes |
|---------------------|--------------|-------|--------------------------|-----|---|
| | Trigger | V | Trigger | °C | |
| Normal to Low Power | VOLT_HI_CRIT | 4.4 | TEMP_LO_CRIT | -45 | <ul style="list-style-type: none"> RF activity suspended |
| | VOLT_LO_CRIT | 3.135 | TEMP_HI_CRIT | 105 | |

Table 5-5: Power State Transition Trigger Levels (Continued)

| Transition | Voltage | | Temperature ^a | | Notes |
|--|--------------|-----|--------------------------|-----|--|
| | Trigger | V | Trigger | °C | |
| Low Power to Normal | VOLT_HI_NORM | 4.3 | TEMP_NORM_LO | -30 | |
| Low Power to Normal or Remain in Normal (Remove warnings) | VOLT_LO_NORM | 3.3 | TEMP_HI_NORM | 70 | <ul style="list-style-type: none"> RF activity resumed |
| Normal (Issue warning) | VOLT_LO_WARN | 3.2 | TEMP_HI_WARN | 85 | <ul style="list-style-type: none"> In the TEMP_HI_WARN state, the module may have reduced performance (Class B temperature range). |
| Power off/on (Host-initiated) | - | - | - | - | <ul style="list-style-type: none"> Power off recommended when supply voltage or module operating temperature is critically low or high. |

a. Module-reported temperatures at the printed circuit board.

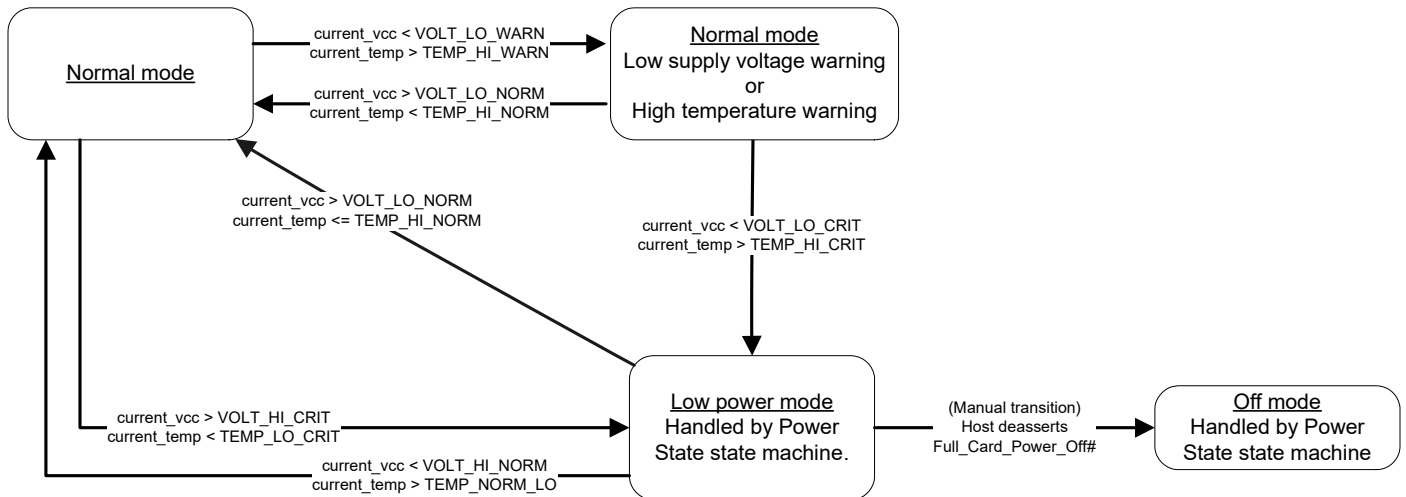


Figure 5-1: Voltage/Temperature Monitoring State Machines

Power Interface

Power Ramp-up

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

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

Timing

Power On/Off Timing for the USB

Figure 5-2 describes the timing sequence for powering the module on and off.

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

Note: The host should not drive any signals to the module until > 100 ms from the start of the power-on sequence.

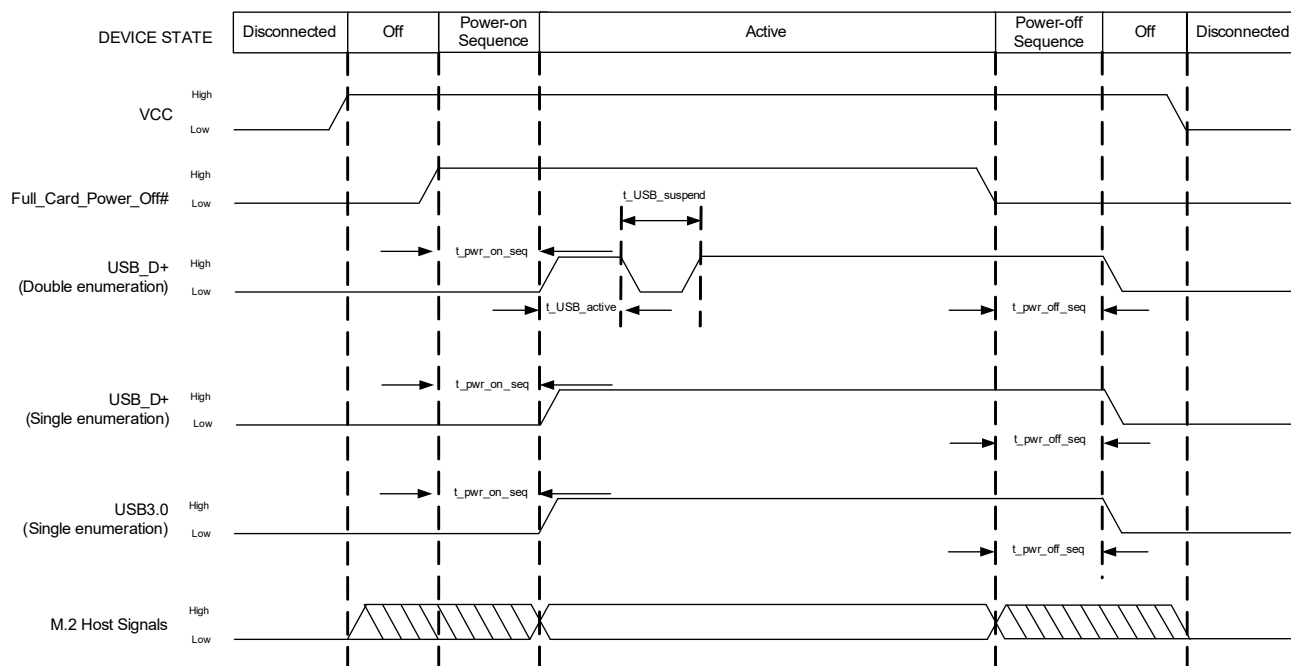


Figure 5-2: Signal Timing (Full_Card_Power_Off#, and USB Enumeration)

Table 5-6: USB 2.0 Power-On/Off Timing Parameters (Double Enumeration)

| Parameter | Typical (s) | Maximum (s) |
|----------------------|-------------|-------------|
| t_pwr_on_seq | 0.8 | 0.9 |
| t_USB_active | 0.12 | 0.2 |
| t_USB_suspend | 8.5 | 11 |
| t_pwr_off_seq | 21.4 | 25 |

Table 5-7: USB 2.0 Power-On/Off Timing Parameters (Single Enumeration)

| Parameter | Typical (s) | Maximum (s) |
|---------------|-------------|-------------|
| t_pwr_on_seq | 8.7 | 11 |
| t_pwr_off_seq | 21.4 | 25 |

Table 5-8: USB 3.0 Power-On/Off Timing Parameters (Single Enumeration)

| Parameter | Typical (s) | Maximum (s) |
|---------------|-------------|-------------|
| t_pwr_on_seq | 8.6 | 11 |
| t_pwr_off_seq | 21.5 | 25 |

USB Enumeration

The unit supports single and double USB enumeration with the host:

- Single enumeration:
 - Enumeration starts within maximum t_pwr_on_seq seconds of power-on.
- Double enumeration—As shown in [Figure 5-2](#):
 - First enumeration starts within t_pwr_on_seq seconds of power-on (while USB_D+ is high)
 - Second enumeration starts after t_USB_suspend (when USB_D+ goes high again)

Reset Timing

To reset the module, hold the RESET# signal low for at least 3 seconds.

Required Shutdown Sequence

Warning: To avoid causing issues with the file system, follow this shutdown sequence.

1. Drive Full_Card_Power_Off# low.
2. Wait for at least t_pwr_off_seq seconds.
3. Remove power.

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 100 mVp-p 1 Hz to 100 kHz. This limit includes voltage ripple due to transmitter burst activity.

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

SED (Smart Error Detection)

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

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

Tx Power Control

The module's Tx power limit may be controlled using either SAR backoff AT commands, defined in [2] *AirPrime EM75xx AT Command Reference (Doc# 41111748)*, or the DPR (Dynamic power control) signal. Use the GPIOARENABLE parameter for !CUSTOM to choose the method:

- AT commands:
 - !SARSTATEDFLT—Set (or report) the default SAR backoff state that the device uses when it powers up. This setting is persistent across power cycles and overrides any PRI setting.
 - !SARSTATE—Set (or report) the current SAR backoff state (override the default state). This change in state is non-persistent across power cycles.
 - !SARBACKOFF—Set (or report) the maximum Tx power limit for a specific band/technology/state combination.
- Dynamic power control—The module's firmware monitors DPR (pin 25) and adjusts the RF Tx power appropriately, as detailed in [Table 5-9](#). (This state change is equivalent to issuing the !SARSTATE AT command.)

Note: A customization is available to invert the DPR logic. (e.g. make DPR low = No SAR backoff)

Table 5-9: Dynamic Power Control of SAR Backoff State

| DPR | SAR backoff state |
|-------------------|-------------------|
| High ^a | No SAR backof |
| Low | Backoff 1 |

a. DPR is pulled high by default.

Note: The host can implement an open collector drive for the DPR pin (if a 1.8 V-compatible drive is not available).

>> 6: Software Interface

Support Tools

The EM7565 is compatible with the following support tools from Sierra Wireless and authorized third parties:

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

Host Interface

The device supports the following protocols for modem communication:

- MBIM (Mobile Broadband Interface Model)
- Qualcomm QMI interface. (Please contact your Sierra Wireless account representative for QMI interface documentation.)

>> 7: Mechanical and Environmental Specifications

The EM7565 module complies with the mechanical and environmental specifications in [Table 7-1](#). Final product conformance to these specifications depends on the [OEM](#) device implementation.

Table 7-1: Mechanical and Environmental Specifications

| | Mode | Details |
|---|---------------------|--|
| Ambient temperature | Operational Class A | -30°C to +70°C – 3GPP compliant |
| | Operational Class B | -40°C to +85°C, with appropriate heatsinking – non-3GPP compliant (reduced operating parameters required) |
| | Non-operational | -40°C to +85°C, 96 hours (from MIL-STD 202 Method 108) |
| Relative humidity | Non-operational | 85°C, 85% relative humidity for 48 hours (non-condensing) |
| Vibration | Non-operational | Random vibration, 10 to 2000 Hz, 0.1 g ² /Hz to 0.0005 g ² /Hz, in each of three mutually perpendicular axes. Test duration of 60 minutes for each axis, for a total test time of three hours. |
| Shock | Non-operational | Half sine shock, 11 ms, 30 g, 8x each axis Half sine shock, 6 ms, 100 g, 3x each axis |
| Drop | Non-operational | 1 m on concrete on each of six faces, two times (module only) |
| (Electrostatic discharge (See Electrostatic Discharge (ESD) on page 59 .) | Operational | The RF port (antenna launch and RF connector) complies with the IEC 61000-4-2 standard: <ul style="list-style-type: none"> Electrostatic Discharge Immunity: Test: Level3 Air Discharge: ±8 kV |
| | Non-operational | The host connector interface complies with the following standard only: <ul style="list-style-type: none"> minimum ±500 V Human Body Model (JESD22-A114-B) |
| Thermal considerations | | See Thermal Considerations on page 60 . |
| Form factor | | M.2 Form Factor |
| Dimensions | | Length: 42±0.15 mm (max) Width: 30±0.15 mm (max) Thickness: Above PCB—1.50 mm (max) PCB—0.88 mm (max) Weight: 6.5 g |

Device Views

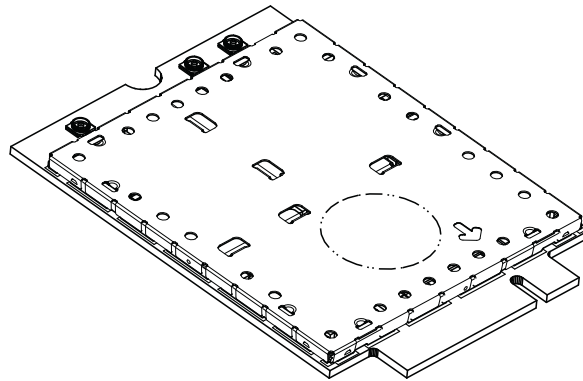


Figure 7-1: Top View

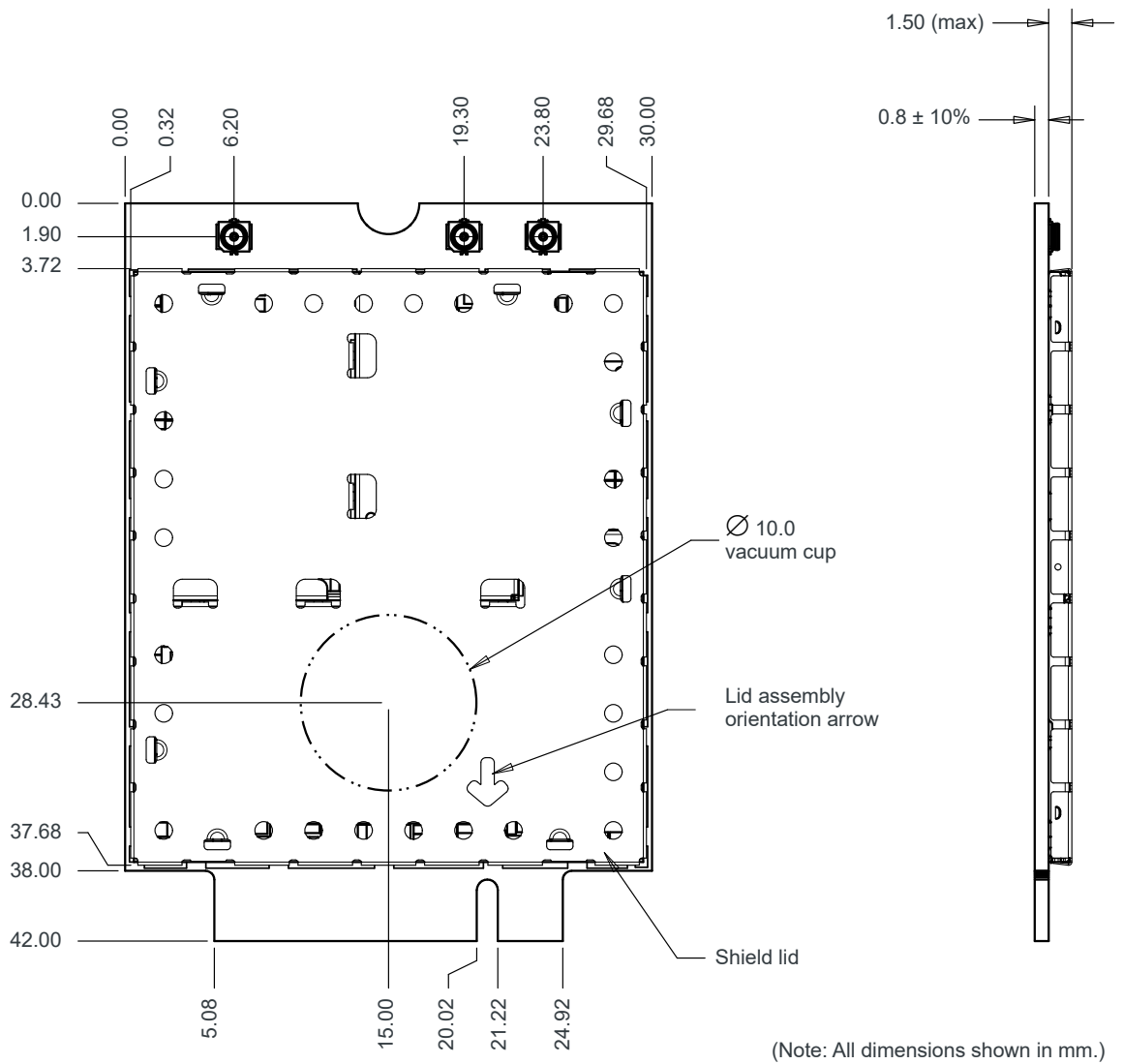


Figure 7-2: Dimensioned View

Product Marking (Labeling)



Figure 7-3: Unit Product Marking Example—Laser-etched, Typical Representation (Not to scale. Contents will vary by SKU.)

The EM7565 product marking is laser-etched and may contain:

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

Note: The EM7565 supports [OEM](#) partner-specific label requirements.

Electrostatic Discharge (ESD)

The OEM is responsible for ensuring that the EM7565 host interface pins are not exposed to ESD during handling or normal operation. (See [Table 7-1 on page 57](#) for specifications.)

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

Thermal Considerations

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

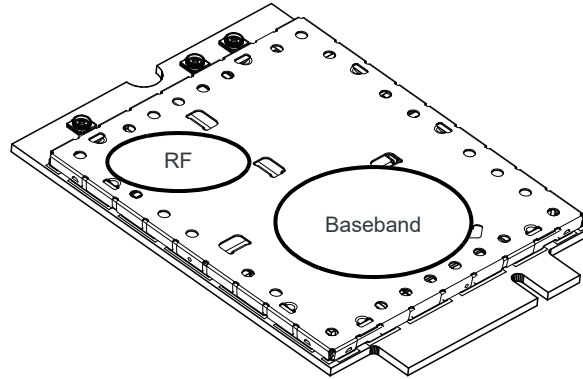


Figure 7-4: Shield Locations (Top View)

The amount of thermal dissipation required depends on:

- Supply voltage—Maximum power dissipation for the module can be up to 3.5 W at voltage supply limits.
- Usage—Typical power dissipation values depend on the location within the host, amount of data transferred, etc.

Specific areas requiring heat dissipation are shown in [Figure 7-5](#):

- RF—Bottom face of module near RF connectors. Likely to be the hottest area.
- Baseband—Bottom face of module, below the baseband area.

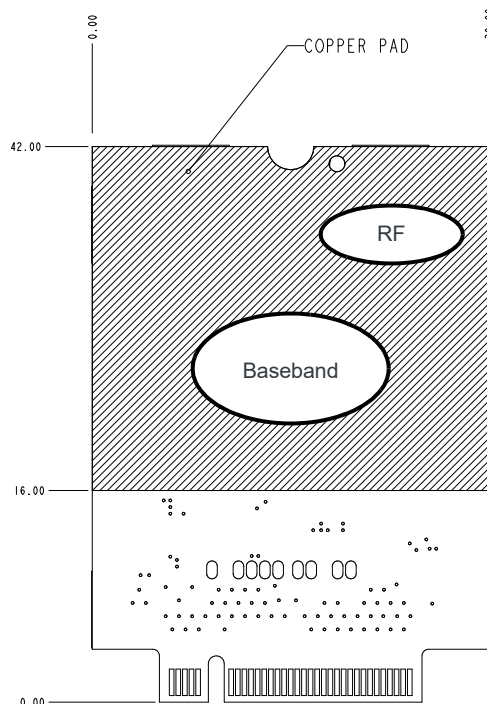


Figure 7-5: Copper Pad Location on Bottom Side of Module

To enhance heat dissipation:

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

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

Module Integration Testing

When testing your integration design:

- Test to your worst case operating environment conditions (temperature and voltage)
- Test using worst case operation (transmitter on 100% duty cycle, maximum power)
- Monitor temperature at all shield locations. Attach thermocouples to the areas indicated in [Figure 7-4 on page 60](#) (RF, Baseband).

Note: Make sure that your system design provides sufficient cooling for the module.

(For acceptance, certification, quality, and production (including RF) test suggestions, see [Testing on page 75](#).)

>> 8: Regulatory Compliance and Industry Certifications

This module is designed to meet, and upon commercial release, will meet the requirements of the following regulatory bodies and regulations, where applicable:

- Federal Communications Commission (FCC) of the United States
- The Certification and Engineering Bureau of Industry Canada (IC)
- The National Communications Commission (NCC) of Taiwan, Republic of China
- Ministry of Internal Affairs and Communications (MIC) of Japan
- Radio Equipment Directive (RED) of the European Union

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

- GCF
- PTCRB

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

Additional testing and certification may be required for the end product with an embedded EM7565 module and are the responsibility of the [OEM](#). Sierra Wireless offers professional services-based assistance to OEMs with the testing and certification process, if required.

Important Notice

Because of the nature of wireless communications, transmission and reception of data can never be guaranteed. Data may be delayed, corrupted (i.e., have errors) or be totally lost. Although significant delays or losses of data are rare when wireless devices such as the Sierra Wireless module are used in a normal manner with a well-constructed network, the Sierra Wireless module 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 module, or for failure of the Sierra Wireless module to transmit or receive such data.

Safety and Hazards

Do not operate your EM7565 module:

- 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 EM7565 module **MUST BE POWERED OFF**. Otherwise, the EM7565 module can transmit signals that could interfere with this equipment.

In an aircraft, the EM7565 module **MUST BE POWERED OFF**. Otherwise, the EM7565 module 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 EM7565 module may be used normally at this time.

Important Compliance Information for the United States and Canada

The EM7565 module, upon commercial release, will have been granted modular approval for mobile applications. Integrators may use the EM7565 module 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 limits stipulated in [Table 8-1 on page 64](#).
3. The EM7565 module may transmit simultaneously with other collocated radio transmitters within a host device, provided the following conditions are met:
 - Each collocated radio transmitter has been certified by FCC/IC for mobile application.
 - At least 20 cm separation distance between the antennas of the collocated transmitters and the user's body must be maintained at all times.
 - The radiated power of a collocated transmitter must not exceed the EIRP limit stipulated in [Table 8-1 on page 64](#).

Table 8-1: Antenna Gain and Collocated Radio Transmitter Specifications

| | Operating mode | Tx Freq Range (MHz) | | Max Time-Avg Cond Power (dBm) | Antenna Gain Limit (dBi) | | EIRP Limits (dBm) |
|-------------------------|----------------------|---------------------|-------|-------------------------------|--------------------------|------------|-------------------|
| | | | | | Standalone | Collocated | |
| EM7565 Embedded Module | WCDMA Band 2/ LTE B2 | 1850 | 1910 | 24 | 6 | 4 | 30 |
| | WCDMA Band 4/ LTE B4 | 1710 | 1755 | 24 | 6 | 4 | 30 |
| | WCDMA Band 5/ LTE B5 | 824 | 849 | 24 | 6 | 4 | 30 |
| | LTE B7 | 2500 | 2570 | 23.8 | 9 | 4 | 32.8 |
| | LTE B12 | 699 | 716 | 24 | 6 | 4 | 30 |
| | LTE B13 | 777 | 787 | 24 | 6 | 4 | 30 |
| | LTE B26 | 814 | 849 | 24 | 6 | 4 | 30 |
| | LTE B41 | 2496 | 2690 | 23.8 | 9 | 4 | 32.8 |
| | LTE B66 | 1710 | 1780 | 24 | 6 | 4 | 30 |
| Collocated transmitters | WLAN 2.4 GHz | 2400 | 2500 | | | | 30 |
| | WLAN 5 GHz | 5150 | 5850 | | | | 30 |
| | BT | 2400 | 2500 | | | | 16 |
| | WiGig | 58320 | 62640 | | | | 25 |

4. A label must be affixed to the outside of the end product into which the EM7565 module is incorporated, with a statement similar to the following:
 - **This device contains FCC ID: N7NEM75**
Contains transmitter module IC: 2417C-EM75 where 2417C-EM75 is the module’s certification number.
5. A user manual with the end product must clearly indicate the operating requirements and conditions that must be observed to ensure compliance with current FCC/IC RF exposure guidelines.

The end product with an embedded EM7565 module may also need to pass the FCC Part 15 unintentional emission testing requirements and be properly authorized per FCC Part 15.

Note: If this module is intended for use in a portable device, you are responsible for separate approval to satisfy the SAR requirements of FCC Part 2.1093 and IC RSS-102.

>> A: Audio Support

The EM7565 host I/O connector provides pins to support PCM or I2S audio interfaces as listed in [Table A-1](#).

Table A-1: Host interface (67-pin) Connections — Module View^a

| Pin | Signal name | Pin type ^b | Description | Direction to module | Active state | Voltage levels (V) | | |
|-----|--------------------------------|-----------------------|---|---------------------|--------------|--------------------|------|------|
| | | | | | | Min | Typ | Max |
| 20 | PCM_CLK / I2S_CLK ^c | - | (PCM_CLK) PCM Clock | Input | High | 1.17 | 1.80 | 2.10 |
| | | | | | Low | -0.30 | | 0.63 |
| | | | | Output | High | 1.35 | 1.80 | 1.90 |
| | | | Low | | 0 | | 0.45 | |
| | | | (I2S_CLK) I ² S Clock | Output | High | 1.35 | | 1.90 |
| | | | | Low | 0 | | 0.45 | |
| 22 | PCM_DIN / I2S DIN | - | PCM Data In/ I ² S Data In | Input | High | 1.17 | 1.80 | 2.10 |
| | | | | | Low | -0.30 | | 0.63 |
| 24 | PCM_DOUT / I2S DOUT | - | PCM Data Out/ I ² S Data Out | Output | High | 1.35 | 1.80 | 1.90 |
| | | | | | Low | 0 | | 0.45 |
| 28 | PCM_SYNC / I2S_WS ^c | - | (PCM_SYNC) PCM Sync | Input | High | 1.17 | 1.80 | 2.10 |
| | | | | | Low | -0.30 | | 0.63 |
| | | | | Output | High | 1.35 | 1.80 | 1.90 |
| | | | Low | | 0 | | 0.45 | |
| | | | (I2S_WS) I ² S Word Select | Output | High | 1.35 | | 1.90 |
| | | | | Low | 0 | | 0.45 | |
| 56 | I2C_DATA ^d | - | I ² C serial bus data (for external codec) | Input | High | 1.17 | 1.80 | 2.10 |
| | | | | | Low | -0.30 | | 0.63 |
| | | | | Output | High | 1.35 | 1.80 | 1.90 |
| | | | | | Low | 0 | | 0.45 |
| 58 | I2C_CLK ^d | - | I ² C serial bus clock (for external codec) | Input | High | 1.17 | 1.80 | 2.10 |
| | | | | | Low | -0.30 | | 0.63 |
| | | | | Output | High | 1.35 | 1.80 | 1.90 |
| | | | | | Low | 0 | | 0.45 |

- The host should leave all 'NC' ('no connect') pins unconnected.
- I—Input; O—Digital output; OC—Open Collector output; PU—Digital input (internal pull up); PD—Digital input (internal pull down); V—Power or ground
- Functions as input when in PCM slave mode. Otherwise, functions as output in either PCM or I2S master mode.
- Keep this pin NC when not used (I²C function is not needed).

PCM/I2S Audio Interface

The module implements a PCM/I²S digital audio interface using a dedicated serial link for digital audio data; all other signals, such as subcoding and control, are transmitted separately. Default setting is PCM slave mode, but this can be switched, using AT commands, to PCM master mode, I²S master mode, or I²S slave mode.

PCM/I²S signals are summarized in the following table.

Table A-2: PCM/I2S Interface Signals

| Signal name | Pin | Description |
|-------------------|-----|---------------------------|
| PCM_CLK/I2S_CLK | 20 | PCM Clock/I2S Clock |
| PCM_DIN/I2S_DIN | 22 | PCM Data In/I2S Data In |
| PCM_DOUT/I2S_DOUT | 24 | PCM Data Out/I2S Data Out |
| PCM_SYNC/I2S_WS | 28 | PCM Sync/I2S Word Select |

PCM

The PCM interface supports the following features:

- Either master mode or slave mode
- Auxiliary PCM
- 8k and 16k sampling rates
- Linear, μ -law and A-law formats
- Padding setting (enable or disable)
- 8, 16, 32, 64, 128, and 256 bits per frame
- Bit frequency (sample rate * bits per frame)

The following figures and table illustrate PCM signals timing.

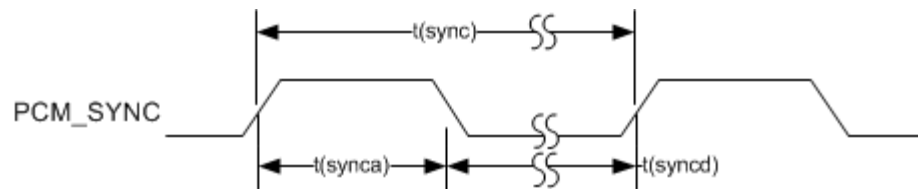


Figure A-1: PCM_SYNC Timing

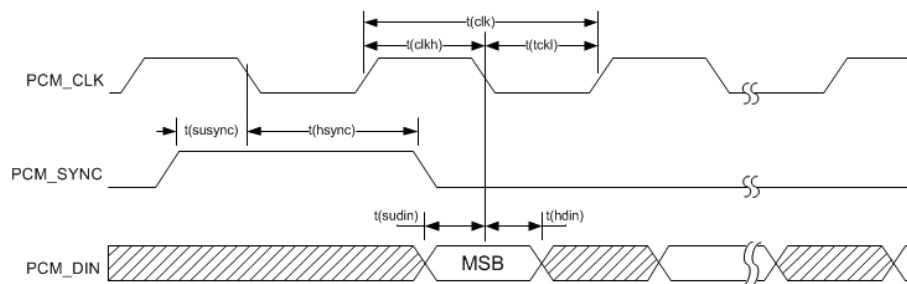


Figure A-2: PCM Codec to Module Timing

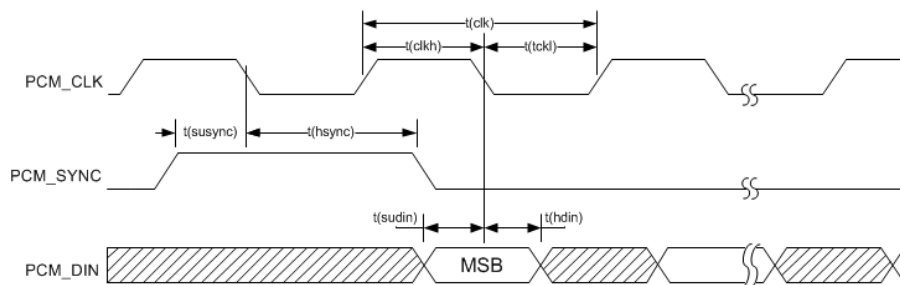


Figure A-3: Module to PCM Codec Timing

Table A-3: PCM Timing^a

| Parameter | Description | Min | Typ | Max | Units |
|-----------------------|---|-----|-------|-----|-------|
| T(sync) | PCM_FS cycle time | - | 125 | - | us |
| T(synch) | PCM_FS high time | - | 488 | - | ns |
| T(cyncl) | PCM_FS low time | - | 124.5 | - | us |
| T(clk) | PCM_CLK cycle time | - | 488 | - | ns |
| T(clkh) | PCM_CLK high time | - | 244 | - | ns |
| T(clkl) | PCM_CLK low time | - | 244 | - | ns |
| T(sync_offset) | PCM_SYNC offset time to PCM_CLK falling | - | 122 | - | ns |
| T(sudin) | PCM_DIN setup time before falling edge of PCM_CLK | 60 | - | - | ns |
| T(hdin) | PCM_DIN hold time after falling edge of PCM_CLK | 60 | - | - | ns |
| T(pdout) | Delay from PCM_CLK rising to PCM_DOUT valid | - | - | 60 | ns |
| T(zdout) | Delay from PCM_CLK falling to PCM_DOUT HIGH-Z | - | - | 60 | ns |

a. Maximum PCM clock rate is 2.048 MHz.

I²S

The I²S interface can be used to transfer serial digital audio to or from an external stereo DAC/ADC and supports the following features:

- Master mode only (follows Philips I²S bus specifications for timing)
- 48K sampling rate
- 16 bits per channel
- 1536 kHz bit clock

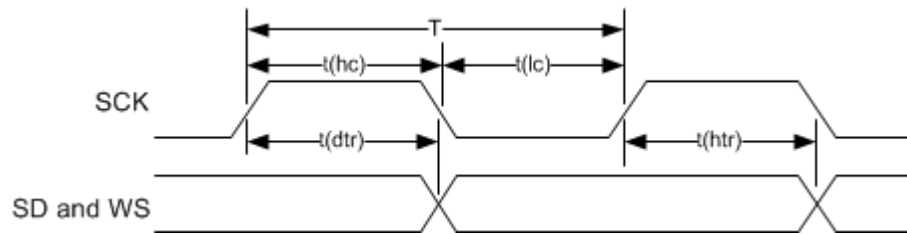


Figure A-4: I²S Transmitter Timing Diagram

Table A-4: Master Transmitter with Data Rate = 3.072 MHz (±10%)^a

| Parameter | Description | Condition | Min | Typ | Max | Units |
|-----------|--------------|---|-----|-----|-----|-------|
| T | Clock period | I ² S requirement: min T=293 | 293 | 326 | 359 | ns |
| t(hc) | Clock high | I ² S requirement: min > 0.35T | 120 | - | - | ns |
| t(lc) | Clock low | I ² S requirement: min > 0.35T | 120 | - | - | ns |
| t(dtr) | Delay | I ² S requirement: max < 0.8T | - | - | 250 | ns |
| t(htr) | Hold time | I ² S requirement: min > 0 | 100 | - | - | ns |

a. maximum sample rate = 48 KHz at 3.072 MHz (32 bits per sample)

»» B: Antenna Specification

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

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

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

Recommended Main/Diversity Antenna Specifications

Table B-1: Antenna Requirements ^a

| Parameter | Requirements | Comments |
|---|---|--|
| Antenna system | (LTE) External multi-band 2x2 MIMO antenna system (Ant1/Ant2) ^b (3G) External multi-band antenna system with diversity (Ant1/Ant2) ^c | If Ant2 includes GNSS, then it must also satisfy requirements in Table B-2 on page 71 . |
| Operating bands — Antenna 1 | All supporting Tx and Rx frequency bands. | |
| Operating bands — Antenna 2 | All supporting Rx frequency bands, plus GNSS frequency bands if Antenna 2 is used in shared Diversity/MIMO/GNSS mode. | |
| VSWR of Ant1 and Ant2 | <ul style="list-style-type: none"> < 2:1 (recommended) < 3:1 (worst case) | On all bands including band edges |
| Total radiated efficiency of Ant1 and Ant2 | > 50% on all bands | <ul style="list-style-type: none"> Measured at the RF connector. Includes mismatch losses, losses in the matching circuit, and antenna losses, excluding cable loss. Sierra Wireless recommends using antenna efficiency as the primary parameter for evaluating the antenna system. Peak gain is not a good indication of antenna performance when integrated with a host device (the antenna does not provide omni-directional gain patterns). Peak gain can be affected by antenna size, location, design type, etc.—the antenna gain patterns remain fixed unless one or more of these parameters change. |

Table B-1: Antenna Requirements (Continued)^a

| Parameter | Requirements | Comments |
|---|--|--|
| Radiation patterns of Ant1 and Ant2 | Nominally Omni-directional radiation pattern in azimuth plane. | |
| Envelope correlation coefficient between Ant1 and Ant2 | <ul style="list-style-type: none"> < 0.5 on Rx bands below 960 MHz < 0.2 on Rx bands above 1.4 GHz | |
| Mean Effective Gain of Ant1 and Ant2 (MEG1, MEG2) | ≥ -3 dBi | |
| Ant1 and Ant2 Mean Effective Gain Imbalance MEG1 / MEG2 | < 2 dB for MIMO operation < 6 dB for diversity operation | |
| Maximum antenna gain | Must not exceed antenna gains due to RF exposure and ERP/EIRP limits, as listed in the module's FCC grant. | See Important Compliance Information for the United States and Canada on page 63 . |
| Isolation between Ant1 and Ant2 (S21) | > 10 dB | <ul style="list-style-type: none"> If antennas can be moved, test all positions for both antennas. Make sure all other wireless devices (Bluetooth or WLAN antennas, etc.) are turned OFF to avoid interference. |
| Power handling | <ul style="list-style-type: none"> > 1 W | <ul style="list-style-type: none"> Measure power endurance over 4 hours (estimated talk time) using a 1 W CW signal—set the CW test signal frequency to the middle of each supporting Tx band. Visually inspect device to ensure there is no damage to the antenna structure and matching components. VSWR/TIS/TRP measurements taken before and after this test must show similar results. |

- a. These worst-case VSWR figures for the transmitter bands may not guarantee RSE levels to be within regulatory limits. The device alone meets all regulatory emissions limits when tested into a cabled (conducted) 50 ohm system. With antenna designs with up to 2.5:1 VSWR or worse, the radiated emissions could exceed limits. The antenna system may need to be tuned in order to meet the RSE limits as the complex match between the module and antenna can cause unwanted levels of emissions. Tuning may include antenna pattern changes, phase/delay adjustment, passive component matching. Examples of the application test limits would be included in FCC Part 22, Part 24 and Part 27, test case 4.2.2 for WCDMA (ETSI EN 301 908-1), where applicable.
- b. Ant1—Primary, Ant2—Secondary (Diversity/MIMO/GNSS)
- c. Ant1—Primary, Ant2—Secondary (Diversity/GNSS)

Recommended GNSS Antenna Specifications

Table B-2: GNSS Antenna Requirements

| Parameter | Requirements | Comments |
|---|--|--|
| Frequency range | <ul style="list-style-type: none"> Wide-band GNSS: 1559–1606 MHz recommended Narrow-band GPS: 1575.42 MHz \pm2 MHz minimum Narrow-band Galileo: 1575.42 MHz \pm2 MHz minimum Narrow-band BeiDou: 1561.098 MHz \pm2 MHz minimum Narrow-band GLONASS: 1601.72 MHz \pm4.2 MHz minimum Narrow-band QZSS: 1575.42 MHz \pm2 MHz minimum | |
| Field of view (FOV) | <ul style="list-style-type: none"> Omni-directional in azimuth -45° to +90° in elevation | |
| Polarization (average Gv/Gh) | > 0 dB | Vertical linear polarization is sufficient. |
| Free space average gain (Gv+Gh) over FOV | > -6 dBi (preferably > -3 dBi) | Gv and Gh are measured and averaged over -45° to +90° in elevation, and \pm 180° in azimuth. |
| Gain | <ul style="list-style-type: none"> Maximum gain and uniform coverage in the high elevation angle and zenith. Gain in azimuth plane is not desired. | |
| Average 3D gain | > -5 dBi | |
| Isolation between GNSS and Ant1 | > 10 dB in all uplink bands | |
| Typical VSWR | < 2.5:1 | |
| Polarization | Any other than LHCP (left-hand circular polarized) is acceptable. | |

Antenna Tests

The following guidelines apply to the requirements described in [Table B-1 on page 69](#) and [Table B-2 on page 71](#):

- Perform electrical measurements at room temperature (+20°C to +26°C) unless otherwise specified
- For main and diversity path antennas, make sure the antennas (including contact device, coaxial cable, connectors, and matching circuit with no more than six

components, if required) have nominal impedances of 50 Ω across supported frequency bands.

- All tests (except isolation/correlation coefficient)—Test the main or diversity antenna with the other antenna terminated.
- Any metallic part of the antenna system that is exposed to the outside environment needs to meet the electrostatic discharge tests per IEC61000-4-2 (conducted discharge +8kV).
- The functional requirements of the antenna system are tested and verified while the embedded module's antenna is integrated in the host device.

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

>> C: Design Checklist

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 C-1: Hardware Integration Design Considerations

| Suggestion | Section where discussed |
|---|---|
| Component placement | |
| If an ESD suppressor is not used on the host device, allow space on the SIM connector for series resistors in layout. (Up to 100 Ω may be used depending on ESD testing requirements). | SIM Implementation on page 32 |
| Minimize RF cable losses as these affect performance values listed in product specification documents. | RF Connections on page 37 |
| Antennas | |
| Match the module/antenna coax connections to 50 Ω —mismatched antenna impedance and cable loss negatively affect RF performance. | RF Connections on page 37 |
| If installing UMTS and CDMA modules in the same device, consider using separate antennas for maximum performance. | Antenna and Cabling on page 38 |
| Power | |
| Make sure the power supply can handle the maximum current specified for the module type. | Power Consumption on page 48 |
| Limit the total impedance of VCC and GND connections to the SIM at the connector to less than 1 Ω (including any trace impedance and lumped element components—inductors, filters, etc.). All other lines must have a trace impedance less than 2 Ω . | SIM Implementation on page 32 |
| Decouple the VCC line close to the SIM socket. The longer the trace length (impedance) from socket to module, the greater the capacitance requirement to meet compliance tests. | SIM Implementation on page 32 |
| PCB signal routing | |
| USB 2.0/3.0—Route these signals over 90 Ω differential lines on the PCB. | |
| I2C port—If supported, route these signals away from noise-sensitive signals on the PCB. | |
| PCM port—If supported, route these signals away from noise-sensitive signals on the PCB. | |
| EMI/ESD | |
| Investigate sources of localized interference early in the design cycle. | Methods to Mitigate Decreased Rx Performance on page 40 |

Table C-1: Hardware Integration Design Considerations (Continued)

| Suggestion | Section where discussed |
|--|---|
| Provide ESD protection for the SIM connector at the exposed contact point (in particular, the CLK, VCC, IO, and RESET# lines). | SIM Implementation on page 32 |
| Keep very low capacitance traces on the UIM_DATA and UIM_CLK signals. | SIM Implementation on page 32 |
| To minimize noise leakage, establish a very good ground connection between the module and host. | Ground Connection on page 39 |
| Route cables away from noise sources (for example, power supplies, LCD assemblies, etc.). | Methods to Mitigate Decreased Rx Performance on page 40 |
| Shield high RF-emitting components of the host device (for example, main processor, parallel bus, etc.). | Methods to Mitigate Decreased Rx Performance on page 40 |
| Use discrete filtering on low frequency lines to filter out unwanted high-order harmonic energy. | Methods to Mitigate Decreased Rx Performance on page 40 |
| Use multi-layer PCBs to form shielding layers around high-speed clock traces. | Methods to Mitigate Decreased Rx Performance on page 40 |
| Thermal | |
| Test to worst case operating conditions—temperature, voltage, and operation mode (transmitter on 100% duty cycle, maximum power). | Thermal Considerations on page 60 |
| Use appropriate techniques to reduce module temperatures (for example, airflow, heat sinks, heat-relief tape, module placement, etc.). | Thermal Considerations on page 60 |
| Host/Modem communication | |
| Make sure the host USB driver supports remote wakeup, resume, and suspend operations, and serial port emulation. | <i>[4] AirCard/AirPrime USB Driver Developer's Guide (Doc# 2130634)</i> |
| When no valid data is being sent, do not send SOF tokens from the host (causes unnecessary power consumption). | <i>[4] AirCard/AirPrime USB Driver Developer's Guide (Doc# 2130634)</i> |

>> D: Testing

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

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

Suggested phases include:

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

AT Command Entry Timing Requirement

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

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

Acceptance Testing

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

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

From a random sampling of units, test that:

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

Acceptance Test Requirements

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

Acceptance Test Procedure

The following is a suggested acceptance testing procedure using Sierra Wireless' Skylight™ 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 Skylight.
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 Skylight, 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 Skylight:

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

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

Certification Testing

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

The AirPrime embedded module has been certified as described in [Regulatory Compliance and Industry Certifications on page 62](#).

When you produce a host device with a Sierra Wireless AirPrime embedded module, you must obtain certifications for the final product from appropriate regulatory bodies in the jurisdictions where it will be distributed.

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

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

Production Testing

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

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

Typical items to test include:

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

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

Use an appropriate test station for your testing environment (see [Acceptance Test Requirements on page 75](#) for suggestions) and use AT commands to control the integrated module.

Note: Your test location must be protected from ESD to avoid interference with the module and antenna(s), assuming that your test computer is in a disassembled state. Also, consider using an RF shielding box—local government regulations may prohibit unauthorized transmissions.

Functional Production Test

This section presents a suggested procedure for performing a basic manual functional test on a laboratory bench using an EM7565 Embedded Module and a hardware development kit. When you have become familiar with the testing method, use it to develop your own automated production testing procedures.

Suggested Production Tests

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

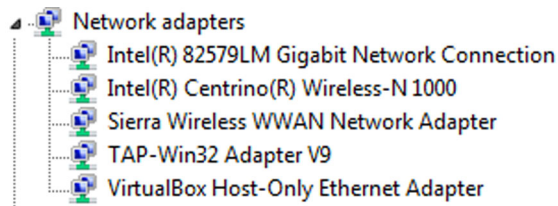
- Visual check of the module's connectors and RF assemblies
- Module is operational
- USB connection is functional
- LED is functional
- Power on/off
- Firmware revision check
- Rx tests on main and auxiliary paths
- Tx test

Production Test Procedure

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

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

1. Visually inspect the module's connectors and RF assemblies for obvious defects before installing it in the test station.
2. Ensure that the module is turned off before beginning your tests—Drive Full_Card_Power_Off# low or leave floating.
3. Test Full_Card_Power_Off#—Turn on the module by driving Full_Card_Power_Off# high.
4. Test USB functionality—Check for USB enumeration.
 - (Windows systems) The Device Manager shows the device under Network adapters. For example:



5. 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 to the Sierra Wireless modem (see listings in [Step 4](#)):
 - a. Start HyperTerminal.
 - b. Select **File > Connection Description**. The Connection Description dialog box appears.
 - i. Type Sierra in the Name box and click **OK**. The Connect To dialog box appears.
 - ii. Click **OK** without changing any of the displayed information. The Connect dialog box appears.
 - iii. Click **Cancel**.
 - iv. Type ATZ in the HyperTerminal window. If the connection is established, the message OK appears.
6. Display the firmware version:
 - **AT+GMR**
7. Test the LED—Set the LED in blinking mode using this command, then visually verify that the LED turns off and on:
 - **AT!LDTEST=0,0** (LED on)
 - **AT!LDTEST=0,1** (LED off)

Note: If necessary, use ATE1 to enable echo.

8. Unlock the extended AT command set. (Note: Use `ATI!ENTERCND?` to check command syntax, which is SKU-dependent.):
 - `ATI!ENTERCND="<password>"`
9. Put the module in diagnostic/factory test mode:
 - `ATI!DAFTMACT`
10. Communicate with the SIM using `+CPIN` or `+CIMI`.
When performing RF tests, use a test platform as described in [Suggested Testing Equipment on page 88](#).
11. Test RF transmission, if desired:
 - (UMTS) See [UMTS \(WCDMA\) RF Transmission Path Test on page 79](#).
 - (LTE) See [LTE RF Transmission Path Test on page 81](#).
12. Test RF reception, if desired:
 - (UMTS) See [UMTS \(WCDMA\) RF Receive Path Test on page 83](#).
 - (LTE) See [LTE RF Receive Path Test on page 85](#).
13. Test standalone GNSS functionality—See [GNSS RF Receive Path Test on page 87](#).
14. Drive `Full_Card_Power_Off#` low (or leave floating) 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.

UMTS (WCDMA) RF Transmission Path Test

Note: This procedure segment is performed in [Step 11](#) of the [Production Test Procedure on page 78](#).

The suggested test procedure that follows uses the parameters in [Table D-1](#).

Table D-1: Test Settings—UMTS Transmission Path

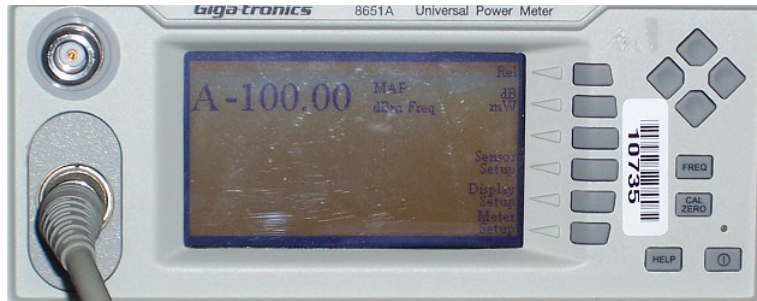
| | Band | Frequency (MHz) | Band ID | Channel ^a |
|----------|---------|-----------------|-----------------|----------------------|
| 2100 MHz | Band 1 | 1950.0 | 9 | 9750 |
| 1900 MHz | Band 2 | 1880.0 | 15 ^b | 9400 |
| 1700 MHz | Band 4 | 1732.6 | 28 | 1413 |
| 850 MHz | Band 5 | 836.6 | 22 | 4183 |
| 800 MHz | Band 6 | 835.0 | 22 | 4175 |
| 900 MHz | Band 8 | 897.6 | 29 | 2788 |
| 1700 MHz | Band 9 | 1767.4 | 31 | 8837 |
| 800 MHz | Band 19 | 837.6 | 75 | 338 |

- a. Channel value used by the `!DARCONFIG` command (`!DARCONFIG` uses uplink (Tx) channel at the center of the corresponding band (rounded down), for both Tx and Rx testing).
- b. Either 15 (WCDMA1900A) or 16 (WCDMA1900B) may be used for testing.

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

To test the DUT's transmitter path:

1. Set up the power meter:



- a. Make sure the meter has been given sufficient time to warm up, if necessary, to enable it to take accurate measurements.
 - b. Zero-calibrate the meter.
 - c. Enable MAP mode.
2. Prepare the DUT using the following AT commands:
- a. `AT!ENTERCND=<password>` (Unlock extended AT command set.)
 - b. `AT!DAFTMACT` (Enter test mode.)
 - c. `AT!DARCONFIG=0,1,<bandValue>,<channel>`
(e.g. `AT!DARCONFIG=0,1,2,9400`)
(Set frequency band and channel.
See [Table D-1](#) for values.)
 - d. `AT!DAWTXCONTROL=1,<power_dBm>`
(e.g. `AT!DAWTXCONTROL=1,10`)
(Enable Tx power output.
`<power_dBm>` = -57.0 to 23.0)
 - e. Take the measurement.
 - f. Repeat steps c–e with different Tx power levels if needed.
 - g. `AT!DAWTXCONTROL=0` (Disable Tx power output.)
 - h. `AT!DARCONFIGDROP=1` (Drop the current UMTS configuration.)
3. Test limits—Run ten or more good DUTs through this test procedure to obtain a nominal output power value.
- Apply a tolerance of ± 5 to 6 dB to each measurement (assuming a good setup design).
 - Monitor these limits during mass-production ramp-up to determine if further adjustments are needed.

Note: The module has a nominal output power of +23 dBm ± 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.

LTE RF Transmission Path Test

Note: This procedure segment is performed in Step 11 of the [Production Test Procedure on page 78](#).

The suggested test procedure that follows uses the parameters in [Table D-2](#).

Table D-2: Test Settings—LTE Transmission Path

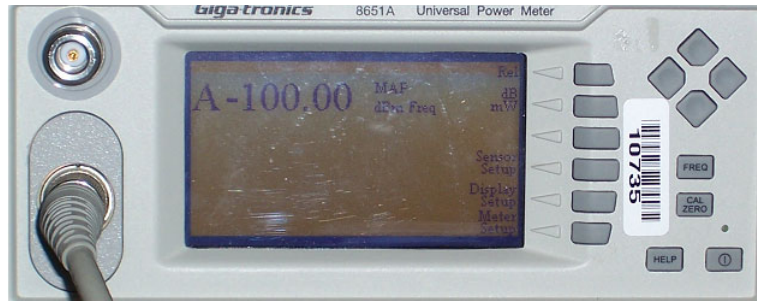
| | Band # | Frequency (MHz) | Band ID | Channel ^a |
|----------|------------------|-----------------|---------|----------------------|
| 2100 MHz | B1 | 1950.0 | 34 | 18300 |
| 1900 MHz | B2 | 1880.0 | 43 | 18900 |
| 1800 MHz | B3 | 1747.5 | 44 | 19575 |
| 1700 MHz | B4 | 1732.5 | 42 | 20175 |
| 850 MHz | B5 | 836.5 | 45 | 20525 |
| 2600 MHz | B7 | 2535.0 | 35 | 21100 |
| 900 MHz | B8 | 897.5 | 47 | 21625 |
| 1800 MHz | B9 | 1767.4 | 48 | 21975 |
| 700 MHz | B12 | 707.5 | 50 | 23095 |
| 700 MHz | B13 | 782.0 | 36 | 23230 |
| 850 MHz | B18 | 822.5 | 54 | 23925 |
| 850 MHz | B19 | 837.5 | 55 | 24075 |
| 800 MHz | B20 | 847.0 | 56 | 24300 |
| 850 MHz | B26 | 831.5 | 62 | 26865 |
| 700 MHz | B28 | 725.5 | 64 | 27435 |
| 2500 MHz | B41 | 2593.0 | 76 | 40620 |
| 3500 MHz | B42 ^b | 3500.0 | 77 | 42590 |
| 3700 MHz | B43 ^b | 3700.0 | 88 | 44590 |
| 3600 MHz | B48 ^b | 3625.0 | 96 | 55990 |
| 1700 MHz | B66 | 1745.0 | 83 | 132322 |

- a. Channel value used by the !DARCONFIG command (!DARCONFIG uses uplink (Tx) channel at the center of the corresponding band (rounded down), for both Tx and Rx testing).
- b. B42/B43/B48 disabled as of publication date, support pending regulatory approval

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

To test the DUT's transmitter path:

1. Set up the power meter:



- a. Make sure the meter has been given sufficient time to warm up, if necessary, to enable it to take accurate measurements.
 - b. Zero-calibrate the meter.
 - c. Enable MAP mode.
2. Prepare the DUT using the following AT commands:
- a. `AT!ENTERCND=<password>` (Unlock extended AT command set.)
 - b. `AT!DAFTMACT` (Enter test mode.)
 - c. `AT!DARCONFIG=0,3,<bandValue>,<channel>,<lte_bw>`
(e.g. `AT!DARCONFIG=0,3,1,18300,3`)
(Set frequency band and channel. See [Table D-1](#) for values. `<lte_bw>`: 0 (1.4 MHz), 1 (3 MHz), 2 (5 MHz), 3 (10 MHz), 4 (15 MHz), 5(20 MHz))
 - d. `AT!DALTXCONTROL=0,1,<tx_pwr>,<waveform>,<mod>,<ns_val>,<num_RB>,<start_RB>`
(e.g. `AT!DALTXCONTROL=0,1,10,1,0,1,12,19`)
(Set LTE Tx power level, waveform, modulation and NS value. Programs PA range, LUT index, and digital gain to reach Tx power level with power limiting enabled.)
 - e. Take the measurement.
 - f. Repeat steps c–e with different Tx power levels if desired.
 - g. `AT!DALTXCONTROL=0,0` (Disable Tx power control.)
 - h. `AT!DARCONFIGDROP=3` (Drop the current LTE configuration.)
3. Test limits—Run ten or more good DUTs through this test procedure to obtain a nominal output power value.
- Apply a tolerance of ± 5 to 6 dB to each measurement (assuming a good setup design).
 - Monitor these limits during mass-production ramp-up to determine if further adjustments are needed.

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

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

UMTS (WCDMA) RF Receive Path Test

Note: This procedure segment is performed in [Step 12 of Production Test Procedure on page 78](#).

The suggested test procedure that follows uses the parameters in [Table D-3](#).

Table D-3: Test Settings—UMTS Receive Path

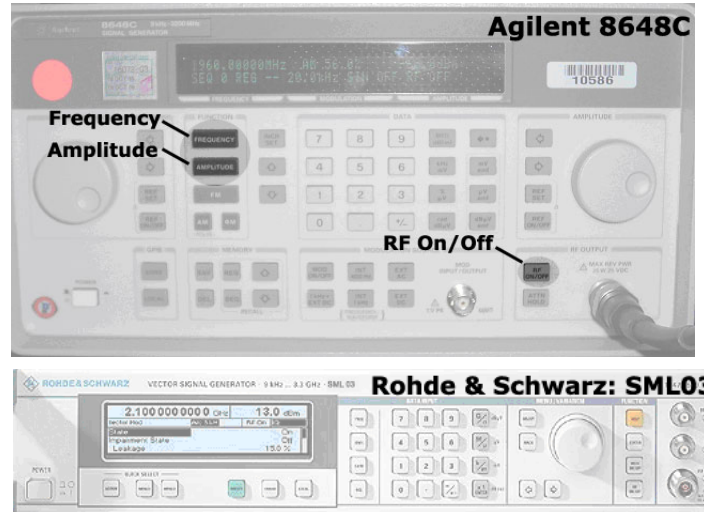
| | Band # | Frequency^a (MHz) | Band ID | Channel^b |
|----------|---------------|------------------------------------|-----------------|----------------------------|
| 2100 MHz | Band 1 | 2141.2 | 9 | 9750 |
| 1900 MHz | Band 2 | 1961.2 | 15 ^c | 9400 |
| 1700 MHz | Band 4 | 2133.7 | 28 | 1413 |
| 850 MHz | Band 5 | 882.7 | 22 | 4183 |
| 800 MHz | Band 6 | 881.2 | 22 | 4175 |
| 900 MHz | Band 8 | 943.7 | 29 | 2788 |
| 1700 MHz | Band 9 | 1863.6 | 31 | 8837 |
| 800 MHz | Band 19 | 883.7 | 75 | 338 |

- Receive frequencies shown are 1.2 MHz offset from center
- Channel value used by the !DARCONFIG command (!DARCONFIG uses uplink (Tx) channel at the center of the corresponding band (rounded down), for both Tx and Rx testing).
- Either 15 (WCDMA1900A) or 16 (WCDMA1900B) may be used for testing.

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

To test the DUT's receive path:

1. Set up the signal generator:



- a. Set the amplitude to:
 - -80 dBm
- b. Set the frequency for the band being tested. See [Table D-3 on page 83](#) for frequency values.

2. Set up the DUT:

Warning: The maximum RF power level allowable on any RF port is +10dBm—damage may occur if this level is exceeded.

- a. AT!ENTERCND="**<password>**" (Unlock extended AT command set.)
 - b. AT!DAFTMACT (Put modem into factory test mode.)
 - c. AT!DARCONFIG=0,1,**<bandValue>**,**<channel>**
(e.g. AT!DARCONFIG=0,1,2,9400)
(Set frequency band and channel.
See [Table D-3](#) for values.)
 - d. AT!DAGFTMRXAGC=0,1,0,0
(Set LNA to maximum gain on primary Rx, and get the RSSI.)
 - e. AT!DAGFTMRXAGC=0,1,0,1 (Set LNA to maximum gain on Diversity Rx, and get the RSSI.)
 - f. AT!DARCONFIGDROP=1 (Drop the current UMTS configuration.)
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).

LTE RF Receive Path Test

Note: This procedure segment is performed in [Step 12](#) of the [Production Test Procedure on page 78](#).

The suggested test procedure that follows uses the parameters in [Table D-4](#).

Table D-4: Test Settings — LTE Receive Path

| | Band # | Frequency ^a (MHz) | Band ID | Channel ^b |
|----------|------------------|------------------------------|---------|----------------------|
| 2100 MHz | B1 | 2142.0 | 34 | 18300 |
| 1900 MHz | B2 | 1962.0 | 43 | 18900 |
| 1800 MHz | B3 | 1844.5 | 44 | 19575 |
| 1700 MHz | B4 | 2134.5 | 42 | 20175 |
| 850 MHz | B5 | 883.5 | 45 | 20525 |
| 2600 MHz | B7 | 2657.0 | 35 | 21100 |
| 900 MHz | B8 | 944.5 | 47 | 21625 |
| 1800 MHz | B9 | 1864.4 | 48 | 21975 |
| 700 MHz | B12 | 739.5 | 50 | 23095 |
| 700 MHz | B13 | 753.0 | 36 | 23230 |
| 850 MHz | B18 | 869.5 | 54 | 23925 |
| 850 MHz | B19 | 884.5 | 55 | 24075 |
| 800 MHz | B20 | 808.0 | 56 | 24300 |
| 850 MHz | B26 | 878.5 | 62 | 26865 |
| 700 MHz | B28 | 782.5 | 64 | 27435 |
| 700 MHz | B29 | See footnote ^c . | | |
| 2300 MHz | B30 | 2357.0 | 66 | 27710 |
| 1500 MHz | B32 | See footnote ^c . | | |
| 2500 MHz | B41 | 2595.0 | 76 | 40620 |
| 3500 MHz | B42 ^d | 3502.0 | 77 | 42590 |

Table D-4: Test Settings—LTE Receive Path (Continued)

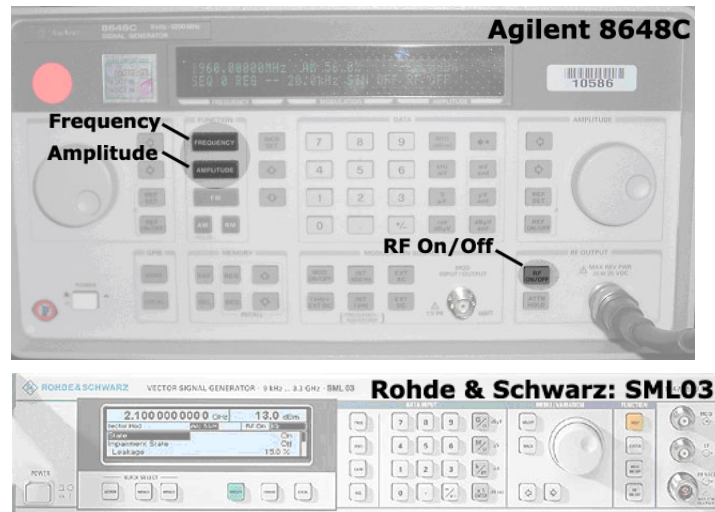
| | Band # | Frequency ^a (MHz) | Band ID | Channel ^b |
|----------|------------------|------------------------------|---------|----------------------|
| 3700 MHz | B43 ^d | 3702.0 | 88 | 44590 |
| 5200 MHz | B46 | See footnote ^c . | | |
| 3600 MHz | B48 ^d | 3627.0 | 96 | 55990 |
| 1700 MHz | B66 | 2157.0 | 83 | 132322 |

- a. Receive frequencies shown are 2 MHz offset from center
- b. Channel value used by the !DARCONFIG command (!DARCONFIG uses uplink (Tx) channel at the center of the corresponding band (rounded down), for both Tx and Rx testing).
- c. Test procedure does not apply to this band. Downlink-only band requires CA mode testing in signaling mode (outside scope of this document; testing methodology to be determined by user).
- d. B42/B43/B48 disabled as of publication date, support pending regulatory approval

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

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

1. Set up the signal generator:



- a. Set the amplitude to -70 dBm
- b. Set the frequency for the band being tested. See [Table D-4](#) for frequency values.

2. Set up the DUT:

Warning: The maximum RF power level allowable on any RF port is +10dBm—damage may occur if this level is exceeded.

- a. AT!ENTERCND="**<password>**" (Unlock extended AT command set.)
- b. AT!DAFTMACT (Put modem into factory test mode.)
- c. AT!DARCONFIG=0,3,**<bandValue>**,**<channel>**,**<lte_bw>**
(e.g. AT!DARCONFIG=0,3,1,18300,3)
(Set frequency band and channel. See [Table D-4](#))

- for values. <lte_bw>: 0 (1.4 MHz), 1 (3 MHz), 2 (5 MHz), 3 (10 MHz), 4 (15 MHz), 5(20 MHz))
- d. **ATIDAGFTMRXAGC=0,3,0,0** (Set LNA to maximum gain on primary Rx, and get the RSSI.)
 - e. **ATIDAGFTMRXAGC=0,3,0,1** (Set the LNA to maximum gain on Diversity Rx, and get the RSSI.)
 - f. **ATIDARCONFIGDROP=0,3** (Drop the current LTE configuration.)
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).

GNSS RF Receive Path Test

The GNSS receive path uses either the dedicated GNSS connector or the shared Diversity/MIMO/GNSS connector.

To test the GNSS receive path:

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

5. (Optional) Turn the signal generator on again, and reduce the level to -120dBm. Take more **!DACGPSCTON** readings and use these as a reference for what a marginal/poor signal would be.

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

Quality Assurance Testing

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

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

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

- Module registration on cellular networks
- Power consumption
- Originate and terminate data and voice (if applicable) calls
- Cell hand-off
- Transmitter and receiver tests
- FER (Frame Error Rate) as an indicator of receiver sensitivity/performance
- Channel and average power measurements to verify that the device is transmitting within product specifications
- RF sensitivity tests
- RF sensitivity testing—BER/BLER for different bands and modes
- Transmitter and receiver tests (based on relevant sections of the 3GPP TS51010 and 3GPP 34121 documents)

Suggested Testing Equipment

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

Testing Assistance Provided by Sierra Wireless

Extended AT commands have been implemented to assist with performing FTA GCF tests and portions of CE Mark tests requiring radio module access. These are documented in the [2] *AirPrime EM75xx AT Command Reference (Doc# 4111748)*.

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

IOT/Operator Testing

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

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

Extended AT Commands for Testing

Sierra Wireless provides the [2] *AirPrime EM75xx AT Command Reference (Doc# 41111748)*, which describes proprietary AT commands that may help in hardware integration design and testing (these commands are NOT intended for use by end users).

Some commands from this document that may be useful for hardware integration are listed in [Table D-5 on page 89](#).

Table D-5: Extended AT Commands

| Command | Description |
|--|---|
| Password commands | |
| !ENTERCND | Enable access to password-protected commands |
| !SETCND | Set AT command password |
| Modem reset and status commands | |
| !GSTATUS | Return the operation status of the modem (mode, band, channel, and so on) |
| !RESET | Reset the modem |
| Diagnostic commands | |
| !BAND | Select a set of frequency bands or reports current selection |
| Test commands | |
| !DAFTMACT | Put the modem into FTM (Factory Test Mode) |
| !DAFTMDEACT | Put the modem into online mode |
| !DAGFTMRXAGC | Get FTM Rx AGC (Primary or Diversity) |
| !DALGRXAGC | Return Rx AGC value (LTE) |
| !DALGTXAGC | Return Tx AGC value and transmitter parameters (LTE) |
| !DALTXCONTROL | Configure LTE Tx Parameters |
| !DAOFFLINE | Place modem offline |
| !DARCONFIG | Set Band and Channel |
| !DARCONFIGDROP | Drop Radio Configurations |

Table D-5: Extended AT Commands

| Command | Description |
|----------------------|--|
| !DASLNAGAIN | Set the LNA (Low Noise Amplifier) gain state |
| !DAWGAVGAGC | Return averaged RX AGC value (WCDMA) |
| !DAWINFO | Return WCDMA mode RF information |
| !DAWTXCONTROL | Configure WCDMA Tx Power |

» E: Thermal Testing

Worst Case Testing—Absolute vs Realistic

Sierra Wireless recommends that customers identify realistic worst-case conditions for their applications and perform appropriate thermal testing.

For example:

- If the device has very good throughput, it is likely near a tower so will not have to transmit at maximum Tx output power.
- If the device is transmitting at maximum Tx power, it is likely *not* near a tower and will not reach maximum throughput rates.
- Networks usually are sharing capacity among many users, so no single user is likely to reach maximum throughput rates for any significant length of time.
- If the device is transmitting at maximum throughput, it will likely do so for a limited time to limit the amount of data usage consumed from their data plan.

Suggested realistic worst-case test conditions

Sierra Wireless suggests using a worst-case test such as shown in [Table E-1](#).

Table E-1: Suggested worst-case conditions

| Condition | Value |
|----------------------|---|
| Data throughput rate | 150 Mbps/40 Mbps |
| Tx output power | 20 dBm |
| Carrier aggregation | 3CA |
| Test case | Scheduling—50% duty cycle, 2 ms period (i.e. On for 1 ms, Off for 1 ms) |

Thermal Testing Process

To perform thermal testing of the module:

1. Mount the module in its designed location on the platform.
2. Provide the same amount of airflow as will be experienced in your application.
3. Set the platform's ambient to the higher limit of its ambient temperature specification and observe the board temperature ramp due to the ambient temperature. (Use `AT!PCTEMP?` or `SLQSNasSwiModemStatus`.)

Note: It is highly recommended to have a thermocouple measuring the air temperature around the module inside the platform, which will be close to the module's board temperature.

4. Set up a call with the use case for the platform (throughput rate, output power, duty cycle) on the worst-case band.

Note: The worst case band for power consumption and thermals is a 3CA call with PCC LTE Band 66 (20 MHz) and SCC any bands (20 MHz + 20 MHz). For example, Sierra Wireless tests using B66+B2+B66.

5. Observe the ramp in board temperature due to the call, and confirm whether the overall system performance still meets customer requirements.
6. Use AT!TMSTATUS? to check the module's thermal mitigation status (see [2] AirPrime EM75xx AT Command Reference (Doc# 41111748) for details).
7. Increase the platform's ambient temperature to determine the margin that exists over the desired temperature specifications as subsequent mitigation methods activate (e.g. UL data rate throttled, DL throughput throttled (third and second CA dropped), UL power reduced, Emergency Service).

>> F: Packaging

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

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

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

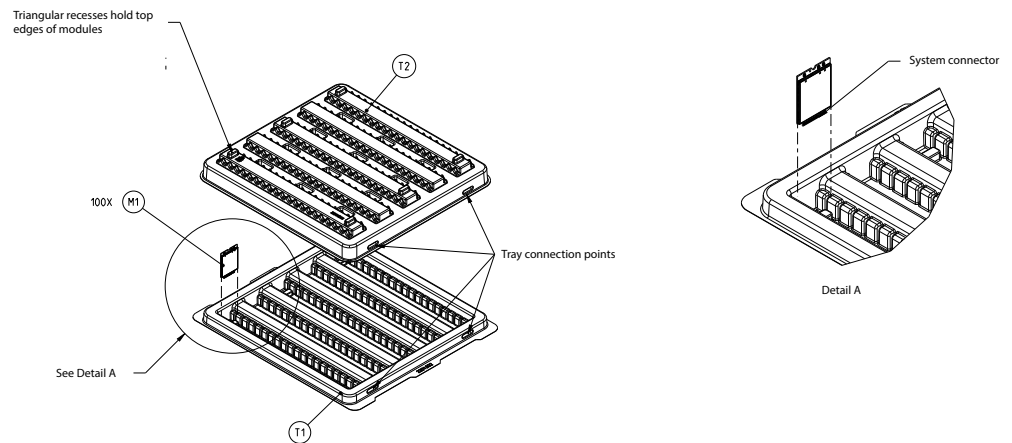


Figure F-1: Device Placement in Module Tray

The tray cover is secured to the tray base with ESD-safe tape (EP1) at the locations indicated. The tray is placed in a manufacturing box(B1), sealed with a security tape (P1), a manufacturing label (L3) is placed on the bottom-right corner, above the security tape, and if required a label (L4) is applied beside the manufacturing label. (See [Figure F-2.](#))

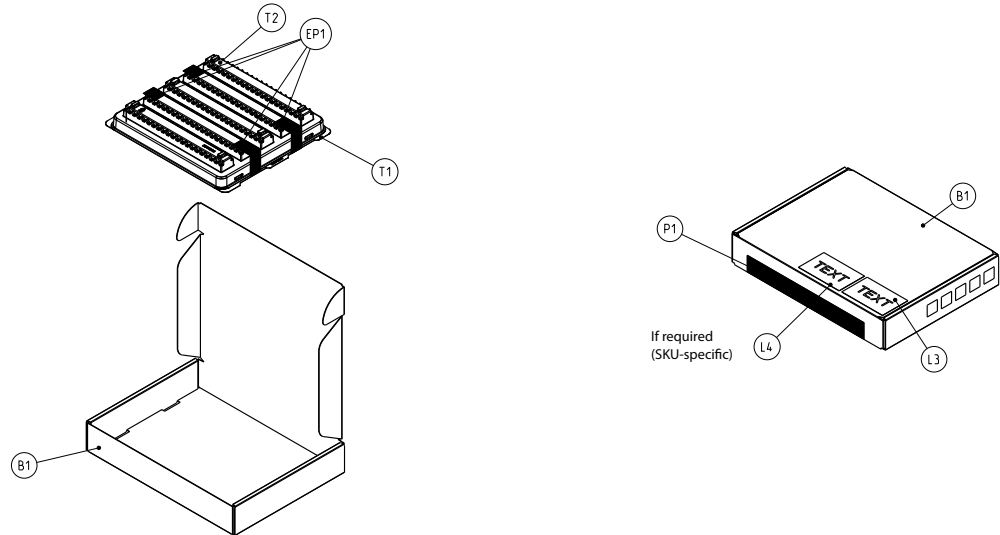


Figure F-2: Shipping Package

>> | G: References

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

Sierra Wireless Documents

The Sierra Wireless documents listed below are available from www.sierrawireless.com. For additional documents describing embedded module design, usage, and integration issues, contact your Sierra Wireless account representative.

Command Documents

- [1] AT Command Set for User Equipment (UE) (Release 6) (Doc# 3GPP TS 27.007)
- [2] AirPrime EM75xx AT Command Reference (Doc# 41111748)

Other Sierra Documents

- [3] M.2 Dev Kit Welcome Letter (Doc# 2400323)
- [4] AirCard/AirPrime USB Driver Developer's Guide (Doc# 2130634)

Industry/Other Documents

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

- [5] FCC Regulations - Part 15 - Radio Frequency Devices
- [6] IEC-61000-4-2 level 3 (Electrostatic Discharge Immunity Test)
- [7] Mobile Station (MS) Conformance Specification; Part 4: Subscriber Interface Module (Doc# 3GPP TS 11.10-4)
- [8] PCI Express NGFF (M.2) Electromechanical Specification Revision 1.0
- [9] Universal Serial Bus Specification, Rev 2.0
- [10] Universal Serial Bus Specification, Rev 3.0
- [11] JESD22-A114-B
- [12] JESD22-C101
- [13] MIPI Alliance Specification for RF Front-End Control Interface

>> H: Acronyms

Table H-1: Acronyms and Definitions

| Acronym or term | Definition |
|-----------------|--|
| 3GPP | 3rd Generation Partnership Project |
| 8PSK | Octagonal Phase Shift Keying |
| AGC | Automatic Gain Control |
| A-GPS | Assisted GPS |
| API | Application Programming Interface |
| BeiDou | BeiDou Navigation Satellite System A Chinese system that uses a series of satellites in geostationary and middle earth orbits to provide navigational data. |
| BER | Bit Error Rate—A measure of receive sensitivity |
| BLER | Block Error Rate |
| bluetooth | Wireless protocol for data exchange over short distances |
| CQI | Channel Quality Indication |
| COM | Communication port |
| CS | Circuit-switched |
| CSG | Closed Subscriber Group |
| CW | Continuous waveform |
| dB | Decibel = $10 \times \log_{10} (P1/P2)$ <i>P1 is calculated power; P2 is reference power</i> Decibel = $20 \times \log_{10} (V1/V2)$ <i>V1 is calculated voltage, V2 is reference voltage</i> |
| dBm | A logarithmic (base 10) measure of relative power (dB for decibels); relative to milliwatts (m). A dBm value will be 30 units (1000 times) larger (less negative) than a dBW value, because of the difference in scale (milliwatts vs. watts). |
| DC-HSPA+ | Dual Carrier HSPA+ |
| DCS | Digital Cellular System A cellular communication infrastructure that uses the 1.8 GHz radio spectrum. |
| DL | Downlink (network to mobile) |
| DRX | Discontinuous Reception |
| DSM | Distributed Shared Memory |
| DUT | Device Under Test |
| eICIC | Enhanced Inter-Cell Interference Coordination |
| EIRP | Effective (or Equivalent) Isotropic Radiated Power |

Table H-1: Acronyms and Definitions (Continued)

| Acronym or term | Definition |
|------------------------|--|
| EMC | Electromagnetic Compatibility |
| EMI | Electromagnetic Interference |
| ERP | Effective Radiated Power |
| ESD | Electrostatic Discharge |
| FCC | Federal Communications Commission The U.S. federal agency that is responsible for interstate and foreign communications. The FCC regulates commercial and private radio spectrum management, sets rates for communications services, determines standards for equipment, and controls broadcast licensing. Consult www.fcc.gov . |
| FDD | Frequency Division Duplexing |
| FDMA | Frequency Division Multiple Access |
| feICIC | Further Enhanced Inter-Cell Interference Coordination |
| FER | Frame Error Rate—A measure of receive sensitivity. |
| firmware | Software stored in ROM or EEPROM; essential programs that remain even when the system is turned off. Firmware is easier to change than hardware but more permanent than software stored on disk. |
| FOTA | Firmware Over The Air—Technology used to download firmware upgrades directly from the service provider, over the air. |
| FOV | Field Of View |
| FSN | Factory Serial Number—A unique serial number assigned to the mini card during manufacturing. |
| Galileo | A European system that uses a series of satellites in middle earth orbit to provide navigational data. |
| GCF | Global Certification Forum |
| GLONASS | Global Navigation Satellite System—A Russian system that uses a series of 24 satellites in middle circular orbit to provide navigational data. |
| GMSK | Gaussian Minimum Shift Keying modulation |
| GNSS | Global Navigation Satellite Systems (GPS, GLONASS, BeiDou, and Galileo) |
| GPS | Global Positioning System An American system that uses a series of 24 satellites in middle circular orbit to provide navigational data. |
| Host | The device into which an embedded module is integrated |
| HSDPA | High Speed Downlink Packet Access |
| HSPA+ | Enhanced HSPA, as defined in 3GPP Release 7 and beyond |
| HSUPA | High Speed Uplink Packet Access |
| Hz | Hertz = 1 cycle/second |

Table H-1: Acronyms and Definitions (Continued)

| Acronym or term | Definition |
|------------------------|--|
| IC | Industry Canada |
| IF | Intermediate Frequency |
| IMEI | International Mobile Equipment Identity |
| IMS | IP Multimedia Subsystem—Architectural framework for delivering IP multimedia services. |
| inrush current | Peak current drawn when a device is connected or powered on |
| inter-RAT | Radio Access Technology |
| IOT | Interoperability Testing |
| IS | Interim Standard. After receiving industry consensus, the TIA forwards the standard to ANSI for approval. |
| ISIM | IMS Subscriber Identity Module (Also referred to as a SIM card) |
| LED | Light Emitting Diode. A semiconductor diode that emits visible or infrared light. |
| LHCP | Left-Hand Circular Polarized |
| LNA | Low Noise Amplifier |
| LPM | Low Power Mode |
| LPT | Line Print Terminal |
| LTE | Long Term Evolution—a high-performance air interface for cellular mobile communication systems. |
| MCS | Modulation and Coding Scheme |
| MHz | Megahertz = 10e6 Hz |
| MIMO | Multiple Input Multiple Output—wireless antenna technology that uses multiple antennas at both transmitter and receiver side. This improves performance. |
| NAS/AS | Network Access Server |
| NC | No Connect |
| NIC | Network Interface Card |
| NLIC | Non-Linear Interference Cancellation |
| NMEA | National Marine Electronics Association |
| OEM | Original Equipment Manufacturer—a company that manufactures a product and sells it to a reseller. |
| OFDMA | Orthogonal Frequency Division Multiple Access |
| OMA DM | Open Mobile Alliance Device Management—A device management protocol. |
| OTA | 'Over the air' (or radiated through the antenna) |

Table H-1: Acronyms and Definitions (Continued)

| Acronym or term | Definition |
|------------------------|--|
| PA | Power Amplifier |
| packet | A short, fixed-length block of data, including a header, that is transmitted as a unit in a communications network. |
| PCB | Printed Circuit Board |
| PCC | Primary Component Carrier |
| PCS | Personal Communication System A cellular communication infrastructure that uses the 1.9 GHz radio spectrum. |
| PDN | Packet Data Network |
| PMI | Pre-coding Matrix Index |
| PSS | Primary synchronisation signal |
| PST | Product Support Tools |
| PTCRB | PCS Type Certification Review Board |
| QAM | Quadrature Amplitude Modulation. This form of modulation uses amplitude, frequency, and phase to transfer data on the carrier wave. |
| QCI | QoS Class Identifier |
| QMI | Qualcomm MSM/Modem Interface |
| QOS | Quality of Service |
| QPSK | Quadrature Phase-Shift Keying |
| QPST | Qualcomm Product Support Tools |
| QZSS | Quasi-Zenith Satellite System—Japanese system for satellite-based augmentation of GPS. |
| RAT | Radio Access Technology |
| RF | Radio Frequency |
| RI | Ring Indicator |
| roaming | A cellular subscriber is in an area where service is obtained from a cellular service provider that is not the subscriber's provider. |
| RSE | Radiated Spurious Emissions |
| RSSI | Received Signal Strength Indication |
| SCC | Secondary Component Carrier |
| SDK | Software Development Kit |
| SED | Smart Error Detection |
| Sensitivity (Audio) | Measure of lowest power signal that the receiver can measure. |

Table H-1: Acronyms and Definitions (Continued)

| Acronym or term | Definition |
|------------------|--|
| Sensitivity (RF) | Measure of lowest power signal at the receiver input that can provide a prescribed BER/BLER/SNR value at the receiver output. |
| SG | An LTE signaling interface for SMS (“SMS over SGs”) |
| SIB | System Information Block |
| SIM | Subscriber Identity Module. Also referred to as USIM or UICC. |
| SIMO | Single Input Multiple Output—smart antenna technology that uses a single antenna at the transmitter side and multiple antennas at the receiver side. This improves performance and security. |
| SISO | Single Input Single Output—antenna technology that uses a single antenna at both the transmitter side and the receiver side. |
| SKU | Stock Keeping Unit—identifies an inventory item: a unique code, consisting of numbers or letters and numbers, assigned to a product by a retailer for purposes of identification and inventory control. |
| SMS | Short Message Service. A feature that allows users of a wireless device on a wireless network to receive or transmit short electronic alphanumeric messages (up to 160 characters, depending on the service provider). |
| S/N | Signal-to-noise (ratio) |
| SNR | Signal-to-Noise Ratio |
| SOF | Start of Frame—A USB function. |
| SSS | Secondary synchronisation signal. |
| SUPL | Secure User Plane Location |
| TDD | Time Division Duplexing |
| TD-SCDMA | Time Division Synchronous Code Division Multiple Access |
| TIA/EIA | Telecommunications Industry Association / Electronics Industry Association. A standards setting trade organization, whose members provide communications and information technology products, systems, distribution services and professional services in the United States and around the world. Consult www.tiaonline.org . |
| TIS | Total Isotropic Sensitivity |
| TRP | Total Radiated Power |
| UDK | Universal Development Kit (for PCI Express Mini Cards) |
| UE | User Equipment |
| UICC | Universal Integrated Circuit Card (Also referred to as a SIM card.) |
| UL | Uplink (mobile to network) |
| UMTS | Universal Mobile Telecommunications System |
| USB | Universal Serial Bus |

Table H-1: Acronyms and Definitions (Continued)

| Acronym or term | Definition |
|------------------------|---|
| USIM | Universal Subscriber Identity Module (UMTS) |
| VCC | Supply voltage |
| VSWR | Voltage Standing Wave Ratio |
| WAN | Wide Area Network |
| WCDMA | Wideband Code Division Multiple Access (also referred to as UMTS) |
| WLAN | Wireless Local Area Network |
| ZIF | Zero Intermediate Frequency |
| ZUC | ZUC stream cypher |

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