AirPrime WP76xx Accessory Board

Product Technical Specification

41113059
Rev 2

Important Notice

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

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

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

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Revision History

Revision number	Release date	Changes
1	March 2019	Creation
2	April 2020	• Added preliminary current consumption values • Renamed GPIO21 to GPIO4 • Updated W_DISABLE_N pull-up value (20k) • Added SYSTEM_RESET_N signal details (was marked as NC) • Corrected B66 frequency in Table 10-10

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1: Introduction

This document defines the high-level product features and illustrates the interfaces for AirPrime WP76xx Accessory Boards (WP7607 Accessory Board, WP7610 Accessory Board). It covers the hardware aspects of the product series, including electrical and mechanical.

1.1 General Features

The AirPrime WP76xx Accessory Board belongs to the AirPrime MC Series product family and provides voice and data connectivity on the wireless networks listed in Table 1-1.

Table 1-1: Supported Networks and Voice Capability

Device	Networks	Network Voice Support	LTE Category
WP7607 Accessory Board	LTE UMTS (DC-HSPA+, HSPA+, HSPA, WCDMA) GSM/GPRS/EDGE	Circuit switch voice + VoLTE[a]	Cat4
WP7610 Accessory Board	LTE UMTS (DC-HSPA+, HSPA+, HSPA, WCDMA)	Circuit switch voice + VoLTE[a]	Cat4

a. VoLTE support is SKU-dependent.

GNSS functionality is available on all WP76xx Accessory Board variants.

The following tables detail supported RF bands/connectivity.

Table 1-2: WP7607 Accessory Board Supported Bands/Connectivity

RF Band		Tx Band (MHz)	Rx Band (MHz)	Notes
LTE	B1	1920–1980	2110–2170	MIMO and diversity
	B3	1710–1785	1805–1880	
	B7	2500–2570	2620–2690	
	B8	880–915	925–960	
	B20	832–862	791–821	
	B28	703–748	758–803	
UMTS	B1	1920–1980	2110–2170	Diversity
	B8	880–915	925–960	
GSM/GPRS/EDGE	E-GSM 900	880–915	925–960	
	DCS 1800	1710–1785	1805–1880	

Table 1-2: WP7607 Accessory Board Supported Bands/Connectivity (Continued)

RF Band		Tx Band (MHz)	Rx Band (MHz)	Notes
GNSS[a]	GPS	-	1575.42 ± 1.023	
	GLONASS	-	1597.52–1605.92	
	Galileo	-	1575.42 ± 2.046	
	BeiDou	-	1561.098 ± 2.046	

a. GNSS support is SKU-dependent.

Table 1-3: WP7610 Accessory Board Supported Bands/Connectivity

RF Band		Transmit Band (Tx) (MHz)	Receive Band (Rx) (MHz)	Notes
LTE	B2	1850–1910	1930–1990	MIMO and diversity
	B4	1710–1755	2110–2155	
	B5	824–849	869–894	
	B12	699–716	729–746	
	B13	777–787	746–756	
	B14	788–798	758–768	
	B17	704–716	734-746	
	B66	1710–1780	2110-2200	
UMTS	B2	1850–1910	1930–1990	Diversity
	B4	1710–1755	2110–2155	
	B5	824–849	869–894	
GNSS[a]	GPS	-	1575.42 ± 1.023	
	GLONASS	-	1597.52–1605.92	
	Galileo	-	1575.42 ± 2.046	
	BeiDou	-	1561.098 ± 2.046	

a. GNSS support is SKU-dependent.

1.2 Interfaces

The AirPrime WP76XX provides the following interfaces and peripheral connectivity:

- VCC power supply—See Power Supply on page 29.
- RF (Main Antenna, Diversity Antenna) —See RF on page 41.
- GNSS (GNSS Antenna)—See GNSS on page 45.
- ON/OFF control—See W_DISABLE_N (Power control, Modem enable/disable) on page 53.
- (1x) USB 2.0—See USB on page 56.
- (1x) 1.8V/3V SIM—See UIM Interface on page 57.

- (3x shared pins, 1x dedicated pin) GPIOs—See General Purpose Input/Output (GPIO) on page 59.
- (1x) VGPIO1.8V voltage reference—See VGPIO on page 61.
- (3x shared pins) Antenna control—See Antenna Control on page 66.
- WAN_LED_N—Active-low LED drive signal indicating RADIO ON state. See WAN_LED_N on page 67.
- WAKE_ON_WWAN—Signal to wake host when specific events occur. See WAKE_ON_WWAN on page 68.
- Digital audio (PCM/I^2S)—See Digital Audio on page 61.

1.3 Physical Dimensions and Connection Interface

The AirPrime WP76xx Accessory Board is a compact, robust device with a fully shielded and labeled (laser-etched) embedded WP76xx module. The WP76xx Accessory Board's dimensions are noted in Table 1-4.

Table 1-4: Physical Parameters[a]

Parameter	Nominal	Tolerance	Units
Length	50.80	±0.15	mm
Width	29.90	±0.15	mm
Thickness	3.55	±0.40	mm
Weight	7.8		g

a. Dimensions are approximate, subject to confirmation.

For device views, see Figure 4-2 on page 52 and Figure 4-3 on page 52. For a product marking example, see Figure 6-1 on page 71.

1.4 ESD

The OEM is responsible for ensuring that the Mini Card host interface pins are not exposed to ESD during handling or normal operation. (For specifications, see Table 4-1 on page 49.)

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 embedded WP module includes ESD protection on its antenna ports.)

1.5 Accessories

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

- Development board
- Cables
- Antennas (Additional antennas may be required to support all bands.)

- Initial allotment of support hours
- Other accessories

For instructions on setting up the UDK (Part # 6000270), see [7] PCI Express Mini Card Dev Kit Quick Start Guide.

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

1.6 Required connectors

Table 1-5 describes the connectors used to integrate AirPrime AirPrime WP76xx Accessory Boards into your host device.

Table 1-5: Required host-module connectors[a]

Connector type	Description
RF cables	• Mate with Hirose U.FL connectors (model U.FL #CL331-0471-0-10) • Three connector jacks
EDGE (52-pin)	• Industry-standard mating connector • Some manufacturers include Tyco, Foxconn, Molex • Example: UDK board uses Molex 67910-0001
SIM	• Industry-standard connector. Type depends on how host device exposes the SIM socket • Example: UDK board uses ITT CCM03-3518

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

2: Functional Specifications

2.1 Architecture

The following figures present overviews of the AirPrime WP76xx Accessory Board's internal architecture and external interfaces.

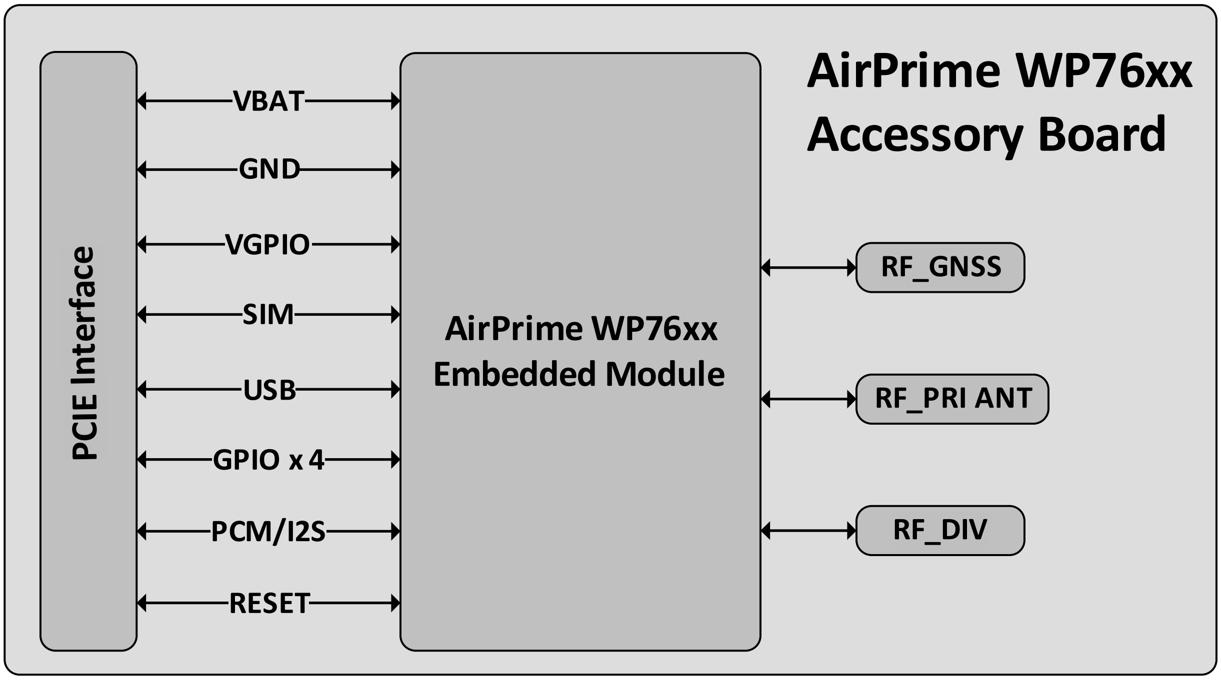


Figure 2-1: Accessory Board Architecture Overview

2.2 Telecom Features

Table 2-1 summarizes the Airprime WP7610 Accessory Board's telecom capabilities.

Table 2-1: General Features

Feature	Description
Physical	• RF connection (RF main interface) • Baseband signals connection
Electrical	Supply voltage (VCC): • WP7607 Accessory Board—3.2–4.3 V • WP7610 Accessory Board—3.4–4.3 V
RF	Supported bands—See Table 1-2 on page 12 and Table 1-3 on page 13.

Table 2-1: General Features

Feature	Description
SIM interface	• 1.8V/3V support • SIM extraction • SIM/USIM support • Conforms with ETSI UICC Specifications • Supports SIM application tool kit with proactive SIM commands
Application interface	• NDIS NIC interface support (Windows XP, Windows 7, Windows 8, Windows CE, Linux) • Multiple non-multiplexed USB channel support • Dial-up networking • USB selective suspend to maximize power savings • AT command interface—3GPP 27.007 standard, plus proprietary extended AT commands
Voice (Digital Audio)	• PCM/I^2S digital audio interface • Supports Enhanced Full Rate (EFR), Full Rate (FR), Half Rate (HR), and both Narrow-Band and Wide-band Adaptive Multirate (AMR-NB and AMR-WB) vocoders • MO and MT calling • Echo cancellation and noise reduction • Emergency calls (112, 110, 911, etc.) • Incoming call notification • DTMF generation
SMS	• SMS MO and MT • CS and PS support • SMS saving to UIM card or ME storage • SMS reading from UIM card or ME storage • SMS sorting • SMS concatenation • SMS Status Report • SMS replacement support • SMS storing rules (support of AT+CNMI, AT+CNMA)

Connectivity	• Multiple (up to 24) cellular packet data profiles
	• Sleep mode for minimum idle power draw
	• Mobile-originated PDP context activation / deactivation
	• Support QoS profile
	  · Release 97 - Precedence Class, Reliability Class, Delay Class, Peak Throughput, Mean Throughput
	  · Release 99 QoS negotiation - Background, Interactive, and Streaming
	• Static and Dynamic IP address. The network may assign a fixed IP address or dynamically assign one using DHCP (Dynamic Host Configuration Protocol).
	• Supports PAP and CHAP authentication protocols
	• PDP context type (IPv4, IPv6, IPv4v6). IP Packet Data Protocol context
	• RFC1144 TCP/IP header compression

2.3 RF

The WP76xx Accessory Board includes three RF connectors for use with host-supplied antennas:

- Main RF connector — Rx / Tx path
- GNSS connector 1 — Dedicated GNSS
- Diversity / MIMO connector — Diversity or MIMO

The module does not have integrated antennas.

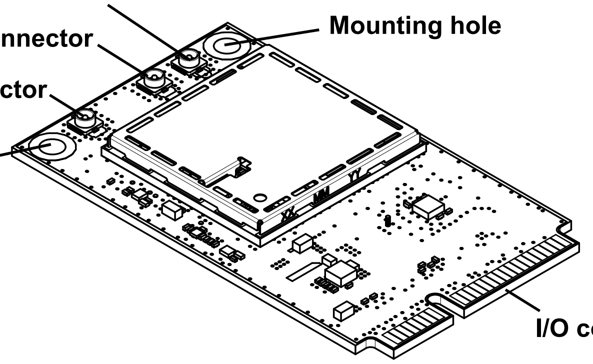


Figure 2-2: Module Connectors

2.3.1 RF connections

When attaching antennas to the module:

- Use Hirose U.FL connectors (3 mm x 3 mm, low profile; model U.FL #CL331-0471-0-10) to attach antennas to connection points on the module, as shown in Figure 2-1.

  (To disconnect the antenna, make sure you use the Hirose U.FL connector removal tool (Part # UFL-LP-N-2(01)) to prevent damage to the module or coaxial cable assembly.)
- 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, mounting holes must be used to attach (ground) the device to the main PCB ground or a metal chassis.

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

2.3.2 Shielding

The accessory board’s embedded module is fully shielded to protect against EMI. The shielding must not be removed.

2.3.3 Antenna and cabling

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

Note: For detailed electrical performance criteria, see *Table 3.3.2 on page 44* and *Table 3.4.2 on page 46*.

2.3.3.1 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 recommended 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.

2.3.3.2 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 multiple RF modules will be installed in the same platform, you may want to develop separate antennas for maximum performance.

2.3.3.3 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 noise or spurious interference 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 20.

2.3.3.4 Disabling the diversity antenna

Certification testing of a device with an integrated WP76xx Accessory Board may require the board's main and diversity antennas to be tested separately.

To facilitate this testing, receive diversity can be enabled/disabled using the AT command !RXDEN. See [1] AirPrime WP8548/WP75xx/WP76xx/WP77xx AT Command Reference for details.

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.*

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.

2.3.4 Ground connection

When connecting the module to system ground:

- Prevent noise leakage by establishing a very good ground connection to the module through the host connector.
- Connect to system ground using the two mounting holes at the top of the module (shown in Figure 2-2 on page 18).
- 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.

2.3.5 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 Methods to mitigate decreased Rx performance on page 21 and Radiated sensitivity measurement on page 21.

Note: The WP76xx Accessory Board 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.

2.3.5.1 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.

2.3.5.2 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

2.3.5.3 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.

2.3.6 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.
- Shield the host device. The module itself is well shielded to avoid external interference. 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.

2.3.7 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.

2.3.7.1 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.

2.3.7.2 Sensitivity vs. frequency

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

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

2.3.8 Supported Frequencies

The following tables indicate the RF frequencies supported by WP76xx Accessory Boards. For additional RF information, see RF on page 41.

Table 2-2: AirPrime WP7607 Accessory Board RF Bands

Technology	RF Band	Transmit Band (Tx) (MHz)	Receive Band (Rx) (MHz)
LTE	B1	1920–1980	2110–2170
	B3	1710–1785	1805–1880
	B7	2500–2570	2620–2690
	B8	880–915	925–960
	B20	832–862	791–821
	B28	703–748	758–803
UMTS	B1	1920–1980	2110–2170
	B8	880–915	925–960
GSM/GPRS/EDGE	E-GSM 900	880–915	925–960
	DCS 1800	1710–1785	1805–1880

Table 2-2: AirPrime WP7607 Accessory Board RF Bands (Continued)

Technology	RF Band	Transmit Band (Tx) (MHz)	Receive Band (Rx) (MHz)
GNSS[a]	GPS	-	1575.42 ± 1.023
	GLONASS	-	1597.52–1605.92
	Galileo	-	1575.42 ± 2.046
	BeiDou	-	1561.098 ± 2.046

a. GNSS support is SKU-dependent.

Table 2-3: AirPrime WP7607 Accessory Board RF Bands

Technology	RF Band	Transmit Band (Tx) (MHz)	Receive Band (Rx) (MHz)
LTE	B1	1920–1980	2110–2170
	B3	1710–1785	1805–1880
	B7	2500–2570	2620–2690
	B8	880–915	925–960
	B20	832–862	791–821
	B28	703–748	758–803
UMTS	B1	1920–1980	2110–2170
	B8	880–915	925–960
GSM/GPRS/EDGE	E-GSM 900	880–915	925–960
	DCS 1800	1710–1785	1805–1880
GNSS[a]	GPS	-	1575.42 ± 1.023
	GLONASS	-	1597.52–1605.92
	Galileo	-	1575.42 ± 2.046
	BeiDou	-	1561.098 ± 2.046

a. GNSS support is SKU-dependent.

2.3.9 Network Technology Specifications

2.3.9.1 GSM/GPRS/EDGE Specifications

The following table describes GSM/GPRS/EDGE specifications for AirPrime WP7607 Accessory Boards.

Table 2-4: Supported GSM Specifications[a]

Standard	Feature Description
GPRS	Packet-switched data: • DTM (simple class A) operation • GPRS Multislot class 10 (no backoff)—Four Rx slots (maximum), two Tx slots (maximum), five active slots total • Coding schemes—CS1–CS4 • GEA1, GEA2, and GEA3 ciphering • WCDMA/GERAN system selection
EDGE	• E2 power class for 8 PSK • DTM (simple class A), multislot class 12 • EGPRS—Multislot class 12 (with backoff)—Four Rx slots (maximum), four Tx slots (maximum), five active slots total • Coding schemes—MCS1–MCS9 • BEP reporting • SRB loopback and test modes A and B • 8-bit and 11-bit RACH • PBCCH support • One-phase/two-phase access procedures • Link adaptation and IR • NACC, extended UL TBF • PFC/PFI (Packet Flow Context/Packet Flow Identifier) support - allows identity tagging of RLC blocks to identify separate QoS streams at the radio link layer • GPRS/EDGE MSC12-EDA - permits allocation of more than two uplink timeslots for GPRS/EDGE • Enh DL RLC/MAC Segmentation - permits reception of MAC control messages that exceed one radio block capacity in length • Enhanced Ext UL TBF - dummy block transmission is punctured for current saving purposes • 2G PS handover - packet-switched equivalent of CS handover to ensure faster cell change and improved throughput • WCDMA/GERAN • Band Scan: Run-time Configurable RRC Band Scan Order • Power and Network Optimizations: Frame Early Termination for Power Optimization • Protocols: MRAB-Pack-1 Enhancements - reduces multi-RAB call drops • GPRS/EDGE - Class 33 (296 kbps downlink, 236.8 kbps uplink) • CSD (Circuit-switched data bearers) • Release 4 GERAN Feature Package 1 • SAIC / DARP Phase 1

Table 2-4: Supported GSM Specifications[a] (Continued)

Standard	Feature Description
EDGE	• Latency reduction • Repeated FACCH, Repeated SACCH • A-GPS support • GPRS ROHC • Enhanced Operator Name String (EONS) • Enhanced Network Selection (ENS)

a. WP7607 Accessory Board only

2.3.9.2 WCDMA Specifications

The following table describes WCDMA specifications for AirPrime WP76xx Accessory Boards.

Table 2-5: Supported WCDMA Specifications

Standard	Feature Description

R99	• All modes and data rates for WCDMA FDD, with the following restrictions:
	  • The downlink supports the following specifications:
	    • Up to four physical channels, including the broadcast channel (BCH), if present
	    • Up to three dedicated physical channels (DPCHs)
	    • Spreading factor (SF) range support from 4 to 256
	  • The uplink supports the following specifications:
	    • One physical channel, eight TrCH, and 16 TrBks starting at any frame boundary
	    • A maximum data rate of 384 kbps
	  • Full SF range support from 4 to 256
	• PS data rates of 384 kbps DL and 384 kbps UL

R8 HSDPA	• PS data speeds up to 42 Mbps (UE category 24) on the downlink
	• HS-DSCH (HS-SCCH, HS-PDSCH, and HS-DPCCH)
	• Maximum of 15 HS-PDSCH channels, both QPSK and 16 QAM modulation
	• Support for 3GPP-defined features:
	  • R99 transport channels
	  • Maximum of four simultaneous HS-SCCH channels
	  • CQI and ACK/NACK on HS-DPCCH channel
	  • All incremental redundancy versions for HARQ
	  • Configurable support for power classes 3 or 4, per TS 25.101
	  • TFC selection limitation on UL factoring in transmissions on the HS-DPCCH, per TS 25.133
	• Switching between HS-PDSCH and DPCH channel resources, as directed by the network
	• Network activation of compressed mode by SF/2 or HLS on the DPCH for conducting inter-frequency or inter-radio access technology (RAT) measurements when the HS-DSCH is active

Table 2-5: Supported WCDMA Specifications (Continued)

Standard	Feature Description
R8 HSDPA	• STTD on both associated DPCH and HS-DSCH simultaneously • CLTD mode 1 on the DPCH when the HS-PDSCH is active • STTD on HS-SCCH when STTD or CLTD mode 1 are configured on the associated DPCH • SCH-IC support • HS-DSCH DRX support

R6 HSUPA	• E-DCH data rates of up to 5.76 Mbps for 2 ms TTI (UE category 6) uplink
	• Support for 3GPP-defined features:
	  · E-AGCH, E-RGCH, and E-HICH channels for downlink; E-RGCH and E-HICH supports serving and non-serving radio links, with up to four radio links in the E-DCH active set
	  · All HARQ incremental redundancy versions and maximum number of HARQ retransmissions
	  · Uplink E-DCH channel with support for up to four E-DPDCH channels
	  · HSUPA channels run simultaneously with R99 and HSDPA channels
	• STTD on all HSUPA downlink channels
	• CLTD mode 1 on HS-PDSCH and DPCH alongQ with HSUPA channels
	• Switch between HSUPA channels and DPCH channel resources, as directed by the network
	• Handover using compressed mode with simultaneous E-DCH and HS-DSCH interactive, background, and streaming QoS classes
	• CSD fallback (WP7607 Accessory Board)
	• DPCCH DTX support

2.3.9.3 LTE Specifications

The following table describes LTE specifications for AirPrime WP76xx Accessory Boards.

Table 2-6: Supported LTE Specifications

Standard	Feature Description
R13	• eDRX (Extended Discontinuous Reception) to extend battery life in devices that do not require frequent network access
R10	• Release 10 mandatory LTE features • Data rates—Cat 4 FDD (up to 150 Mbps downlink, 50 Mbps uplink) • 1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz and 20 MHz RF bandwidth • IPv6, QoS • Inter-RAT capabilities with HSPA+ • NAS & RRC standalone security

Table 2-6: Supported LTE Specifications (Continued)

Standard	Feature Description

R10	• Commercial Mobile Alert System (CMAS)
	• ETWS (Earthquake Tsunami Warning System) notification
	• Inter-frequency/bandwidth mobility
	• DRX cycle while in:
	  · Connected mode
	  · Idle mode
	• UE IRAT support for Self Organizing Networks and Automatic Neighbor Relation (SON AR)
	• Mode reselections:
	  · LTE ↔ GERAN Idle mode mobility (cell reselection)
	  · LTE ↔ UMTS Idle mode mobility (cell reselection)
	• Mode redirections:
	  · UMTS to LTE redirections
	    · Blind redirection
	    · Based on measurements during WCDMA compressed mode gaps
	  · GERAN to LTE redirections (blind; no measurements)
	  · LTE to UMTS redirections (with measurements on UMTS)
	• LTE to UMTS PS Handover
	• LTE/GW Data Silent Redial for InterRAT
	• Attach/detach PS during Voice Call or SMS
	• WCDMA fallback (WP7607 Accessory Board only)

System Determination	• Frequency Scan and System Selection within LTE • LTE BPLMN support • LTE Connected mode OOS • System selection across RATs, Standalone Security, Dedicated EPS Bearer Management and Dormancy • System selection across LTE, UMTS, GERAN • 256 UPLMN and 256 OPLMN entries in UIM support • Carrier Specific BSR Requirements
Data	• Data call throttling • Default IPv4 bearer activation at attach/IPv4 data call • NW and UE initiated QoS • Dual IP and IPv4/IPv6 continuity • IPv4/IPv6 session continuity • W/G IP session continuity • Emergency services—LTE NAS Support for Control Plane LTE Positioning Protocol

2.3.10 Modem Specifications

Table 2-7: Supported Modem Specifications[a]

Standard	Feature Description
Data	• IPHC protocol as RFC 2509 • Stateless DHCPv4 protocol to get P-CSCF and DNS addresses • IPv4/IPv6 • Dual IP on single QMAP PDN • Multi-QMAP PDN Data Call

a. Preliminary

3: Technical Specifications

3.1 Environmental

The environmental specifications for operation and storage of the AirPrime WP76xx Accessory Board are defined in Table 3-1.

Table 3-1: Environmental Specifications[a]

Parameter	Range	Operating Class
Ambient Operating Temperature	-30°C to +70°C	Class A
	-40°C to +85°C	Class B
Ambient Storage Temperature	-40°C to +85°C	-
Relative Humidity	$\leq$ 85%	

a. For more detailed specifications, see Table 4-1 on page 49

Class A is defined as the operating temperature range within which the device:

- Shall exhibit normal function during and after environmental exposure.
- Shall meet the minimum requirements of 3GPP or appropriate wireless standards.

Class B is defined as the operating temperature range within which the device:

- Shall remain fully functional during and after environmental exposure
- Shall exhibit the ability to establish any of the device’s supported call modes (SMS, Data, and emergency calls) at all times even when one or more environmental constraints exceed the specified tolerances.
- Unless otherwise stated, full performance should return to normal after the excessive constraint(s) have been removed.

3.2 Power Supply

The host provides power to the WP76xx Accessory Board through multiple power and ground pins as summarized in Table 3-2 on page 30.

The host must provide safe and continuous power at all times; the WP76xx Accessory Board does not have an independent power supply, or protection circuits to guard against electrical issues.

Table 3-2: Power and Ground Pin Specifications

Pin	Name	Direction	Function
2, 24, 39, 41, 52	VCC	Input	Power supply
4, 9, 15, 18, 21, 26, 27, 29, 34, 35, 37, 40, 43, 50	GND	-	Ground

Table 3-3: Operating Conditions[a]

Parameter		Min	Typ	Max	Units	Notes
Power supply voltage[b]		(WP7607) 3.2 (WP7610) 3.4	3.7	4.3	V	Must be within min/max values over all operating conditions (including voltage ripple, droop, and transient).
Power supply ripple		-	-	100	mV_{pp}	See Figure 3-1 on page 30.
Power supply voltage droop		-	-	250[c]	mV	See Figure 3-1 on page 30.
Power supply voltage transient (overshoot/undershoot)		-	-	300[c]	mV	See Figure 3-1 on page 30.
Supply current	LTE, UMTS	-	0.8	1.5	A	• Typical value varies and depends on output power, band, and operating voltage. See Current Consumption on page 38 for values measured under normal operating conditions. • Max value measured over 100 µs period.
	GSM	-	1.0	3.0	A	

a. Preliminary values, subject to change.
b. Power supply voltage outside the required range may affect call quality (dropped calls, data transfer errors, etc.)
c. Values to be confirmed for WP76xx Accessory Board

Customer should characterize the ripple, droop, and transient response (overshoot/undershoot) of the power supply delivery system at the WP76xx Accessory Boards embedded module input under full transmit power in GSM mode if supported, or LTE mode if not. To minimize voltage variation, add suitable capacitors to the supply line as close as possible to the embedded module—depending on the power supply design, these capacitors may range from tens to several thousand µF.

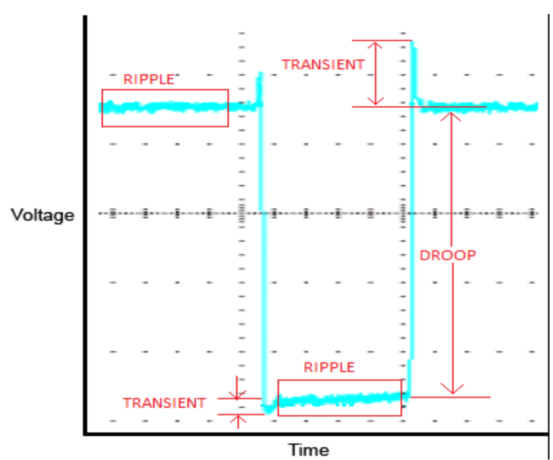


Figure 3-1: Power Supply Characteristics (capture enlarged)

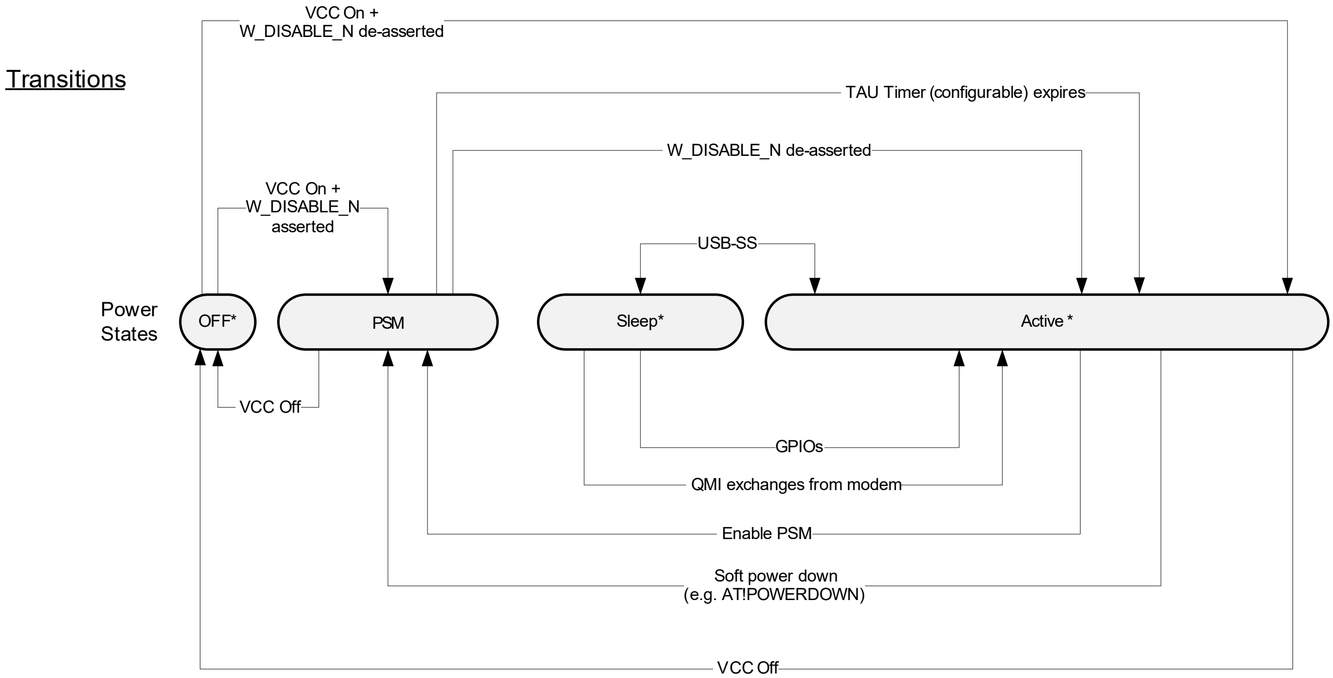
The WP76xx Accessory Board has three basic power states (Active, Sleep, and Off). As the accessory board transitions between power states, the range of available device functionality adjusts appropriately, as described in Table 3-4 on page 31.

Table 3-4: Supported Power States

State	Description
Active	Module is fully powered and operating in one of the following modes: • Full function (WWAN radio active; GNSS radio can be turned on/off)—Highest power consumption. • Idle mode (WWAN radio on; Module registered on network, but no active connection; GNSS radio can be turned on/off) • Airplane mode (WWAN radio off; GNSS radio can be active if allowed by PRI) • eDRX (Extended Discontinuous Reception)—eDRX mode provides a 'flexible sleep' for the modem, which significantly reduces energy consumption. For eDRX details, see Extended Discontinuous Reception (eDRX) on page 36.
Sleep	Lower power consumption than Active state. • Modem is in DRX/eDRX. The module monitors signals (triggers) that can 'wake' it—see Wakeup Interrupt (Sleep State) on page 60 for details. Sleep state can be entered based on USB-SS (if USB is connected to the module), configured GPIOs, and QMI exchanges from the modem. *Note: On Windows systems, due to limitations of the Windows ECM driver, Sleep state is only supported if ECM is disabled or USB is disconnected.*
LTE Power Saving Mode (PSM)	3GPP Release 12 introduced network support of PSM. PSM allows the module to negotiate, with the network, an extended period during which registration context with the network is retained while the module is unreachable. During the negotiated period, the module enters PSM, which enables the module to attain its lowest power consumption. When a wakeup source triggers exit from PSM, the modem boots up and the module sends a TAU (Tracking Area Update) to the network. After sending the TAU, the module remains active to allow any pending data to be exchanged with the network. Then, after a negotiated period of inactivity, the module automatically repeats the PSM cycle. *Note: Wakeup sources are retained across PSM cycles, but may be changed by the application during the active period, if desired.* For PSM details, see Power Saving Mode (PSM) on page 32.
OFF	Module is OFF (no power to the system). Apply power and de-assert W_DISABLE_N to go to the Active state. For details, see Power Sequence on page 54.

Table 3-5: PSM Wakeup Sources

Type	Description
PSM TAU timer	Periodic TAU—PSM Cycle Timer (T3412) Configurable timer specifying PSM sleep duration. See Table 3-6 on page 34 for configuration methods.
Wakeup timer	Timer that triggers after a specified period. Derived from TAU timer (value is automatically set slightly shorter than TAU timer to ensure module boot completes before TAU timer expires).
W_DISABLE_N	Wakes the module when de-asserted (transitions from OFF to ON).



* Refer to Table 3-4 on page 31 for Power State definitions.

Figure 3-2: Power State Transitions

3.2.1 Power Saving Mode (PSM)

Power Saving Mode (PSM) is a 3GPP feature that allows the WP76xx to minimize power consumption by registering on a PSM-supporting LTE network, entering a very low power ‘dormant’ state for a pre-configured duration (via a periodic TAU (Tracking Area Update) timer), and then booting up for a short period to transmit/receive data, before re-entering PSM. During the dormant period, the module remains unreachable by the network until it is woken by the TAU timer expiring or by being rebooted.

Note: When using PSM, the W_DISABLE_N signal must be asserted. If this signal is floating or pulled high, it will automatically trigger a wake.

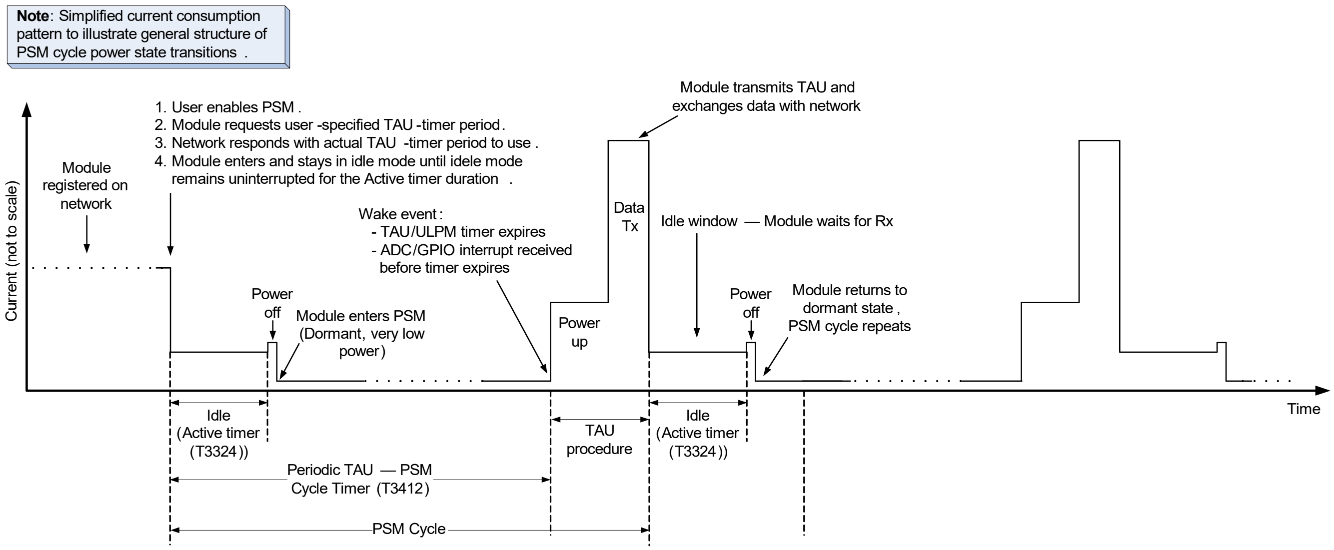


Figure 3-3: PSM Example (Simplified)

Typical candidates for PSM are systems (such as monitors and sensors) that:

- Require long battery life (low power consumption)
- Tolerate very long latency for mobile-terminated SMS/data
- Do not use mobile-terminated voice
- Send and/or receive data infrequently and periodically (e.g. on a given schedule of once every few hours, days, weeks, etc.)

For example, a WP76xx Accessory Board connected to a sensor can be configured to:

- Wake periodically to transmit collected data to a server or network entity (e.g. once per week schedule), then
- Wait a short (configured) period of time to receive transmissions (e.g 60 seconds) and then return to its dormant state.

Table 3-6 identifies available AT commands that are used to configure PSM.

Table 3-6: PSM-Related AT Commands

Command[a]/Interface	Description
Note: PSM can be enabled and configured using either +CPSMS, or the combination of !POWERMODE and !POWERWAKE. Setup may be easier (more clear) using !POWERMODE/!POWERWAKE since timer values are specified in integer format instead of the bitmap format used by +CPSMS.	
+CPSMS	3GPP-defined command (3GPP TS27.007 Release 12) that allows direct control of all LTE PSM parameters, and is useful for advanced users wanting to test/ experiment with different options. This command is limited to networks that support PSM. It is not expected that every user must be fully versed in the details of PSM to take advantage of its capabilities. Use this command to: • Enable/disable LTE PSM. • Configure Period TAU timer (T3412) with a requested maximum duration of the dormant period. • Configure Active timer (T3324) with a requested 'idle mode time' (the duration the module remains idle before going dormant) • For usage details, refer to [1] AirPrime WP8548/WP75xx/WP76xx/WP77xx AT Command Reference. (This command follows the 3GPP TS 27.007, Release 12 specification, with exceptions noted for certain parameters.) *Note: The requested timer values are negotiated with the network and the final negotiated values take effect immediately, then persist across power cycles (e.g. after a power cycle, the settings will be used during network attach).*
!POWERMODE and !POWERWAKE	Custom Sierra Wireless commands used to configure the TAU timer and Active timer, and to enable/disable PSM. **Important:** *When using !POWERMODE to enable PSM, make sure to set <mode>=2 (Enable PSM with wakeup sources). Do not use option 1 (Enable PSM with ULPM fallback).*
Important: *Sierra Wireless recommends not combining use of +CPSMS and !POWERWAKE/ !POWERMODE. These commands have some functional overlap, which may result in unexpected effects.*	

a. For AT command details, refer to [1] AirPrime WP8548/WP75xx/WP76xx/WP77xx AT Command Reference, available from the device's page on source.sierrawireless.com.
For API library function details, refer to docs.legato.io/latest/legatoServicesPowerMain.html.

Example: PSM Process

The following example describes how the module uses PSM (as shown in Figure 3-3 on page 33):

1. Module registers on an LTE network.
2. User enables PSM via AT command or API library function, specifying the desired TAU timer and Active timer periods.
3. Module submits the PSM request (including desired TAU timer) to the network.
4. Network responds and indicates whether PSM is supported and (if it is) indicates the actual TAU timer to use.
5. If the network supports PSM:
   a. Module enters idle mode (waiting for Rx from network).
   b. When module has remained idle for the Active timer period, module powers off (except for maintaining timer and interrupts) and enters PSM.
   c. Module remains in PSM for the specified TAU timer period or until W_DISABLE_N wakes it.

Note: If traffic must be transmitted when the module is in the sleep portion of the cycle, the module can initiate data/SMS/voice session immediately.

   d. Module powers up before TAU timer expires, then transmits TAU and/or exchanges data with network.
   e. Module enters idle mode and cycle repeats.

Note: When the module is powered up, the PSM request can be re-issued with different timers and triggers to adjust the PSM behavior. These new settings take effect immediately.

Important Notes

- Carefully select the PSM Periodic-TAU timer and Active Time values to match the intended use case(s) for the module:
  - Periodic TAU PSM Cycle timer (T3412)—Note that while the module is dormant (for the duration of this timer, unless woken by W_DISABLE_N), it will be completely unreachable by the network.
  - Active Time (Idle mode time after transmission (T3324))—Make sure to set the Active timer high enough to provide appropriate delay-tolerance for mobile-terminated/network-originated transmissions to be received.
- When using multiple devices, consider scheduling the modules to wake at different times so that the network does not get flooded by all modules waking and transmitting simultaneously.

3.2.2 Active State to PSM Transition

If the module will be used in situations where it needs to be active very infrequently (for example, in a remote monitoring station that must transmit data periodically—e.g. on a regular schedule ranging from days to weeks or more), PSM may be used to reduce power consumption much more than is possible in Sleep state (low power active state):

1. Configure the PSM TAU timer.

Note: The TAU timer value is persistent — if the module enters PSM and then returns to Active power state, the configured timer value remains in effect.

2. Initiate PSM. The module will enter PSM.

3.2.3 Extended Discontinuous Reception (eDRX)

The WP76xx Accessory Board supports eDRX, which is a 'flexible sleep' active mode that allows for longer sleep duration ($T_{C\text{-}eDRX}$, $T_{I\text{-}eDRX}$) and a significant decrease in power consumption compared to regular DRX ($T_{C\text{-}DRX}$, $T_{I\text{-}DRX}$).

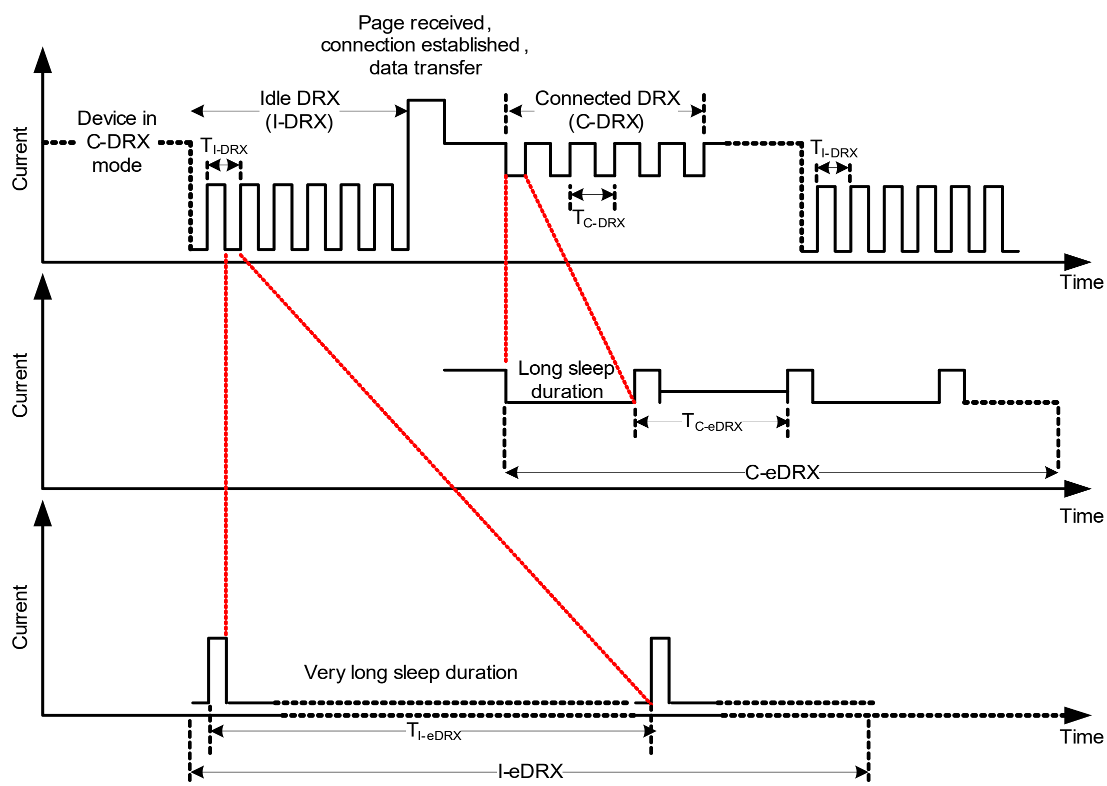


Figure 3-4: eDRX Example (Simplified)

Specifically, the WP76xx Accessory Board supports two forms of eDRX, both of which extend the DRX cycle (the paging cycle comprised of a paging window during which the module is awake and able to receive or transmit on the network, and a sleep period during which the network cannot wake the module) by increasing the sleep duration beyond the DRX maximum of 2.56 seconds:

- I-eDRX (Idle mode eDRX)—The sleep duration of the DRX cycle can be set up to 44 minutes for LTE-M.

  Note that I-eDRX has wider network support than C-eDRX.
- C-eDRX (Connected mode eDRX)—The sleep duration of the DRX cycle can be set up to 10 seconds.

Note: If traffic must be transmitted when the module is in the sleep portion of the cycle, the module can initiate data/SMS/voice session immediately.

Table 3-7 describes the available methods for configuring eDRX.

Table 3-7: eDRX-Related Commands[a]

Type	Command	Description
AT	+CEDRXS	Enable/disable eDRX, and configure related settings
AT	+CEDRXRDP	Display current eDRX settings

a. For AT command details, refer to [1] AirPrime WP8548/WP75xx/WP76xx/WP77xx AT Command Reference from the device's page on source.sierrawireless.com.

Example: eDRX Process

- Use the AT+CEDRXS command to configure the desired eDRX behavior.
- During the network attachment process:
  - eDRX request and settings are sent to the network
  - Network responds and indicates whether eDRX is supported for the connection and may adjust the eDRX parameters.
- If eDRX is supported by the network:
  - While in active mode (connected), the C-eDRX sleep duration is used if supported, otherwise the regular DRX sleep duration is used.
  - While in idle mode, the I-eDRX sleep duration is used if supported, otherwise the network uses the standard LTE I-DRX value.

Important Notes

- The sleep duration must be carefully selected to match the intended use case(s) for the module. While the module is asleep, it will be unreachable by the network. The duration should provide appropriate delay-tolerance for mobile-terminated/ network-originated transmissions to be received.
- Due to the extended sleep time compared to regular DRX, eDRX is not suitable for most mobile-terminated voice connections.
- Network-side store and forward is supported—Packets will be stored until the module is reachable.

3.2.4 Current Consumption

Power consumption measurements in the tables below are for the WP7607 Accessory Board and WP7610 Accessory Board connected to the host PC via USB.

The module does not have its own power source and depends on the host device for power. For a description of input voltage requirements, see Power Supply on page 29.

Table 3-8: WP7607 Accessory Board Averaged Standby DC Power Consumption[a]

Signal	Description	Bands	Current			Notes / configuration
			Typ	Max[b]	Unit	
VCC	**Standby current consumption (Sleep mode activated[c])**					
	LTE	LTE bands	3.0	3.6	mA	DRX cycle = 8 (2.56 s)
	DC-HSPA+ / HSPA+ / HSPA / WCDMA	UMTS bands	3.0	3.6	mA	DRX cycle = 8 (2.56 s)
	GSM / GPRS / EDGE	All bands	3.1	3.7	mA	MFRM = 5 (1.175 s)
	Standby current consumption[d] (Sleep mode deactivated[c])					
	LTE	LTE bands	26.5	31.0	mA	DRX cycle = 8 (2.56 s)
	DC-HSPA+ / HSPA+ / HSPA / WCDMA	UMTS bands	26.5	31.0	mA	DRX cycle = 8 (2.56 s)
	GSM / GPRS / EDGE	All bands	26.5	31.0	mA	MFRM = 5 (1.175 s)
	Low Power Mode (LPM)/Offline Mode[d] (Sleep mode activated[c])					
	RF disabled, but module is operational		2.1	2.8	mA	
	Low Power Mode (LPM)/Offline Mode[d] (Sleep mode deactivated[c])					
	RF disabled, but module is operational		26.0	30.0	mA	
	Leakage current					
	Module powered off—W_DISABLE_N is Low, and the module is in OFF state while VCC is supplied		70	120	µA	

a. Preliminary values
b. Measured at 30ºC/nominal 3.7 V voltage.
c. Assumes USB bus is fully suspended during measurements
d. 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 3-9: WP7610 Accessory Board Averaged Standby DC Power Consumption[a]

Signal	Description	Bands	Current			Notes / configuration
			Typ	Max[b]	Unit	
VCC	**Standby current consumption (Sleep mode activated[c])**					
	LTE	LTE bands	1.7	2.3	mA	DRX cycle = 8 (2.56 s)
	DC-HSPA+ / HSPA+ / HSPA / WCDMA	UMTS bands	1.7	2.3	mA	DRX cycle = 8 (2.56 s)
	Standby current consumption[d] (Sleep mode deactivated[c])					
	LTE	LTE bands	25.5	30.0	mA	DRX cycle = 8 (2.56 s)
	DC-HSPA+ / HSPA+ / HSPA / WCDMA	UMTS bands	25.5	30.0	mA	DRX cycle = 8 (2.56 s)
	Low Power Mode (LPM)/Offline Mode[d] (Sleep mode activated[c])					
	RF disabled, but module is operational		1.4	2.0	mA	
	Low Power Mode (LPM)/Offline Mode[d] (Sleep mode deactivated[c])					
	RF disabled, but module is operational		25.0	29.0	mA	
	Leakage current					
	Module powered off—W_DISABLE_N is Low, and the module is in OFF state while VCC is supplied		70	120	µA	

a. Preliminary values
b. Measured at 30ºC/nominal 3.7 V voltage.
c. Assumes USB bus is fully suspended during measurements
d. 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 3-10: WP7607 Accessory Board Averaged Call Mode DC Power Consumption[a]

Description	Tx power	Current[b]		Notes
		Typ	Unit	
LTE	0 dBm	640[c]	mA	75/25 Mbps, 10 MHz bandwidth
		790[c]	mA	150/50 Mbps, 20 MHz bandwidth
	20 dBm	670[c]	mA	75/25 Mbps, 10 MHz bandwidth
		1040[c]	mA	150/50 Mbps, 20 MHz bandwidth
	23 dBm	820[c]	mA	75/25 Mbps, 10 MHz bandwidth
		1210[c]	mA	150/50 Mbps, 20 MHz bandwidth
DC-HSPA+/HSPA+ / HSPA / WCDMA	0 dBm	440[c]	mA	19/5 Mbps, All bands
	20 dBm	690[c]	mA	19/5 Mbps, All bands
	23 dBm	880[c]	mA	19/5 Mbps, All bands

Table 3-10: WP7607 Accessory Board Averaged Call Mode DC Power Consumption[a] (Continued)

Description	Tx power	Current[b]		Notes
		Typ	Unit	
EDGE	4 slots, 27 dBm	550[d]	mA	All bands
Peak Current		2	A	All GSM/GPRS/EDGE bands

a. Preliminary values
b. Measured at 30ºC/nominal 3.7 V voltage
c. Measured worst case plus 100 mA margin
d. Average current 480 mA plus 70 mA margin for data throughput

Table 3-11: WP7610 Accessory Board Averaged Call Mode DC Power Consumption[a]

Description	Tx power	Current[b]		Notes
		Typ	Unit	
LTE	0 dBm	710[c]	mA	75/25 Mbps, 10 MHz bandwidth
		720[c]	mA	150/50 Mbps, 20 MHz bandwidth
	20 dBm	880[c]	mA	75/25 Mbps, 10 MHz bandwidth
		1020[c]	mA	150/50 Mbps, 20 MHz bandwidth
	23 dBm	910[c]	mA	75/25 Mbps, 10 MHz bandwidth
		1170[c]	mA	150/50 Mbps, 20 MHz bandwidth
DC-HSPA+/HSPA+ / HSPA / WCDMA	0 dBm	325[c]	mA	19/5 Mbps, All bands
	20 dBm	735[c]	mA	19/5 Mbps, All bands
	23 dBm	940[c]	mA	19/5 Mbps, All bands

a. Preliminary values
b. Measured at 30ºC/nominal 3.7 V voltage
c. Measured worst case plus 100 mA margin

Table 3-12: WP7607 Accessory Board Miscellaneous DC Power Consumption[a]

Signal	Description	Current/Voltage			Unit	Notes/configuration
		Min	Typ	Max		
VCC	USB active current	—	23.5	30.0	mA	High speed USB connection
	Inrush current	—	1.0	1.5	A	• Assumes power supply turn on time > 100µs • Dependent on host power supply rise time.
	Maximum current	—	—	2.0	A	• Across all bands, all temperature ranges • 3.7 V supply

Table 3-12: WP7607 Accessory Board Miscellaneous DC Power Consumption[a] (Continued)

Signal	Description	Current/Voltage			Unit	Notes/configuration
		Min	Typ	Max		
GNSS Signal connector	Active bias on GNSS port	—	—	100	mA	
		3.0	3.15	3.25	V	

a. Preliminary values

Table 3-13: WP7610 Accessory Board Miscellaneous DC Power Consumption[a]

Signal	Description	Current/Voltage			Unit	Notes/configuration
		Min	Typ	Max		
VCC	USB active current	—	24.0	30.0	mA	High speed USB connection
	Inrush current	—	2.0	2.5	A	• Assumes power supply turn on time > 100µs • Dependent on host power supply rise time.
	Maximum current	—	—	2.0	A	• Across all bands, all temperature ranges • 3.7 V supply
GNSS Signal connector	Active bias on GNSS port	—	—	100	mA	
		3.0	3.15	3.25	V	

a. Preliminary values

3.3 RF

AirPrime WP76xx Accessory Boards are designed to be compliant with the standards in Table 3-14.

Table 3-14: Standards Compliance

Technology	Standards	WP7607	WP7610
LTE	• 3GPP Release 10	Yes	Yes
UMTS (WCDMA)	• 3GPP Release 8	Yes	Yes
GSM	• ETSI GSM 05.05 • 3GPP TS 45.005/Antecedent TS 05.05	Yes	N/A

3.3.1 Rx Sensitivity/Tx Output Power

Conducted Rx sensitivity and conducted Tx output power values for the AirPrime WP76xx Accessory Board depend on the model of embedded WP module on the board (e.g. WP7607, WP7610).

Table 3-15—Table 3-19 (below) present the Rx sensitivity values for the WP7607 and WP7610 accessory boards.

For Tx output power values, refer to [2] AirPrime WP76xx Product Technical Specification.

Important: *The Rx sensitivity values measured below are for WP76xx modules integrated on WP76xx accessory boards—these values will differ from values in the WP76xx Product Technical Specification (PTS) due to sensitivity drops incurred by the accessory board. As well, changes to the WP76xx PTS values that occur after publication of this WP76xx Accessory Board Product Specification may need to be considered.*

Table 3-15: WP7607 Accessory Board Conducted Rx Sensitivity—GSM/GPRS/EDGE Bands[a,b]

Band	@ +25°C (dBm)[c]		@ Class A (dBm)[d]		Standard Limits (dBm)		Notes
	GMSK (Typ)	EDGE (Typ)	GMSK (Typ)	EDGE (Typ)	GMSK	EDGE	
E-GSM 900	-106	-94	-104	-92	-99.6	-86	GMSK MCS4 EDGE MCS9
DCS 1800	-105	-93	-104	-92	-99.6	-86	

a. All values are preliminary, pending testing confirmation.
b. Stated sensitivity values satisfy 3GPP TS 51.010-1 requirements for normal (25°C) and Class A (extreme) conditions.
c. Typical values, tested at 25°C
d. Typical values, tested at Class A extreme condition

Table 3-16: WP7607 Accessory Board Conducted Rx Sensitivity—WCDMA Bands[a,b]

Band	+25°C (dBm)[c]		Class A (dBm)[d]		Standard Limit (dBm)	Notes
	Primary	Secondary	Primary	Secondary		
B1	-110	-110	-109	-109	-106.7	CS 0.1% BER 12.1 kbps Reference Measurement Channel
B8	-111	-110	-110	-108	-103.7	

a. All values are preliminary, pending testing confirmation.
b. Stated sensitivity values satisfy 3GPP TS 34.121-1 V8.10.0 requirements for normal (25°C) and Class A (extreme) conditions.
c. Typical values, tested at 25°C
d. Typical values, tested at Class A extreme condition

Table 3-17: WP7610 Accessory Board Conducted Rx Sensitivity—WCDMA Bands[a,b]

Band	+25°C (dBm)[c]		Class A (dBm)[d]		Standard Limit (dBm)	Notes
	Primary	Secondary	Primary	Secondary		
B2	-110	-111	-109	-110	-104.7	CS 0.1% BER 12.2 kbps Reference Measurement Channel
B4	-110	-111	-109	-110	-106.7	
B5	-112	-111	-110	-111	-104.7	

a. All values are preliminary, pending testing confirmation.
b. Stated sensitivity values satisfy 3GPP TS 34.121-1 V8.10.0 requirements for normal (25°C) and Class A (extreme) conditions.
c. Typical values, tested at 25°C
d. Typical values, tested at Class A extreme condition

Table 3-18: WP7607 Accessory Board Conducted Rx Sensitivity—LTE Bands[a]

LTE bands		+25°C (dBm)[b]			Class A (dBm)[c]			SIMO (Worst case)[d]
		Primary	Secondary	SIMO	Primary	Secondary	SIMO	
B1	Full RB BW: 10 MHz[e]	-97	-97	-101	-97	-96	-99	-96.3
B3		-97	-98	-100	-96	-97	-100	-93.3
B7		-96	-98	-100	-95	-97	-99	-94.3
B8		-98	-97	-100	-97	-96	-99	-93.3
B20		-97	-94	-99	-96	-93	-98	-93.3
B28		-96	-94	-99	-95	-93	-97	-94.8

a. All values are preliminary, pending testing confirmation.
b. Typical values, tested at 25°C
c. Typical values, tested at Class A extreme condition
d. Per 3GPP specification.
e. Sensitivity values scale with bandwidth: x_MHz_Sensitivity = 10_MHz_Sensitivyt - 10×log(10 MHz/x_MHz)
Note: Bandwidth support is dependent on firmware version.

Table 3-19: WP7610 Accessory Board Conducted Rx Sensitivity—LTE Bands[a]

LTE bands		+25°C (dBm)[b]			Class A (dBm)[c]			SIMO (Worst case)[d]
		Primary	Secondary	SIMO	Primary	Secondary	SIMO	
B2	Full RB BW: 10 MHz[e]	-98	-98	-101	-98	-97	-101	-94.3
B4		-98	-98	-101	-97	-97	-101	-96.3
B5		-99	-98	-102	-98	-98	-101	-94.3
B12		-95	-91	-98	-94	-91	-97	-93.3
B13		-99	-93	-100	-97	-91	-99	-93.3
B14		-96	-95	-99	-95	-94	-98	-93.3
B17		-95	-92	-98	-95	-91	-97	-93.3
B66		-98	-98	-101	-97	-97	-101	-95.8

a. All values are preliminary, pending testing confirmation.
b. Typical values, tested at 25°C
c. Typical values, tested at Class A extreme condition
d. Per 3GPP specification.
e. Sensitivity values scale with bandwidth: x_MHz_Sensitivity = 10_MHz_Sensitivyt - 10×log(10 MHz/x_MHz)
Note: Bandwidth support is dependent on firmware version.

3.3.2 WWAN Antenna Recommendations

Table 3-20 defines the key characteristics to consider for antenna selection.

Table 3-20: Antenna Recommendations[a,b]

Parameter		Recommendations	Comments
Antenna system		External multi-band antenna system	Dual WWAN antennas for diversity (Antenna 1/ Antenna 2)[c]
Operating bands	WP7607 Accessory Board	703–960 MHz	Operating bands depend on the module’s supported bands/modes.
		1710–1980 MHz	
		2110–2170 MHz	
		2500–2690 MHz	
	WP7610 Accessory Board	699–894 MHz	Operating bands depend on the module’s supported bands/modes.
		1710–2200 MHz	
		2110–2155 MHz	
		2496–2690 MHz	
VSWR		< 2.5:1 (worst case)	• On all bands including band edges • Applies to both antennas
Total radiated efficiency		> 50% on all bands	• Measured at the RF connector. • Applies to both antennas. • 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 omnidirectional gain patterns). Peak gain can be affected by antenna size, location, design type, etc.—the antenna gain pattern remains fixed unless one or more of these parameters change.
Radiation patterns		Nominally omnidirectional radiation pattern in azimuth plane.	
Envelope correlation coefficient between Antenna 1 and Antenna 2		• < 0.5 on Rx bands below 960 MHz • < 0.2 on Rx bands above 1.4 GHz	
Mean Effective Gain (MEG)		≥ -3 dBi	
Mean Effective Gain Imbalance—Antenna 1 and Antenna 2 (MEG1 / MEG2)		< 6 dB for diversity operation	

Table 3-20: Antenna Recommendations[a,b] (Continued)

Parameter	Recommendations	Comments
Maximum antenna gain	Must not exceed antenna gains due to RF exposure and ERP/EIRP limits, as listed in the module's FCC grant.	See Important Compliance Information for North American Users on page 76.
Isolation between Antenna 1 and Antenna 2 (S21)	> 10 dB	• If antennas can be moved, test all positions for both antennas. • Make sure all other wireless devices (Bluetooth or WLAN antennas, etc.) are turned OFF to avoid interference.
Power handling	• > 1 W on all bands	• Measure power endurance over 4 hours (estimated talk time) using a 2 W CW signal—set the CW test signal frequency to the middle of the PCS Tx band (1880 MHz for PCS). • Visually inspect device to ensure there is no damage to the antenna structure and matching components. • VSWR/TIS/TRP measurements taken before and after this test must show similar results.

a. These worst-case VSWR figures for the transmitter bands may not guarantee RSE levels to be within regulatory limits. The device alone meets all regulatory emissions limits when tested into a cabled (conducted) 50 ohm system. With antenna designs with up to 2.5:1 VSWR or worse, the radiated emissions could exceed limits. The antenna system may need to be tuned in order to meet the RSE limits as the complex match between the module and antenna can cause unwanted levels of emissions. Tuning may include antenna pattern changes, 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 4.2.16 for GSM (ETSI EN 301 511), and test case 4.2.2 for WCDMA (ETSI EN 301 908-1), where applicable.
b. All values are preliminary and subject to change.
c. Antenna 1—Primary, Antenna 2—Secondary (Diversity/MIMO)

3.4 GNSS

The AirPrime WP76xx Accessory Board includes Global Navigation Satellite System (GNSS) capabilities via the QUALCOMM IZat™ Gen8C Engine (formerly gpsOne), capable of operation in assisted and standalone GNSS modes (GPS/Galileo/GLONASS/BeiDou).

3.4.1 GNSS Characteristics

The GNSS implementation supports GPS L1, Galileo E1, BeiDou-B1 and GLONASS L1 FDMA operation.

Table 3-21: GNSS Characteristics[a,b]

Parameter		Value
Sensitivity[c]	Standalone or MS-based tracking sensitivity	-160 dBm
	Cold start acquisition sensitivity	-145 dBm
	MS-assisted acquisition sensitivity	-158 dBm
Accuracy in open sky (1 Hz tracking)		< 2 m CEP-50
Satellite channels available[d]	Acquisition	118
	Simultaneous tracking	40
Support for predicted orbits		Yes
Predicted orbit CEP-50 accuracy		5 m
Standalone Time To First Fix (TTFF)	Hot	1 s
	Warm	29 s
	Cold	32 s
Altitude (max)		18,2888 m (60,000 ft)
Velocity (max)		1,852 km/h (1150.8 mph)
Acceleration (max)		20 m/s^2
GNSS message protocols		NMEA

a. All values are preliminary and subject to change.
b. Acquisition / tracking sensitivity performance figures assume open sky with active patch GNSS antenna and a 2.5 dB noise figure.
c. GNSS sensitivity may degrade for modules installed in snap-in sockets.
d. Resources are dynamically assigned and not constellation-specific.

3.4.2 GNSS Antenna Recommendations

Table 3-22 defines the key characteristics to consider for GNSS antenna selection.

Table 3-22: GNSS Standalone Antenna Recommendations[a]

Parameter	Recommendations	Notes
Frequency range	• Wide-band GPS, Galileo, GLONASS, and BeiDou: 1559–1606 MHz recommended • Narrow-band GPS: 1575.42 MHz ± 2.046 MHz minimum	
Field of view (FOV)	• Omni-directional in azimuth • -45° to +90° in elevation	

Table 3-22: GNSS Standalone Antenna Recommendations[a] (Continued)

Parameter	Recommendations	Notes
Polarization (average Gv/Gh)	> 0 dB	Vertical linear polarization is sufficient.
Free space average gain (Gv+Gh) over FOV	> -6 dBi (preferably > -3 dBi)	Gv and Gh are measured and averaged over -45° to +90° in elevation, and ±180° in azimuth.
Gain	• Maximum gain and uniform coverage in the high elevation angle and zenith. • Gain in azimuth plane is not desired.	
Average 3D gain	> -5 dBi	
Isolation between GNSS and RF Antenna	> 10 dB in all uplink bands	
Typical VSWR	< 2.5:1	
Polarization	Any other than LHCP (left-hand circular polarized) is acceptable.	Type of antenna and polarization (RHCP/linear) to be implemented is a matter of consideration based on specific end application.
Maximum voltage applied to antenna	6.3 VDC	
700 MHz harmonic[b]	< -56 dBm (input jammer 787.76 MHz at -25 dBm and measure the harmonic tone at 1575.42 MHz)	This specification is for B13 and B14 coexistence.
IIP2[b]	> 45 dBm (Input jammers at 824.6 MHz with level -25 dBm and 2400 MHz with level -32 dBm and measure output IM2 at 1575.4 MHz)	Out of band
IIP3[b]	> 2 dBm (Input jammers at 1712.7 MHz with level -20 dBm and 1850 MHz with level -65 dBm and measure output IM3 at 1575.4 MHz)	Out of band
Input 1 dB power compression point[b]	> -10 dBm	
Out of band rejection for an active antenna		
777–798 MHz	> 50 dB	
814–915 MHz	> 40 dB	50 dB is preferred
925–960 MHz	> 30 dB	50 dB is preferred
1427–1463 MHz	> 35 dB	
1710–1785 MHz	> 35 dB	
1850–1980 MHz	> 40 dB	
2010–2025 MHz	> 40 dB	
2305–2315 MHz	> 40 dB	

Table 3-22: GNSS Standalone Antenna Recommendations[a] (Continued)

Parameter	Recommendations	Notes
2401–2483 MHz	> 40 dB	
2500–2570 MHz	> 35 dB	

a. All values are preliminary and subject to change.
b. For the LNA used by an active antenna

4: Mechanical and Environmental Specifications

The AirPrime WP76xx Accessory Board complies with the mechanical and environmental specifications in Table 4-1. Final product conformance to these specifications depends on the OEM device implementation.

Table 4-1: Mechanical and environmental specifications

	Mode	Details
Temperature	Operational	Ambient temperature: • Class A[1]: -30ºC to +70ºC (3GPP compliant) Class A is defined as the operating temperature range within which the device: • Exhibits normal function during and after environmental exposure. • Meets the minimum requirements of 3GPP, 3GPP2, or appropriate wireless standards.
		Ambient temperature: • Class B[1]: -40ºC to +85ºC (non-3GPP compliant) Class B is defined as the operating temperature range within which the device: • Remains functional during and after environmental exposure. • Exhibits the ability to establish a voice, SMS or DATA call (emergency call) at all times even when one or more environmental constraints exceed the specified tolerances.
		Internal module temperature: • Class A—Recommended temperature[2]: < 85ºC (3GPP compliant) • Class B—Maximum temperature[2]: < 100ºC (non-3GPP compliant)
	Non-operational	-40ºC to +85ºC, 96 hours (from MIL-STD 202 Method 108)
Relative humidity	Non-operational	85ºC, 85% relative humidity for 48 hours (non-condensing)
Vibration	Operational	High vibration limit test: • Tri-axial vibration (20–5000 Hz), test 20 G_{rms}, 10 minutes
Shock	Non-operational	Half sine shock, 6 ms, 30 g, 3x each axis
Drop	Non-operational	1 m on concrete on each of six faces, one time

Table 4-1: Mechanical and environmental specifications (Continued)

	Mode	Details
(Electrostatic discharge (See ESD on page 14.)	Operational	The RF port (antenna launch and RF connector) complies with the IEC 61000-4-2 standard: • Electrostatic Discharge Immunity: Test: Level3 Contact Discharge: ±6 kV
	Non-operational	The host connector Interface complies with the following standard only: • minimum ±500 V Human Body Model (JESD22-A114-B)
Thermal considerations		See Thermal considerations on page 50.
Dimensions		Length: 50.80 ± 0.15 mm Width: 29.90 ± 0.15 mm Thickness: 3.55 ± 0.40 mm Weight: 7.8 g

1. Ambient temperature (temperature around the module). Proper mounting, heat sinks and active cooling may be required, depending on the integrated application.
2. Measured by AT!PCTEMP

4.5 Thermal considerations

When transmitting, the AirPrime WP76xx Accessory Board's embedded WP module can generate significant amounts of heat that must be dissipated in the host device for safety and performance reasons.

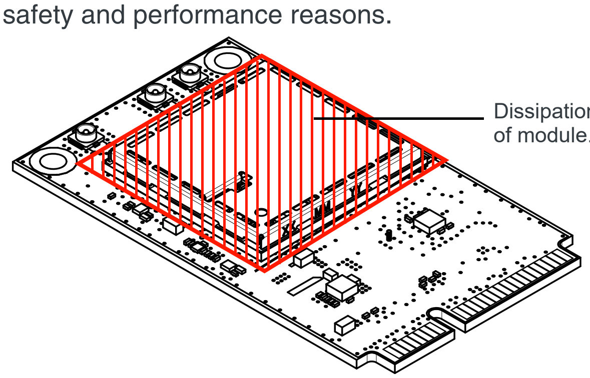


Figure 4-1: Heat Dissipation Requirement Location

The amount of thermal dissipation required depends on:

- Supply voltage—Maximum power dissipation for the module can be up to 3 W at voltage supply limits.
- Usage—Typical power dissipation values depend on the location within the host, throughput, amount of data transferred, etc.

Figure 4-1 indicates the location of the embedded WP module on the accessory board.

To enhance heat dissipation:

- Maximize airflow over/around the module.
- Locate the accessory board away from other heat-generating components.

- Module mounting holes must be used to attach (ground) the device to the main PCB ground or a metal chassis.
- You may need to add a heat sink that mounts the assembly board to the main PCB (thermal compound or pads must be used between the assembly board and the heat sink).
- You may also need active cooling to pull heat away from the assembly board.

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

4.6 Mechanical Drawing

Note: Dimensions in Figure 4-2 are preliminary and subject to change.

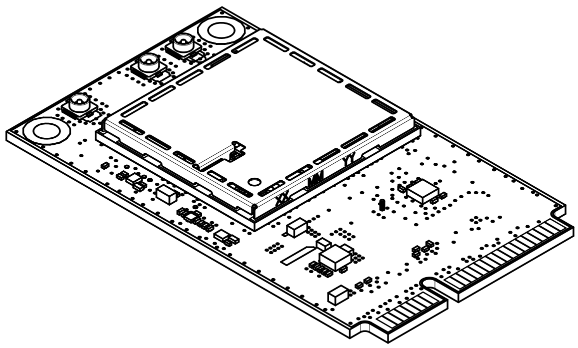


Figure 4-2: Top View (Preliminary)

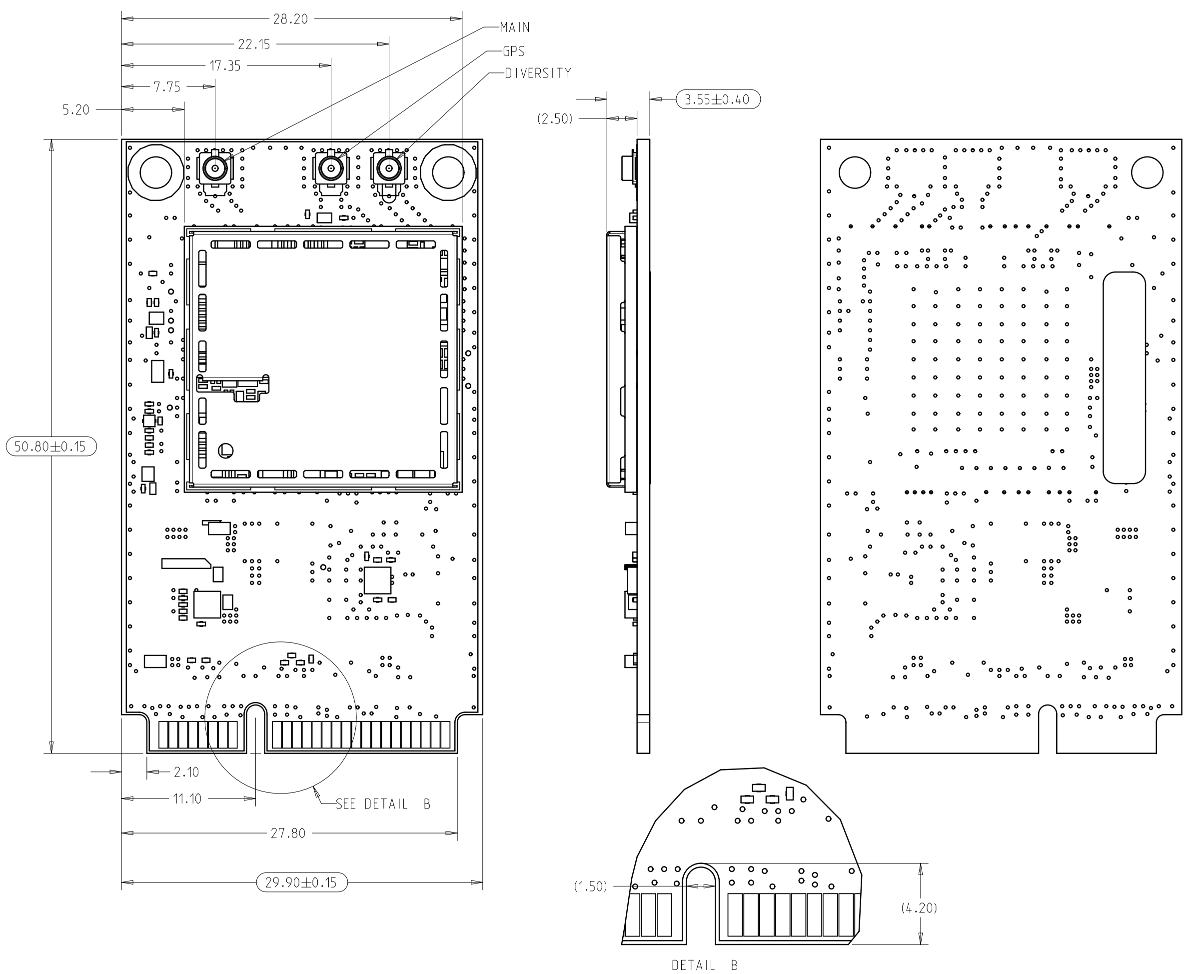


Figure 4-3: Dimensioned View (Preliminary)

5: Interfaces Specification

5.1 Overview

This section describes the interfaces supported by the AirPrime WP76xx Accessory Board and provides specific voltage, timing, and circuit recommendations for each interface.

5.2 W_DISABLE_N (Power control, Modem enable/disable)

The host device uses W_DISABLE_N (pin 20) to power on the WP76xx Accessory Board's embedded WP module, and then can use it to enable/disable the WWAN/ radio modem. When disabled, the modem cannot transmit or receive information.

As described in Power On/Off and Modem Enable/Disable Timing on page 54, W_DISABLE_N must be driven high to turn the embedded WP module on. Once the module is powered on, W_DISABLE_N is left floating (high impedance) to enable the modem, or driven (and kept) low to disable the modem.

Letting this signal float high allows the module to operate normally. See Figure 5-1 for a recommended implementation.

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

- The signal is an input to the module and should be driven low only for its active state (controlling the power state); otherwise it should be floating (high impedance). It should never be driven to a logic high level.
  The module has an internal pull-up resistor to VCC in place, so if the signal is floating (high impedance), then the radio is on.
- Wait for 2 seconds after asserting W_DISABLE_N before disconnecting power.
- If the host never needs to assert this power state control to the module, leave this signal unconnected from the host interface.

Table 5-1: W_DISABLE_N Electrical Characteristics[a,b]

Parameter	Min	Typ	Max	Units
Input Voltage—Low	0.35	-	0.67	V
Internal pull-up resistor	18	20	22	kΩ

a. All values are preliminary and subject to change.
b. When floating, voltage will be approximately 800 mV.

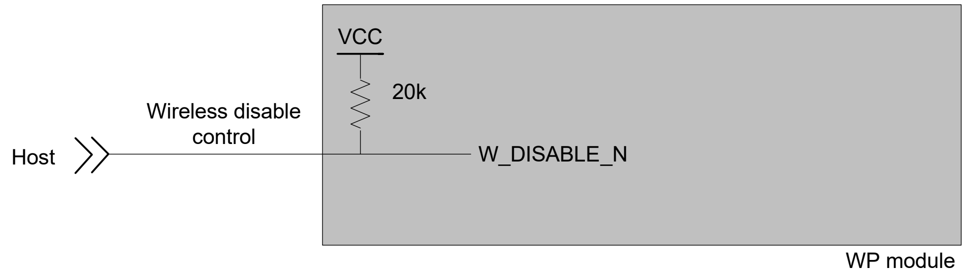


Figure 5-1: Recommended Wireless Disable Connection

5.2.1 Power Sequence

5.2.1.1 Power On/Off and Modem Enable/Disable Timing

Figure 5-2 describes the timing sequence for powering the assembly board's embedded WP module on and off, including detail for W_DISABLE_N (in the Active state) disabling/enabling the modem.

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.

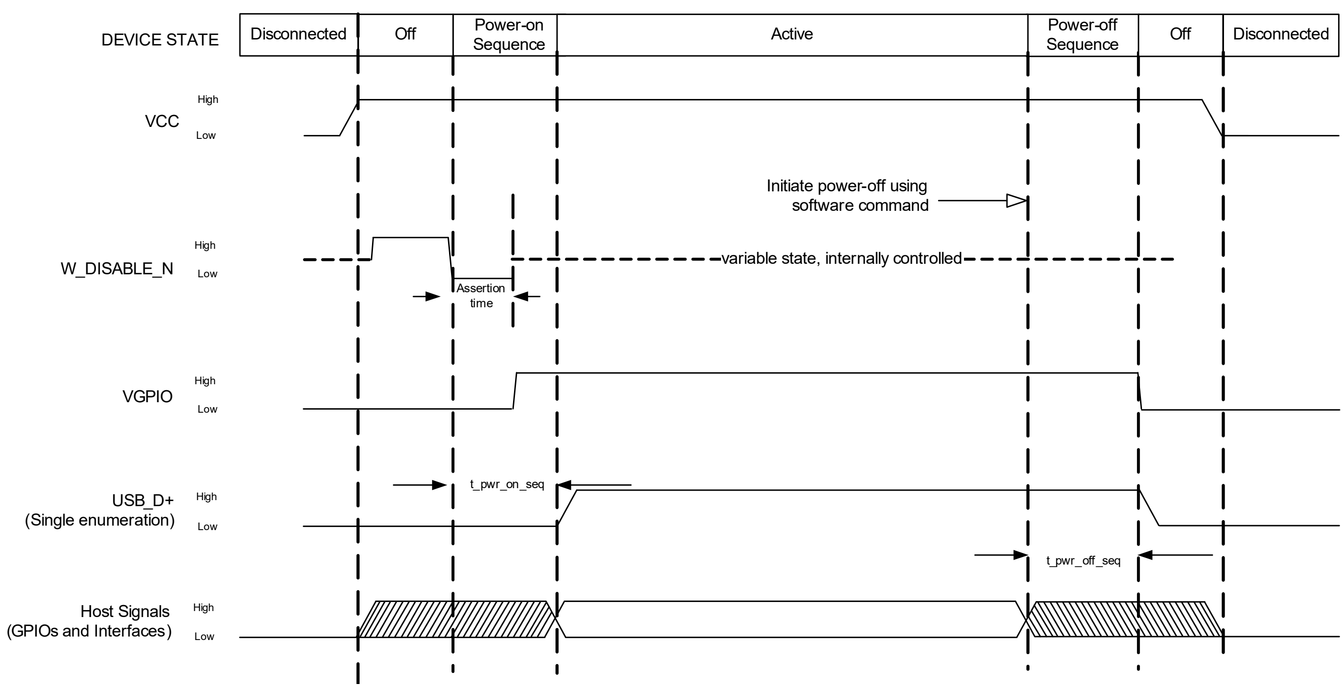


Figure 5-2: Signal Timing (W_DISABLE_N, and USB Enumeration)

Table 5-2: Power Sequence Timing Parameters

Parameter	Min	Typ	Max	Units
t_pwr_on_seq	-	15	22	s
t_pwr_off_seq	-	0.4–5.5	6	s
Assertion time[a]	200			ms

a. Assertion time is the time required to keep W_DISABLE_N at LOW level to ensure the module can be powered ON successfully.

5.2.1.2 USB Enumeration

The unit supports single USB enumeration with the host. Enumeration starts within (maximum) t_pwr_on_seq seconds of power-on.

5.2.1.3 Software-Initiated Power Down

To power down the module via software:

1. Initiate the power down process:
   AT!POWERDOWN
2. Wait at least 2 seconds, then remove power.

5.3 W_DISABLE_N Use Cases

Table 5-3 lists the behavior of the WP76xx for W_DISABLE_N and AT!POWERDOWN use cases.

Table 5-3: W_DISABLE_N and AT!POWERDOWN Use Cases

Use Case		WP7607	WP7610
W_DISABLE_N	VCC is applied then W_DISABLE_N is asserted	Turns ON	Turns ON
	W_DISABLE_N is asserted then VCC is applied	Turns ON	Turns ON
AT!POWERDOWN AT Command	W_DISABLE_N is asserted then the power OFF command is sent	Turns OFF	Restarts
	W_DISABLE_N is de-asserted then the power OFF command is sent	Turns OFF	Turns OFF

5.4 Tx Power Control

The module's Tx power limit may be controlled using the following methods:

- SAR backoff AT commands (see document [1] AirPrime WP8548/WP75xx/ WP76xx/WP77xx AT Command Reference):
  - !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.
- GPIO control via !SARGPIO command (see [1] AirPrime WP8548/WP75xx/ WP76xx/WP77xx AT Command Reference)—Set an unallocated external GPIO to control SAR. (Available GPIOs are ANT_CNTL0:2 (correspond to WP76xx GPIO28–30) and GPIO4 (corresponds to WP76xx GPIO21).)

5.5 USB

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

The WP76xx Accessory Board implements a high-speed USB 2.0 Interface, which conforms to the *Universal Serial Bus Specification, Revision 2.0*, and the host device must be designed to the same standard. (When designing the host device, careful PCB layout practices must be followed.)

Table 5-4: USB Pin Descriptions

Pin	Signal name	Direction	Function
12	USB_D-	Input/Output	Differential data interface negative
13	USB_D+	Input/Output	Differential data interface positive

USB interface features include:

- Data rate: Full-speed (12 Mbps)/High-speed (480 Mbps)
- Module enumeration:
  - Windows: Modem or COM ports, using host Windows drivers
  - Linux: /dev/ttyUSBn devices for Linux systems with the Sierra Wireless driver installed
- USB-compliant transceivers
- Selective suspend mode
- Resumption initiated by host or module

5.5.1 USB high/full speed throughput performance

This device has been designed to achieve optimal performance and maximum throughput using USB high speed mode. Although the device may operate with a full speed host, throughput performance will be on an “as is” basis and needs to be characterized by the OEM. Note that throughput will be reduced and may vary significantly based on packet size, host interface, and firmware revision. Sierra Wireless does not recommend using this device in USB full speed mode.

5.6 UIM Interface

Note: Host support for UIM interface signals is required.

The AirPrime WP76xx Accessory Board supports one UIM interface (UIM1), which allows for control of external 1.8 V/3 V UIMs.. The SIM holds account information, allowing users to use their account on multiple devices.

Table 5-5 describes the SIM pins that provide the connections necessary to interface to a SIM socket located on the host device as shown in Figure 5-3 on page 58. Voltage levels over this interface comply with 3GPP standards.

Table 5-5: UIM Interface Pins

Pin	Name	Description	UIM contact[a]	Direction[b]	Function	If Unused
8	UIM1_VCC	UIM voltage	1	Output	Power supply for UIM	Leave open
10	UIM1_DATA	Data I/O	7	Input/Output	Bi-directional UIM data line	Leave open
12	UIM1_CLK	Serial clock	3	Output	Serial clock for UIM data	Leave open
14	UIM1_RESET_N	Reset	2	Output	Active low UIM reset	Leave open
	USIM_GND	Ground	5		Ground reference. Common to module ground.	

a. See Figure 5-4 on page 58 for UIM card contacts.
b. Signal direction with respect to the module. Examples: UIM1_DET (pin 64) is an input to the module from the host; UIM1_RESET_N (pin 29) is an output from the module to the host.

Figure 5-3 illustrates the recommended implementation of a UIM holder. (For a more detailed UIM schematic, see Figure 14-4 on page 119.)

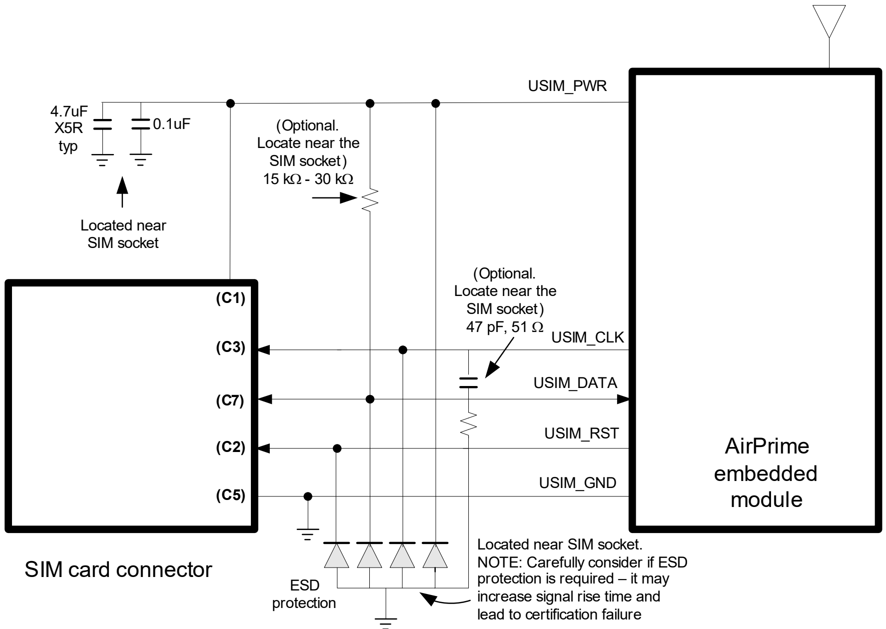


Figure 5-3: Recommended UIM Holder Implementation

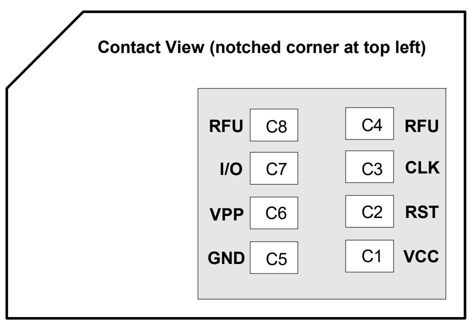


Figure 5-4: SIM card contacts (contact view)

5.6.1 SIM implementation

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

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

Some design recommendations include:

- Total impedance of the VCC and GND connections to the SIM, measured at the module connector, should be less than 1 Ω to minimize voltage drop (includes any trace impedance and lumped element components — inductors, filters, etc.).
- Position the SIM connector ≤10 cm from the module. If a longer distance is required because of the host device design, use a shielded wire assembly —

connect one end as close as possible to the SIM connector and the other end as close as possible to the module connector. The shielded assembly may help shield the SIM interface from system noise.

- Reduce crosstalk on the USIM_DATA line to reduce the risk of failures during GCF approval testing.
- Avoid routing the USIM_CLK and USIM_DATA lines in parallel over distances >2 cm — cross-coupling of these lines can cause failures.
- 3GPP has stringent requirements for I/O rise time (<1 µs), signal level limits, and noise immunity — consider this carefully when developing your PCB layout.
    - Keep signal rise time <1 µs — keep USIM signals as short as possible, and keep very low capacitance traces on the USIM_DATA and USIM_CLK signals. High capacitance increases signal rise time, potentially causing your device to fail certification tests.
- Add external pull-up resistors (15–30 kΩ), if required, between the USIM_DATA and USIM_PWR lines to optimize the signal rise time.
- VCC line should be decoupled close to the SIM socket.
- SIM is specified to run up to 5 MHz (SIM clock rate). Take note of this speed in the placement and routing of the SIM signals and connectors.
- You must decide whether additional ESD protection is required for your product, as it is dependent on the application, mechanical enclosure, and SIM connector design. The SIM pins will require additional ESD protection if they are exposed to high ESD levels (i.e. can be touched by a user).
- Putting an optional decoupling capacitor at USIM_PWR near the SIM socket is recommended — the longer the trace length (impedance) from the socket to the module, the greater the capacitance requirement to meet compliance tests.
- Putting an optional series resistor and shunt capacitor to ground at USIM_CLK at the SIM socket to reduce EMI and increase signal integrity is recommended if the trace length between the SIM socket and module is long — 47 pF and 50 Ω resistor are recommended.
- Test your first prototype host hardware with a Comprion IT^3 SIM test device at a suitable testing facility.

5.7 General Purpose Input/Output (GPIO)

The AirPrime WP76xx Accessory Board defines several GPIOs for customer use, as described in Table 5-6.

Note: There should not be any voltage applied to the GPIOs when the module is off to prevent damaging the module.

Table 5-6: GPIO Pin Descriptions

Pin	Signal Name	Edge Wakeable	Default State	Function	If Unused
3	ANT_CNTL0	Yes	No pull[a]	General purpose I/O	Leave open
	GPIO1				
5	ANT_CNTL1	Yes			
	GPIO2				
44	ANT_CNTL2				
	GPIO3				
46	GPIO4	Yes			

a. Internal configuration of all GPIOs—no internal pull-ups.

Important: *Pin numbers 3, 5, 44 and 46 map to the WP module's GPIO28, GPIO29, GPIO30 and GPIO21, respectively. References to GPIOs in [1] AirPrime WP8548/WP75xx/WP76xx/WP77xx AT Command Reference use the WP module pin identifications.*

5.8 Wakeup Interrupt (Sleep State)

GPIO4 can be used to wake the module when it is in Sleep state (low-power state).

The GPIO pin can be configured as a wakeup source by using the AT+WIOCFG command (see [1] AirPrime WP8548/WP75xx/WP76xx/WP77xx AT Command Reference).

If the module firmware is monitoring this pin while it is in USB-SS mode, any transition on the pin will wake the module.

Note: This signal wakes the module when it is in Sleep state (a low-power ACTIVE state where the module is fully powered).

5.9 VGPIO

The AirPrime WP76xx Accessory Board utilizes 1.8V logic, provided via the VGPIO (GPIO voltage output) pin.

Table 5-7: VGPIO Reference Pin

Pin	Signal name	Direction[a]	Function	If Unused
45	VGPIO	Output	GPIO voltage output	Leave open

a. Signal direction with respect to the module—VGPIO (pin 45) is an output from the module to the host.

Table 5-8: VGPIO Electrical Characteristics

Parameter	Min	Typ	Max	Unit	Remarks
Voltage level	1.7	1.8	1.9	V	Applies to active mode and USB-SS mode
	-	-	-	V	Off in ULPM
Current capability	-	-	50	mA	Power Management support up to 50 mA output

The VGPIO pin is available when the module is switched ON, and can be used to:

- Pull up signals such as I/Os
- Supply external digital transistors driving LEDs

5.10 Digital Audio

The AirPrime WP76xx Accessory Board provides a 4-wire digital audio interface that can be configured as either PCM (Pulse Code Modulation) or I^{2}S (Inter-IC Sound).

Table 5-9 on page 61 describes the audio interface signals.

Note: Voice support is SKU-dependent.

Table 5-9: PCM/I^{2}S Interface Signals

Pin	Signal name	Direction[a]	Function	If Unused
45	PCM_CLK	Input/Output	PCM Clock The frame bit clock signal controls data transfer with the audio peripheral.	Leave open
	I2S_CLK	Output	I2S Clock The frame bit clock signal controls data transfer with the audio peripheral.	
47	PCM_OUT	Output	PCM Data Out The frame “data out” relies on the selected configuration mode.	Leave open
	I2S_OUT	Output	I2S Data Out The frame “data out” relies on the selected configuration mode.	

Table 5-9: PCM/I^{2}S Interface Signals (Continued)

Pin	Signal name	Direction[a]	Function	If Unused
49	PCM_IN	Input	PCM Data In The frame “data in” relies on the selected configuration mode.	Leave open
	I2S_IN	Input	I2S Data In The frame “data in” relies on the selected configuration mode.	
51	PCM_SYNC	Input/Output	PCM Sync The frame synchronization signal delivers an 8 kHz frequency pulse that synchronizes the frame data in and the frame data out.	Leave open
	I2S_WS	Output	I2S Word Select The word select clock indicates which channel is currently being transmitted (low cycle indicates left audio channel, high cycle indicates right audio channel).	

a. Signal direction with respect to the module. Examples: PCM_IN (pin 49) is an input to the module from the host; PCM_OUT (pin 47) is an output from the module to the host.

5.10.1 PCM

Table 5-10 defines the PCM interface configuration.

Table 5-10: PCM Interface Configurations

Element	PCM
Slot configuration	Slot-based
Sync type	Short
Clock (in Master mode)	2.048 MHz
Data (audio compression) formats	16-bit linear, 8-bit A-law, 8-bit mu-law
Mode	Master or Slave

5.10.1.1 PCM Data Format

The PCM data is 8 kHz and 16 bits with the following PDM (Pulse-density modulation) bit format:

- PCM_DIN—SDDD DDDD DDDD DDVV
- PCM_DOUT—SDDD DDDD DDDD DDVV

Where:

- S—Signed bit
- D—Data
- V—Volume padding

5.10.1.2 PCM Timing

The following table and drawings illustrate PCM signals timing when operating in PCM mode.

Table 5-11: PCM Mode Timing[a,b]

Parameter	Description	Min	Typ	Max	Units
t(sync)	PCM_SYNC cycle time	-	125	-	µs
t(synch)	PCM_SYNC high time	-	488	-	ns
t(syncl)	PCM_SYNC low time	-	124.5	-	µs
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(susync)	PCM_SYNC setup time high before falling edge of PCM_CLK	-	122	-	ns
t(sudin)	PCM_IN setup time before falling edge of PCM_CLK	60	-	-	ns
t(hdin)	PCM_IN hold time after falling edge of PCM_CLK	10	-	-	ns
t(pdout)	Delay from PCM_CLK rising to PCM_OUT valid	-	-	60	ns
t(zdout)	Delay from PCM_CLK falling to PCM_OUT HIGH-Z	-	160	-	ns

a. Maximum PCM clock rate is 2.048 MHz.
b. All values are preliminary and subject to change.

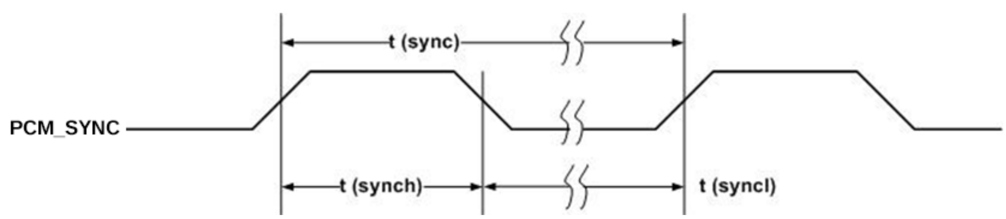


Figure 5-5: PCM_SYNC Timing Diagram (2048 kHz clock)

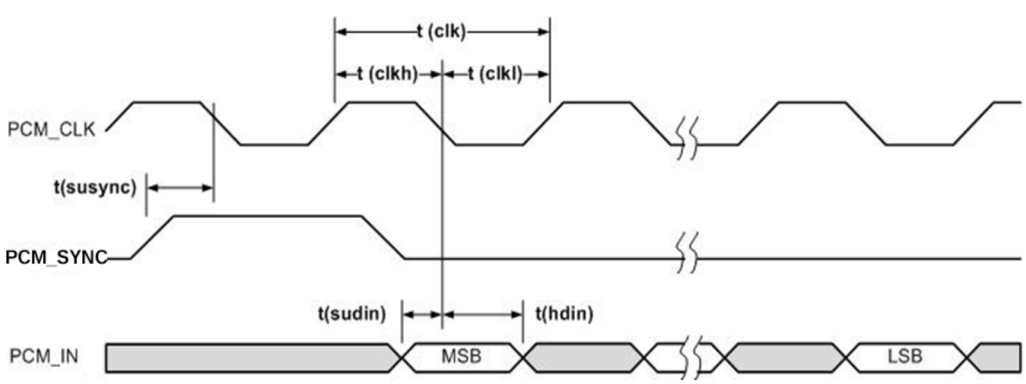


Figure 5-6: PCM Codec to Device Timing Diagram

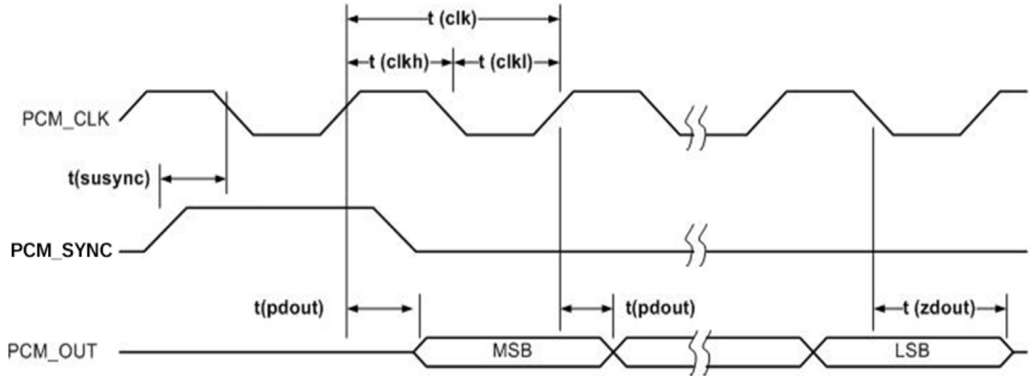


Figure 5-7: Device to PCM Codec Timing Diagram

5.10.2 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:

- Mode: Master (Slave mode is not supported)
- Sampling rate: 48 kHz
- Bits per frame: 16
- Bit clock: 1536 kHz

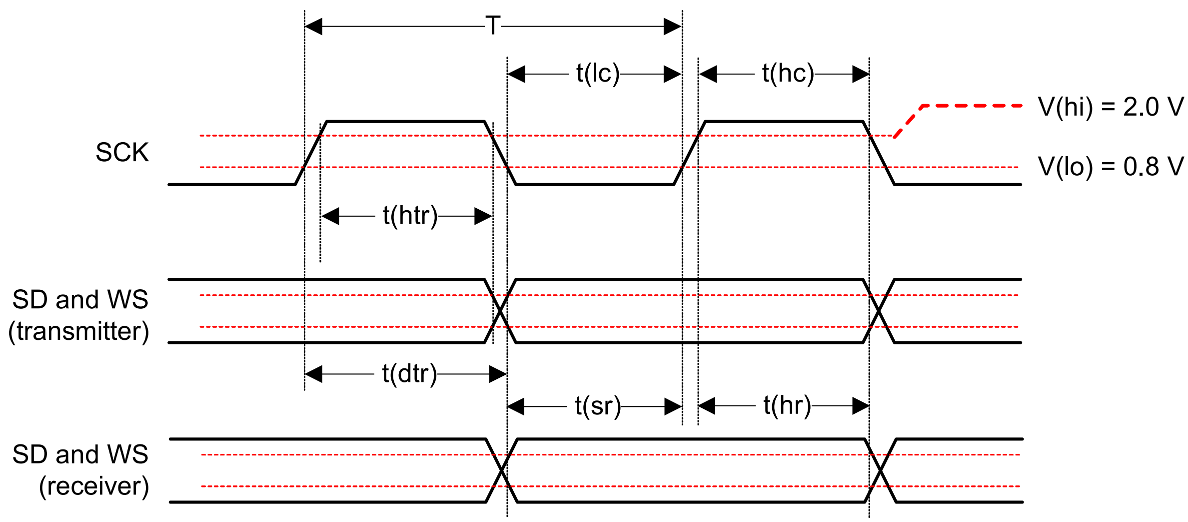


Figure 5-8: I²S Transmitter Timing

Table 5-12: I²S Interface Timing[a]

Parameter	Description	Min	Typ	Max	Units
	Frequency	-	-	12.288	MHz
T	Clock period	81.380	-	-	ns
t(hc)	Clock high	0.45×T	-	0.55×T	ns

Table 5-12: I^2S Interface Timing[a] (Continued)

Parameter	Description	Min	Typ	Max	Units
t(lc)	Clock low	0.45×T	-	0.55×T	ns
t(sr)	SD and WS input setup time	16.276	-	-	ns
t(hr)	SD and WS input hold time	0	-	-	ns
t(dtr)	SD and WS output delay	-	-	65.100	ns
t(htr)	SD and WS output hold time	0	-	-	ns

a. Load capacitance is 10–40 pF

5.11 Temperature Monitoring

The AirPrime WP76xx Accessory Board provides internal temperature monitoring of the module’s baseband thermistor, as detailed below in Figure 5-9 and Table 5-13.

The temperature state can be queried directly, and unsolicited notifications of temperature state transitions can be received by using:

- AT!PATEMP—Display the current temperature state (normal, hi or low warning, hi or low critical).
- AT+WUSLMSK—Enable unsolicited notifications for !PATEMP, to be received over the AT port whenever the state changes.

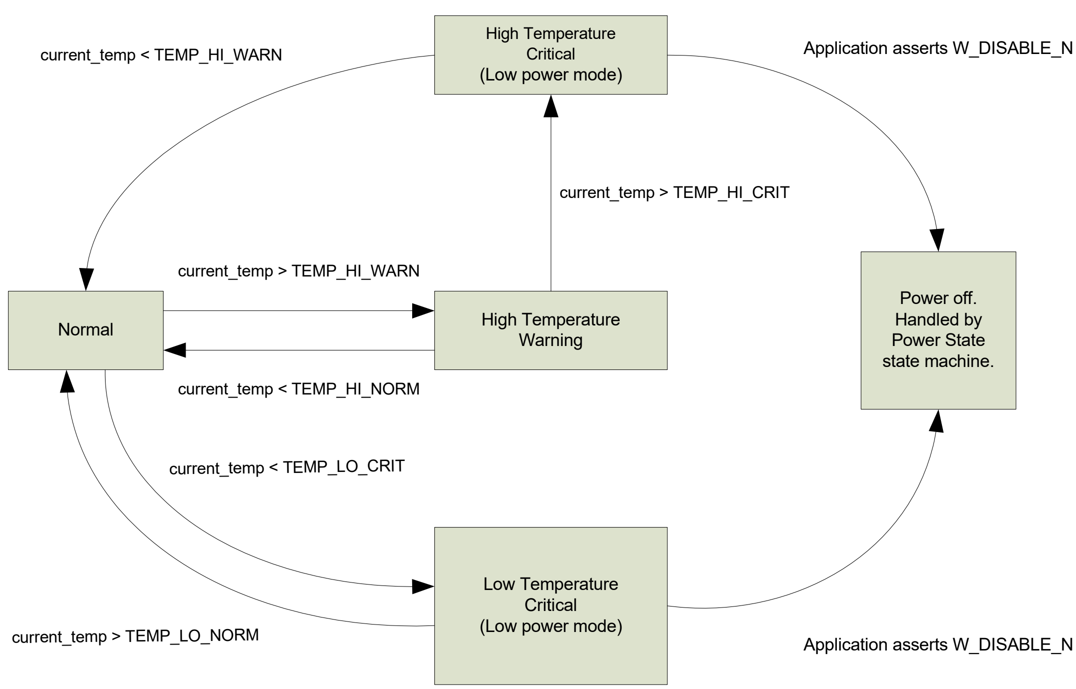


Figure 5-9: Temperature Monitoring State Machine

Table 5-13: Temperature Monitoring States

State	Description	Threshold	Default Temp value (C)[a]	Functionality
Normal	Baseband thermistor is between	TEMP_HI_NORM	+100	Class A
		TEMP_LO_NORM	-40	Class B
High Temperature Warning	Baseband thermistor has exceeded	TEMP_HI_WARN	+110	Class B
High Temperature Critical	Baseband thermistor has exceeded	TEMP_HI_CRIT	+115	Low Power Mode
Low Temperature Critical	Baseband thermistor has descended past	TEMP_LO_CRIT	-45	Low Power Mode

a. Junction (PA thermistor) temperature

To restore full operation, the baseband thermistor's temperature reading must be within the normal or high temperature warning state thresholds.

5.12 Antenna Control

Note: Antenna control signals support is optional.

The AirPrime WP76xx Accessory Board provides three output signals that can be used for host designs that incorporate tunable antennas.

Note: It is the responsibility of developers of host designs to evaluate the performance of tunable antennas that use these signals for neighbor cell measurements, Inter-RAT handovers, etc. Sierra Wireless does not guarantee ANT_CNTLx signal timing.

Note: These pins can be configured for use as GPIOs using +WIOCFG.

Table 5-14: Antenna Control Signals

Pin	Name	Direction[a]	Function	If Unused
3	ANT_CNTL0	Output	Customer-defined external switch control for tunable antennas	Leave open
5	ANT_CNTL1	Output		Leave open
44	ANT_CNTL2	Output		Leave open

a. Signal direction with respect to module. Examples: ANT_CNTL0 (pin 153) is an output from the module to the host.

To tune the antenna:

1. Enable band selection, which is required to tune the antennas for specific bands:
   - **AT!CUSTOM="BANDSELEN",1**

   (Note: This setting is persistent unless disabled by issuing AT!CUSTOM="BANDSELEN",0.)
2. Drive the antenna control signals high or low, as required, for a specific band:
   - **AT!ANTSEL=<band>, <gpio1>, <gpio2>, <gpio3>[, <gpio4>]**

   See [1] AirPrime WP8548/WP75xx/WP76xx/WP77xx AT Command Reference for details.

   (Note: <gpio1>–<gpio3> correspond to ANT_CTRL0–ANTCTRL2. <gpio4> is not supported by the accessory board.)

5.13 Indication Interfaces

The AirPrime WP76XX module provides several indication interfaces that deliver notifications when specific events occur. These interfaces include:

- WAN_LED_N on page 67
- WAKE_ON_WWAN on page 68

5.13.1 WAN_LED_N

The AirPrime WP76xx Accessory Board provides an LED control output signal. This signal is an open drain output.

Table 5-15: LED Interface Pin

Pin	Signal name	Direction[a]	Voltage / Current	Function	If Unused
42	WAN_LED_N	Output	• Voltage (max)=VCC + 0.5 V • Maximum current sink capability=40 mA	LED driver control	Leave open

a. Signal direction with respect to module—WAN_LED_N (pin 42) is an output from the module to the host.

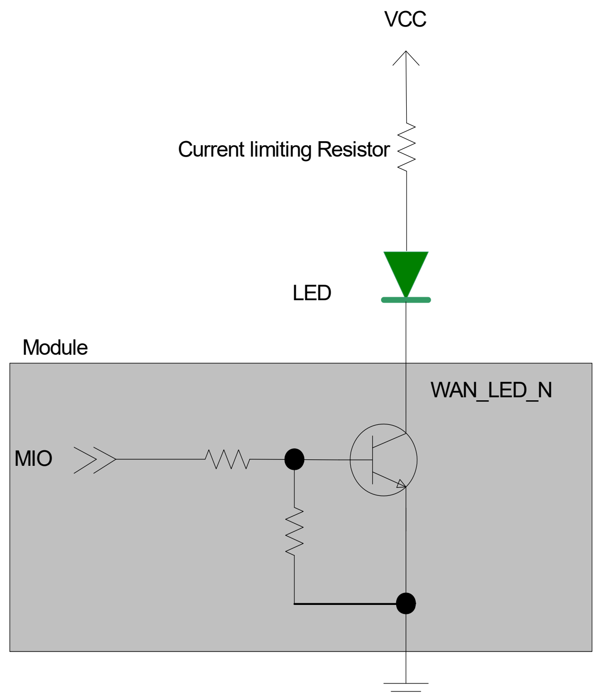


Figure 5-10: LED Reference Circuit

5.13.2 WAKE_ON_WWAN

Note: Host support for WAKE_ON_WWAN signal is optional.

The AirPrime WP76xx Accessory Board drives WAKE_ON_WWAN high to wake the host when specific events occur.

The host must provide a 5–100 kΩ pullup resistor that considers total line capacitance (including parasitic capacitance) such that when WAKE_ON_WWAN is de-asserted, the line will rise to 3.7 V (Host power rail) in < 100 ns.

See Figure 5-11 on page 68 for a recommended implementation.

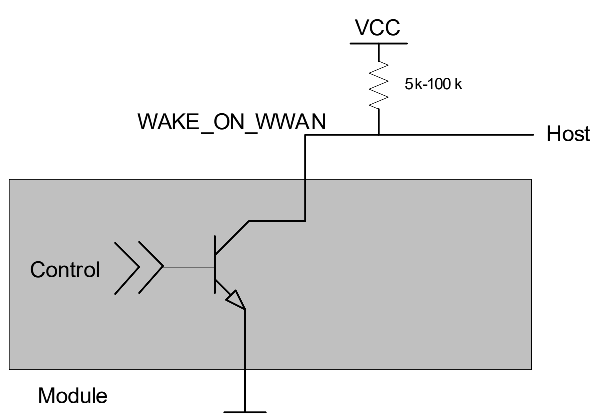


Figure 5-11: Recommended WAKE_ON_WWAN Connection

5.14 Reset Signal (SYSTEM_RESET_N)

Note: Host support for SYSTEM_RESET_N is optional.

SYSTEM_RESET_N (pin 33) has an internal 1.8 V internal pull up. Set this signal to active low to reset the device. Note that the minimum pulse width is 500 ms.

6: Software and Tools

6.1 Support Tools

The AirPrime WP76xx Accessory Board is compatible with Sierra Wireless' SwiLogPlus trace tool that allows users to send error logs to Sierra Wireless.

6.2 SED (Smart Error Detection)

The AirPrime WP76xx Accessory Board uses a form of SED to track premature module resets. In such cases, the module automatically forces a pause in boot-and-hold mode at power-on to accept an expected firmware download to resolve the problem.

1. Module tracks consecutive resets within 30 seconds of power-on.
2. After a sixth consecutive reset, the module waits in boot-and-hold mode (up to 30 seconds) for a firmware download to resolve the power-cycle problem.

A RAM dump tool that can be used to help isolate the cause of premature resets is available from Sierra Wireless. Contact your Sierra Wireless account representative for assistance.

6.3 Firmware Upgrade

Firmware upgrades are downloaded to the embedded module over the USB interface or over the air via Sierra Wireless' AVMS (AirVantage Management System). Contact your Sierra Wireless account representative for assistance.

6.4 Product Marking

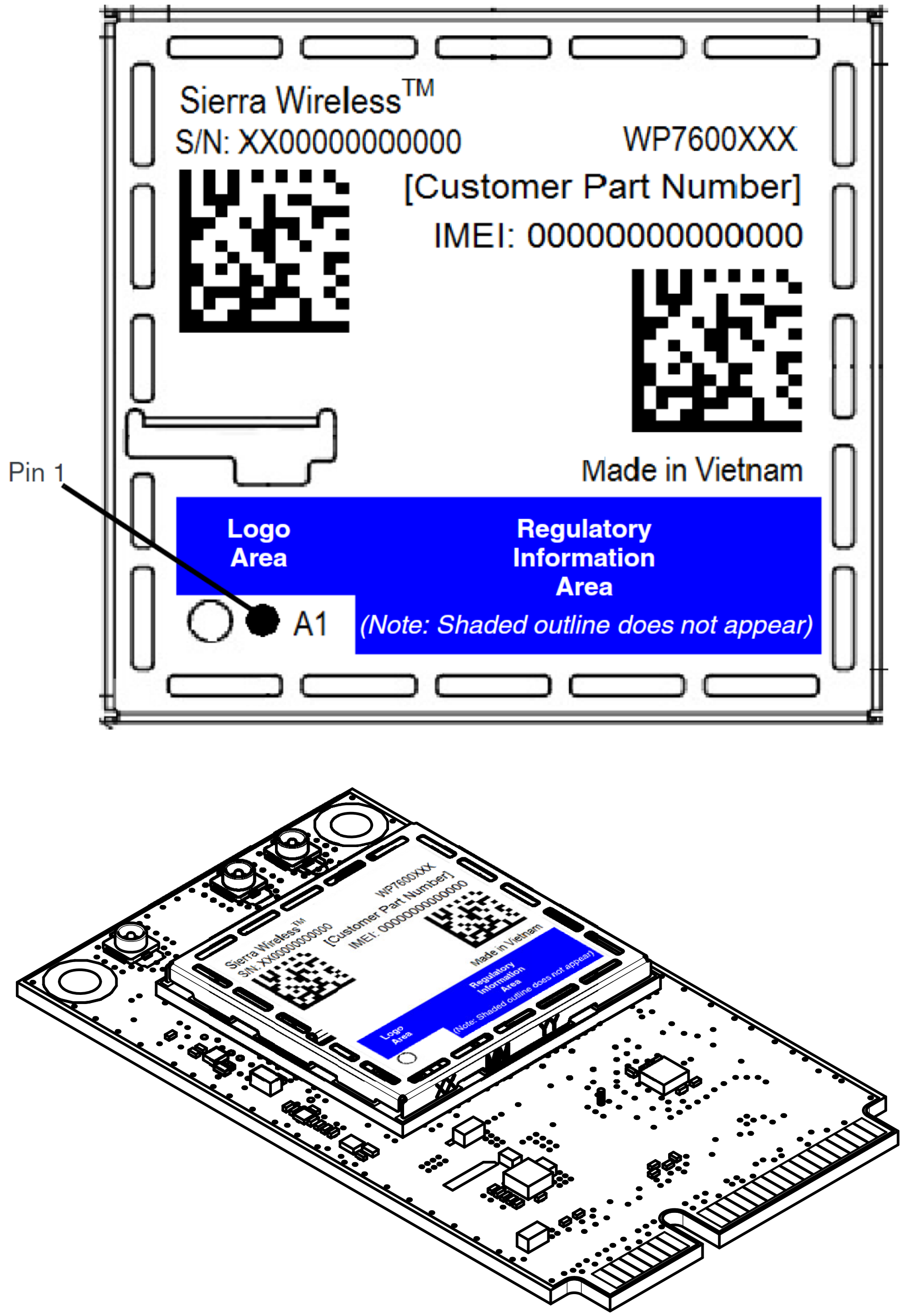


Figure 6-1: Unit Product Marking—Laser-etched, Typical Representation

Note: The figure above is not to scale. Contents will vary by SKU.

The AirPrime WP76xx Accessory Board product marking is laser-etched and may contain:

- Product identification (Model name, serial number)
- IMEI or MEID number and barcode
- Fabrication country
- Required regulatory markings (CE logo, Japan approval mark, FCC ID, IC certification number, etc., as appropriate)
- Pin 1 indicator

Note: The AirPrime WP76xx Accessory Board supports OEM partner specific product marking requirements.

7: Debug and Assembly Considerations

7.1 Testing Assistance Provided by Sierra Wireless

Sierra Wireless offers optional professional services based assistance to OEMs with regulatory approvals.

7.2 Integration Requirements

When integrating the AirPrime WP76xx Accessory Board, 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 described in Approval on page 75
- Service provisioning—Manufacturing process

Sierra Wireless provides guidelines for successful AirPrime WP76xx Accessory Board integration with the document suite and offers integration support services as necessary.

7.3 IOT/Operator

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.

7.4 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 the embedded WP module’s junction temperature using **AT!PCTEMP**. This command polls a thermistor located near the module’s power amplifier (typically the hottest spot on the module). (See *[1] AirPrime WP8548/WP75xx/ WP76xx/WP77xx AT Command Reference*.)

Note: Make sure that your system design provides sufficient cooling for the module—proper mounting, heat sinks, and active cooling may be required, depending on the integrated application.
The WP module's RF shield temperature should not be exposed to an ambient temperature greater than 85°C, to prevent damage to the WP module's components.

(For acceptance, certification, quality, and production (including RF) test suggestions, see Testing on page 81.)

7.5 RF Output Accessibility

During the integration phase of the AirPrime WP76xx Accessory Board, it can be helpful to connect the module to a simulator to check critical RF TX parameters and power behavior for supported RATs.

Although the AirPrime WP76xx Accessory Board has been certified, some parameters may have degraded if some basic precautions have not been followed (poor power supply, for example). This may not affect the functionality of the product, but the product may not comply with 3GPP specifications.

The following TX parameters can be checked using a Radio Communication tester:
- Phase & Frequency Error
- Output Power and Burst Time
- Output Spectrum (Modulation and Switching)

The following are available typical Radio Communication testers:
- Rohde & Schwarz: CMU200, CMW500
- Keysight (formerly Agilent): 8960
- Anritsu: MD8475

Because of the high prices associated with Radio Communication testers and the necessary RF know-how to perform simulations, customers can check their applications in the Sierra Wireless laboratories. Contact the Sierra Wireless support team for more information.

8: Approval

8.1 Disposing of the Product

This electronic product is subject to the EU Directive 2012/19/EU for Waste Electrical and Electronic Equipment (WEEE). As such, this product must not be disposed of at a municipal waste collection point. Please refer to local regulations for directions on how to dispose of this product in an environmental friendly manner.

8.2 Important Notice

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

8.3 Safety and Hazards

Do not operate your AirPrime WP76xx Accessory Board embedded module:
- In areas where blasting is in progress
- Where explosive atmospheres may be present including refueling 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 AirPrime WP76xx Accessory Board modem **MUST BE IN AIRPLANE MODE OR POWERED OFF**. Otherwise, the AirPrime WP76XX modem can transmit signals that could interfere with this equipment.

In an aircraft, the AirPrime WP76xx Accessory Board modem **MUST BE IN AIRPLANE MODE OR POWERED OFF**. Otherwise, the AirPrime WP76xx Accessory Board modem can transmit signals that could interfere with various onboard systems and may be dangerous to the operation of the aircraft or disrupt the cellular network. Use of a cellular phone in an aircraft is illegal in some jurisdictions. Failure to observe this instruction may lead to suspension or denial of cellular telephone services to the offender, or legal action or both.

Some airlines may permit the use of cellular phones while the aircraft is on the ground and the door is open. The AirPrime WP76xx Accessory Board modem may be used normally at this time.

8.4 Certification Compliance

8.4.1 Important Compliance Information for North American Users

The Airprime WP7610 Accessory Board module, upon commercial release, will have been granted modular approval for mobile applications. Integrators may use the Airprime WP7610 Accessory Board 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 76.

Table 8-1: WP7610 Antenna Gain Specifications

Technology	Band	Frequency (MHz)	Maximum antenna gain (dBi)
LTE	2	1850–1910	6
	4	1710–1755	6
	5	824–849	6
	12	699–716	6
	13	777–787	6
	14	788–798	6
	17	704–716	6
	66	1710–1780	6
UMTS	2	1850–1910	6
	4	1710–1755	6
	5	824–849	6

3. The Airprime WP7610 Accessory Board 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 8-2 on page 77.

Table 8-2: WP7610 Accessory Board Collocated Radio Transmitter Specifications

Device	Technology	Frequency (MHz)	EIRP Limit (dBm)
Collocated transmitters[a]	WLAN	2400–2500	25
		5150–5850	27
	WiMAX	2300–2400	25
		2500–2700	25
		3300–3800	25
	BT	2400–2500	15

a. Valid collocated transmitter combinations: WLAN+BT; WiMAX+BT. (WLAN+WiMAX+BT is not permitted.)

4. A label must be affixed to the outside of the end product into which the Airprime WP7610 Accessory Board module is incorporated, with a statement similar to the following:

   This device contains FCC ID: N7NWP7610/IC:2417C-WP7610.

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 Airprime WP7610 Accessory Board 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.

9: Pinout

Table 9-1 describes the AirPrime WP76xx Accessory Board's host I/O connector pins.

Note: Pins marked as "Leave open" or "Reserved" should not be used or connected.

9.1 Pin Description

Table 9-1: Connector pin assignments[a]

Pin	Signal	Description	I/O[b]	Pin type[c]	Power Supply Domain	Active
1	WAKE_ON_WWAN_N	Wake host	O	OC	1.8 V	Low
2	VCC	Power supply	I	V	3.2 V (WP7607 min) 3.4 V (WP7610 min) 3.7 V (typ) 4.3 V (max)	Power
3	ANT_CNTL0/GPIO1 *Note: Maps to WP module's GPIO28.*	(ANT_CTRL0) Customer-defined external switch control for multiple antennas	O	-	1.8 V	High
		(GPIO1) General purpose I/O	I/O			
4	GND	Ground	I	V	0 V	Power
5	ANT_CNTL1/GPIO2 *Note: Maps to WP module's GPIO29.*	(ANT_CTRL1) Customer-defined external switch control for multiple antennas	O	-	1.8 V	High
		(GPIO2) General purpose I/O	I/O			
6	NC	No connect	-	-		-
7	NC	No connect	-	-		-
8	UIM1_VCC	SIM VCC supply	O	-	1.8 V / 3 V	Power
9	GND	Ground	I	V	0 V	Power
10	UIM1_DATA	SIM I/O pin	I/O	-	1.8 V / 3 V	Low
11	VGPIO	1.8V reference voltage output	O	V	1.8 V	Power
12	UIM1_CLK	SIM Clock	O	-	1.8 V / 3 V	Low
13	NC	No connect	-	-		-
14	UIM1_RST	SIM Reset	O	-	1.8 V / 3 V	Low
15	GND	Ground	I	V	0 V	Power
16	NC	No connect	-	-		-
17	NC	No connect	-	-		-
18	GND	Ground	I	V	0 V	Power

Table 9-1: Connector pin assignments[a] (Continued)

Pin	Signal	Description	I/O[b]	Pin type[c]	Power Supply Domain	Active
19	NC	No connect	-	-		-
20	W_DISABLE_N	Wireless Disable	I	-	1.8 V	Low
21	GND	Ground	I	V	0 V	Power
22	NC	No connect	-	-		-
23	NC	No connect	-	-		-
24	VCC	Power supply	I	V	3.2 V (WP7607 min) 3.4 V (WP7610 min) 3.7 V (typ) 4.3 V (max)	Power
25	NC	No connect	-	-		-
26	GND	Ground	I	V	0 V	Power
27	GND	Ground	I	V	0 V	Power
28	NC	No connect	-	-		-
29	GND	Ground	I	V	0 V	Power
30	I2C_CLK	I2C serial bus clock	I/O	-	1.8 V	
31	NC	No connect	-	-		-
32	I2C_DATA	I2C serial bus data	I/O	-	1.8 V	
33	SYSTEM_RESET_N	Reset	I	-	1.8 V	Low
34	GND	Ground	I	V	0 V	Power
35	GND	Ground	I	V	0 V	Power
36	USB_DN	USB data negative	I/O	-		Differential
37	GND	Ground	I	V	0 V	Power
38	USB_DP	USB data positive	I/O	-		Differential
39	VCC	Power supply	I	V	3.2 V (WP7607 min) 3.4 V (WP7610 min) 3.7 V (typ) 4.3 V (max)	Power
40	GND	Ground	I	V	0 V	Power
41	VCC	Power supply	I	V	3.2 V (WP7607 min) 3.4 V (WP7610 min) 3.7 V (typ) 4.3 V (max)	Power
42	WAN_LED_N	LED Driver	O	OC	VCC[d]	Low
43	GND	Ground	I	V	0 V	Power

Table 9-1: Connector pin assignments[a] (Continued)

Pin	Signal	Description	I/O[b]	Pin type[c]	Power Supply Domain	Active
44	ANT_CNTL2/GPIO3 *Note: Maps to WP module's GPIO30.*	(ANT_CTRL2) Customer-defined external switch control for multiple antennas	O	-	1.8 V	High
		(GPIO3) General purpose I/O	I/O			
45	PCM_CLK / I2S_CLK[e]	(PCM_CLK) PCM Clock—Input in Slave mode, output in Master mode	I/O	-	1.8 V	
		(I2S_CLK) I^2S Clock	O			High
46	GPIO4 *Note: Maps to WP module's GPIO21.*	(GPIO4) General purpose I/O	I/O			
47	PCM_OUT / I2S_DOUT[e]	PCM Data Out/ I^2S Data Out	O	-	1.8 V	High
48	NC	No connect	-	-		-
49	PCM_IN / I2S_DIN[e]	(PCM_IN) PCM Data In/	I	-	1.8 V	High
		(I2S_DIN) I^2S Data In	I			Low
50	GND	Ground	I	V	0 V	Power
51	PCM_SYNC / I2S_SYNC[e]	PCM Sync—Input in Slave mode, output in Master mode	I	-	1.8 V	
		I^2S WS	O			High
52	VCC	Power supply	I	V	3.2 V (WP7607 min) 3.4 V (WP7610 min) 3.7 V (typ) 4.3 V (max)	Power

a. The host should leave all 'NC' ('no connect) pins unconnected.
b. Signal direction with respect to the accessory board. For example, WAKE_ON_WWAN_N (pin 1) is an output from the module to the host. I—Input; O—Output; I/O—Input/Output
c. A—Analog; I—Input; NP—No pull; O—Digital output; OC—Open Collector; PU—Digital input (internal pull up); PD—Digital output (internal pull down); V—Power or ground
d. Maximum rating is VCC + 0.5V, with maximum current sink capability of 40 mA.
e. PCM Master/Slave mode and I2S Master mode are supported.

10: Testing

10.1 Certification Testing

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

When you produce a host device with a Sierra Wireless AirPrime embedded module (such as the one on the WP76xx Accessory Board), 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

10.2 Production Testing

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

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

Typical items to test include:

- Host connectivity
- Baseband (host/assembly board 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 and use AT commands to control the integrated assembly board.

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

Note: The tests described in this chapter are done using a Linux O/S (e.g. Ubuntu 16.04).

10.3 Functional Production Test

This section presents a suggested procedure for performing a basic manual functional test on a laboratory bench using an AirPrime WP76xx Accessory Board and a hardware development kit. When you have become familiar with the testing method, use it to develop your own automated production testing procedures.

10.3.1 Suggested Production Tests

Consider the following tests when you design your production test procedures for devices with the AirPrime WP76xx Accessory Board installed.

- Visual check of the assembly board's connectors and RF assemblies
- Embedded 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

10.3.2 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 test station, and referring to the appropriate AT command references:

1. Visually inspect the assembly board for obvious defects (such as tainted or damaged shields) before installing it in the test station.

2. Ensure that the assembly board is powered off (no voltage on VCC) before beginning your tests.

3. Determine whether any USB devices are currently connected to the computer:

  a. Open a shell window and enter the command **ls /dev/tty/USB***.

  b. Record the ttyUSB*n* values that are returned; these are the currently connected USB devices. If the command returns "no such file or directory", there are no devices currently connected.

4. Provide power to the assembly board (voltage on VCC).

5. Test W_DISABLE_N—Turn on the module by driving W_DISABLE_N low, as shown in Figure 5-2 on page 54.
6. Test USB functionality—Check for USB enumeration.

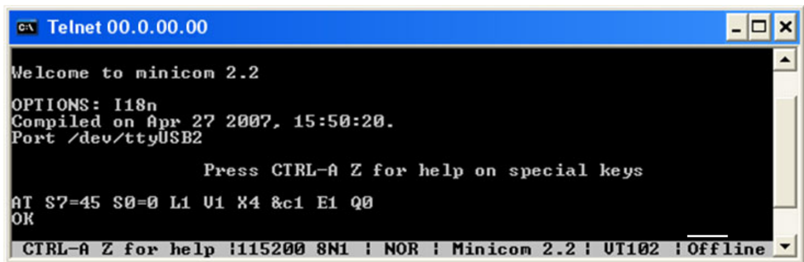
   Enter the command **ls /dev/tty/USB*** and then record and compare the results with those from Step 3. If there are any new ttyUSB*n* devices, then the modem has enumerated successfully. (The AT port is usually the *last* new device.)
7. Make sure your modem is connected and running, and then establish contact with the module:

   Use a terminal emulation/communications program such as minicom to connect over the device handle for AT commands (see listings in Step 6):

Note: If the command "minicom" is not found, then use a different program, or download minicom and repeat this step. See Downloading and Configuring minicom for Linux Systems on page 84 for details.

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

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



8. Display the firmware version:
   - **ATI**
9. Unlock the extended AT command set. (Note: Use AT!ENTERCND? to check command syntax, which is SKU-dependent.):
   - **AT!ENTERCND="<password>"**
10. Test the LED—Visually confirm that the LED turns on and off using:
    - **AT!LDTEST=0,1** (LED on)
    - **AT!LDTEST=0,0** (LED off)
11. Put the module in diagnostic/factory test mode:
    - **AT!DAFTMACT**
12. Communicate with the SIM using **AT+CPIN** or **AT+CIMI**.
13. Test RF transmission, if desired:
    - (UMTS) See UMTS (WCDMA/GSM) RF Transmission Path Test on page 84.
    - (LTE) See LTE RF Transmission Path Test on page 86.
14. Test RF reception, if desired:
    - (UMTS) See UMTS (WCDMA/GSM) RF Receive Path Test on page 89.
    - (LTE) See LTE RF Receive Path Test on page 91.
15. Test standalone GNSS functionality—See GNSS RF Receive Path Test on page 93.
16. Remove power from the module.

10.3.2.1 Downloading and Configuring minicom for Linux Systems

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

To download and configure minicom in a Ubuntu system:

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

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

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

      minicom -s
4. Use the down-arrow key to select the **Serial port setup** option.
5. Refer to Step 6 on page 83 to identify the device file handle (/dev/ttyUSBn) used for AT commands.
6. Indicate the file handle to use for AT commands—Enter A and then replace the serial device string with the AT file handle.
7. Press **Enter** twice.
8. Use the down-arrow key to select **Save setup as dfl**.
9. Select **Exit**.

10.4 UMTS (WCDMA/GSM) RF Transmission Path Test

Note: This procedure segment is performed in Step 13 of the Production Test Procedure on page 82.

The suggested test procedure that follows uses the parameters in the following tables.

Table 10-1: Test Settings—WP7607 Accessory Board UMTS Transmission Path

	Band	Frequency (MHz)	Band ID	Tx Channel[a]
2100 MHz	B1	1950.0	9	9750
900 MHz	B8	897.6	29	2788

a. Channel values shown are at the center of the corresponding bands.

Table 10-2: Test Settings—WP7610 Accessory Board UMTS Transmission Path

	Band	Frequency (MHz)	Band ID	Tx Channel[a]
1900 MHz	B2	1880.0	15[b]	9400
1700 MHz	B4	1732.4	28	1412
850 MHz	B5	836.4	22	4182

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

Table 10-3: Test Settings—WP7607 Accessory Board 2G Transmission Path

Band		Frequency (MHz)	Band ID	Tx Channel[a]
900 MHz	E-GSM 900	897.4	10	37
1800 MHz	DCS 1800	1747.8	11	700

a. Channel values shown are at the center of the corresponding bands.

To test the DUT's transmitter path:

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

1. Set up the power meter:

   a. Make sure the meter has been given sufficient time to warm up, if necessary, to enable it to take accurate measurements.
   b. Zero-calibrate the meter.
   c. Enable MAP mode.
2. Prepare the DUT using the following AT commands:
   a. AT!ENTERCND="<password>" (Unlock extended AT command set.)
   b. AT!DAFTMACT (Enter test mode.)
   c. AT!DASBAND=<bandValue> (Set frequency band.)
      - See tables 10-1–10-3 for appropriate <bandValue> values
   d. AT!DASCHAN=<channel> (Set modem channel)
      - See tables 10-1–10-3 for appropriate <channel> values
   e. AT!DASTXON (Turns on the transmit path.)
   f. AT!DAWSTXPWR=1,15 (Begin transmitting at requested power level.

g. Take the measurement.

h. Repeat Step f with different power levels if desired.

i. AT!DAWSTXPWR=0,0 (Reduce Tx power to 0, so next time transmitter is turned on, it will come on with 0 dBm power.)

j. AT!DASTXOFF (Turn off the transmitter.)

3. Test limits—Run ten or more good DUTs through this test procedure to obtain a nominal output power value.
   - Apply a tolerance of ±5 to 6 dB to each measurement (assuming a good setup design).
   - Monitor these limits during mass-production ramp-up to determine if further adjustments are needed.
   - For GSM mode, the transmit signal is bursted, so the transmit power will appear averaged on the power meter reading.

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

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

10.5 LTE RF Transmission Path Test

Note: This procedure segment is performed in Step 13 of the Production Test Procedure on page 82.

The suggested test procedure that follows uses the parameters in the following tables.

Table 10-4: Test Settings—WP7607 Accessory Board LTE Transmission Path

Band		Frequency (MHz)	Band ID	Channel[a]
2100 MHz	B1	1950.0	34	18300
1800 MHz	B3	1747.5	44	19575
2600 MHz	B7	2535.0	35	21100
900 MHz	B8	897.5	47	21625
800 MHz	B20	847.0	56	24300
700 MHz	B28	725.5	64	27435

a. Channel value used by the !DASCHAN command (!DASCHAN uses uplink (Tx) channel at the center of the corresponding band, for both Tx and Rx testing)

Table 10-5: Test Settings—WP7610 Accessory Board LTE Transmission Path

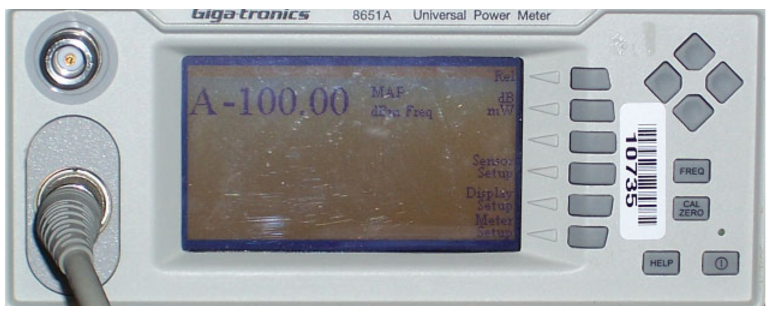
Band		Frequency (MHz)	Band ID	Channel[a]
1900 MHz	B2	1880.0	43	18900
1700 MHz	B4	1732.4	42	20175
850 MHz	B5	836.5	45	20525
700 MHz	B12	707.5	50	23095
700 MHz	B13	782.0	36	23230
700 MHz	B14	793.0	51	23330
700 MHz	B17	710.0	37	23790
1700 MHz	B66	1745.0	83	132322

a. Channel value used by the !DASCHAN command (!DASCHAN uses uplink (Tx) channel at the center of the corresponding band, for both Tx and Rx 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 (adjusting the band, channel, bandwidth, modulation, RB allocation, NS, and power level as necessary):

a. AT!ENTERCND="<password>" (Unlock extended AT command set.)

b. AT!DAFTMACT (Enter test mode.)

c. AT!DASBAND=<bandValue> (Set frequency band (e.g. 34 for LTE B1.)

- See tables 10-4–10-5 for appropriate <bandValue> values.

d. AT!DALSTXBW=3 (Set Tx bandwidth to 10 MHz.)

e. AT!DALSRXBW=3 (Set Rx bandwidth to 10 MHz.)

f. AT!DASCHAN=<channel> (Set modem channel (e.g. 18300 for LTE B1).)

- See tables 10-4–10-5 for appropriate <channel> values.

g. AT!DALSTXMOD=0 (Set Tx modulation type to QPSK.)

h. AT!DALSWAVEFORM=1,12,0,19 (Set the Tx waveform characteristics. Make sure to set the correct resource block allocation (2nd parameter) appropriately. For example, 12 is used to produce max power—refer to 3GPP 36.521 table for Maximum Power Reduction (MPR) for Power Class 3 for more information.)

i. AT!DALSNSVAL=1 (Set the LTE NS (Net Sig) value.)

j. AT!DASTXON (Turn on the transmitter. Note that the transmitter will put out the last power level that was programmed.)

k. AT!DALSTXPWR=1,10 (Begin transmitting at requested power level.)

l. Take the measurement.

m. Repeat Step k with different power levels if desired.

n. AT!DALSTXPWR=0,0 (Reduce Tx power to 0, so next time transmitter is turned on, it will come on with 0 dBm power.)

o. AT!DASTXOFF (Turn off the transmitter.)

3. Test limits—Run ten or more good DUTs through this test procedure to obtain a nominal output power value.
   - Apply a tolerance of ±5 to 6 dB to each measurement (assuming a good setup design).
   - Monitor these limits during mass-production ramp-up to determine if further adjustments are needed.

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.

10.6 UMTS (WCDMA/GSM) RF Receive Path Test

Note: This procedure segment is performed in Step 14 of the Production Test Procedure on page 82.

The suggested test procedure that follows uses the parameters in the following tables.

Table 10-6: Test Settings—WP7607 Accessory Board UMTS Receive Path

Band		Frequency[a] (MHz)	Band ID	Rx Channel[b]
2100 MHz	B1	2141.2	9	9750
900 MHz	B8	943.8	29	2788

a. Receive frequencies shown are 1.2 MHz offset from center
b. Channel values shown are at the center of the corresponding bands.

Table 10-7: Test Settings—WP7610 Accessory Board UMTS Receive Path

Band		Frequency[a] (MHz)	Band ID	Channel[b]
1900 MHz	B2	1961.20	15[c]	9400
1700 MHz	B4	2133.20	28	1412
850 MHz	B5	882.60	22	4182

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

Table 10-8: Test Settings—WP7607 Accessory Board 2G Receive Path

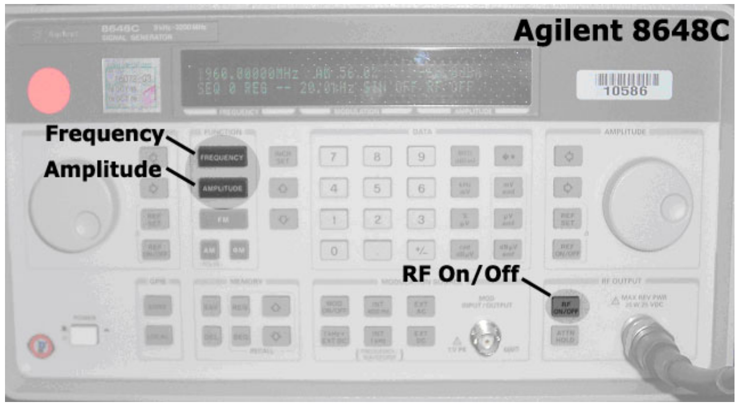
Band		Frequency[a] (MHz)	Band ID	Rx Channel[b]
900 MHz	E-GSM 900	942.467	10	37
1800 MHz	DCS 1800	1842.867	11	700

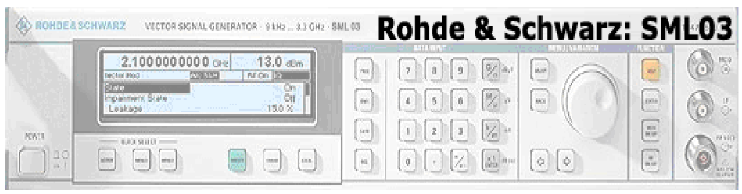
a. Receive frequencies shown are 67 KHz offset from center
b. Channel values shown are at the center of the corresponding bands.

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 (WCDMA mode)
  -60 dBm (GSM mode)

b. Set the frequency for the band being tested. See tables 10-7–10-10 for frequency values.

2. Set up the DUT:

a. AT!ENTERCND="<password>" (Unlock extended AT command set.)

b. AT!DAFTMACT (Put modem into factory test mode.)

c. AT!DASBAND=<band> (Set frequency band.)

- See tables 10-6–10-8 for <band> values

d. AT!DASCHAN=<channel> (Set modem channel)

- See tables 10-6–10-8 for <channel> values

e. AT!DASLNAGAIN=0 (Set the LNA to maximum gain.)

f. (WCDMA mode)
AT!DAWGAVGAGC=9400,0 (For PCS1900, channel 9400 as an example.)

(GSM mode)

i. AT!DAGSRXBURST=0 (Set to receive bursted mode.)

ii. AT!DAGGAVGRSSI=190,0 (For channel 190, for example)

The returned value is the RSSI in dBm.

3. Test limits—Run ten or more good DUTs through this test procedure to obtain a nominal received power value.

- Apply a tolerance of ±5 to 6 dB to each measurement (assuming a good setup design).
- Make sure the measurement is made at a high enough level that it is not influenced by DUT-generated and ambient noise.

- The Signal Generator power level can be adjusted and new limits found if the radiated test needs greater signal strength.
- Monitor these limits during mass-production ramp-up to determine if further adjustments are needed.

Note: The value measured from the DUT is significantly influenced by the test setup and DUT design (host RF cabling loss, antenna efficiency and pattern, test antenna efficiency and pattern, and choice of shield box).

Note: Setup of the DUT is the same as in Step 2, except for a change to AT!DAWGAVGAGC and the addition of AT!DAWSSCHAIN.

4. Test diversity paths:

a. Set up the signal generator as in Step 1.

b. Set up the DUT:

i. AT!ENTERCND="<password>" (Unlock extended AT command set.)

ii. AT!DAFTMACT (Put modem into factory test mode.)

iii. AT!DASBAND=<band> (Set frequency band.)
- See tables 10-6–10-8 for <band> values

iv. AT!DAWSSCHAIN=1 (Enable the secondary chain.)

v. AT!DASCHAN=<channel> (Set modem channel)
- See tables 10-6–10-8 for <channel> values

vi. AT!DASLNAGAIN=0 (Set the LNA to maximum gain.)

vii. AT!DAWGAVGAGC=9400,0,1 (The ‘1’ indicates the diversity path is used.)

c. Test the limits as in Step 3.

10.7 LTE RF Receive Path Test

Note: This procedure segment is performed in Step 14 of the Production Test Procedure on page 82.

The suggested test procedure that follows uses the parameters in the following tables.

Table 10-9: Test Settings—WP7607 LTE Receive Path

Band		Frequency[a] (MHz)	Band ID	Rx Channel[b]
2100 MHz	B1	2142.00	34	18300
1800 MHz	B3	1844.5	44	19575
2600 MHz	B7	2657.00	35	21100
900 MHz	B8	944.5	47	21625
800 MHz	B20	808.00	56	24300
700 MHz	B28	782.5	64	27435

a. Receive frequencies shown are 2 MHz offset from center
b. Channel values shown are at the center of the corresponding bands.

Table 10-10: Test Settings—WP7610 Accessory Board LTE Receive Path

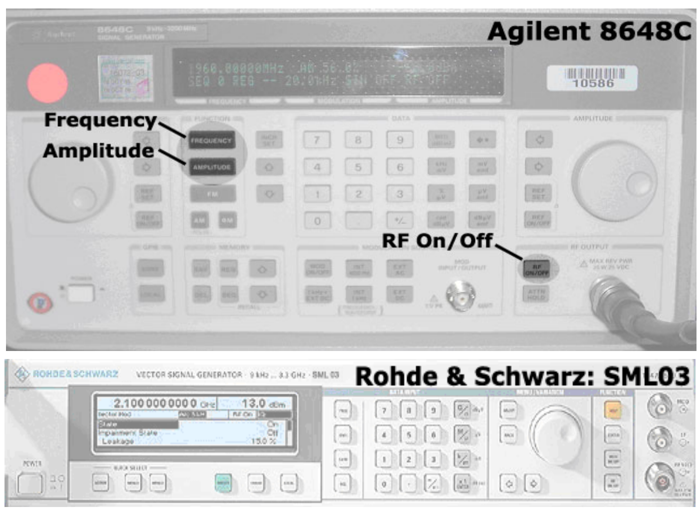
Band		Frequency[a] (MHz)	Band ID	Channel[b]
1900 MHz	B2	1962.00	43	18900
1700 MHz	B4	2134.50	42	20175
850 MHz	B5	883.50	45	20525
700 MHz	B12	739.50	50	23095
700 MHz	B13	753.00	36	23230
700 MHz	B14	765.00	51	23330
700 MHz	B17	742.00	37	23790
1700 MHz	B66	2147.00	83	132322

a. Receive frequencies shown are 2 MHz offset from center
b. Channel value used by the !DASCHAN command (!DASCHAN uses uplink (Tx) channel at the center of the corresponding band, for both Tx and Rx testing)

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 tables 10-9–10-10 for frequency values.
2. Set up the DUT:
   a. AT!ENTERCND="<password>" (Unlock extended AT command set.)
   b. AT!DAFTMACT (Put modem into factory test mode.)
   c. AT!DASBAND=<band> (Set frequency band.)
      - See tables 10-9–10-10 for <band> values
   d. AT!DALSRXBW=2 (Set Rx LTE bandwidth to 5MHz.)
   e. AT!DALSTXBW=2 (Set Tx LTE bandwidth to 5MHz.)

f. **AT!DASCHAN=<channel>** (Set modem channel)
   - See tables 10-9–10-10 for <channel> values

g. **AT!DALGAVGAGC=<channel>,0** (Get averaged Rx AGC)
   - See tables 10-9–10-10 for <channel> values

3. Test limits—Run ten or more good DUTs through this test procedure to obtain a nominal received power value.
   - Apply a tolerance of ±5 to 6 dB to each measurement (assuming a good setup design).
   - Make sure the measurement is made at a high enough level that it is not influenced by DUT-generated and ambient noise.
   - The Signal Generator power level can be adjusted and new limits found if the radiated test needs greater signal strength.
   - Monitor these limits during mass-production ramp-up to determine if further adjustments are needed.

Note: The value measured from the DUT is significantly influenced by the test setup and DUT design (host RF cabling loss, antenna efficiency and pattern, test antenna efficiency and pattern, and choice of shield box).

10.8 GNSS RF Receive Path Test

The GNSS receive path uses the dedicated 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. **AT!ENTERCND="<password>"** (Unlock extended AT command set.)
   b. **AT!DAFTMACT** (Put modem into factory test mode.)
   c. **AT!DACGPSTESTMODE=1** (Start CGPS diagnostic task.)
   d. **AT!DACGPSSTANDALONE=1** (Enter standalone RF mode.)
   e. **AT!DACGPSMASKON** (Enable log mask.)
   f. **AT!DACGPSCTON** (Return signal-to-noise and frequency measurements.)
   g. Repeat **AT!DACGPSCTON** five to ten times to ensure the measurements are repeatable and stable.
3. Leave the RF connection to the embedded module intact, and turn off the signal generator.
4. Take several more **!DACGPSCTON** readings. This will demonstrate a 'bad' signal in order to set limits for testing, if needed. This frequency offset should fall outside of the guidelines in the note below, which indicates that the CtoN result is invalid.
5. (Optional) Turn the signal generator on again, and reduce the level to -120dBm. Take more **!DACGPSCTON** readings and use these as a reference for what a marginal/poor signal would be.

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

11: References

For more details, several references can be consulted, as detailed below.

11.1 Web Site Support

Check http://source.sierrawireless.com for the latest documentation available for the AirPrime WP76XX.

11.2 Reference Documents

[1] AirPrime WP8548/WP75xx/WP76xx/WP77xx AT Command Reference
Reference number: 4118047

[2] AirPrime WP76xx Product Technical Specification
Reference number: 4119652

[3] Inter-Chip USB Supplement to the USB 2.0 Specification Revision 1.0

[4] AirPrime WPx5/WP76 Series Customer Process Guidelines
Reference number: 4116612

[5] AirPrime WPx5xx/WP76xx Scalability Guide
Reference number: 41110866

[6] I^2C Bus Specification, Version 2.1, January 2000
Reference: Phillips Semiconductor document number 9398 393 40011

[7] PCI Express Mini Card Dev Kit Quick Start Guide
Reference number: 2130705

12: Abbreviations

Table 12-1: Acronyms and Definitions

Acronym or term	Definition
3GPP	3rd Generation Partnership Project
8PSK	Octagonal Phase Shift Keying
ADC	Analog to Digital Converter
AF	Audio-Frequency
API	Application Programming Interface
AT	Attention (prefix for modem commands)
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
CEP CEP-##	Circular Error Probability—Measure of GPS horizontal accuracy indicating the radius of a circle around the actual position that contains 50% of GPS measurements. CEP-##—Radius of circle containing ##% of GPS measurements (e.g. CEP-90 indicates 90% of measurements contained within circle)
CF3	Common Flexible Form Factor
CLK	Clock
CMOS	Complementary Metal Oxide Semiconductor
CPU	Central Processing Unit
CQI	Channel Quality Indication
CS	Circuit-Switched
	Coding Scheme
CTS	Clear To Send
CW	Continuous waveform
DAC	Digital to Analog Converter
dB	Decibel = 10 x $\log_{10}$ (P1/P2) *P1 is calculated power; P2 is reference power* Decibel = 20 x $\log_{10}$ (V1/V2) *V1 is calculated voltage, V2 is reference voltage*
dBm	A logarithmic (base 10) measure of relative power (dB for decibels); relative to milliwatts (m). A dBm value will be 30 units (1000 times) larger (less negative) than a dBW value, because of the difference in scale (milliwatts vs. watts).

Table 12-1: Acronyms and Definitions (Continued)

Acronym or term	Definition
DC	Direct Current
DCD	Data Carrier Detect
DCS	Digital Cellular System A cellular communication infrastructure that uses the 1.8 GHz radio spectrum.
DL	Downlink (network to mobile)
DRX	Discontinuous Reception
DSR	Data Set Ready
DTR	Data Terminal Ready
E-GSM	Extended GSM
EDGE	Enhance Data rates for GSM Evolution
EFR	Enhanced Full Rate
EGPRS	Enhance GPRS
EIRP	Effective (or Equivalent) Isotropic Radiated Power
EMC	Electromagnetic Compatibility
EN	Enable
ERP	Effective Radiated Power
ESD	Electrostatic Discharges
eSIM	Embedded SIM
ETSI	European Telecommunications Standards Institute
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
firmware	Software stored in ROM or EEPROM; essential programs that remain even when the system is turned off. Firmware is easier to change than hardware but more permanent than software stored on disk.
FOV	Field Of View
FR	Full Rate
FSN	Factory Serial Number—A unique serial number assigned to the module during manufacturing.
Galileo	A European system that uses a series of satellites in middle earth orbit to provide navigational data.

Table 12-1: Acronyms and Definitions (Continued)

Acronym or term	Definition
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
GND	Ground
GNSS	Global Navigation Satellite Systems (GPS, GLONASS, BeiDou, and Galileo)
GPIO	General Purpose Input Output
GPRS	General Packet Radio Service
GPS	Global Positioning System An American system that uses a series of 24 satellites in middle circular orbit to provide navigational data.
GSM	Global System for Mobile communications
Hi Z	High impedance (Z)
Host	The device into which an embedded module is integrated
HR	Half Rate
HSDPA	High Speed Downlink Packet Access
HSUPA	High Speed Uplink Packet Access
Hz	Hertz = 1 cycle/second
I/O	Input/Output
IC IC	Industry Canada
	Integrated Circuit
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
IOT	Interoperability Testing
IS	Interim Standard. After receiving industry consensus, the TIA forwards the standard to ANSI for approval.
ISIM	IMS Subscriber Identity Module.
LED	Light Emitting Diode. A semiconductor diode that emits visible or infrared light.
LGA	Land Grid Array
LHCP	Left-Hand Circular Polarized

Table 12-1: Acronyms and Definitions (Continued)

Acronym or term	Definition
LNA	Low noise Amplifier
LTE	Long Term Evolution—a high-performance air interface for cellular mobile communication systems.
MAX	Maximum
MCS	Modulation and Coding Scheme
MHz	Megahertz = 10e6 Hz
MIC	Microphone
MIMO	Multiple Input Multiple Output—wireless antenna technology that uses multiple antennas at both transmitter and receiver side. This improves performance.
MIN	Minimum
MO	Mobile Originated
MT	Mobile Terminated
N/A	Not Applicable
NMEA	National Marine Electronics Association
NOM	Nominal
OEM	Original Equipment Manufacturer—a company that manufactures a product and sells it to a reseller.
PA	Power Amplifier
packet	A short, fixed-length block of data, including a header, that is transmitted as a unit in a communications network.
PBCCH	Packet Broadcast Control Channel
PC	Personal Computer
PCB	Printed Circuit Board
PCL	Power Control Level
PCS	Personal Communication System A cellular communication infrastructure that uses the 1.9 GHz radio spectrum.
PDN	Packet Data Network
PFM	Power Frequency Modulation
PLL	Phase Lock Loop
PMIC	Power Management Integrated Circuit
PSM	Phase Shift Modulation
PSS	Primary synchronization signal
PST	Product Support Tools

Table 12-1: Acronyms and Definitions (Continued)

Acronym or term	Definition
PTCRB	PCS Type Certification Review Board
PWM	Pulse Width Modulation
QAM	Quadrature Amplitude Modulation. This form of modulation uses amplitude, frequency, and phase to transfer data on the carrier wave.
QMAP	Qualcomm MUX and Aggregation Protocol
QPSK	Quadrature Phase-Shift Keying
R2C	Ready-To-Connect
RAM	Random Access Memory
RAT	Radio Access Technology
RF	Radio Frequency
RHCP	Right Hand Circular Polarization
RI	Ring Indicator
RSE	Radiated Spurious Emissions
RSSI	Received Signal Strength Indication
RST	Reset
RTC	Real Time Clock
RTS	Request To Send
RX	Receive
SCLK	Serial Clock
SED	Smart Error Detection
Sensitivity (Audio)	Measure of lowest power signal that the receiver can measure.
Sensitivity (RF)	Measure of lowest power signal at the receiver input that can provide a prescribed BER/BLER/SNR value at the receiver output.
SIM	Subscriber Identity Module.
SIMO	Single Input Multiple Output—Wireless antenna technology that uses multiple antennas at the receiver side and one antenna at the source (transmitter).
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
SNR	Signal-to-Noise Ratio
SPI	Serial Peripheral Interface
SPK	Speaker

Table 12-1: Acronyms and Definitions (Continued)

Acronym or term	Definition
SW	Software
TBC	To Be Confirmed
TBD	To Be Determined
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
TP	Test Point
TRP	Total Radiated Power
TX	Transmit
TYP	Typical
UART	Universal Asynchronous Receiver-Transmitter
UE	User Equipment
UICC	Universal Integrated Circuit Card
UIM	User Identity Module. Generic term used in this document to refer to UICC, where the application on the UICC (USIM, ISIM, CSIM, etc.) varies depending on the provider of the card.
UL	Uplink (mobile to network)
UMTS	Universal Mobile Telecommunications System
USB	Universal Serial Bus
USB-SS	USB Selective Suspend/USB not enumerated
USIM	Universal Subscriber Identity Module (UMTS)
USSD	Unstructured Supplementary Services Data
UTRA	UMTS Terrestrial Radio Access
VBAT-BB	Baseband power supply
VBAT-RF	RF power supply
VCC	Supply voltage
VSWR	Voltage Standing Wave Ratio
WCDMA	Wideband Code Division Multiple Access (also referred to as UMTS)
WLAN	Wireless Local Area Network
WWAN	Wireless Wide Area Network
ZIF	Zero Intermediate Frequency