



AirPrime WP75xx/WP8548

Product Technical Specification



SIERRA
WIRELESS®

4116440
Rev 10

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Revision History

Revision number	Release date	Changes
1	October 2014	Creation (limited release)
2	January 2015	Reorganized content extensively

Revision number	Release date	Changes
3	April 2015	<p>Removed analog audio</p> <p>Removed diversity</p> <p>Changed signal names: 2G_TX_ON to TX_ON; LED1_N to WWAN_LED_N; 19M_CLKOUT to SYS_CLK; 32K_CLKOUT to SLEEP_CLK; TP1_N to TP1; TP2-TP10 to J1-J9</p> <p>Updated test point dimensions, changed test point signal names</p> <p>Updated Table 1-3 on page 21: GNSS band ranges</p> <p>Updated Figure 2-3, AirPrime WP8548 Architecture Overview, on page 26</p> <p>Updated Electrical description in Table 2-1 on page 27</p> <p>Updated Table 3-2, Absolute Maximum Ratings, on page 36: Ripple value, footnotes</p> <p>Updated Figure 3-1, Power Supply Characteristics (capture enlarged), on page 38</p> <p>Updated Power Consumption States on page 39</p> <p>Updated Table 3-9, WP8548 Current Consumption Values, on page 44</p> <p>Updated Table 3-17, WP7500 Conducted Tx Max Output Power Tolerances—WCDMA, on page 37: Band 6</p> <p>Updated Table 3-22, WP7502 Conducted Rx Sensitivity—WCDMA Bands,, on page 40: Band 6</p> <p>Replaced Table 3-31, Absolute Maximum Ratings, on page 59</p> <p>Updated Table 3-30, GNSS Standalone Antenna Recommendations, on page 58: frequency ranges, IIP2/3 descriptions</p> <p>Updated Mechanical Drawing on page 63</p> <p>Updated descriptive info for Application Core on page 62 and Embedded Memory on page 63</p> <p>Updated BAT_RTC on page 65</p> <p>Updated Table 4-3, POWER_ON_N Electrical Characteristics, on page 66 and removed associated note</p> <p>Updated Table 4.3.1, Power-up Sequence, on page 66 sequence, timing parameters, USB enumeration description</p> <p>Updated Table 4-5, USB Pin Descriptions, on page 67</p> <p>Updated Table 4-8, GPIO Pin Description, on page 72</p> <p>Added WAKE_ON_WWAN on page 89</p> <p>Updated I2C Interface on page 74 description</p> <p>Updated ADC on page 76</p> <p>Updated Temperature Monitoring on page 85, added AT info for solicited/unsolicited notifications; updated functionality descriptions in table</p> <p>Added SAFE_PWR_REMOVE on page 90 and UIM1_DET/UIM2_DET on page 90</p> <p>Updated Figure 5-1, Voltage Limiter Example, on page 68</p> <p>Updated Figure 5-5, UIM Interface, on page 73</p> <p>Added Figure 5-7, USB OTG Interface, on page 74</p> <p>Updated Labeling on page 101</p> <p>Updated Figure 9-1, Pin Configuration (Bottom View), on page 111 core/extension/ground identifications</p> <p>Updated Table 9-1, Pin Definitions, on page 112: core/extension/ground identifications; “if unused” values throughout table; USB_VBUS details; removed SPKR_N/SPKR_P/MIC_P/MIC_N; changed name SYS_CLK; changed name SLEEP_CLK; added DR_SYNC (was GPIO); updated GPIO numbers; changed name TP1; changed name TX_ON; updated UIM1_DET/UIM2_DET details; replaced LCD signals with Reserved; moved COEX pins; changed name WWAN_LED_N; moved W_DISABLE_N; changed name WAKE_ON_WWAN; replaced some GND/NC/GPIOs as reserved; removed SYSTEM_POWER_CTRL; updated ANT_CTL directions; replaced GPS_DISABLE_N with GPIO</p> <p>Updated supply voltage (3.4-4.3V)</p> <p>Updated Table 2-5, Supported GSM/GPRS/EDGE Specifications, on page 30: Removed R99 details; updated class values GPRS/EDGE</p>

Revision number	Release date	Changes
4	April 2015	Removed SPI2, GPIO34-37, COEX, and ADC2-3 content
5	June 2015	<p>Updated Power Consumption States on page 39</p> <p>Updated Table 3-34, Internal Device Frequencies, on page 62 (PLL frequencies)</p> <p>Updated Figure 3-4, AirPrime WP75xx/AirPrime WP8548 Mechanical Drawings, on page 64</p> <p>Updated Figure 4-2, Recommended UIM Holder Implementation, on page 70 and sample part number</p> <p>Updated Figure 5-5, UIM Interface, on page 73</p> <p>Corrected pin group field (pins 30,32,36,128) and function field (pins 110,136,139) in Table 9-1, Pin Definitions, on page 112</p> <p>Updated Table 3-11, Conducted Tx Max Output Power Tolerances—GSM, on page 45, Table 3-14, WP8548 Conducted Rx Sensitivity—GSM/EDGE Bands, on page 47, Table 3-17, WP7500 Conducted Tx Max Output Power Tolerances—WCDMA, on page 37, Table 3-22, WP7502 Conducted Rx Sensitivity—WCDMA Bands,, on page 40.</p> <p>Added DR_SYNC on page 90.</p> <p>Changed GPIO6 to RESET_OUT_N.</p>
6	October 2015	<p>Updated Table 3-9, WP8548 Current Consumption Values, on page 44.</p> <p>Removed references to “Antenna 1” (since only one antenna) in Table 3-27, Antenna Recommendations, on page 54.</p> <p>Added footnotes explaining signal direction in interface tables in Chapter 3.</p> <p>Noted that USB_VBUS should be connected by customers for future scalability, but is not currently connected internally.</p> <p>Updated Reset Timing (Trlen) parameter in Table 4-14, Reset Timing, on page 75.</p> <p>Added section W_DISABLE_N—Wireless Disable on page 91.</p> <p>Updated Figure 5-5, UIM Interface, on page 73.</p> <p>Updated Figure 5-6, USB Interface, on page 74.</p> <p>Cleanup—replaced “No connect” with “Leave open” throughout document.</p> <p>Updated Table 9-1 on page 112 “I/O” and/or “If unused” columns for pins 1, 16, 31, 55–58, 71–90, 91, 96, 97, 98, 99, 100–103, 107–108, 114–124, 129–135, 140–146, 160.</p> <p>Updated Table 2-5 on page 30 (GPRS—added MCS1-9).</p>
7	February 2016	<p>Updated Table 3-9, WP8548 Current Consumption Values, on page 44</p> <p>Updated Table 3-12, Conducted Tx Max Output Power Tolerances—GSM, on page 46</p> <p>Updated Table 3-14, WP8548 Conducted Rx Sensitivity—GSM/EDGE Bands, on page 47</p> <p>Updated Table 3-16, Conducted Tx Max Output Power Tolerances—WCDMA, on page 44</p> <p>Updated Table 3-18, WP8548 Conducted Rx Sensitivity—WCDMA Bands, on page 49</p> <p>Updated RF Circuit on page 94</p> <p>Updated Important Compliance Information for North American Users on page 106</p>

Revision number	Release date	Changes
8	March 2016	<p>Updated GPS frequency range and added Galileo.</p> <p>Updated I2C1_CLK references from 'O' to 'I/O'.</p> <p>Removed DRX_IQ from Figure 2-3 on page 26.</p> <p>Removed 'sku-dependent' notes from GNSS availability throughout document.</p> <p>Updated Power Supply Ratings on page 36 description, Table 3-2 on page 36, Table 3-4 on page 37, and added Figure 3-1 on page 38.</p> <p>Updated current consumption descriptions and values in Table 3-6 on page 40, Figure 3-3 on page 41, and Table 3-9 on page 44.</p> <p>Added Active State to ULPM Transition on page 42.</p> <p>Updated POWER_ON_N on page 66 (momentary switch recommendation) Table 4-3 on page 66, and Figure 4-1 on page 66 (POWER_ON_N and SAFE_PWR_REMOVE signals).</p> <p>Exposed additional GPIOs —General Purpose Input/Output (GPIO) on page 72, Figure 9-1 on page 111, Table 9-1 on page 112).</p> <p>Exposed additional ADCs —ADC on page 76, Figure 9-1 on page 111, Table 9-1 on page 112).</p> <p>Removed pins (for GPIOs/ADCs) from Table 9-4 on page 118.</p> <p>Removed auxiliary PCM timing content.</p> <p>Added RF trace design requirement to Important Compliance Information for North American Users on page 106</p>
9	April 2016	<p>Updated Table 8-3 on page 108 (Column heading—EIRP values; marked unused cells as '—')</p>
10	September 2016	<p>Merged in content from 4118045 rev3 WP75XX PTS</p> <p>Added chapter: Testing on page 127.</p> <p>Updated Coin cell voltage in Table 4-2 on page 65.</p> <p>Updated idle/Airplane mode current consumption, and removed sleep mode current consumption in WP8548 Current Consumption Values on page 44.</p> <p>Added note indicating UART1 (8-wire) software support will be in future f/w release.</p> <p>Added notes indicating ADC2/ADC3 will be available as wakeup pins in future f/w release.</p>

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>> 1: Introduction

This document defines the high-level product features and illustrates the interfaces for the AirPrime WP75xx/AirPrime WP8548 Smart Embedded Modules. It covers the hardware aspects of the product series, including electrical and mechanical.

The AirPrime WP7502 is an LTE, HSPA, WCDMA, and dual-band GSM/GPRS/EDGE embedded wireless module.

The AirPrime WP7504 is an LTE, HSPA, WCDMA, and CDMA embedded wireless module.

The AirPrime WP8548 is an HSPA, WCDMA, and quad-band GSM/GPRS/EDGE embedded wireless module.

1.1 General Features

The AirPrime WP75xx/AirPrime WP8548 is an industrial-grade LGA 239-pad module. Its wireless modem provides voice and data connectivity on the following networks:

- WP7502—LTE, HSPA, WCDMA, EDGE/GPRS
- WP7504—LTE, HSPA, WCDMA, CDMA
- WP8548—HSPA, WCDMA, EDGE/GPRS

Note: VoLTE is not supported.

GNSS functionality is also available:

- WP75xx—Available as a SKU-configuration
- WP8548—Standard feature

In addition to modem features, the AirPrime WP75xx/AirPrime WP8548 also embeds several cores for maximum flexibility and security for embedded software execution, including:

- A Telecom Core that natively manages 2G (WP7502/WP8548)/3G/4G (WP75xx) modem features
- An Application Core dedicated to customer applications, natively provided with Legato Application framework.

The following tables detail the bands/connectivity supported by the AirPrime WP7502, AirPrime WP7504, and AirPrime WP8548.

Table 1-1: WP7502 Supported Bands/Connectivity

Technology	RF band	Transmit band (Tx) (MHz)	Receive band (Rx) (MHz)	Notes
LTE	B1	1920–1980	2110–2170	MIMO support
	B3	1710–1785	1805–1880	
	B7	2500–2570	2620–2690	
	B8	880–915	925–960	
	B20	832–862	791–821	

Table 1-1: WP7502 Supported Bands/Connectivity (Continued)

Technology	RF band	Transmit band (Tx) (MHz)	Receive band (Rx) (MHz)	Notes
UMTS	B1	1920–1980	2110–2170	Diversity support
	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	

a. GNSS support is SKU-dependent.

Table 1-2: WP7504 Supported Bands/Connectivity

Technology	RF band	Transmit band (Tx) (MHz)	Receive band (Rx) (MHz)	Notes
LTE	B2	1850–1910	1930–1990	MIMO support
	B4	1710–1755	2110–2155	
	B5	824–849	869–894	
	B12	699–716	729–746	
	B17	704–716	734–746	
	B25	1850–1915	1930–1995	
	B26	814–849	859–894	
UMTS	B2	1850–1910	1930–1990	Diversity support
	B4	1710–1755	2110–2155	
	B5	824–849	869–894	
CDMA EVDO Release A	BC0	824–849	869–894	Diversity support
	BC1	1850–1910	1930–1990	
	BC10	816–824	861–869	
GNSS ^a	GPS	-	1575.42 ± 1.023	
	GLONASS	-	1597.52–1605.92	
	Galileo	-	1575.42 ± 2.046	

a. GNSS support is SKU-dependent.

Table 1-3: WP8548 Supported Bands/Connectivity

Technology	RF band	Transmit band (Tx) (MHz)	Receive band (Rx) (MHz)	
UMTS	B1	1920–1980	2110–2170	
	B2	1850–1910	1930–1990	
	B5	824–849	869–894	
	B6	830–840	875–885	
	B8	880–915	925–960	
	B19	830–845	875–890	
GSM/GPRS/ EDGE	GSM 850	824–849	869–894	
	E-GSM 900	880–915	925–960	
	DCS 1800	1710–1785	1805–1880	
	PCS 1900	1850–1910	1930–1990	
GNSS	GPS	-	1575.42 ± 1.023	
	GLONASS	-	1597.52–1605.92	
	Galileo	-	1575.42 ± 2.046	

1.2 Interfaces

The AirPrime WP75xx/AirPrime WP8548 module provides the following interfaces and peripheral connectivity:

- Digital section running under 1.8V
- Dual UIM interfaces—See [UIM interface on page 69](#).
- VBAT_RF/VBAT_BB power supply—See [Power Supply Ratings on page 36](#).
- RF—See [RF on page 46](#).
- GNSS¹ (RF_GNSS)—See [GNSS on page 56](#).
- Real Time Clock battery backup—See [BAT_RTC on page 65](#).
- ON/OFF control:
 - POWER_ON_N—See [POWER_ON_N on page 66](#).
 - RESET_IN_N—See [Reset Signal \(RESET_IN_N\) on page 75](#).
- USB 2.0—See [USB on page 67](#).
- Two UART serial links—primary (8-line) and secondary (4-line)—See [UART on page 68](#).
- GPIOs—See [General Purpose Input/Output \(GPIO\) on page 72](#).
- SDIO—See [Secure Digital IO \(SDIO\) interface on page 73](#).
- I²C—See [I2C Interface on page 74](#).
- 1.8V voltage reference—See [VGPIO on page 74](#).
- Four ADCs—See [ADC on page 76](#).
- Digital audio (PCM/I²S)—See [Digital Audio on page 77](#).
- HSIC bus—See [HSIC Bus on page 83](#).
- Digital I/O

1. (WP75xx) GNSS support is SKU-dependent; (WP8548) Supported

- Antenna control—See [Antenna Control](#) on page 87.
- Two System Clock outputs—See [Clock](#) on page 83.
- Test pins—See [Test Pins](#) on page 87.
- Tx Activity Indicator (TX_ON)—See [Tx Activity Indicator \(TX_ON\)](#) on page 88.

1.3 Common Flexible Form Factor (CF3)

The AirPrime WP75xx/AirPrime WP8548 belongs to the Common Flexible Form Factor (CF3) family of modules. This family consists of a series of WWAN modules that share the same mechanical dimensions (same width and length with varying thicknesses) and footprint. The CF3 form factor provides a unique solution to a series of problems faced commonly in the WWAN module space as it:

- Accommodates multiple radio technologies (from GSM to LTE advanced) and band groupings
- Supports bit-pipe (Essential Module Series) and value-add (Smart Module Series) solutions
- Offers electrical and functional compatibility

1.4 Physical Dimensions and Connection Interface

The AirPrime WP75xx/AirPrime WP8548 module is a compact, robust, fully shielded and labeled module with the dimensions noted in [Table 1-4](#).

Table 1-4: AirPrime WP75xx/AirPrime WP8548 Dimensions^a

Parameter	Nominal	Tolerance	Units
Length	23.00	±0.10	mm
Width	22.00	±0.10	mm
Thickness	4.352	±0.203	mm
Weight (with label)	4.2	±0.1	g

a. Dimensions are accurate as of the release date of this document.

The AirPrime WP75xx/AirPrime WP8548 module is an LGA form factor device. All electrical and mechanical connections are made through the 239 Land Grid Array (LGA) pads on the bottom side of the PCB. (See [Figure 9-1 on page 111](#) for details.)

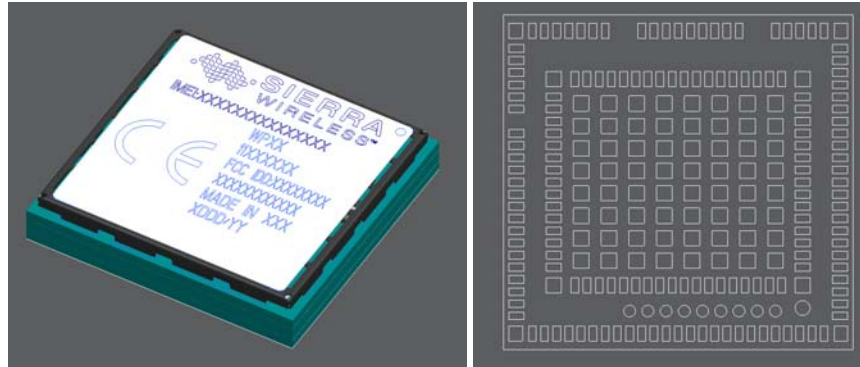


Figure 1-1: AirPrime WP75xx/AirPrime WP8548 Mechanical Overview

The 239 pads have the following distribution:

- 157 signal pads, 1.0x0.5 mm, 0.8 mm pitch
 - 66 inner signal pads
 - 91 outer signal pads
- 10 test points:
 - 1 polarity mark (Ground), 1.0 mm diameter
 - 9 test points, 0.8 mm diameter, 1.20 mm pitch
- 72 ground pads:
 - 64 inner ground pads, 1.0x1.0 mm, pitch 1.83 mm/1.48 mm
 - 4 inner corner ground pads, 1.0x1.0 mm
 - 4 outer corner ground pads, 1.0x0.9 mm

2: Functional Specifications

2.1 Architecture

The following figures present overviews of the AirPrime WP75xx/AirPrime WP8548 modules' internal architecture and external interfaces.

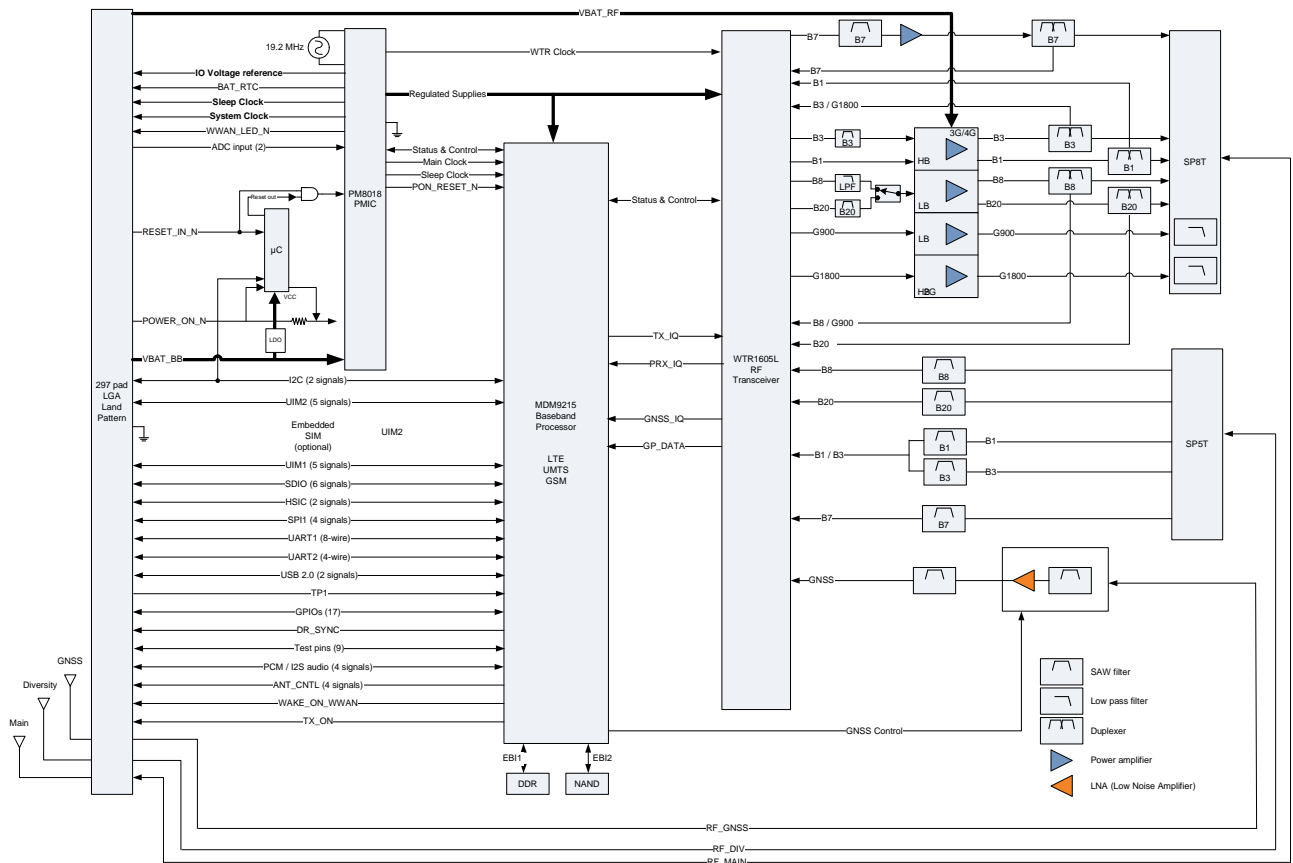


Figure 2-1: AirPrime WP7502 Architecture Overview

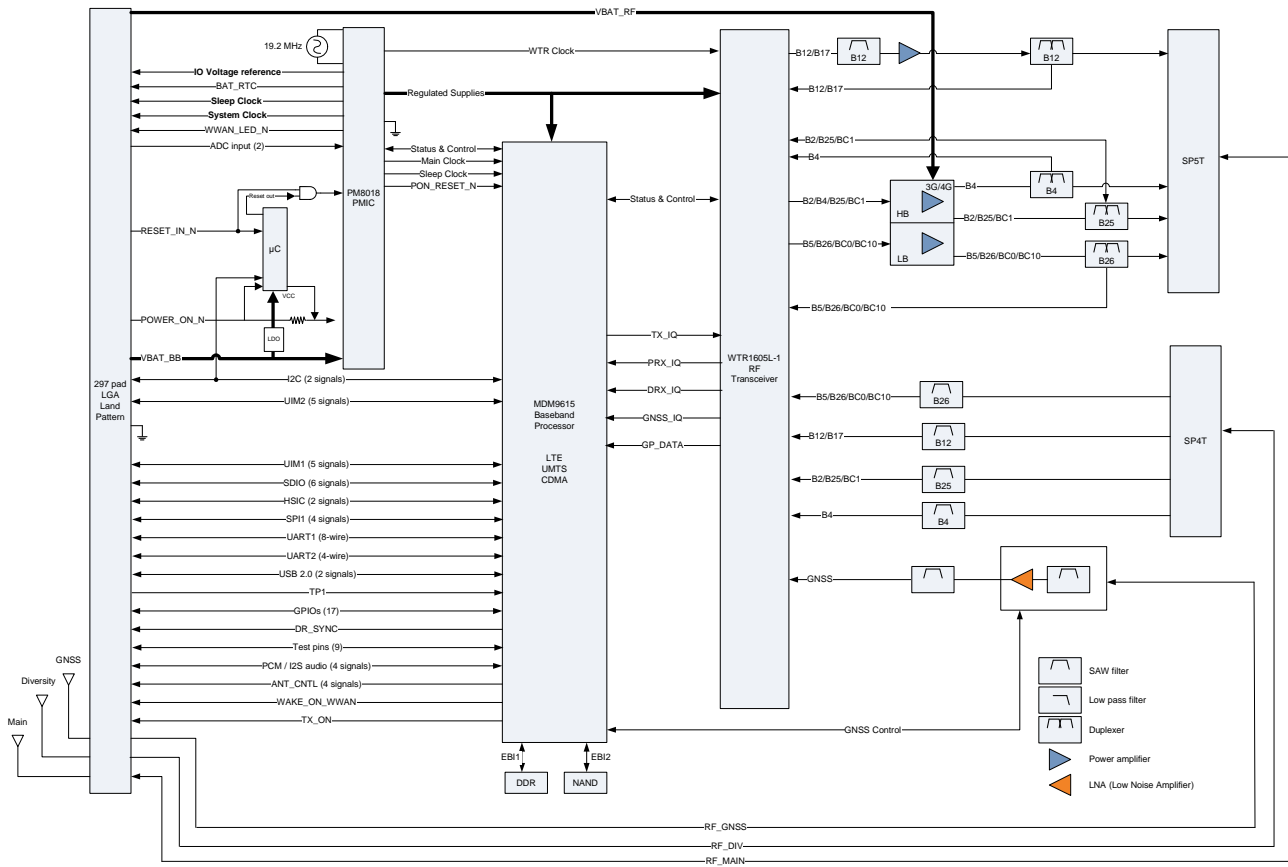


Figure 2-2: AirPrime WP7504 Architecture Overview

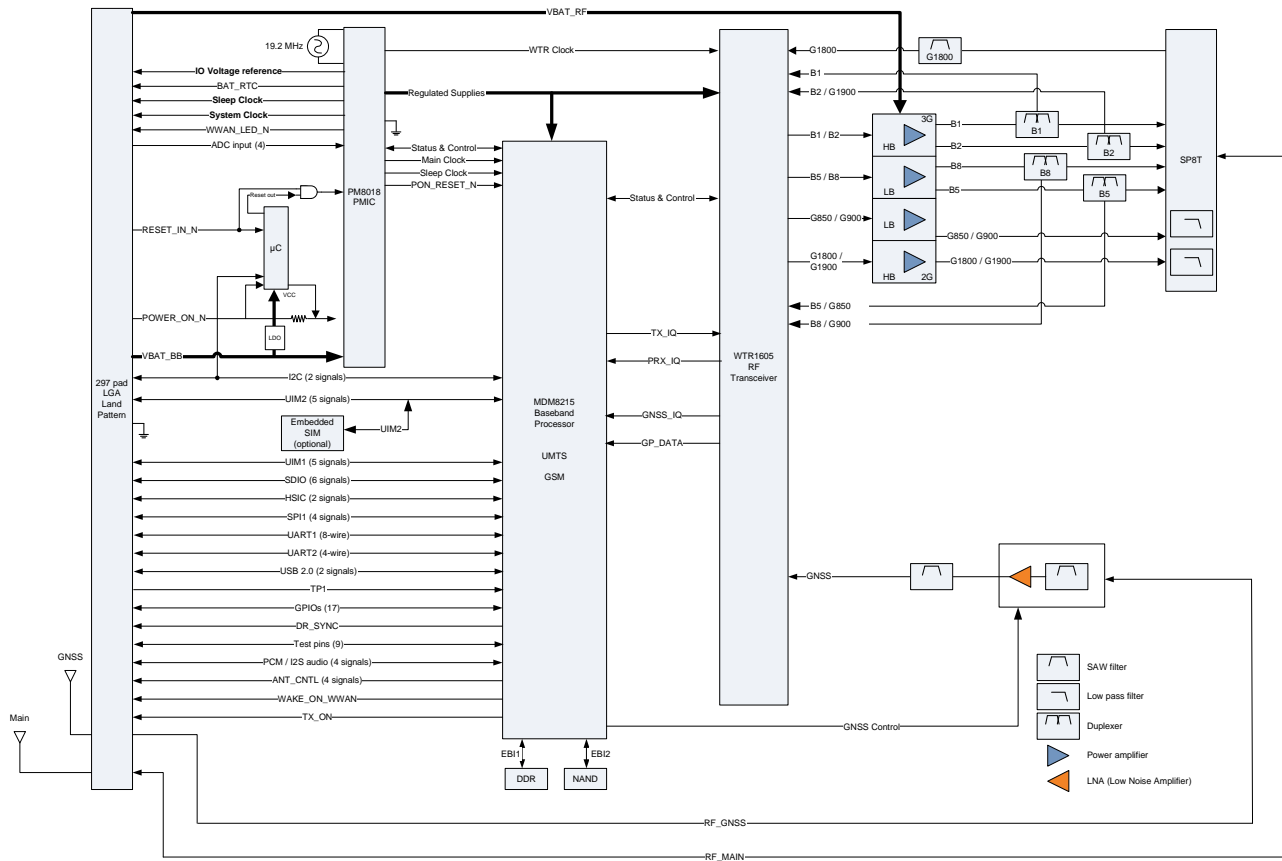


Figure 2-3: AirPrime WP8548 Architecture Overview

2.1.1 Chipsets

The AirPrime WP75xx/AirPrime WP8548 modules are based on the following Qualcomm baseband processors:

- MDM8215—AirPrime WP8548
- MDM9215—AirPrime WP7502
- MDM9615—AirPrime WP7504

2.2 Telecom Features

Table 2-1 summarizes the AirPrime WP75xx/AirPrime WP8548 module’s capabilities offered through the Telecom core.

Table 2-1: AirPrime WP75xx/AirPrime WP8548 Capabilities

Feature	Description
Electrical	3.4–4.3V supply voltage (VBAT_BB, VBAT_RF): <ul style="list-style-type: none"> • Single supply (recommended), VBAT_BB tied to VBAT_RF <i>or</i> • Dual supplies, single supply each for VBAT_BB and VBAT_RF
Voice (Digital Audio)	<ul style="list-style-type: none"> • PCM/I²S 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 • Internal codec driver for WM8944
SMS	<ul style="list-style-type: none"> • 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)
Supplementary services	<ul style="list-style-type: none"> • Call Barring • Call Forwarding • Call Hold • Caller ID • Call Waiting • Multi-party service • USSD • Automatic answer

Table 2-2: WP7502 RF Bands/Connectivity

Technology	RF band	Transmit band (Tx) (MHz)	Receive band (Rx) (MHz)	Maximum output power
LTE	B1	1920–1980	2110–2170	23 dBm \pm 1 dBm; Class 3bis
	B3	1710–1785	1805–1880	23 dBm \pm 1 dBm; Class 3bis
	B7	2500–2570	2620–2690	22 dBm \pm 1 dBm; Class 3bis
	B8	880–915	925–960	23 dBm \pm 1 dBm; Class 3bis
	B20	832–862	791–821	23 dBm \pm 1 dBm; Class 3bis
UMTS	B1	1920–1980	2110–2170	23 dBm \pm 1 dBm; Class 3bis
	B8	880–915	925–960	23 dBm \pm 1 dBm; Class 3bis
GSM/GPRS/EDGE	E-GSM 900	880–915	925–960	2 Watts GSM/GPRS/EDGE
	DCS 1800	1710–1785	1805–1880	1 Watt GSM/GPRS/EDGE
GNSS ^a	GPS	-	1575.42 \pm 1.023	-
	GLONASS	-	1597.52–1605.92	-
	Galileo	-	1575.42 \pm 2.046	-

a. GNSS support is SKU-dependent.

Table 2-3: WP7504 RF Bands/Connectivity

Technology	RF band	Transmit band (Tx) (MHz)	Receive band (Rx) (MHz)	Maximum output power
LTE	B2	1850–1910	1930–1990	23 dBm \pm 1 dBm; Class 3bis
	B4	1710–1755	2110–2155	23 dBm \pm 1 dBm; Class 3bis
	B5	824–849	869–894	23 dBm \pm 1 dBm; Class 3bis
	B12	699–716	729–746	23 dBm \pm 1 dBm; Class 3bis
	B17	704–716	734–746	23 dBm \pm 1 dBm; Class 3bis
	B25	1850–1915	1930–1995	23 dBm \pm 1 dBm; Class 3bis
	B26	814–849	859–894	23 dBm \pm 1 dBm; Class 3bis
UMTS	B2	1850–1910	1930–1990	23 dBm \pm 2 dBm; Class 3bis
	B4	1710–1755	2110–2155	23 dBm \pm 1 dBm; Class 3bis
	B5	824–849	869–894	23 dBm \pm 1 dBm; Class 3bis
CDMA	BC0	824–849	869–894	23 dBm \pm 1 dBm; Class 3bis
	BC1	1850–1910	1930–1990	23 dBm \pm 1 dBm; Class 3bis
	BC10	816–824	861–869	23 dBm \pm 1 dBm; Class 3bis

Table 2-3: WP7504 RF Bands/Connectivity (Continued)

Technology	RF band	Transmit band (Tx) (MHz)	Receive band (Rx) (MHz)	Maximum output power
GNSS ^a	GPS	-	1575.42 ± 1.023	-
	GLONASS	-	1597.52–1605.92	-
	Galileo	-	1575.42 ± 2.046	-

a. GNSS support is SKU-dependent.

Table 2-4: WP8548 RF Bands/Connectivity

Technology	RF band	Transmit band (Tx) (MHz)	Receive band (Rx) (MHz)	Maximum output power
UMTS	B1	1920–1980	2110–2170	23 dBm ± 1 dBm; Class 3bis
	B2	1850–1910	1930–1990	23 dBm ± 1 dBm; Class 3bis
	B5	824–849	869–894	23 dBm ± 1 dBm; Class 3bis
	B6	830–840	875–885	23 dBm ± 1 dBm; Class 3bis
	B8	880–915	925–960	23 dBm ± 1 dBm; Class 3bis
	B19	830–845	875–890	23 dBm ± 1 dBm; Class 3bis
GSM/GPRS/EDGE	GSM 850	824–849	869–894	2 Watts GSM/GPRS/EDGE
	E-GSM 900	880–915	925–960	2 Watts GSM/GPRS/EDGE
	DCS 1800	1710–1785	1805–1880	1 Watt GSM/GPRS/EDGE
	PCS 1900	1850–1910	1930–1990	1 Watt GSM/GPRS/EDGE
GNSS	GPS	-	1575.42 ± 1.023	-
	GLONASS	-	1597.52–1605.92	-
	Galileo	-	1575.42 ± 2.046	-

2.2.1 Network Technology Specifications

2.2.1.1 GSM/GPRS/EDGE Specifications

The following table describes GSM/GPRS/EDGE specifications for WP7502 and WP8548 modules.

Table 2-5: Supported GSM/GPRS/EDGE Specifications^a

Standard	Feature Description
GPRS	Packet-switched data: <ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • 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

a. WP7502/WP8548 only

2.2.1.2 WCDMA Specifications

The following table describes WCDMA specifications for WP75xx/WP8548 modules.

Table 2-6: Supported WCDMA Specifications

Standard	Feature Description
R99	<ul style="list-style-type: none"> • All modes and data rates for WCDMA FDD, with the following restrictions: <ul style="list-style-type: none"> • The downlink supports the following specifications: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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
R5 HSDPA	<ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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 • 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

Table 2-6: Supported WCDMA Specifications (Continued)

Standard	Feature Description
R6 HSUPA	<ul style="list-style-type: none"> • E-DCH data rates of up to 5.76 Mbps for 2 ms TTI (UE category 6) uplink • Support for 3GPP-defined features: <ul style="list-style-type: none"> • E-AGCH, E-RGCH, and E-HICH channels for downlink; E-RGCH and E-HICH supports serving and nonserving 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 along 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 • DPCCH DTX support

2.2.1.3 LTE Specifications

The following table describes LTE specifications for WP75xx modules.

Table 2-7: Supported LTE Specifications^a

Standard	Feature Description
R9 Cat 3 FDD	<ul style="list-style-type: none"> • Release 9 mandatory LTE features • FDD: up to 100 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+, CDMA (WP7504 only), EDGE (WP7502 only) and applicable backward-compatible modes • NAS & RRC standalone security • Commercial Mobile Alert System (CMAS) • ETWS (Earthquake Tsunami Warning System) notification • Inter-frequency/bandwidth mobility • DRX cycle while in: <ul style="list-style-type: none"> • Connected mode • Idle mode • UE IRAT support for Self Organizing Networks and Automatic Neighbor Relation (SON AR) • Mode reselections: <ul style="list-style-type: none"> • eHRPD to LTE in idle mode based on LTE neighbor cell measurements • LTE in idle mode to eHRPD idle • LTE <-> GERAN Idle mode mobility (cell reselection) • LTE <-> UMTS Idle mode mobility (cell reselection) • Mode redirections: <ul style="list-style-type: none"> • LTE in connected mode to eHRPD idle <ul style="list-style-type: none"> • Blind redirection • Based on measurement gaps • UMTS to LTE redirections <ul style="list-style-type: none"> • 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

Table 2-7: Supported LTE Specifications^a (Continued)

Standard	Feature Description
System Determination	<ul style="list-style-type: none"> • 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 Services: eHRPD/LTE - Data System Determination for Multiple Radio Systems • Multimode system selection - facilitates system selection and avoids unnecessary attach requests in a 3GPP+3GPP2 multimode UE
Data	<ul style="list-style-type: none"> • 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 • Data services - LTE-eHRPD Mobility Support of APN Class and APN Bearer in Application Profile over LTE

a. WP75xx only

2.2.1.4 CDMA Specifications

The following table describes CDMA specifications for WP7504 modules.

Table 2-8: Supported CDMA Specifications^a

Standard	Feature Description
CDMA IS-2000	<ul style="list-style-type: none"> • Up to 153 kbps, simultaneous forward and reverse channel
CDMA IS-856 (1xEV-DO Release A)	<ul style="list-style-type: none"> • Up to 3.1 Mbps forward channel • Up to 1.8 Mbps reverse channel

a. WP7504 only

2.2.2 Modem Specifications

Table 2-9: Supported Modem Specifications^a

Standard	Feature Description
Data	<ul style="list-style-type: none">• IPHC protocol as RFC 2509• Stateless DHCPv4 protocol to get P-CSCF and DNS addresses• IPv4/IPv6• 4 PDNs Support over Multi-RmNet• Dual IP on single RmNet• IP only Mode/Raw IP Mode• Multi-RmNet Data Call

a. Preliminary

2.3 Multi-Core Processing Capabilities

The AirPrime WP75xx/AirPrime WP8548 is a powerful multiple-core system that includes:

- One QDSP6 core, embedding Telecom firmware with integrated cellular voice (future firmware release), data and wireless Internet connectivity
- One Cortex-A5 core entirely dedicated to customer application and natively provided with Linux operating system

3: Technical Specifications

3.1 Environmental

The environmental specifications for operation and storage of the AirPrime WP75xx/AirPrime WP8548 are defined in Table 3-1.

Table 3-1: Environmental Specifications

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	-
Ambient Humidity	95% or less	-

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 constraint exceeds the specified tolerance.
- Unless otherwise stated, full performance should return to normal after the excessive constraint(s) have been removed.

3.2 Power Supply Ratings

The AirPrime WP75xx/AirPrime WP8548 is powered via:

- (Recommended) A single regulated DC power supply (3.7V nominal)
- Two regulated DC power supplies (3.7V nominal), one each for VBAT_BB and VBAT_RF

The AirPrime WP75xx/AirPrime WP8548 does not support USB bus-operation. DC power is supplied via the VBAT_RF and VBAT_BB signals.

Table 3-2: Absolute Maximum Ratings

Parameter	Min	Max	Units
Power supply voltage (VBAT_BB/VBAT_RF)	-0.3	+6.0	V

Table 3-3: Power Supply Pins

Pin	Name	Direction	Function	Notes
63, 158	VBAT_BB	Input	Baseband power supply	63—Must be used 158—Optional
61, 62, 157	VBAT_RF	Input	RF power supply	61/62—Must be used 157—Optional

Table 3-4: Operating Conditions

Parameter	Min	Typ	Max	Units	Notes
Power supply voltage ^a	3.4	3.7	4.3	V	Must be within min/max values over all operating conditions (including voltage ripple, droop, and transient), especially (for the WP7502 and WP8548) during the GSM transmit burst.
Power supply ripple	-	-	100	mV _{pp}	See Figure 3-1 on page 38 .
Power supply voltage droop	-	-	250	mV	See Figure 3-1 on page 38 and Under-Voltage Lockout (UVLO) on page 38 .
Power supply voltage transient (overshoot/undershoot)	-	-	300	mV	See Figure 3-1 on page 38 .
Supply current	-	1.0	3.0	A	<ul style="list-style-type: none"> Typical value varies and depends on output power, band, and operating voltage. See Current Consumption on page 42 for values measured under normal operating conditions. Max value measured over 100 μs period.

a. Power supply voltage outside the required range may affect call quality (dropped calls, data transfer errors, etc.).

Customer should characterize the ripple, droop, and transient response (overshoot/undershoot) of the power supply delivery system at the module input under full GSM transmit power. To minimize voltage variation, add suitable capacitors to the supply line as close as possible to the module—depending on the power supply design, these capacitors may range from tens to several thousand μF.

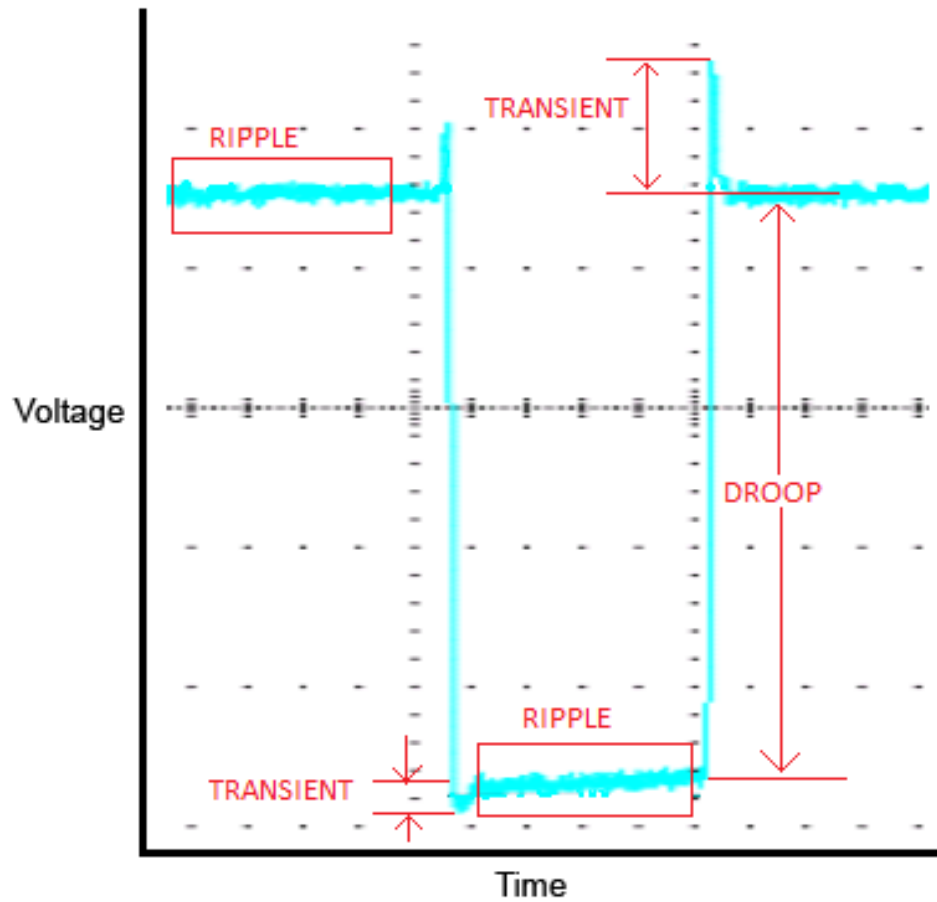


Figure 3-1: Power Supply Characteristics (capture enlarged)

3.2.1 Under-Voltage Lockout (UVLO)

The power management section of the AirPrime WP75xx/AirPrime WP8548 includes an under-voltage lockout circuit that monitors supply and shuts down when VBAT_BB/VBAT_RF falls below the threshold.

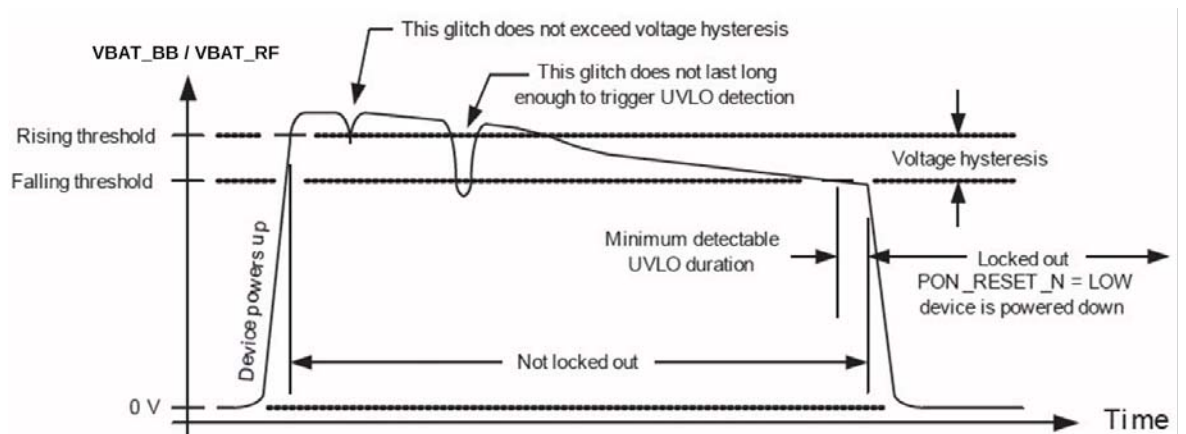


Figure 3-2: Under-Voltage Lockout (UVLO) Diagram

The AirPrime WP75xx/AirPrime WP8548 will power down and remain off until the level of VBAT_BB/VBAT_RF returns to the valid range and the ON/OFF signal is active.

Note: If the device experiences six consecutive UVLO events less than 45 seconds apart (approximately) and a host-initiated power down or reset has not occurred, the device enters a mode in which only the DM port enumerates on the USB.

Table 3-5: UVLO Specifications^a

Parameter	Min	Typ	Max	Units	Notes
Threshold voltage, falling	1.500	2.550	3.050	V	Programmable value
Threshold voltage, accuracy	-5	-	+5	%	
Hysteresis	100	175	250	mV	
UVLO detection interval	-	1.0	-	μs	

a. All values are preliminary and subject to change.

3.2.2 Power Consumption States

The AirPrime WP75xx/AirPrime WP8548 has three basic power states (Active, Ultra Low Power Mode, and Off). As the module transitions between power states, the range of available device functionality adjusts appropriately, as described in [Table 3-6 on page 40](#) and [Figure 3-3 on page 41](#).

Table 3-6: Supported Power States

State	Description
Active	<p>Module is fully powered and operating in one of the following modes:</p> <ul style="list-style-type: none"> • Full function (WWAN radio active; GNSS radio can be turned on/off)—Highest power consumption. • Idle (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) • USB-SS mode—Lowest power consumption while module is in Active state. When the module is in this mode, the processor monitors certain signals (triggers) that can ‘wake’ the module—see Wakeup Interrupt (USB-SS Mode) on page 73 for details. <p>While in the Active state, the module actively reduces power consumption by disabling components that are not in use (for example, stepping down clock signals, putting the USB into ‘selective suspend’, etc.). If the device needs to be in use infrequently and greater current consumption savings are needed, the module can be configured to enter Ultra Low Power Mode. See Active State to ULPM Transition on page 42 for details.</p>
Ultra Low Power Mode (ULPM)	<p>Module is in its lowest power state monitoring configured triggers that will return the module to the Active state.</p> <ul style="list-style-type: none"> • For details on how ULPM is configured and entered, see Active State to ULPM Transition on page 42. • The module remains in ULPM until any of the following occur: <ul style="list-style-type: none"> • A configured trigger occurs. (See Wakeup Interrupt (USB-SS Mode) on page 73 for details.) • POWER_ON_N is asserted (transitioned from OFF to ON) • RESET_IN_N is used to reset the module with POWER_ON_N on. (If RESET_IN_N is used when POWER_ON_N is off, an emergency power off occurs—see Emergency Power Off on page 67.) • ULPM current consumption varies depending on which triggers are configured. For example, the lowest consumption occurs when the processor is waiting only for a timer (approximately 6 μA), and the highest consumption occurs when all supported triggers are configured.
OFF	<p>Module is OFF (no power to the system). Apply power for system to go to Active state.</p>

[Figure 3-3 on page 41](#) illustrates the current consumption requirements of the different power states and the possible transitions between power states. For specific values, see [Table 3-7 on page 42](#), [Table 3-8 on page 43](#), and [Table 3-9 on page 44](#).

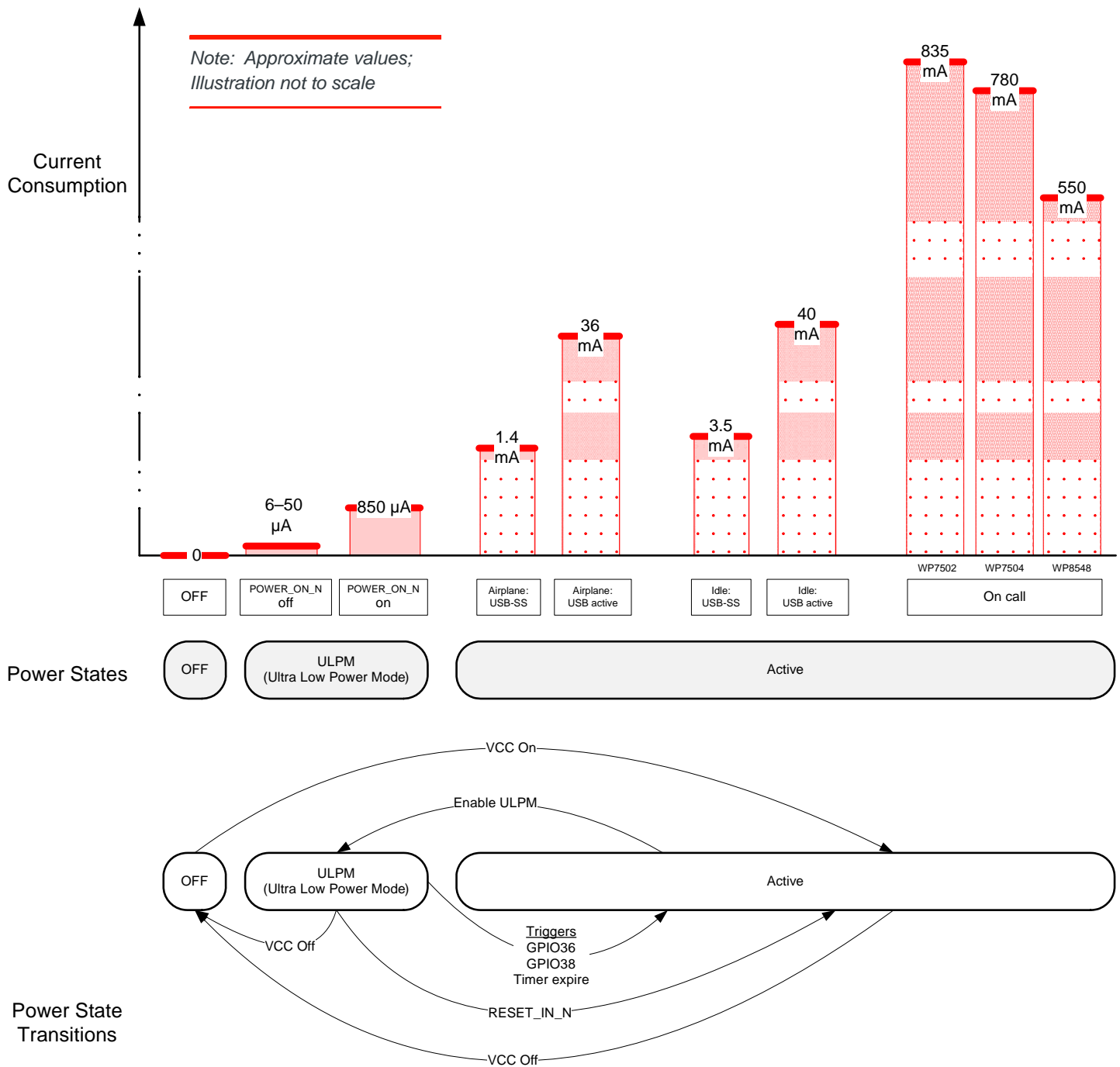


Figure 3-3: Power State Transitions

3.2.3 Active State to ULPM 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 once a day), it can be placed in Ultra Low Power Mode (ULPM) via sysfs/Legato to achieve significantly lower power consumption than is possible in USB-SS mode (low power active state):

1. Configure one or more supported wakeup triggers that the processor will monitor when the module is in ULPM. Supported triggers include:
 - Interrupt-capable GPIOs (GPIO36, GPIO38)
 - Timer — The module returns to Active state after a specified period. (1–4294967 seconds; 0=timer disabled)
 - Note — Additional triggers may be included in future firmware revisions.
2. Initiate ULPM. If the configured wakeup conditions are still valid (they have not triggered yet), the module will enter ULPM, otherwise the request will fail and will need to be repeated.

Note: These triggers are non-persistent — if the module enters ULPM and then returns to Active power state, the triggers are erased and will need to be reconfigured.

3.2.4 Current Consumption

The following tables describe the WP7502, WP7504, and WP8548 modules' current consumption under various power states. Typical values are measured at nominal supply voltage, nominal ambient temperature, and with a conducted 50Ω load on the antenna port.

Table 3-7: WP7502 Current Consumption Values^a

Mode	Parameter	Min	Typ ^b	Max ^c	Units
Power state—Active					
On Call—GSM ^d	900 MHz PCL5	-	317 ^e	835 ^f	mA
	1800 MHz PCL0	-	200 ^e	500 ^f	mA
GSM Peak current ^d	900 MHz PCL5	-	-	2.5 ^f	A
	1800 MHz PCL0	-	-	1.5 ^f	A
HSDPA Data transfer ^g	Band 1	-	690	743	mA
	Band 8	-	602	670	mA
LTE Data transfer ^h	B1	-	835	950	mA
	B3	-	754	924	mA
	B7	-	721	870	mA
	B8	-	758	850	mA
	B20	-	693	797	mA

Table 3-7: WP7502 Current Consumption Values^a (Continued)

Mode	Parameter	Min	Typ ^b	Max ^c	Units	
Idle—GSM	<ul style="list-style-type: none"> Registered MFRMS=5 	USB active	36	39	40	mA
		USB-SS	1.2	2.5	4.5	mA
Idle—WCDMA	<ul style="list-style-type: none"> Registered DRX=8 	USB active	37	38	39	mA
		USB-SS	1.2	1.8	2.5	mA
Idle—LTE	<ul style="list-style-type: none"> Registered Paging cycle=256 	USB active	36	39	41	mA
		USB-SS	2.7	2.9	3.7	mA
Airplane mode	Radio off	USB active	34	36	40	mA
		USB-SS	1.2	1.4	1.6	mA
Power state—Ultra Low Power mode (ULPM)						
See Table 3-10 on page 45 for details.						
GNSS ⁱ						
GNSS	Acquisition (Airplane mode, cold start)		30	40	50	mA
	Tracking (Registered)		25	35	45	mA

- a. All values are preliminary, subject to change.
- b. Typical, measured at nominal temperature, nominal voltage.
- c. Worst case, measured at 70°C, 3.4V.
- d. At GSM conducted max Tx output power (see [Table 3-12 on page 46](#))
- e. Typical—values for one slot
- f. Maximum—values for four slots with no backoff
- g. At WCDMA conducted max Tx output power (see [Table 3-15 on page 48](#))
- h. At LTE conducted max Tx output power (see [Table 3-21 on page 51](#))
- i. GNSS current consumption values are for the GNSS radio only. For total consumption, add the GNSS value to the consumption for the mode being used.

Table 3-8: WP7504 Current Consumption Values^a

Mode	Parameter	Min	Typ ^b	Max ^c	Units
Power state—Active					
On Call—CDMA ^d	BC0	-	530	675	mA
	BC1	-	670	900	
	BC10	-	535	600	mA
EV-DO ^d	BC0	-	500	675	mA
	BC1	-	635	900	
HSDPA data transfer ^e	Band 2	-	675	825	mA
	Band 4	-	585	650	
	Band 5	-	535	625	mA

Table 3-8: WP7504 Current Consumption Values^a (Continued)

Mode	Parameter	Min	Typ ^b	Max ^c	Units	
LTE Data transfer ^f	B2	-	780	975	mA	
	B4	-	645	825	mA	
	B5	-	595	800	mA	
	B12	-	650	800	mA	
	B17	-	665	800	mA	
	B25	-	775	975	mA	
	B26	-	610	800	mA	
Idle—CDMA	<ul style="list-style-type: none"> Registered QPCH=5.12 s 	USB active	36	40	46	mA
		USB-SS	4	5	7.2	mA
Idle—WCDMA	<ul style="list-style-type: none"> Registered DRX=8 	USB active	37	38	39	mA
		USB-SS	1.2	1.8	2.5	mA
Idle—LTE	<ul style="list-style-type: none"> Registered Paging cycle=256 	USB active	36	39	41	mA
		USB-SS	2.7	2.9	3.7	mA
Airplane mode	Radio off	USB active	34	36	40	mA
		USB-SS	1.2	1.4	1.6	mA
Power state—Ultra Low Power mode (ULPM)						
See Table 3-10 on page 45 for details.						
GNSS ^g						
GNSS ^h	Acquisition (Airplane mode, cold start)		30	40	50	mA
	Tracking (Registered)		25	35	45	mA

- a. All values are preliminary, subject to change.
- b. Typical, measured at nominal temperature, nominal voltage.
- c. Worst case, measured at 70°C, 3.4V.
- d. At CDMA conducted max Tx output power (see [Table 3-19 on page 50](#))
- e. At WCDMA conducted max Tx output power (see [Table 3-17 on page 49](#))
- f. At LTE conducted max Tx output power (see [Table 3-22 on page 51](#))
- g. GNSS current consumption values are for the GNSS radio only. For total consumption, add the GNSS value to the consumption for the mode being used.
- h. GNSS support is SKU-dependent.

Table 3-9: WP8548 Current Consumption Values^a

Mode	Parameter	Min	Typ	Max	Units
Power state—Active					
On Call—GSM ^b	850/900 MHz PCL5	-	300 ^c	600 ^d	mA
	1800/1900 MHz PCL0	-	200 ^c	500 ^d	mA

Table 3-9: WP8548 Current Consumption Values^a (Continued)

Mode	Parameter	Min	Typ	Max	Units	
GSM Peak current ^b	850/900 MHz PCL5	-	-	2.5 ^d	A	
	1800/1900 MHz PCL0	-	-	1.5 ^d	A	
HSDPA Data transfer ^e	Band 1	450	550	650	mA	
	Band 2	450	550	650	mA	
	Band 5	350	500	600	mA	
	Band 6	330	500	550	mA	
	Band 8	410	550	650	mA	
	Band 19	330	500	550	mA	
Idle—GSM	<ul style="list-style-type: none"> • Registered • MFRMS=5 	USB active	36	39	40	mA
		USB-SS	1.2	2.5	4.5	mA
Idle—WCDMA	<ul style="list-style-type: none"> • Registered • DRX=8 	USB active	37	38	39	mA
		USB-SS	1.2	1.8	2.5	mA
Airplane mode	Radio off	USB active	34	36	40	mA
		USB-SS	1.2	1.4	1.6	mA
Power state—Ultra Low Power Mode (ULPM)						
See Table 3-10 on page 45 for details.						
GNSS ^f						
GNSS	Acquisition (Airplane mode, cold start)	30	40	50	mA	
	Tracking (Registered)	25	35	45	mA	

- a. All values are preliminary, subject to change.
- b. At GSM conducted max Tx output power (see [Table 3-12 on page 46](#))
- c. Typical—values for one slot
- d. Maximum—values for four slots with no backoff
- e. At WCDMA conducted max Tx output power (see [Table 3-15 on page 48](#))
- f. GNSS current consumption values are for the GNSS radio only. For total consumption, add the GNSS value to the consumption for the mode being used.

[Table 3-10](#) describes parameters that contribute to total current consumption while the module is in ULPM.

Table 3-10: ULPM Current Consumption^a

Parameter	State	Value	Units
POWER_ON_N	Off	6	μA
	On	850	μA

Table 3-10: ULPM Current Consumption^a (Continued)

Parameter		State	Value	Units
MCU monitoring triggers	Wakeup timer	-	Insignificant	
	GPIO36 GPIO38	Configured as open (default)	Insignificant	
		Other (Configured as closed and/or dependent on external circuitry design.)	≤ 50	μA

a. All values are preliminary, subject to change.

3.3 RF

This section presents the module’s WWAN RF interface, and defines the specifications for the LTE, HSPA, WCDMA, GSM, and CDMA interfaces for supporting modules.

Note: RF sensitivity values presented in this section are for soldered-down modules.

AirPrime WP75xx/AirPrime WP8548 embedded modules are designed to be compliant with the standards in [Table 3-11](#).

Table 3-11: Standards Compliance

Technology	Standards	WP7502	WP7504	WP8548
LTE	• 3GPP Release 9	Yes	Yes	
UMTS (WCDMA)	• 3GPP Release 8	Yes	Yes	Yes
CDMA	• 3GPP2 C.S0011-D • 3GPP2 C.S0033-C		Yes	
GSM/GPRS/EDGE	• 3GPP Release 8	Yes		Yes

3.3.1 GSM RF Interface

This section presents the GSM RF specification for AirPrime WP7502 and AirPrime WP8548 modules.

3.3.1.1 GSM Tx Output Power

The module’s GSM maximum transmitter output power is specified in [Table 3-12](#).

Table 3-12: Conducted Tx Max Output Power Tolerances — GSM^a

RF band	Min	Typ	Max	Units	Notes	WP7502	WP7504	WP8548
GSM 850	31	32	33	dBm	GMSK mode (Power class 4; 2 W; 33 dBm)			Yes
E-GSM 900	31	32	33	dBm		Yes		Yes

Table 3-12: Conducted Tx Max Output Power Tolerances—GSM^a (Continued)

RF band	Min	Typ	Max	Units	Notes	WP7502	WP7504	WP8548
DCS 1800	28	29	30	dBm	GMSK mode (Power class 1; 1 W, 30 dBm)	Yes		Yes
PCS 1900	28	29	30	dBm				Yes
GSM 850	25.5	26.5	27.5	dBm	8PSK mode (Power class E2; 0.5 W; 27 dBm)			Yes
E-GSM 900	25.5	26.5	27.5	dBm		Yes		Yes
DCS 1800	24.5	25.5	26.5	dBm	8PSK mode (Power class E2; 0.4 W, 26 dBm)	Yes		Yes
PCS 1900	24.5	25.5	26.5	dBm				Yes

a. Stated power tolerances satisfy 3GPP TS 51.010-1 requirements for normal (25°C) conditions.

3.3.1.2 GSM Rx Sensitivity

The module’s GSM receiver sensitivity is specified in [Table 3-13](#) (WP7502) and [Table 3-14](#) (WP8548).

Table 3-13: WP7502 Conducted Rx Sensitivity—GSM/EDGE Bands^{a,b}

GSM/EDGE Bands			Sensitivity @ +25°C (dBm) ^c	Sensitivity @ Class A (dbm) ^d	Standard Limit (dBm)
EGSM 900	2.44% BER CS	CS	-110.2	-109.8	-102
	10% BLER	GMSK CS1	-114.0	-113.2	-102
	10% BLER	EDGE MCS5	-105.5	-104.5	-98
DCS 1800	2.44% BER CS	CS	-107.6	-107.4	-102
	10% BLER	GMSK CS1	-111.2	-110.1	-102
	10% BLER	EDGE MCS5	-102.9	-101.5	-98

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

Table 3-14: WP8548 Conducted Rx Sensitivity—GSM/EDGE Bands^a

GSM/EDGE Bands			Sensitivity @ +25°C (dBm) ^b	Sensitivity @ Class A (dbm) ^c	Standard Limit (dBm)
GSM 850	2.44% BER CS	CS	-109	-108	-102
	10% BLER	GMSK CS1	-113	-112	-102
	10% BLER	EDGE MCS5	-105	-104	-98

Table 3-14: WP8548 Conducted Rx Sensitivity—GSM/EDGE Bands^a

GSM/EDGE Bands			Sensitivity @ +25°C (dBm) ^b	Sensitivity @ Class A (dbm) ^c	Standard Limit (dBm)
EGSM 900	2.44% BER CS	CS	-109	-108	-102
	10% BLER	GMSK CS1	-113	-112	-102
	10% BLER	EDGE MCS5	-105	-104	-98
DCS 1800	2.44% BER CS	CS	-108	-107	-102
	10% BLER	GMSK CS1	-112	-111	-102
	10% BLER	EDGE MCS5	-104	-103	-98
PCS 1900	2.44% BER CS	CS	-108	-107	-102
	10% BLER	GMSK CS1	-112	-111	-102
	10% BLER	EDGE MCS5	-104	-103	-98

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

3.3.2 WCDMA RF Interface

This section presents the WCDMA RF specification for AirPrime WP75xx and AirPrime WP8548 modules.

3.3.2.1 WCDMA Tx Output Power

The module’s WCDMA maximum transmitter output power is specified in Table 3-15.

Table 3-15: Conducted Tx Max Output Power Tolerances—WCDMA^a

RF band	Min	Typ	Max	Units	Notes	WP7502	WP7504	WP8548
B1	22	23	24	dBm	Power class 3	Yes		Yes
B2	22	23	24	dBm	Power class 3		Yes	Yes
B4	22	23	24	dBm	Power class 3		Yes	
B5	22	23	24	dBm	Power class 3		Yes	Yes
B6	22	23	24	dBm	Power class 3			Yes
B8	22	23	24	dBm	Power class 3	Yes		Yes
B19	22	23	24	dBm	Power class 3			Yes

- a. Stated power tolerances satisfy 3GPP TS 34.121-1 requirements for normal (25°C) conditions.

3.3.2.2 WCDMA Rx Sensitivity

The module’s GSM receiver sensitivity is specified in [Table 3-16](#) (WP7502), [Table 3-17](#) (WP7504) and [Table 3-14](#) (WP8548).

Table 3-16: WP7502 Conducted Rx Sensitivity—WCDMA Bands^{a,b}

Band	+25°C		Class A		Standard Limit (dBm)	Notes
	Primary (dBm) ^c	Secondary (dBm) ^c	Primary (dbm) ^d	Secondary (dbm) ^d		
B1	-111.3	-111.2	-110.5	-111.5	-106	CS 0.1% BER 12.2 kbps Reference Measurement Channel
B8	-112.1	-112.3	-111.6	-110.4	-103	

- a. All values are preliminary.
- 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 value
- d. Typical value, tested at Class A extreme condition

Table 3-17: WP7504 Conducted Rx Sensitivity—WCDMA Bands^{a,b}

Band	+25°C		Class A		Standard Limit (dBm)	Notes
	Primary (dBm) ^c	Secondary (dBm) ^c	Primary (dbm) ^d	Secondary (dbm) ^d		
B2	-110.2	-110.3	-109.3	-109.5	-104	CS 0.1% BER 12.2 kbps Reference Measurement Channel
B4	-110.1	-112.0	-109.3	-111.0	-106	
B5	-111.9	-111.8	-110.8	-110.8	-104	

- a. All values are preliminary.
- 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 value
- d. Typical value, tested at Class A extreme condition

Table 3-18: WP8548 Conducted Rx Sensitivity—WCDMA Bands^a

Band	Sensitivity @ +25°C (dBm) ^b	Sensitivity @ Class A (dbm) ^c	Standard Limit (dBm)	Notes
B1	-109	-108	-106	CS 0.1% BER 12.2 kbps Reference Measurement Channel
B2	-110	-109	-104	
B5	-111	-110	-104	
B6	-111	-110	-106	
B8	-111	-110	-103	
B19	-111	-110	-106	

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

3.3.3 CDMA RF Interface

This section presents the CDMA RF specification for AirPrime WP7504 modules.

3.3.3.1 CDMA Tx Output Power

The module’s CDMA maximum transmitter output power is specified in Table 3-19.

Table 3-19: WP7504 Conducted Tx Max Output Power Tolerances — CDMA^a

RF band	Operating condition	Min	Typ	Max	Units	Notes
BC0	Normal (25°C)	22	23	24	dBm	ERP_min: -7 dBW (0.2W) with antenna gain > 3 dBi
BC1	Normal (25°C)	22	23	24	dBm	EIRP_min: -7 dBW (0.2W) with antenna gain > 1 dBi
BC10	Normal (25°C)	22	23	24	dBm	ERP_min: -7 dBW (0.2W) with antenna gain > 3 dBi

- a. Stated power tolerances are compliant with 3GPP2 ERP/EIRP specifications.

3.3.3.2 CDMA Rx Sensitivity

The module’s CDMA receiver sensitivity is specified in [Table 3-20](#).

Table 3-20: Conducted Rx Sensitivity — CDMA Bands^{a,b,c}

Band	Band	+25°C		Class A		Standard Limit (dBm)
		Primary (dBm) ^d	Secondary (dBm) ^d	Primary (dBm) ^e	Secondary (dBm) ^e	
BC0	CDMA 1x ^f	-109.1	-109.5	-108.0	-108.6	-104.0
	EVDO rev A ^g	-110.8	n/a	-109.8	n/a	-104.0
BC1	CDMA 1x ^f	-107.7	-108.4	-107.0	-107.2	-104.0
	EVDO rev A ^g	-109.6	n/a	-108.6	n/a	-104.0
BC10	CDMA 1x ^f	-108.7	-110.0	-107.9	-108.8	-104.0

- a. All values are preliminary.
- b. Stated sensitivity values satisfy 3GPP2 specifications.
- c. CS 0.1% BER 12.2 kbps Reference Measurement Channel
- d. Typical value
- e. Typical value, tested at Class A extreme condition
- f. CDMA 1x 0.5% FER
- g. EVDO rev A 0.5% PERS

3.3.4 LTE RF Interface

This section presents the LTE RF specification for AirPrime WP75xx modules.

3.3.4.1 LTE Tx Output Power

The module's LTE maximum transmitter output power is specified in [Table 3-21](#) (WP7502) and [Table 3-22](#) (WP7504).

Table 3-21: WP7502 Conducted Tx Max Output Power Tolerances — LTE^a

RF band	Operating condition	Min	Typ	Max	Units	Notes
B1	Normal (25°C)	22	23	24	dBm	Power class 3
B3	Normal (25°C)	22	23	24	dBm	Power class 3
B7	Normal (25°C)	21	22	23	dBm	Power class 3
B8	Normal (25°C)	22	23	24	dBm	Power class 3
B20	Normal (25°C)	22	23	24	dBm	Power class 3

- a. Stated power tolerances satisfy 3GPP TS 36.521-1 requirements for normal (25°C) and Class A (extreme) conditions.

Table 3-22: WP7504 Conducted Tx Max Output Power Tolerances — LTE^a

RF band	Operating condition	Min	Typ	Max	Units	Notes
B2	Normal (25°C)	22	23	24	dBm	Power class 3
B4	Normal (25°C)	22	23	24	dBm	Power class 3
B5	Normal (25°C)	22	23	24	dBm	Power class 3
B12	Normal (25°C)	22	23	24	dBm	Power class 3
B17	Normal (25°C)	22	23	24	dBm	Power class 3
B25	Normal (25°C)	22	23	24	dBm	Power class 3
B26	Normal (25°C)	22	23	24	dBm	Power class 3

- a. Stated power tolerances satisfy 3GPP TS 36.521-1 requirements for normal (25°C) and Class A (extreme) conditions.

3.3.4.2 LTE Rx Sensitivity

The module's LTE receiver sensitivity is specified in [Table 3-23](#) (WP7502) and [Table 3-24](#) (WP7504).

Table 3-23: WP7502 Conducted Rx Sensitivity—LTE Bands

LTE bands		+25°C (dBm)			Class A (dBm)			SIMO (Worst case) ^a
		Primary (Typical)	Secondary (Typical)	SIMO (Typical)	Primary (Typical)	Secondary (Typical)	SIMO (Typical)	
B1	Full RB BW: 10 MHz ^b	-98.7	-98.9	-101.8	-98.1	-97.9	-100.9	-96.3
B3		-97.5	-97.6	-100.5	-98.1	-96.7	-100.2	-93.3
B7		-96.9	-97.0	-99.6	-96.3	-96.0	-98.9	-94.3
B8		-99.2	-99.9	-102.4	-98.6	-98.9	-101.7	-93.3
B20		-98.9	-97.5	-101.6	-98.9	-97.5	-100.9	-93.3

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

Table 3-24: WP7504 Conducted Rx Sensitivity—LTE Bands

LTE bands		+25°C (dBm)			Class A (dBm)			SIMO (Worst case) ^a
		Primary (Typical)	Secondary (Typical)	SIMO (Typical)	Primary (Typical)	Secondary (Typical)	SIMO (Typical)	
B2	Full RB BW: 10 MHz ^b	-97.4	-98.1	-100.8	-96.5	-97.0	-99.9	-94.3
B4		-97.8	-99.5	-101.7	-97.1	-98.6	-101.0	-96.3
B5		-99.1	-99.5	-102.5	-97.9	-98.6	-101.2	-94.3
B12		-98.8	-100.4	-102.8	-98.1	-99.7	-102.0	-93.3
B17		-98.4	-100.3	-102.6	-98.1	-100.0	-101.9	-93.3
B25		-97.4	-98.0	-100.7	-96.5	-96.9	-99.3	-92.8
B26		-98.9	-99.5	-102.3	-97.9	-98.6	-101.3	-93.8

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

3.3.5 WWAN Antenna Interface

The following tables define the WWAN antenna interfaces of the AirPrime WP75xx and AirPrime WP8548.

Table 3-25: WP75xx WWAN Antenna Interface Pins

Pin #	Signal name	Direction	Function
30	GND		Diversity Antenna Ground
31	RF_DIV	Input	Diversity Antenna Interface
32	GND		Diversity Antenna Ground
48	GND		Primary Antenna Ground
49	RF_MAIN	Input/Output	Primary Antenna Interface
50	GND		Primary Antenna Ground
111	GND		Diversity Antenna Ground
113	GND		Diversity Antenna Ground
136	GND		Primary Antenna Ground
139	GND		Primary Antenna Ground

Table 3-26: WP8548 WWAN Antenna Interface Pins

Pin #	Signal name	Direction	Function
48	GND		Primary Antenna Ground
49	RF_MAIN	Input/Output	Primary Antenna Interface
50	GND		Primary Antenna Ground
136	GND		Primary Antenna Ground
139	GND		Primary Antenna Ground

3.3.5.1 WWAN Antenna Recommendations

Table 3-27 defines the key characteristics to consider for antenna selection.

Table 3-27: Antenna Recommendations^{a,b}

Parameter		Recommendations	Comments
Antenna system		External multi-band antenna system	WP75xx—Dual WWAN antennas for diversity (Antenna 1/Antenna 2) ^c <ul style="list-style-type: none"> WP8548—Single WWAN antenna
<p>Important: Some specifications are not compatible with each other—the 3GPP specification for GSM/WCDMA/LTE max conducted power range, the 3GPP2 specification for CDMA/EVDO max radiated power range, and FCC radiated limits. As a result, the antennas that are used with WP8548 and WP7502 must meet different peak gains—gain > 3dBi for WP7504 in CDMA BC0/10, and gain < 3dBi for WP8548 in WCDMA/GSM 850/1900 MHz.</p>			
Operating bands	WP7502 (Antenna 1)	791–960 MHz	Operating bands depend on the module's supported bands/modes.
		1710–1980 MHz	
		2110–2170 MHz	
		2500–2690 MHz	
	WP7502 (Antenna 2)	791–960 MHz	Operating bands depend on the module's supported bands/modes.
		1805–1880 MHz	
		2110–2170 MHz	
		2620–2690 MHz	
	WP7504 (Antenna 1)	699–894 MHz	Operating bands depend on the module's supported bands/modes.
		1710–1995 MHz	
		2110–2155 MHz	
	WP7504 (Antenna 2)	729–894 MHz	Operating bands depend on the module's supported bands/modes.
1930–1995 MHz			
2110–2155 MHz			
WP8548	824–960 MHz	Operating bands depend on the module's supported bands/modes.	
	1710–1990 MHz		
	2110–2170 MHz		
VSWR		< 2.5:1 (worst case)	<ul style="list-style-type: none"> 1:1 (ideal) On all bands including band edges WP75xx—Applies to both antennas

Table 3-27: Antenna Recommendations^{a,b} (Continued)

Parameter		Recommendations	Comments
Total radiated efficiency		> 50% on all bands	<ul style="list-style-type: none"> Measured at the RF connector. WP75xx—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.	<ul style="list-style-type: none"> WP75xx—Applies to both antennas
Envelope correlation coefficient between Antenna 1 and Antenna 2	WP7502	<ul style="list-style-type: none"> < 0.4 on 791–821 MHz and 925–960 MHz bands < 0.2 on 1805–1880 MHz, 2110–2170 MHz, and 2620–2690 MHz bands 	
	WP7504	<ul style="list-style-type: none"> < 0.4 on 729–746 MHz and 859–894 MHz bands < 0.2 on 1930–1995 MHz and 2110–2155 MHz bands 	
Mean Effective Gain (MEG)		≥ -3 dBi	<ul style="list-style-type: none"> WP75xx—Applies to both antennas (Antenna 1—MEG1, Antenna 2—MEG2)
Mean Effective Gain Imbalance—Antenna 1 and Antenna 2 (MEG1 / MEG2)	WP75xx	< 6 dB for diversity operation	
Maximum antenna gain		Must not exceed antenna gains due to RF exposure and ERP/EIRP limits, as listed in the module's FCC grant.	
Isolation between Antenna 1 and Antenna 2 (S21)	WP75xx	> 10 dB	<ul style="list-style-type: none"> If antennas can be moved, test all positions for both antennas. Unless otherwise specified, this isolation requirement must be maintained for optimum operation. Make sure all other wireless devices (Bluetooth or WLAN antennas, etc.) are turned OFF to avoid interference.

Table 3-27: Antenna Recommendations^{a,b} (Continued)

Parameter	Recommendations	Comments
Maximum voltage applied to antenna	6.3 VDC	
Power handling	<ul style="list-style-type: none"> > 2 W RF power on low bands > 1 W on high bands 	<ul style="list-style-type: none"> Measure power endurance over 4 hours (estimated talk time) using a 2 W CW signal—set the CW test signal frequency to the middle of the PCS Tx band (1880 MHz for PCS). Visually inspect device to ensure there is no damage to the antenna structure and matching components. VSWR/TIS/TRP measurements taken before and after this test must show similar results.

- a. These worst-case VSWR figures for the transmitter bands may not guarantee RSE levels to be within regulatory limits. The device alone meets all regulatory emissions limits when tested into a cabled (conducted) 50 ohm system. With antenna designs with up to 2.5:1 VSWR or worse, the radiated emissions could exceed limits. The antenna system may need to be tuned in order to meet the RSE limits as the complex match between the module and antenna can cause unwanted levels of emissions. Tuning may include antenna pattern changes, 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 (RF_MAIN), Antenna 2 (WP75xx only)—Secondary (RF_DIV) (Diversity)

3.4 GNSS

Note: GNSS is supported on AirPrime WP8548 modules, and is a SKU-dependent feature on AirPrime WP75xx modules.

The AirPrime WP75xx/AirPrime WP8548 includes Global Navigation Satellite System (GNSS) capabilities via the Qualcomm IZat™ Gen8A Engine (formerly gpsOne), capable of operation in assisted and standalone GNSS modes (GPS/Galileo/GLONASS).

3.4.1 GNSS Characteristics

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

Table 3-28: GNSS Characteristics^a

Parameter	Value	
Sensitivity	Standalone or MS-based tracking sensitivity	-161 dB
	Cold start sensitivity	-145 dB
	MS-assisted GNSS acquisition sensitivity	-158 dBm
Accuracy in open sky (1 Hz tracking)	< 2 m CEP-50	

Table 3-28: GNSS Characteristics (Continued)^a

Parameter		Value
Satellite channels available ^b	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
GNSS message protocols		NMEA

- a. WP7502/WP7504—All values are preliminary and subject to change.
- b. Resources are dynamically assigned and not constellation-specific.

Note: Acquisition/tracking sensitivity performance figures assume open sky with active patch GNSS antenna and a 2.5 dB noise figure.

3.4.2 GNSS Antenna Interface

The GNSS antenna interface is defined in [Table 3-29](#).

Table 3-29: GNSS Antenna Interface Pads

Pad	Name	Direction ^a	Function
37	GND		GNSS Antenna Ground
38	RF_GNSS	Input	GNSS Antenna Interface
39	GND		GNSS Antenna Ground
125	GND		GNSS Antenna Ground
128	GND		GNSS Antenna Ground

- a. Signal direction with respect to the module.

Note: On WP75xx modules, GNSS functionality is available on the dedicated GNSS antenna only; it is not available on the diversity antenna.

3.4.2.1 GNSS Antenna Recommendations

Table 3-30 defines the key characteristics to consider for antenna selection.

Table 3-30: GNSS Standalone Antenna Recommendations^a

Parameter	Recommendations	Notes
Frequency range	<ul style="list-style-type: none"> Wide-band GPS, Galileo, and GLONASS: 1573–1606 MHz recommended Narrow-band GPS: 1575.42 MHz ± 2.046 MHz minimum 	
Field of view (FOV)	<ul style="list-style-type: none"> Omni-directional in azimuth -45° to +90° in elevation 	
Polarization (average Gv/Gh)	> 0 dB	Vertical linear polarization is sufficient.
Free space average gain (Gv+Gh) over FOV	> -6 dBi (preferably > -3 dBi)	Gv and Gh are measured and averaged over -45° to +90° in elevation, and ±180° in azimuth.
Gain	<ul style="list-style-type: none"> Maximum gain and uniform coverage in the high elevation angle and zenith. Gain in azimuth plane is not desired. 	
Average 3D gain	> -5 dBi	
Isolation between GNSS and 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 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	

Table 3-30: GNSS Standalone Antenna Recommendations^a (Continued)

Parameter	Recommendations	Notes
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	
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

3.5 Electrical Specifications

This section provides details of the key electrical specifications of the AirPrime WP75xx/AirPrime WP8548 embedded module.

3.5.1 Absolute Maximum Ratings

This section defines the absolute maximum ratings of the AirPrime WP75xx/AirPrime WP8548.

Warning: *If these parameters are exceeded, even momentarily, damage may occur to the device.*

Table 3-31: Absolute Maximum Ratings^a

Parameter	Min	Typ	Max	Units
Power supply voltages				
VBAT_BB/ VBAT_RF	-0.3	-	6.0	V
VDD_Px (low-voltage operation)	-	-	2.2	V
VDD_Px (high-voltage operation)	-	-	3.05	V

Table 3-31: Absolute Maximum Ratings (Continued)^a

Parameter		Min	Typ	Max	Units
USB signal pins					
USB_D+	High-speed USB data plus	-	-	5.25	V
USB_D-	High-speed USB data minus	-	-	5.25	V
USB_VBUS	High-speed USB bus voltage	-	-	5.25	V
Thermal conditions					
TS	Storage temperature	-40		85	°C
TJ	Junction temperature	-	-	130	°C
Maximum voltage applied to antenna interface pins					
VANT	RF_MAIN	-		6.3	Vdc
	RF_DIV (WP75xx only)	-		6.3	Vdc
	RF_GNSS	-		6.3	Vdc
ESD ratings					
See EMC and ESD Recommendations on page 96 .					

a. All values are preliminary and subject to change.

3.5.2 Digital I/O Characteristics

The I/O characteristics for supported digital interfaces are described in:

- [Table 3-32](#)—GPIOs, UART, ANT_CNTL, HSIC, TX_ON, and PCM/I²S signals
- [Table 3-33](#)—SDIO signals

Table 3-32: Digital I/O Characteristics (V_{DD_PX} = 1.80 V (nominal))^a

Parameter	Comments	Min	Typ	Max	Units	
V _{IH}	High level input voltage	0.65 * V _{DD_PX}	-	V _{DD_PX} + 0.3	V	
V _{IL}	Low level input voltage	-0.3	-	0.35 * V _{DD_PX}	V	
V _{SHYS}	Schmitt hysteresis voltage	100	-	-	mV	
I _{IH}	Input high leakage current ^b	No pull-down	-	1	μA	
I _{IL}	Input low leakage current ^c	No pull-up	-1	-	μA	
R _P	Pull up/down resistance	55		390	kΩ	
V _{OH}	High level output voltage	CMOS, at pin-rated drive strength	V _{DD_PX} - 0.45	-	V _{DD_PX}	V
V _{OL}	Low level output voltage	CMOS, at pin-rated drive strength	0	-	0.45	V

Table 3-32: Digital I/O Characteristics ($V_{DD_PX} = 1.80\text{ V}$ (nominal)) (Continued)^a

Parameter	Comments	Min	Typ	Max	Units
I_{OZH}	Tri-state leakage current ^b	-		1	μA
I_{OZL}	Tri-state leakage current ^c	-1		-	μA
R_K	Keeper resistance	30		150	$\text{k}\Omega$
I_{ISL}	Sleep crystal input leakage	-0.15	-	0.15	μA
I_{IHVKP}	High-V tolerant input leakage	With keeper	-	-	μA
C_{IN}	Input capacitance ^d	-	-	5	pF
I_{PIN}	Current per pin	-	-	16	mA

- a. All values are preliminary and subject to change.
b. Pin voltage = V_{DD_PX} max. For keeper pins, pin voltage = V_{DD_PX} max - 0.45 V.
c. Pin voltage = GND and supply = V_{DD_PX} max. For keeper pins, pin voltage = 0.45 V and supply = V_{DD_PX} max.
d. Input capacitance is guaranteed by design, but is not 100% tested.

Table 3-33: Digital I/O Characteristics ($V_{DD_PX} = 2.95\text{ V}$ (nominal) signals)^a

Parameter	Comments	Min	Typ	Max	Units
V_{IH}	High level input voltage	$0.65 * V_{DD_PX}$	-	$V_{DD_PX} + 0.3$	V
V_{IL}	Low level input voltage	-0.3	-	$0.25 * V_{DD_PX}$	V
V_{SHYS}	Schmitt hysteresis voltage	100	-	-	mV
I_{IH}	Input high leakage current ^b	No pull-down	-	10	μA
I_{IL}	Input low leakage current ^c	No pull-up	-10	-	μA
R_{PSD}	High-V pad pull up/down resistance	For SDIO_CLK, SDIO_CMD, SDIO_DATA[0:3]	10	100	$\text{k}\Omega$
I_{OZH}	Tri-state leakage current ^b	Logic high output, no pull-down	-	10	μA
I_{OZL}	Tri-state leakage current ^c	Logic low output, no pull-up	-10	-	μA
R_{KSD}	High-V pad keeper resistance	For SDIO_CLK, SDIO_CMD, SDIO_DATA[0:3]	10	100	$\text{k}\Omega$
V_{OH}	High-level output voltage	CMOS, at pin-rated drive strength	$V_{DD_PX} - 0.45$	V_{DD_PX}	V
V_{OL}	Low-level output voltage	CMOS, at pin-rated drive strength	0	0.45	V
C_{IN}	Input capacitance ^d	-	-	5	pF
I_{PIN}	Current per pin	-	-	8	mA

- a. All values are preliminary and subject to change.

- b. Pin voltage = V_{DD_PX} max. For keeper pins, pin voltage = V_{DD_PX} max - 0.45 V.
- c. Pin voltage = GND and supply = V_{DD_PX} max. for keeper pins, pin voltage = 0.45 V and supply = V_{DD_PX} max.
- d. Input capacitance is guaranteed by design, but is not 100% tested.

3.5.3 Internal Device Frequencies

[Table 3-34](#) summarizes the frequencies generated within the AirPrime WP75xx/AirPrime WP8548. This table is provided for reference only to the device integrator.

Table 3-34: Internal Device Frequencies ^a

Subsystem/Feature	Frequency	Units
Real Time Clock	32.768	kHz
PCM Audio Interface (PCM Master Mode)	<ul style="list-style-type: none"> • 128 • 2048 	kHz
I ² C Interface	400	kHz
PMIC switching power supplies	1.6	MHz
Fundamental clock	19.2	MHz
PLL	<ul style="list-style-type: none"> • PLL0: 276.000 • PLL4: 393.216 • PLL5: 576.000 • PLL6: 460.800 • PLL7: 499.200 • PLL8: 384.000 • PLL9: 440.000 (v1) / 550.000 (v2+) • PLL11: 400.000 • PLL14: 480.000 	MHz
USB	480	Mb/s

a. All values are preliminary and subject to change.

3.6 Processing

3.6.1 Application Core

The Application Core is based on a Cortex A5 32-bit RISC architecture core. It has the following main characteristics:

- Up to 550 MHz operation
- Cache: Instruction (32kB) and Data (32kB)

The Application Core supports Legato™, an open source embedded platform built on Linux, which allows the simultaneous safe running of multiple applications.

Refer to [Interfaces Specification on page 65](#) for the list of interfaces supported by this core.

3.6.2 Embedded Memory

The AirPrime WP75xx/AirPrime WP8548 module's embedded memory includes 512 MB Flash and 256 MB RAM.

Half of this memory (256 MB Flash, 128 MB RAM) is dedicated to the Legato platform running on the application processor, including:

- Linux kernel
- Root file system
- Application framework
- Customer applications

3.7 Mechanical Drawing

The AirPrime WP75xx/AirPrime WP8548 module's LGA footprint is a 239-pad array of copper pads (see [Physical Dimensions and Connection Interface on page 22](#)). The following drawing illustrates the device footprint and dimensions.

Note: Dimensions in Figure 3-4 are preliminary and subject to change.

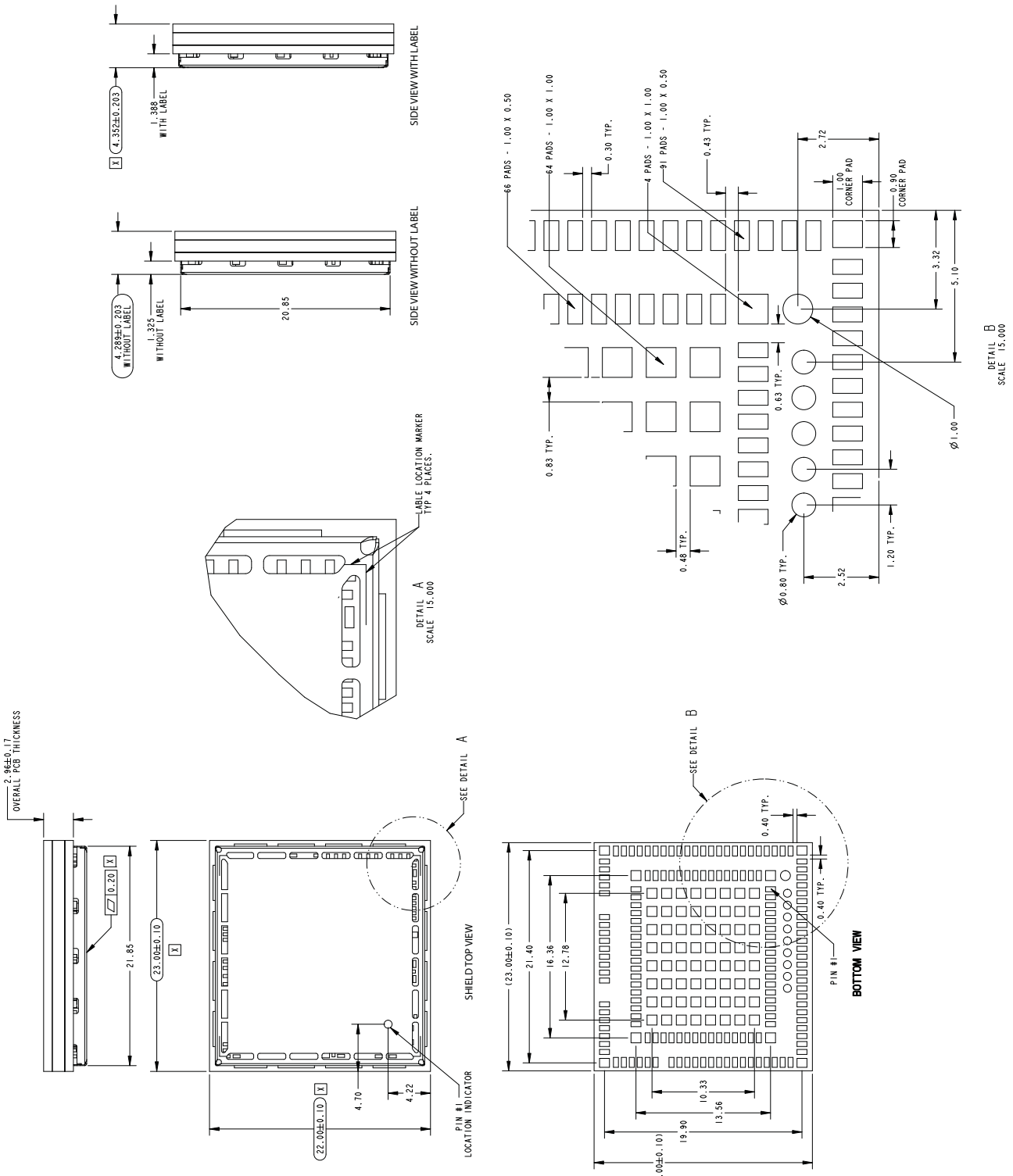


Figure 3-4: AirPrime WP75xx/AirPrime WP8548 Mechanical Drawings

4: Interfaces Specification

4.1 Overview

This section describes the interfaces supported by the AirPrime WP75xx/AirPrime WP8548 embedded module and provides specific voltage, timing, and circuit recommendations for each interface.

4.2 BAT_RTC

The AirPrime WP75xx/AirPrime WP8548 module's internal RTC is powered from the VBAT_BB supply (when available).

The module also provides an interface (BAT_RTC) for using a coin cell to maintain the internal RTC when VBAT_BB is removed from the module. The coin cell can also be charged via BAT_RTC when VBAT_BB is available.

Table 4-1: BAT_RTC Pin

Pin	Name	Direction	Function	If Unused
21	BAT_RTC	Input/Output	Voltage input/Charging output	Leave Open

Table 4-2: BAT_RTC Charging Specifications ^a

Specification	Comments	Min	Typ	Max	Units	
Target regulator voltage ^b	$V_{IN} > 3.3\text{ V}$, $I_{CHG} = 100\ \mu\text{A}$	2.5	-	3.2	V	
Target series resistance ^c		800	-	2100	Ω	
Coin cell voltage		2.0	-	3.25	V	
Coin cell charger voltage error	$I_{CHG} = 0\ \mu\text{A}$	-5	-	+5	%	
Coin cell charger resistor error		-20	-	+20	%	
Dropout voltage ^d	$I_{CHG} = 2\ \text{mA}$	-	-	200	mV	
Current draw	Charging	-	2.0	-	mA	
	Off	-	5.0	8.0	μA	
Ground current, charger enabled	VBAT=3.6V	IC = off; BAT_RTC = open, T=27°C	-	4.5	-	μA
	VBAT=3.4–4.3 V		-	-	8.0	μA
Capacitance		-	-	4.7	μF	

a. All values are preliminary and subject to change

b. Programmable voltage: 2.5/3.0/3.1/3.2

c. Valid series resistor settings are 800, 1200, 1700, and 2100 Ω

d. Dropout is measured by reducing the supply voltage (VBAT) from 3.5 V until the charging voltage drops by 100 mV. Then calculate the dropout voltage: $V_{\text{dropout}} = \text{VBAT} - \text{charger output voltage}$.

4.3 POWER_ON_N

The AirPrime WP75xx/AirPrime WP8548 module requires a low level signal (POWER_ON_N) that is used to switch the module ON.

The signal is connected internally to the permanent 1.8V supply regulator inside the module via a pull-up resistor. Once VBAT_BB is supplied to the module, this 1.8V supply regulator will be enabled and so the POWER_ON_N signal is by default at high level. Use a momentary switch to control this line to reduce leakage current in ULPM mode. Holding POWER_ON_N low in ULPM mode incurs a significant current draw—see [Table 3-10 on page 45](#) for details.

[Table 4-3](#) describes the POWER_ON_N signal's characteristics.

Table 4-3: POWER_ON_N Electrical Characteristics^a

Parameter	Min	Typ	Max	Units
Input Voltage—Low		-	0.63	V
Input Voltage—High	1.7	-	1.9	V
POWER_ON_N assertion time ^b	36.5			ms

a. All values are preliminary and subject to change.

b. Assertion time is the time between POWER_ON_N falling to VGPIO going high.

4.3.1 Power-up Sequence

4.3.1.1 Power On/Off Timing

Figure 4-1 describes the timing sequence for powering the module on and off.

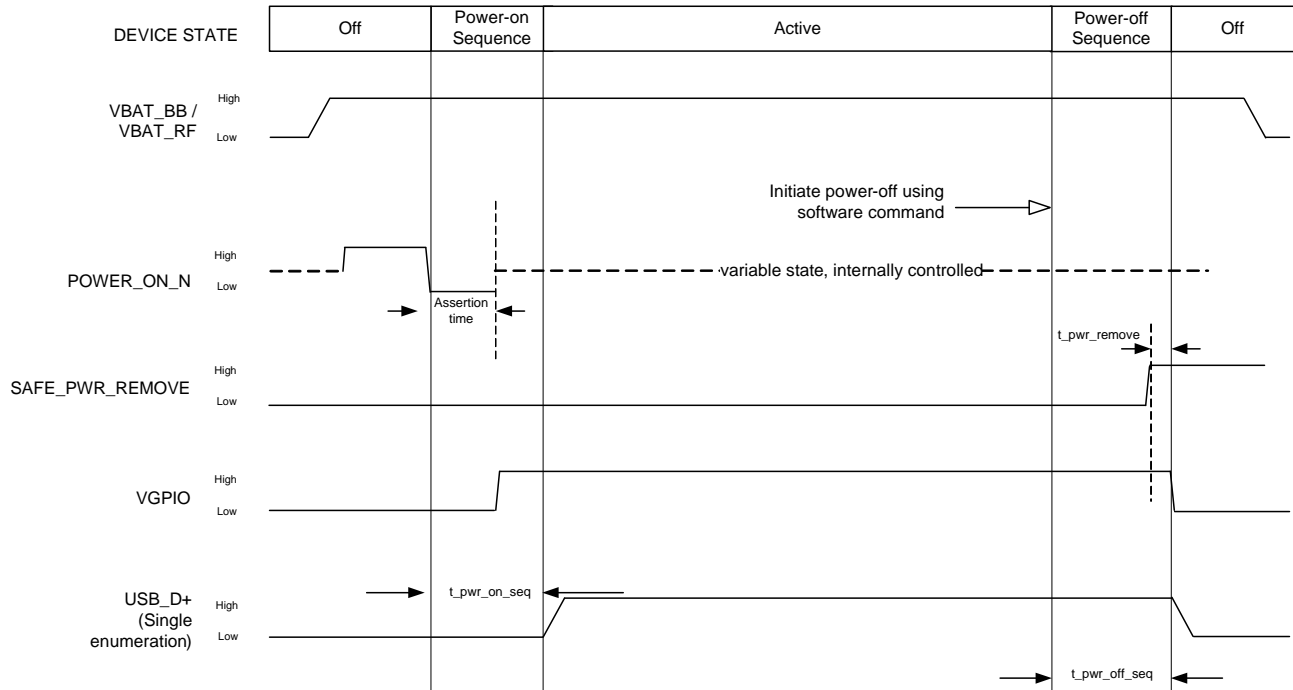


Figure 4-1: Signal timing (POWER_ON_N, and USB Enumeration)

Table 4-4: POWER_ON_N Timing Parameters

Parameter	Typical	Maximum	Units
t_pwr_on_seq	14.5	15.5	s
t_pwr_off_seq	0.4–5.5 ^a	6 ^a	s
t_pwr_remove	13	-	ms

a. Preliminary, subject to change

4.3.1.2 USB enumeration

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

4.3.2 Software-Initiated Power Down

To power down the module via software:

1. Initiate the power down process:
AT!POWERDOWN
2. Monitor SAFE_PWR_REMOVE.
3. When SAFE_PWR_REMOVE transitions from low to high, remove power.

4.4 Emergency Power Off

The module can be switched off by controlling the RESET_IN_N pin. This must only be used in emergency situations if the system freezes (not responding to commands).

To perform an emergency power off:

1. De-assert POWER_ON_N.
2. While POWER_ON_N is de-asserted, assert RESET_IN_N (logic low) for at least 32 ms. This immediately powers down the module.

4.5 USB

The AirPrime WP75xx/AirPrime WP8548 implements one high-speed USB2.0 Interface, which conforms to the *Universal Serial Bus Specification, Revision 2.0*, except for USB_VBUS implementation (not connected internally).

See [USB Interface on page 96](#) for a reference USB schematic.

Table 4-5: USB Pin Descriptions

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

Table 4-5: USB Pin Descriptions (Continued)

Pin	Signal name	Direction ^a	Function
16	Reserved	Input	For compatibility with Sierra Wireless HL devices, connect as indicated in the reference USB schematic.
16	USB_VBUS ^b	Input	USB supply voltage
91	USB_ID	Input	Used for USB_OTG

- a. Signal direction with respect to the module. Example: USB_ID is an input to the module from the host.
- b. Not currently connected internally, but customer solutions should provide this input for compatibility with future module revisions.

4.6 UART

The AirPrime WP75xx/AirPrime WP8548 provides two UART interfaces:

- UART1 (primary UART)—5-wire interface (Software support for 8-wire UART1 will be added in a future firmware revision.)
- UART2 (secondary UART)—2-wire interface (Software support for 4-wire UART2 will be added in a future firmware revision.)

The UART interfaces are used for data communication between the AirPrime WP75xx/AirPrime WP8548 module and a PC or host processor. These interfaces comply with the RS-232 interface.

Flow control is managed using the RTS/CTS signals, or using software XON/XOFF.

[Table 4-6 on page 69](#) describes the signals used for UART1 and UART2.

Note: UART signals are named with respect to the host device, and directions are listed with respect to the module. For example, UART1_RX is an output from the module to the host.

Table 4-6: UART Pins

Pin	Interface	Name ^a	Direction ^b	Function	If unused
2	UART1	UART1_RI	Output	Ring Indicator Signal incoming calls (voice and data), SMS, etc.	Leave open
3		UART1_RTS	Input	Ready To Send, flow control	Leave open ^c
4		UART1_CTS	Output	Clear To Send, flow control	Leave open
5		UART1_TX	Input	Transmit Data	Leave open
6		UART1_RX	Output	Receive Data	Leave open
7		UART1_DTR ^d	Input (active low)	Data terminal ready Prevents the AirPrime WP75xx/ AirPrime WP8548 from entering USB-SS mode, switches between data mode and command mode, and wakes the module.	Leave open
8		UART1_DCD ^d	Output	Data Carrier Detect Signal data connection in progress	Leave open
9		UART1_DSR ^d	Output	Data Set Ready Signal UART interface is ON	Leave open
96		UART2	UART2_TX	Input	Transmit data
97	UART2_RX		Output	Receive data	Leave open
98	UART2_RTS ^d		Input	Ready To Send, flow control	Leave open
99	UART2_CTS ^d		Output	Clear To Send, flow control	Leave open

- a. Signals are named with respect to the host device. For example, UART1_RX is the signal used by the host to receive data from the module.
- b. Signal direction with respect to the module. For example, UART1_RX is an output from the module to the host.
- c. If UART1 is implemented as a 2-wire interface, UART1_RTS should be pulled low to disable flow control.
- d. Software support for 8-wire UART1 and 4-wire UART2 will be available in a future firmware revision.

4.7 UIM interface

The AirPrime WP75xx/AirPrime WP8548 has two physical UIM interfaces—UIM1 and UIM2, which support UIM for WCDMA and GSM.

Both UIM interfaces allow control of external 1.8V/3V UIMs and are fully compliant with GSM 11.11 recommendations concerning UIM functions.

Table 4-7 on page 70 describes the signals used for UIM1 and UIM2.

Table 4-7: UIM Interface Pins

Pin	Interface	Name	Direction ^a	Function	If Unused
26	UIM1	UIM1_VCC	Output	Supply output	Leave open
27		UIM1_CLK	Output	Clock	Leave open
28		UIM1_DATA	Input/Output	Data connection	Leave open
29		UIM1_RESET_N	Output	Reset	Leave open
64		UIM1_DET	Input	Detect UIM	Leave open
55	UIM2	UIM2_VCC	Output	Supply output	Leave open
56		UIM2_DATA	Input/Output	Data connection	Leave open
57		UIM2_RESET_N	Output	Reset	Leave open
58		UIM2_CLK	Output	Clock	Leave open
65		UIM2_DET	Input	Detect UIM	Leave open

a. 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 4-2 illustrates the recommended implementation of a UIM holder. (For a more detailed UIM schematic, see Figure 5-4 on page 98.)

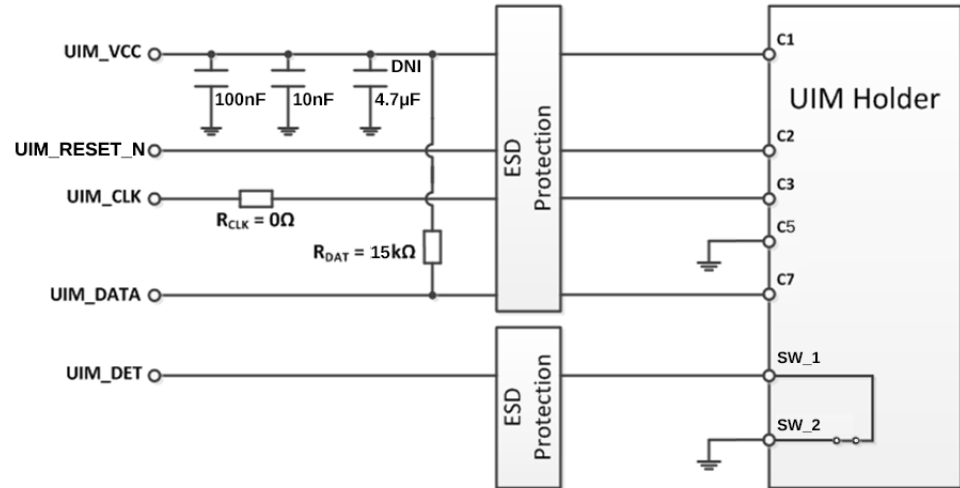


Figure 4-2: Recommended UIM Holder Implementation

The UIM Detect signals (UIM1_DET, UIM2_DET) are used to detect the physical presence of a UIM card in the UIM holder. Each UIM Detect signal has a pull-up internal to the AirPrime WP75xx/AirPrime WP8548. It should be set to GND when a UIM is not present. All signals near the UIM holder must be ESD-protected.

The UIM Detect signals transition:

- When a UIM is inserted—high (logic 0 to logic 1)
- When a UIM is removed—low (logic 1 to logic 0)

The capacitor and the two resistors, RCLK and RDATA, should be added as placeholders to compensate for potential layout issues. UIM_DAT trace should be routed away from the UIM_CLK trace. Keep the distance between the module and the UIM holder as short as possible.

An ESD device specifically designed for UIM cards is recommended for the UIM1 and UIM2 VCC, RESET_IN_N, CLK, and DAT signals (for example, STMicroelectronics DALC208SC6). For UIM1_DET/UIM2_DET a low leakage ESD suppressor should be selected.

4.8 General Purpose Input/Output (GPIO)

The AirPrime WP75xx/AirPrime WP8548 defines several GPIOs for customer use, as described in [Table 4-8](#). For electrical specifications, see [Table 3-32, Digital I/O Characteristics \(VDD_PX=1.80 V \(nominal\)\)](#), on page 60.

Table 4-8: GPIO Pin Description

Pin	Signal Name	Default state	Function	If Unused
10	GPIO2 ^a	PD	General purpose I/O	Leave open
40	GPIO7	PD		Leave open
41	GPIO8	PD		Leave open
44	GPIO13	PD		Leave open
92	GPIO38 ^{b,c}	No pull		Leave open
93	GPIO39 ^c	No pull		Leave open
94	GPIO40 ^{c,d}	No pull		Leave open
95	GPIO41 ^{c,d}	No pull		Leave open
100	GPIO34 ^c	No pull		Leave open
101	GPIO35 ^c	No pull		Leave open
102	GPIO36 ^{b,c}	No pull		Leave open
103	GPIO37 ^c	No pull		Leave open
104	GPIO32	PD		Leave open
105	GPIO33	PD		Leave open
109	GPIO42 ^a	PD		Leave open
147	GPIO21 ^a	PD		Leave open
148	GPIO22	PD		Leave open
149	GPIO23	PD		Leave open
150	GPIO24	PD		Leave open
159	GPIO25	PD		Leave open

- a. Pin is 'wakeable'. Can be used to trigger the module to wake up from USB-SS mode (low power active state). See [Wakeup Interrupt \(USB-SS Mode\) on page 73](#) for details.
- b. Can be configured as a wakeup trigger for ULPM. See [Power Consumption States on page 39](#) for details.
- c. Accessible via sysfs/Legato only.
- d. GPIO40 and GPIO41 may be unavailable in future WP products.

4.9 Wakeup Interrupt (USB-SS Mode)

The following pins can be used to wake the device when it is in USB-SS mode (low-power active state):

- GPIO2
- GPIO21
- GPIO42
- UIM1_DET
- UIM2_DET

If the device firmware is monitoring these pins while the device is in USB-SS mode, any transition on these pins will wake the device. (Note: The UIMx_DET pins transition high when a UIM is installed, and low when a UIM is removed.)

Note: These signals wake the device when it is in USB-SS mode (a low-power ACTIVE state where the module is fully powered). If the device is in ULPM (Ultra Low Power Mode), it is only woken by configured wakeup triggers—see [Table 3-6, Supported Power States](#), on page 40 for details.

4.10 Wakeup Events (ULPM)

The following signals/sources can be used to wake the device from ULPM (Ultra Low Power Mode):

- Configurable:
 - Timer
 - GPIO36, GPIO38
 - ADC2, ADC3
(Support available in future firmware release)
- Always enabled:
 - POWER_ON_N

Note: These signals wake the device only when it is in ULPM. If the device is in regular USB-SS mode (a low-power ACTIVE state where the module is fully powered), it can be woken using the signals described in [Wakeup Interrupt \(USB-SS Mode\)](#) on page 73.

4.11 Secure Digital IO (SDIO) interface

The AirPrime WP75xx/AirPrime WP8548 module defines a 3.0V SDIO interface (SD 2.0-compliant) for customer-defined use with SD cards, connection to a Wi-Fi module, etc.

Note: An external 3.0V supply is required to supply power to the SD card.

Table 4-9 describes the signals used for SDIO.

Table 4-9: SDIO Pin Descriptions

Pin	Signal Name	Direction ^a	Description	If unused	Voltage level
161	SDIO_CMD	Output	SDIO command	Leave Open	3.0V
162	SDIO_CLK	Output	SDIO clock	Leave Open	
163	SDIO_DATA_3	Input/Output	SDIO data bit 3	Leave Open	
164	SDIO_DATA_2	Input/Output	SDIO data bit 2	Leave Open	
165	SDIO_DATA_1	Input/Output	SDIO data bit 1	Leave Open	
166	SDIO_DATA_0	Input/Output	SDIO data bit 0	Leave Open	

a. Signal direction with respect to the module. Example: SDIO_CMD (pin 161) is an output from the module to the host.

4.12 I²C Interface

The AirPrime WP75xx/AirPrime WP8548 module provides one I²C (Inter-Integrated Circuit) dedicated serial port.

Table 4-10: I²C Interface Pins

Pin	Signal name	Direction	Function	If Unused
1	I2C1_CLK	Input/Output	I ² C Clock	Leave open
66	I2C1_DATA	Input/Output	I ² C Data	Leave open

The I²C signals are implemented internally as open drain outputs (per the I²C specification) with 2.2 k Ω pull-up resistors to VGPIO.

4.13 VGPIO

The AirPrime WP75xx/AirPrime WP8548 utilizes 1.8V logic, provided via the VGPIO (GPIO voltage output) pin.

Table 4-11: 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 4-12: VGPIO Electrical Characteristics

Parameter	Min	Typ	Max	Unit	Remarks
Voltage level	1.7	1.8	1.9	V	Both active mode and USB-SS mode
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
- Act as a voltage reference for the ADC interfaces—ADC0–ADC3

4.14 Reset Signal (RESET_IN_N)

The AirPrime WP75xx/AirPrime WP8548 provides an interface to allow an external application to reset the module.

Table 4-13: RESET_IN_N Pin

Pin	Signal name	Direction ^a	Function	If Unused
11	RESET_IN_N	Input	External Reset Input	Leave open

a. Signal direction with respect to the module—RESET_IN_N (pin 11) is an input to the module from the host.

The RESET_IN_N signal is internally pulled-up with a 40 kΩ resistor. An open collector transistor or equivalent should be used to ground the signal when necessary to reset the module.

To reset the module, a low level pulse must be sent on the RESET_IN_N pin for 32 ms. This will immediately restart the module with the POWER_ON_N signal at low level. (If the POWER_ON_N signal is at high level, the module will be powered off.)

The RESET_IN_N signal will reset the registers of the CPU and reset the RAM memory as well, for the next power on.

Note: Using RESET_IN_N to reset the module could result in memory corruption if used inappropriately. This signal should only be used if the module has become unresponsive and it is not possible to perform a power cycle.

Table 4-14: Reset Timing^a

Symbol	Parameter	Min	Typ	Max
Trdet	Duration of RESET_IN_N signal before firmware detects it (debounce timer)	-	32 ms	-
Trlen	Duration reset asserted	42 ms	-	∞
Trdel	Delay between minimum Reset duration and internal reset generated	-	500 ms	-

a. All values are preliminary and subject to change

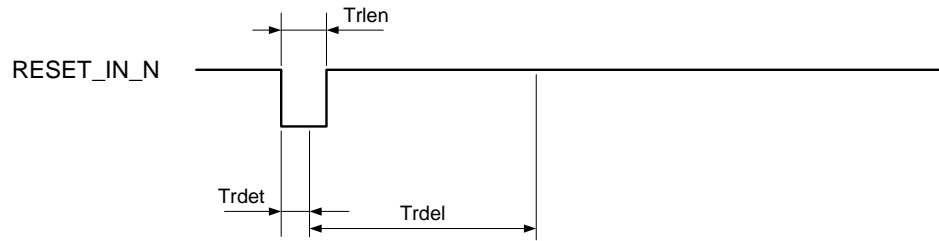


Figure 4-3: Illustration of Reset Timing When RESET_IN_N < Trdel

4.15 Reset Out (RESET_OUT_N)

The AirPrime WP75xx/AirPrime WP8548 provides a signal that will hold peripheral devices (such as a USB hub, I2C device, etc.) in reset until the power-up sequence is complete.

Table 4-15: RESET_OUT_N Pin

Pin	Signal name	Direction ^a	Function	If Unused
46	RESET_OUT_N	Output	Module reset peripheral device control	Leave open

a. Signal direction with respect to the module—RESET_OUT_N is an output from the module to the host.

When the module is in reset or powering up, the signal is held low to put peripheral devices in reset. Once the power-on sequence is complete, the RESET_OUT_N signal will be turned high to take the peripherals out of reset.

4.16 ADC

The AirPrime WP75xx/AirPrime WP8548 provides four general purpose ADC (Analog to Digital Converter) inputs, as described [Table 4-16](#) and [Table 4-17](#).

Table 4-16: ADC Interface Pins

Pin	Signal name	Direction ^a	Function	If Unused
24	ADC1	Input	Analog to Digital Converter	Leave open or Ground
25	ADC0	Input	Analog to Digital Converter	Leave open or Ground
107	ADC2 ^b	Input	Analog to Digital Converter	Leave open or Ground
108	ADC3 ^b	Input	Analog to Digital Converter	Leave open or Ground

- a. Signal direction with respect to the module. Example: ADC1 (pin 24) is an input to the module from the host.
- b. Pin is 'wakeable'. Can be used to trigger the module to wake up from USB-SS mode (low power active state). See [Wakeup Interrupt \(USB-SS Mode\)](#) on page 73 for details.

Table 4-17: ADC Interface Characteristics^a

	ADC0/ADC1 Value	ADC2/ADC3 Value	Units
Full-scale voltage level	0–1.8	0–1.8	V
Resolution	15	12	bit
Sample rate	1.15	20.000–818.330	ksp/s
Voltage error	8 (Typ) 16 (Max)	2 (Typ)	mV

a. All values are preliminary and subject to change

4.17 Digital Audio

The AirPrime WP75xx/AirPrime WP8548 provides a 4-wire digital audio interface that can be configured as either PCM (Pulse Code Modulation) or I²S (Inter-IC Sound).

[Table 4-18 on page 77](#) describes the audio interface signals.

Note: Audio availability is firmware-dependent.

Table 4-18: PCM/I²S Interface Signals

Pin	Signal name	Direction ^a	Function	If Unused
33	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.	
34	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.	
35	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).	

Table 4-18: PCM/I²S Interface Signals (Continued)

Pin	Signal name	Direction ^a	Function	If Unused
36	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.	

- a. Signal direction with respect to the module. Examples: PCM_IN (pin 34) is an input to the module from the host; PCM_OUT (pin 33) is an output from the module to the host.

4.17.1 PCM

Table 4-19 defines the PCM interface configuration.

Table 4-19: PCM Interface Configurations

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

4.17.1.1 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

4.17.1.2 PCM Timing

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

Table 4-20: 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(sync _l)	PCM_SYNC low time	-	124.5	-	μs
T(clk)	PCM_CLK cycle time	-	488	-	ns
T(clk _h)	PCM_CLK high time	-	244	-	ns
T(clk _l)	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	60	-	-	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	-	-	60	ns

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

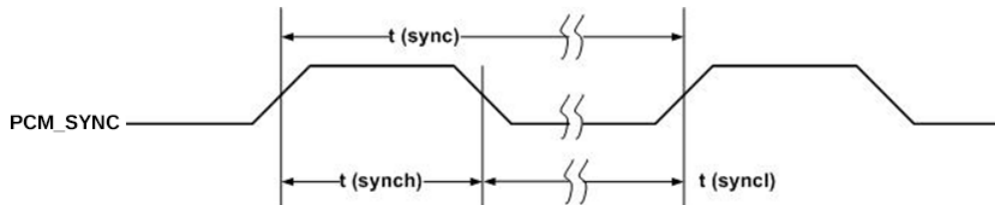


Figure 4-4: PCM_SYNC Timing Diagram (2048 kHz clock)

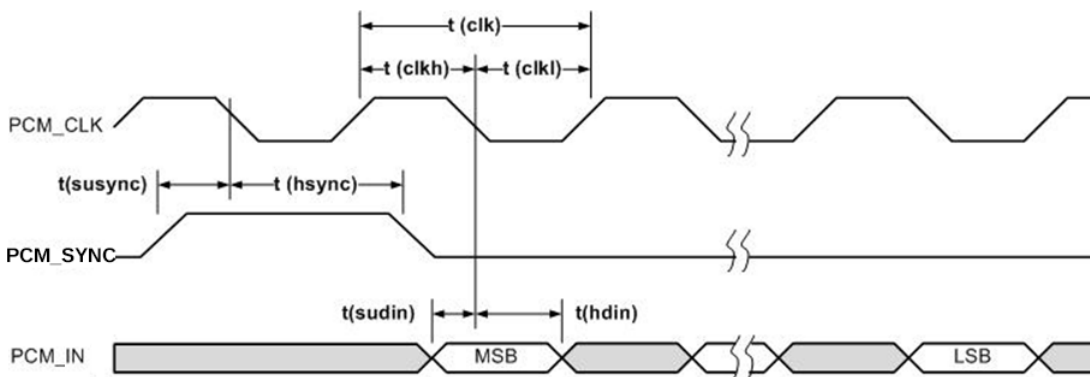


Figure 4-5: PCM Codec to Device Timing Diagram

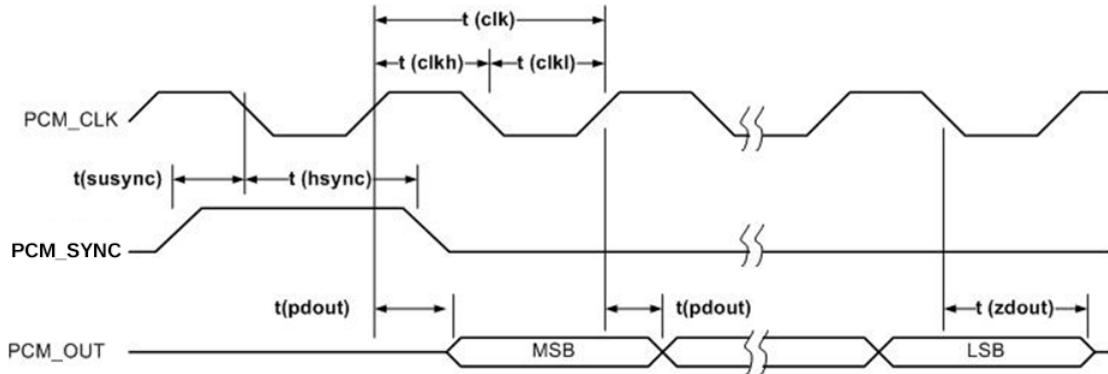


Figure 4-6: Device to PCM Codec Timing Diagram

4.17.2 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

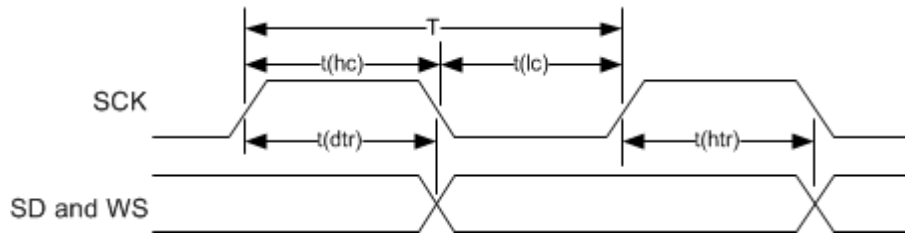


Figure 4-7: I²S Transmitter Timing

Table 4-21: Master Transmitter With Data Rate = 3.072 MHz ($\pm 10\%$)^a

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

a. Maximum sample rate = 48 kHz at 3.072 MHz (16 bits per sample)

4.18 SPI Bus

The AirPrime WP75xx/AirPrime WP8548 module provides one 4-wire serial peripheral interfaces (SPI1).

The following features are available on the SPI bus:

- Mode: Master (Slave mode is not supported)
- SPI speed from 128 kbps to 26 Mbps in master mode operation
- 4-wire interface
- 4 to 32 bits data length

[Table 4-22 on page 81](#) describes the SPI interface pins.

Table 4-22: SPI Pin Descriptions

Pin	Signal Name	Direction ^a	Description	Reset State	I/O Type
51	SPI1_MRDY	Output	SPI Master Ready	Z	1V8
52	SPI1_MISO	Input	SPI Master Input/Slave Output (output from slave)	Z	
53	SPI1_CLK	Output	SPI serial clock (output from Master)	Z	
54	SPI1_MOSI	Output	SPI Master Output/Slave Input (output from master)	Z	

a. Signal direction with respect to module. Examples: SPI1_MISO (pin 52) is an input too the module from the host; SPI1_CLK (pin 53) is an output from the module to the host.

4.18.1 SPI Configuration

Table 4-23: SPI Configuration

Operation	Max Speed	SPI-Mode	Duplex	4-wire Type
Master	26 Mb/s	0,1,2,3	Full	<ul style="list-style-type: none"> • SCLK (SPI1_CLK) • MOSI (SPI1_MOSI) • MISO (SPI1_MISO) • SS (SPI1_MRDY)

4.18.2 SPI Waveforms

The following figure shows waveforms for SPI transfer using a 4-wire configuration.

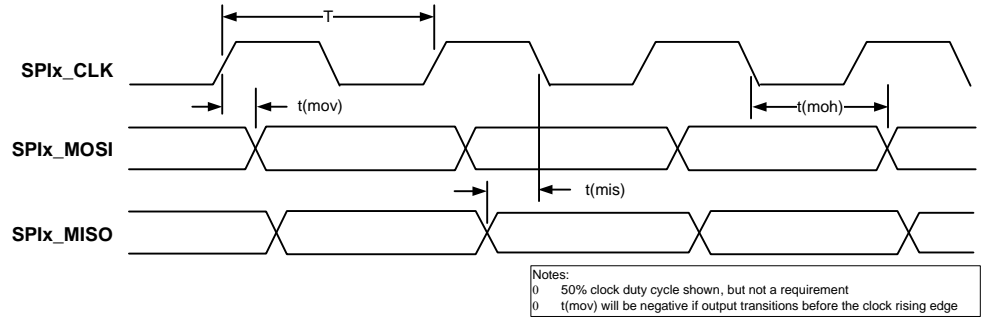


Figure 4-8: 4-Wire Configuration SPI Transfer

Table 4-24: SPI Master Timing Characteristics

Parameter		Min	Typ	Max	Unit
SPI clock frequency		-	-	26	MHz
T	SPI clock period	38	-	-	ns
t(ch)	Clock high	17	-	-	ns
t(cl)	Clock low	17	-	-	ns
t(mov)	Master output valid	-5	-	5	ns
t(mis)	Master input setup	3	-	-	ns
t(moh)	Master output hold	3	-	-	ns
t(tse)	Tri-state enable	-5	-	5	ns
t(tsd)	Tri-state disable	-5	-	5	ns

4.18.3 Application

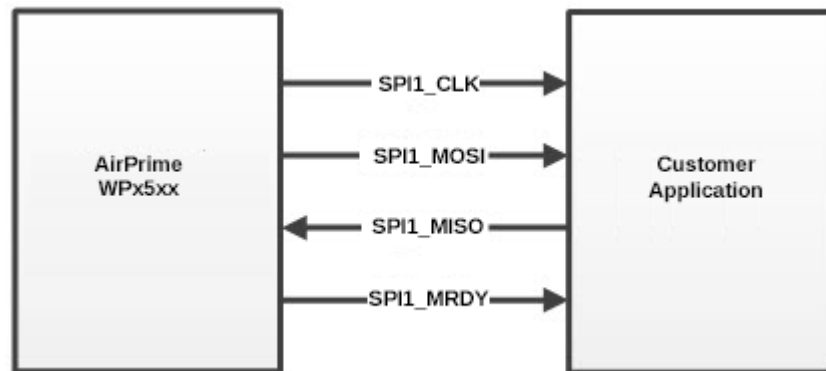


Figure 4-9: Example of 4-wire SPI Bus Application

4.19 HSIC Bus

The AirPrime WP75xx/AirPrime WP8548 module provides a 2-wire HSIC (High-Speed Inter-Chip) bus.

Table 4-25: HSIC Pin Descriptions

Pin	Signal Name ^a	Direction ^a	Description	Reset State	I/O Type
14	HSIC_DATA	I/O	HSIC data	Z	1V8
15	HSIC_STRB	I/O	HSIC strobe signal	Z	

a. From host view

4.19.1 HSIC Waveforms

Refer to [2] Inter-Chip USB Supplement to the USB 2.0 Specification Revision 1.0.

4.19.2 Application

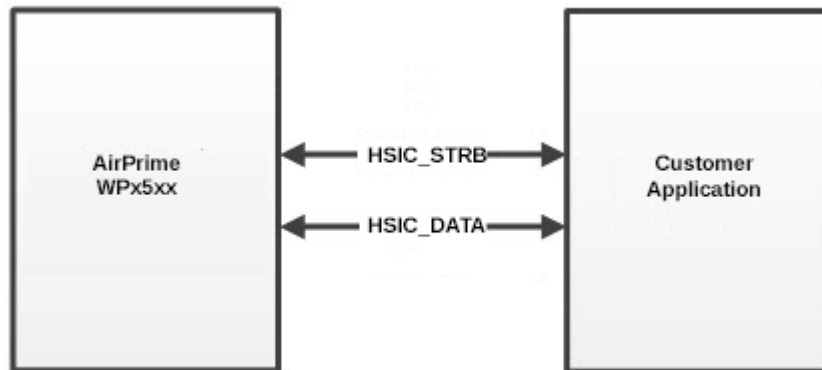


Figure 4-10: Example of 2-wire HSIC Bus Application

Application notes:

- Trace length < 10 cm
- Skew between data and strobe signals < 15 ps
- HSIC_DATA and HSIC_STRB should maintain a 50Ω impedance routing, and isolation between the lines should be maintained

4.20 Clock

The AirPrime WP75xx/AirPrime WP8548 module supports two digital clock interfaces that are connected directly from the PMIC.

Table 4-26 describes the clock interface pins.

Table 4-26: Clock Interface Pin Descriptions

Pin	Signal name	I/O	I/O type	Description	If Unused
22	SYS_CLK	Output	1.8V	19.2 MHz digital clock output	Leave open
23	SLEEP_CLK	Output	1.8V	32.768 kHz digital clock output	Leave open

4.21 TP1 (Boot Pin)

The TP1 pin (boot pin) can be used for two primary purposes:

- The pin can be used to force the module to enter boot-loader mode on power-up—Connect the pin to a control mechanism (for example, a button, switch, or jumper) on the host platform, and use this mechanism to assert (drive low) the TP1 pin on power-up. The boot loader monitors the TP1 pin and when it detects a low signal, prevents normal power-up and prepares to download firmware via the DM port.

When the module has restarted and entered boot-loader mode, make sure to de-assert the TP1 pin. When the firmware download finishes, the module reboots automatically and the de-asserted pin allows the module to boot normally.

- If not connected to a control mechanism, at minimum the pin should be connected to a test point on the host platform, for use by Sierra Wireless in RMA debugging.

Note: Firmware downloads also occur using software tools available on source.sierrawireless.com or over the air using an AirVantage server.

Table 4-27: TP1 Pin Description

Pin	Name	Direction	Function	If Unused
47	TP1	Input	Device recovery (boot load)	Mandatory test point

4.22 Temperature Monitoring

The AirPrime WP75xx/AirPrime WP8548 provides internal temperature monitoring of the module's baseband thermistor, as detailed below in Figure 4-11 and Table 4-28.

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.

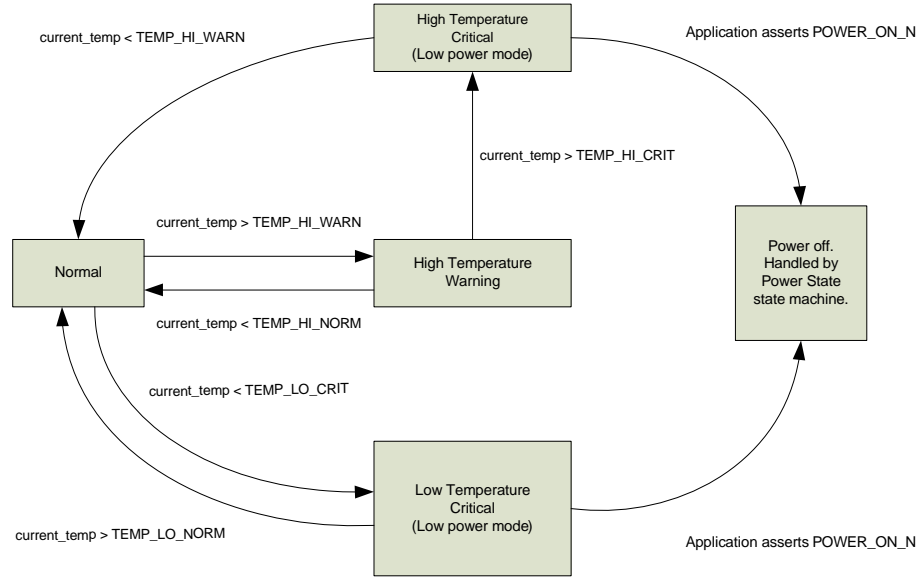


Figure 4-11: Temperature Monitoring State Machine

Table 4-28: Temperature Monitoring States ^a

State	Description	Threshold	Default Temp value (C) ^b	Functionality
Normal	Baseband thermistor is between	TEMP_HI_NORM	+100	All
		TEMP_LO_NORM	-40	
High Temperature Warning	Baseband thermistor has exceeded	TEMP_HI_WARN	+110	All
High Temperature Critical	Baseband thermistor has exceeded	TEMP_HI_CRIT	+120	Low Power Mode
Low Temperature Critical	Baseband thermistor has descended past	TEMP_LO_CRIT	-45	Low Power Mode

a. All values are preliminary and subject to change
 b. Junction temperature

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

4.23 Test Pins

Sierra Wireless requires test points on the customer application for Sierra Wireless RMA and debug service.

Table 4-29: Test Pin Descriptions

Pin	Name	Function	If Unused
236	J1	Test point	Mandatory test point
237	J2	Test point	Mandatory test point
238	J3	Test point	Mandatory test point
239	J4	Test point	Mandatory test point
240	J5	Test point	Mandatory test point
241	J6	Test point	Mandatory test point
242	J7	Test point	Mandatory test point
243	J8	Test point	Mandatory test point
244	J9	Test point	Mandatory test point

4.24 Antenna Control

Note: Antenna control signals support is optional.

The AirPrime WP75xx/AirPrime WP8548 provides four 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.

Table 4-30: Antenna Control Signals

Pin	Name	Direction ^a	Function	If Unused
153	ANT_CNTL0	Output	Customer-defined external switch control for tunable antennas	Leave open
154	ANT_CNTL1	Output		Leave open
155	ANT_CNTL2	Output		Leave open
156	ANT_CNTL3	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:
 - `ATICUSTOM="BANDSELEN",1`

(Note: This setting is persistent unless disabled by issuing `ATICUSTOM="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 WPx5xx AT Command Reference for details.
(Note: <gpio1>–<gpio4> correspond to ANT_CTRL0–ANTCTRL3.)

4.25 Indication Interfaces

The AirPrime WP75xx/AirPrime WP8548 module provides several indication interfaces that deliver notifications when specific events occur. These interfaces include:

- [Tx Activity Indicator \(TX_ON\) on page 88](#)
- [WWAN_LED_N on page 88](#)
- [WAKE_ON_WWAN on page 89](#)
- [Ring Indicator on page 90](#)
- [SAFE_PWR_REMOVE on page 90](#)
- [UIM1_DET/UIM2_DET on page 90](#)

4.25.1 Tx Activity Indicator (TX_ON)

The AirPrime WP75xx/AirPrime WP8548 module provides a digital output signal to indicate the occurrence of Tx activity.

Table 4-31: Tx Activity Indicator States

Pin	Signal name	Direction ^a	I/O type	Module state	Signal State
60	TX_ON	Output	1.8V	During Tx activity	High
				No Tx	Low

a. Signal direction with respect to module—TX_ON (pin 60) is an output from the module to the host.

4.25.2 WWAN_LED_N

The AirPrime WP75xx/AirPrime WP8548 provides an LED control output signal pad. This signal is an open drain output.

Table 4-32: LED Interface Pin

Pin	Signal name	Direction ^a	Voltage / Current	Function	If Unused
106	WWAN_LED_N	Output	<ul style="list-style-type: none"> • Voltage (max)=VBAT_BB + 0.5 V • Maximum current sink capability=300 mA 	LED driver control	Leave open

a. Signal direction with respect to module—WWAN_LED_N (pin 106) is an output from the module to the host.

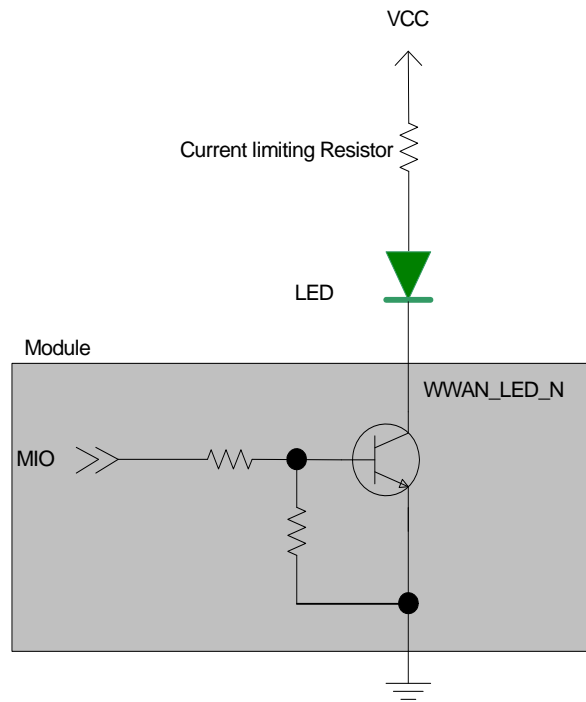


Figure 4-12: LED Reference Circuit

4.25.3 WAKE_ON_WWAN

Note: Host support for WAKE_ON_WWAN signal is optional.

The AirPrime WP75xx/AirPrime WP8548 drives WAKE_ON_WWAN high to wake the host when specific events occur.

See [Figure 4-13 on page 89](#) for a recommended implementation.

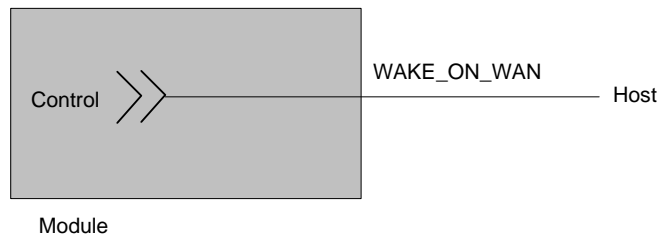


Figure 4-13: Recommended WAKE_ON_WWAN Connection

4.25.4 Ring Indicator

The ring indicator (UART1_RI) may be used to notify an external application of several events such as an incoming call, timer expiration, or incoming SMS. The AirPrime WP75xx/AirPrime WP8548 pulses the signal high when an event occurs.

Table 4-33: UART1_RI Pin

Pin	Name	Direction ^a	Function	If unused
2	UART1_RI	Output	Ring Indicator Signal incoming calls (voice and data), SMS, etc.	Leave open

a. Signal direction with respect to the module—UART1_RI (pin 2) is an output from the module to the host.

For additional details, refer to the Legato API documentation for Legato.io.

4.25.5 SAFE_PWR_REMOVE

The SAFE_PWR_REMOVE signal is used by the AirPrime WP75xx/AirPrime WP8548 to indicate to the host device that VBAT_BB/VBAT_RF can be removed. The signal is driven high when it is safe to remove the power supply.

4.25.6 UIM1_DET/UIM2_DET

The UIM Detect signals (UIM1_DET, UIM2_DET) are used to detect the physical presence of UIM cards in the UIM holders. Each UIM Detect signal has a pull-up internal to the AirPrime WP75xx/AirPrime WP8548. It should be set to GND when a UIM is not present. All signals near the UIM holder must be ESD-protected.

The UIM Detect signals transition:

- When a UIM is inserted—high (logic 0 to logic 1)
- When a UIM is removed—low (logic 1 to logic 0)

4.26 DR_SYNC

The AirPrime WP75xx/AirPrime WP8548 provides DR_SYNC, an output used for GPS dead reckoning synchronization.

The module pulses the DR_SYNC signal once every integer GPS second. While position fixes are occurring, the DR_SYNC pulse is aligned precisely with the GPS time. When a position fix cannot be made (for example, when a vehicle has

entered a tunnel), the module continues to pulse the DR_SYNC signal every second while the level of uncertainty of the GPS time is low. When the uncertainty level is high, the module stops pulsing the signal.

Table 4-34: DR_SYNC Pin Details

Pin	Signal name	Direction ^a	Function	If Unused
42	DR_SYNC	Output	GPS dead reckoning sync signal	Leave open

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

4.27 W_DISABLE_N—Wireless Disable

Note: Host support for wireless disable signals is optional.

The host device uses W_DISABLE_N (pin 151) to enable / disable the WWAN or radio modem. When disabled, the modem cannot transmit or receive information.

Letting this signal float high allows the module to operate normally. The pin has an internal pull-up resistor. See [Figure 4-14](#) for a recommended implementation.

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

- The signal is an input to the module and should be driven LOW only for its active state (controlling the power state); otherwise it should be floating or (High impedance). It should never be driven to a logic high level. The module has an internal pull-up resistor to an internal 1.8V rail, so if the signal is floating or (high impedance), then the radio is on.
- If the host never needs to assert this power state control to the module, leave this signal unconnected from the host interface.

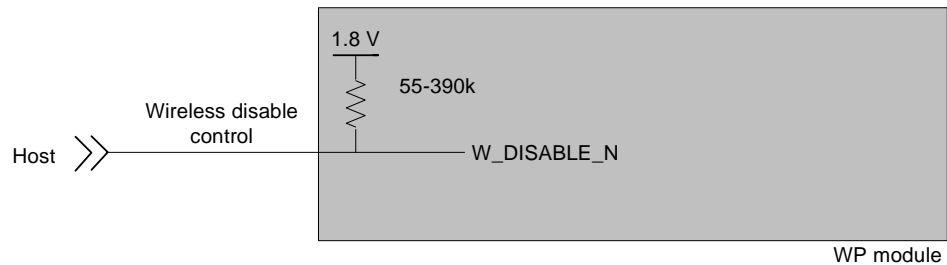


Figure 4-14: Recommended Wireless Disable Connection

>> 5: Routing Constraints and Recommendations

This section describes general routing constraints and recommendations for the AirPrime WP75xx/AirPrime WP8548 module.

Note: This is a non-exhaustive list of suggested design guidelines. The developer is responsible for deciding whether to implement these guidelines.

5.1 General Rules and Recommendations

Clock and other high-frequency digital signals (e.g. serial buses) should be routed as far as possible from the module's analog signals.

If the application design makes it possible, all analog signals should be separated from digital signals by a ground trace on the PCB.

Tip: Avoid routing any signals under the module on the application board.

5.2 PCB Layout Recommendations

Ground pads should be re-flowed on to the host PCB with < 30% voiding to allow effective heat dissipation.

5.3 Power Supply

When designing the power supply, make sure that VBAT_BB/VBAT_RF meet the requirements listed in [Power Supply Ratings on page 36](#).

Careful attention should be paid to the following:

- Power supply quality—PFM, or PSM systems should be avoided; Low ripple, linear regulation or PWM converters are preferred for low noise.
- Capacity to deliver high current peaks in a short time (for pulsed radio emission)
- VBAT_BB/VBAT_RF must support peak currents with an acceptable voltage drop that guarantees the minimum required VBAT_BB/VBAT_RF value.
- VBAT_BB/VBAT_RF signal pads must never exceed the maximum required VBAT_BB/VBAT_RF value, otherwise the module's power amplifier and GPS chipset may be severely damaged.
- A weakly-designed (not robust) power supply could affect EMC performance, the emission spectrum, and the phase error and frequency error.

5.4 Antenna

Sierra Wireless strongly recommends working with an antenna manufacturer either to develop an antenna adapted to the application, or to adapt an existing solution to the application.

For information on routing constraints for the RF circuit, see [RF Circuit on page 94](#).

5.5 PCB Specifications for the Application Board

Sensitive signals (such as audio, UIM, and clocks) should be protected by ground planes/fills. Routing sensitive signals close to noisy signals could result in noise being coupled.

5.6 Recommended PCB Land Pattern

Refer to the AirPrime WP75xx/AirPrime WP8548 Customer Process Guidelines document, available at <http://source.sierrawireless.com>.

5.7 Routing Constraints

5.7.1 Power Supply

If the following design recommendations are not followed, phase error (peak) and power loss could occur.

Note: The recommended power supply capacity (Table 3-4 on page 37) is greater than the maximum peak current to provide an operating margin.

- Since the maximum peak current can reach 2.5 A, Sierra Wireless strongly recommends having a large width for the layout of the power supply signal (to avoid voltage loss between the external power supply and VBAT_BB/ VBAT_RF).

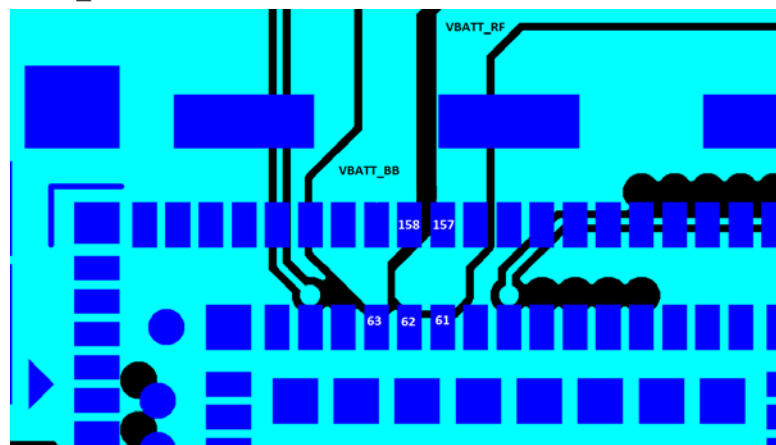


Figure 5-1: Power Supply Routing Example

Note: Figure 5-1 shows separate traces for VBAT_BB and VBAT_RF. If VBAT_BB and VBAT_RF share a single power supply, these traces should be connected.

Note: For optimal decoupling, place the capacitors on the underside of the board, directly under the pins.

- Filtering capacitors (100 nF to 1500 μ F) are recommended near the module's power supply.
- Attention should be paid to the ground trace or the ground plane on the application board for the power supply that supplies the module. The ground trace or ground plane, as well as the VBAT trace, must be able to support current peaks.
- If the ground trace between the module and the power supply is a copper plane, make sure it is a solid plane.
- Design routing to make sure total line impedance does not exceed 10 m Ω @ 217 Hz.

5.7.1.1 Ground Plane Connection

The AirPrime WP75xx/AirPrime WP8548 module requires a solid, central ground plane (with solder mask defined pads) located directly under the module. This will:

- Ensure high current signal returns
- Provide heat dissipation under higher operating temperatures

The ground plane should be connected (with vias) to the reference ground layer of the application board.

5.7.2 UIM Interface

- The length of the tracks between the AirPrime WP75xx/AirPrime WP8548 and the UIM socket should be as short as possible. Maximum recommended length is 10cm.
- ESD protection is mandatory on the UIM lines unless:
 - (WP8548 only) An ESIM is being used, or
 - There is no physical access to the UIM
- The decoupling capacitor(s) should be placed as close as possible to the UIM card connector for the UIM1_VCC signal.

5.7.3 RF Circuit

The RF signal must be routed on the application board using tracks with a 50 Ω characteristic impedance.

The characteristic impedance depends on the dielectric, the track width and the ground plane spacing.

It is recommended to use stripline design if the RF path is fairly long (more than 3cm), since microstrip design is not shielded. Consequently, the RF (transmit) signal may interfere with neighboring electronic circuits. In the same way, the neighboring electronics (micro-controllers, etc.) may interfere with the RF (receive) signal and degrade the reception performance.

The RF trace on the development board is routed from the AirPrime WP75xx/ AirPrime WP8548 antenna port to the RF connector (IPEX MHF-4). The RF trace is designed as a 50Ω coplanar stripline and its length is 20.7 mm.

The following drawings show the location of the AirPrime WP75xx/AirPrime WP8548 on the development board, the routing cross-section, and the top view of the RF trace on the development board.

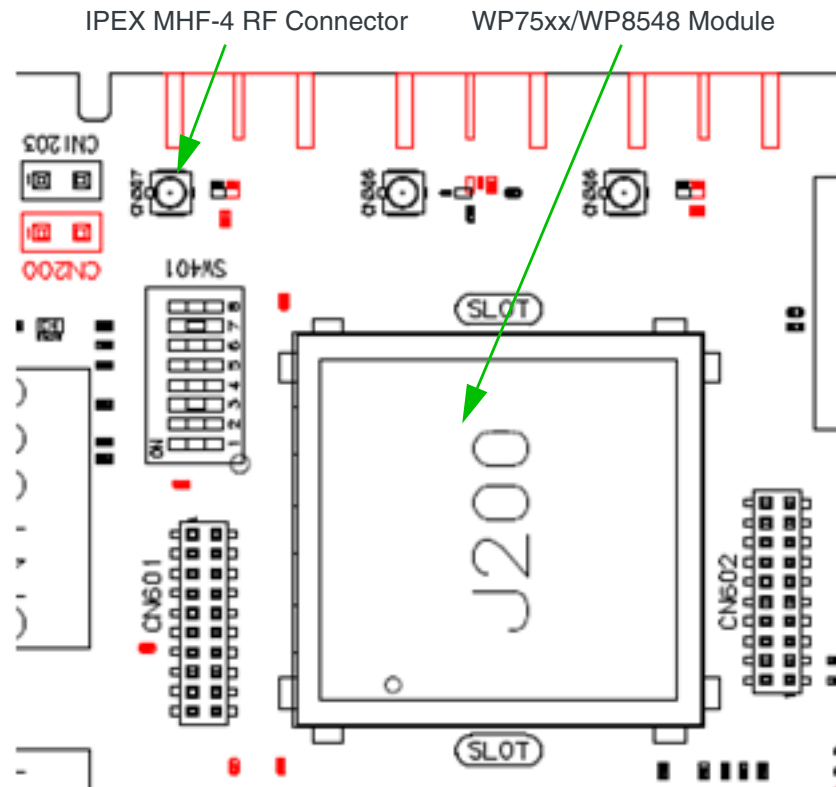


Figure 5-2: Module Location on Development Board

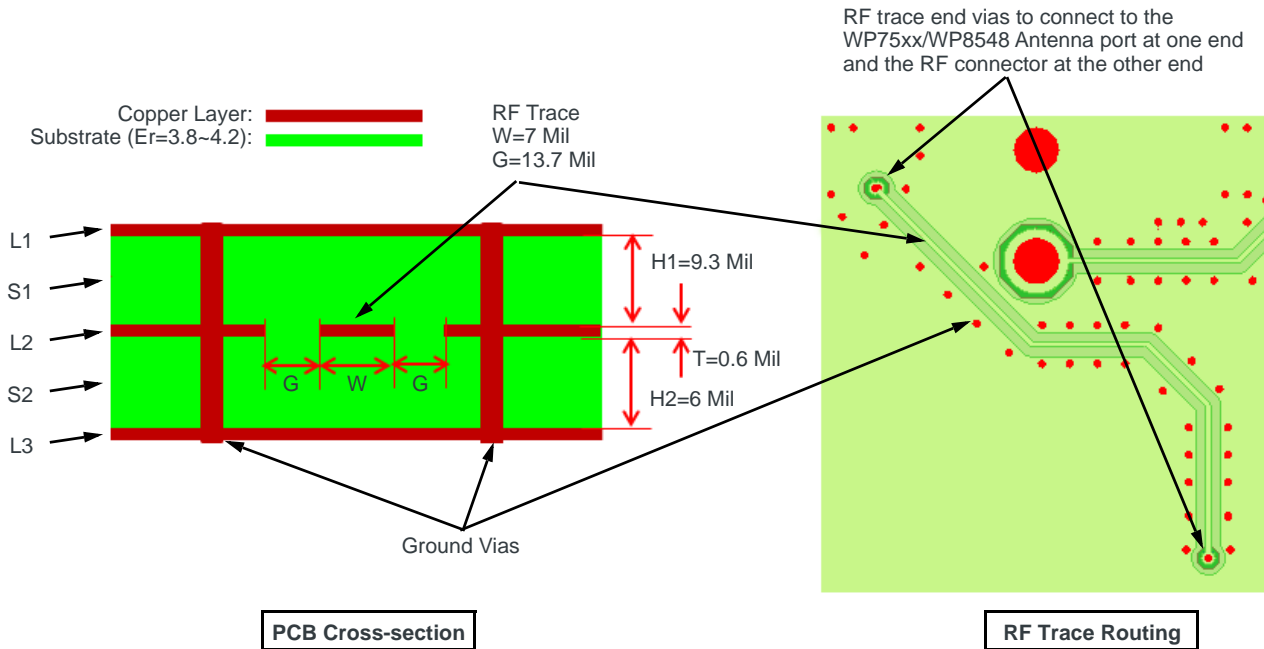


Figure 5-3: Development Board RF Trace Design

5.7.4 USB Interface

When the USB interface is externally accessible, ESD protection is required on the USB_VBUS, USB_D+, and USB_D- signals.

5.8 Thermal Considerations

When transmitting, the AirPrime WP75xx/AirPrime WP8548 can generate significant amounts of heat (due to the internal Power Amplifier) that must be dissipated in the host device for safety and performance reasons.

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

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

To enhance heat dissipation:

- Maximize airflow over / around the module
- Locate the module away from other components that generate heat
- Ensure the module is connected to a solid ground plane

5.9 EMC and ESD Recommendations

EMC tests must be performed on the application as soon as possible to detect any potential problems.

When designing, special attention should be paid to:

- Possible spurious emissions radiated by the application to the RF receiver in the receiver band
- ESD protection—Typically, ESD protection is mandatory for externally accessible signals, including:
 - VBAT_RF/VBAT_BB
 - UIM (if accessible from outside)
 - Serial link
 - USB
 - Antennas
- Length of the UIM interface lines (preferably <10 cm)
- Length of the HSIC interface lines (<10 cm, as required by the HSIC specification)
- EMC protection on audio input/output (filters against 900 MHz emissions)
- Ground plane: Sierra Wireless recommends a common ground plane for analog/digital/RF grounds

Note: The AirPrime WP75xx/AirPrime WP8548 does not include any protection against over-voltage.

The host device must provide adequate ESD protection on digital circuits and antenna ports as detailed in the following table.

Note: The level of protection required depends on your application.

Table 5-1: ESD Specifications ^{a,b}

Category	Connection	Specification
Operational	<ul style="list-style-type: none"> • RF ports • UIM connector • USB connector • UART connector 	IEC-61000-4-2 - Level (Electrostatic Discharge Immunity Test) <ul style="list-style-type: none"> • ± 6kV Contact • ± 8kV Air
Non-operational	Host connector interface	Unless otherwise specified: <ul style="list-style-type: none"> • JESD22-A114 ± 1kV Human Body Model • JESD22-A115 ± 100V Machine Model • JESD22-C101C ± 500V Charged Device Model

- a. ESD specifications are preliminary, subject to change.
- b. ESD protection is highly recommended at the point where the UIM contacts are exposed, and for any other signals that would be subjected to ESD by the user.

5.10 Mechanical Integration

Attention should be paid to:

- Antenna cable integration (bending, length, position, etc)
- Pads of the AirPrime WP75xx/AirPrime WP8548 to be soldered to the ground plane
- Ensuring proper board layout

- Providing sufficient space around the module for heat dissipation

5.11 Signal Reference Schematics

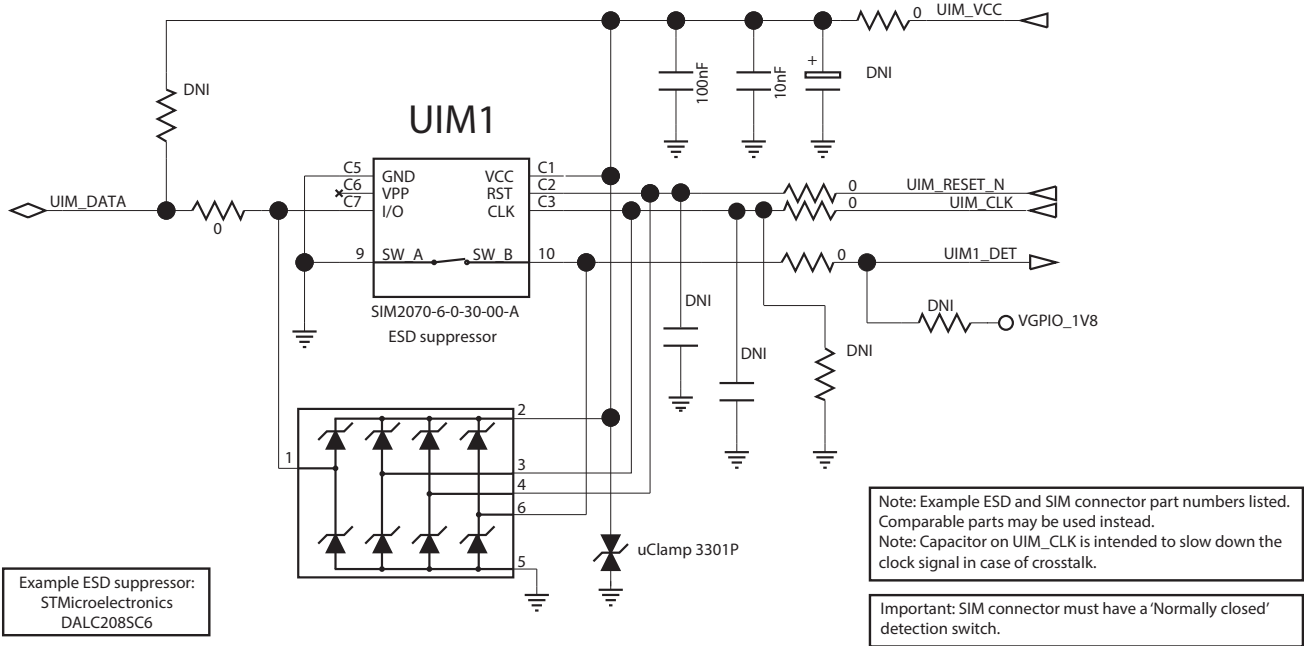


Figure 5-4: UIM Interface

USB Interface

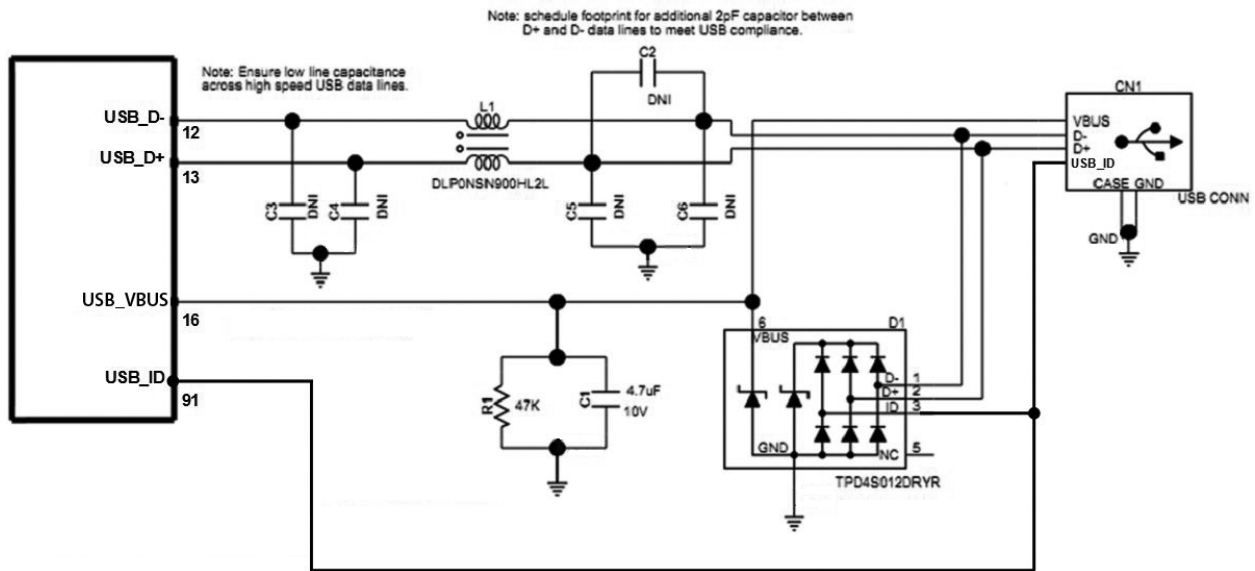


Figure 5-5: USB Interface

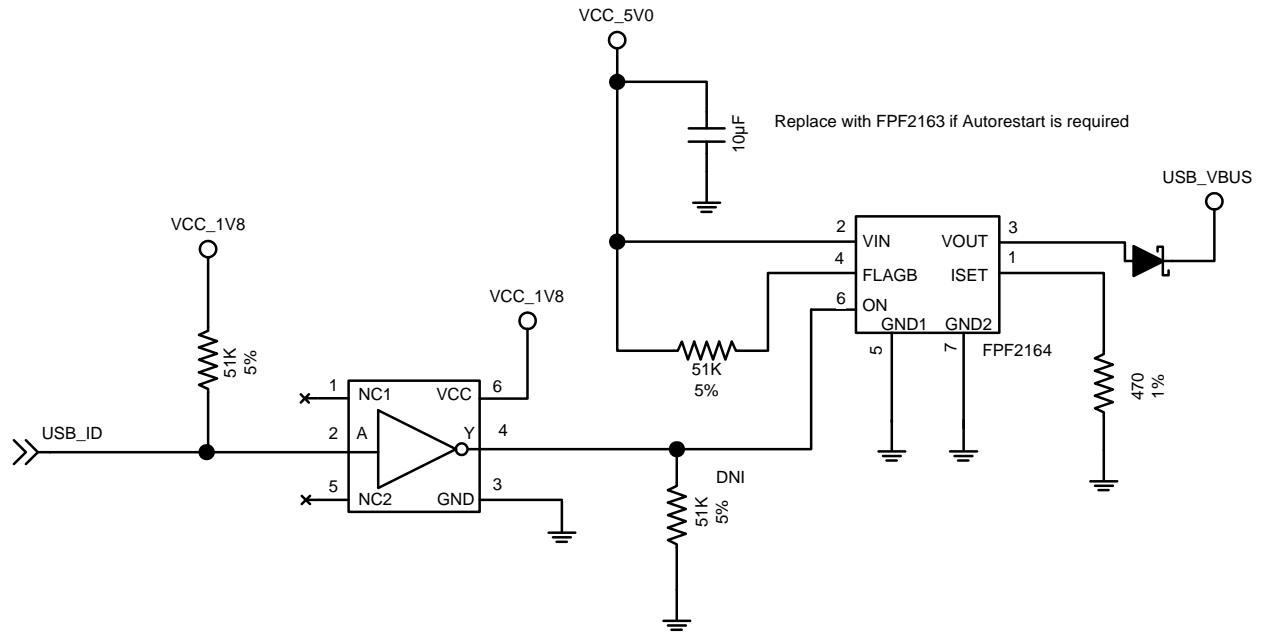


Figure 5-6: USB OTG Interface

>> 6: Software and Tools

6.1 Support Tools

The AirPrime WP75xx/AirPrime WP8548 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 WP75xx/AirPrime WP8548 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 or UART interfaces, or over the air via Sierra Wireless' AVMS (AirVantage Management System). Contact your Sierra Wireless account representative for assistance.

6.4 Operating System Upgrade

The AirPrime WP75xx/AirPrime WP8548 module's operating system is stored in flash memory and can be easily upgraded.

Tip: *To follow regular changes in the 3GPP standard and to offer a state-of-the-art operating system, Sierra Wireless recommends that the application designed around an embedded module (or embedded module based product) should allow easy operating system upgrades on the embedded module via the recommended firmware download protocol. Therefore, the application shall either allow a direct access to the embedded module USB interface through an external connector or implement any mechanism allowing the embedded module operating system to be downloaded.*

6.5 Labeling

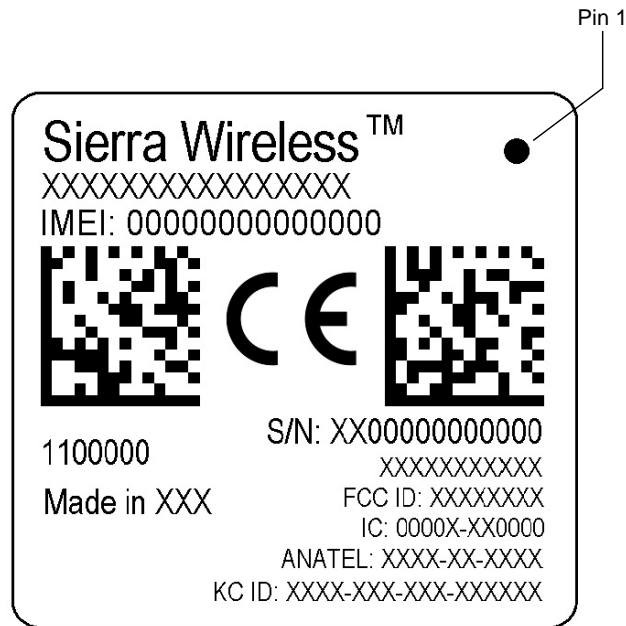


Figure 6-1: Unit Label Example (Contents will vary by SKU)

The AirPrime WP75xx/AirPrime WP8548 label is non-removable and may contain:

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

Note: The AirPrime WP75xx/AirPrime WP8548 supports OEM partner specific label 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 WP75xx/AirPrime WP8548 module, the following items must be addressed:

- Mounting—Effect on temperature, shock, and vibration performance
- Power supply—Impact on battery drain and possible RF interference
- Antenna location and type—Impact on RF performance
- Regulatory approvals—As discussed in [Approval on page 105](#)
- Service provisioning—Manufacturing process

Sierra Wireless provides guidelines for successful AirPrime WP75xx/AirPrime WP8548 module 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 Testing Recommendations

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 module's junction temperature using AT!PATEMP. This command polls a thermistor located near the module's power amplifier (typically the hottest spot on the module).

Note: Make sure that your system design provides sufficient cooling for the integrated module. The ambient temperature should be kept below 85 °C to prevent damage to the module's components.

7.5 Serial Link Access

Direct access to the UART1/UART2 serial link is very useful for:

- Testability operations
- Firmware download (for more information on firmware upgrade, see [SED \(Smart Error Detection\) on page 100](#))
- Accessing the module’s Linux console for debugging

Refer to the following figure for a level shifter implementation that allows UART1 serial link access. (A UART2 level shifter would use the corresponding WP75xx/ WP8548 UART2 pins—UART2_TX (pin 96), UART2_RX (pin 97), UART2_RTS (pin 98), UART2_CTS (pin 99).)

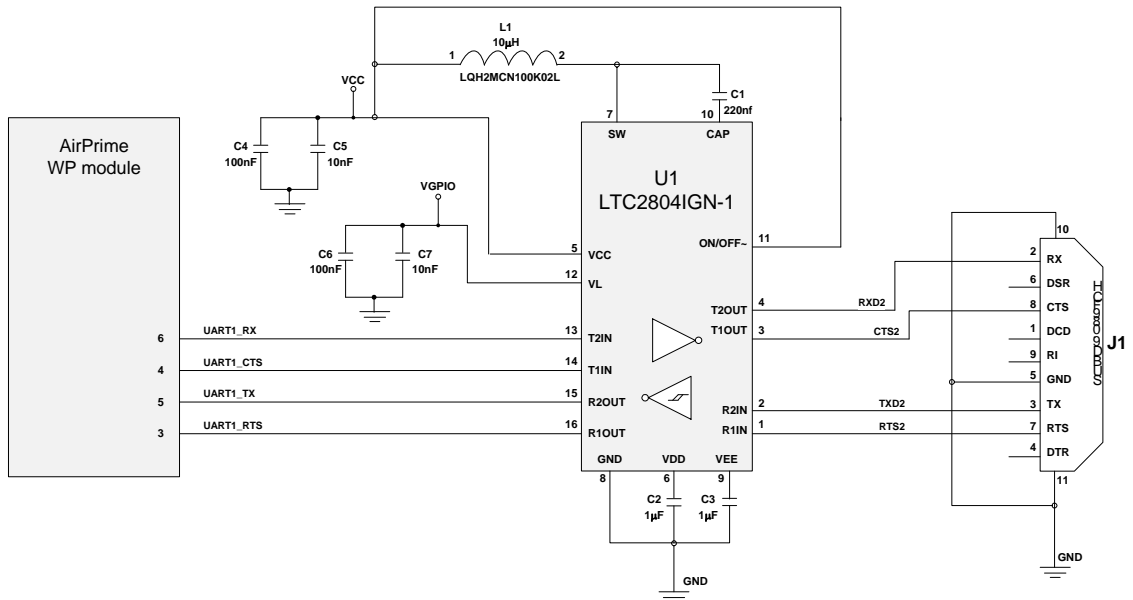


Figure 7-1: Level Shifter Implementation for UART1 Serial Link Access

7.6 RF Output Accessibility

During the integration phase of the AirPrime WP75xx/AirPrime WP8548, it can be helpful to connect the module to a simulator to check critical RF TX parameters and power behavior for supported RATs (LTE (WP75xx), WCDMA, HSDPA, HSUPA, CDMA (WP7504), and GSM/EDGE/GPRS (WP7502/ WP8548)) simulator to check critical RF TX parameters and power behavior.

Although the AirPrime WP75xx/AirPrime WP8548 module 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 RoHS Directive Compliance

The AirPrime WP75xx/AirPrime WP8548 module complies with the European Union's requirements on the restriction of the use of certain hazardous substances in electrical and electronic equipment—RoHS Directive 2011/65/EU, including Commission Delegated Directive (EU) 2015/863 amending Annex II of Directive 2011/65/EU.

8.2 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.

8.3 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.

8.4 Safety and Hazards

Do not operate your AirPrime WP75xx Embedded Module/AirPrime WP8548 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 WP75xx/AirPrime WP8548 modem **MUST BE POWERED OFF**. Otherwise, the AirPrime WP75xx/AirPrime WP8548 modem can transmit signals that could interfere with this equipment.

In an aircraft, the AirPrime WP75xx/AirPrime WP8548 modem **MUST BE POWERED OFF**. Otherwise, the AirPrime WP75xx/AirPrime WP8548 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 WP75xx/AirPrime WP8548 modem may be used normally at this time.

8.5 Compliance Acceptance and Certification

The AirPrime WP75xx is designed to be compliant with the 3GPP Release 8 UTRA and Release 9 E-UTRA Specifications for Mobile Terminated Equipment. The AirPrime WP8548 is designed to be compliant with the 3GPP Release 8 UTRA Specification for Mobile Terminated Equipment.

Final regulatory and operator certification requires regulatory agency testing and approval with the fully integrated UE host device incorporating the AirPrime WP75xx/AirPrime WP8548 module.

The OEM host device and, in particular, the OEM antenna design and implementation will affect the final product functionality, RF performance, and certification test results.

Note: Tests that require features not supported by the AirPrime WP75xx/AirPrime WP8548 (as defined by this document) are not supported.

8.6 Certification Compliance

8.6.1 Important Compliance Information for North American Users

The AirPrime WP7504/AirPrime WP8548 module, upon commercial release, will have been granted modular approval for mobile applications. Integrators may use the AirPrime WP7504/AirPrime WP8548 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. The end product must use the RF trace design approved with the AirPrime WP7504/AirPrime WP8548 module. The Gerber file of the trace design can be obtained from Sierra Wireless upon request.
2. At least 20 cm separation distance between the antenna and the user's body must be maintained at all times.
3. (WP7504)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 107](#).

Table 8-1: WP7504 Antenna Gain Specifications

Device	Technology	Band	Frequency (MHz)	Maximum antenna gain (dBi)
AirPrime WP7504	LTE	2	1850–1910	6
		4	1710–1755	6
		5	824–849	6
		12	699–716	6
		25	1850–1910	6
		26	814–849	6
	UMTS	2	1850–1910	6
		4	1710–1755	6
		5	824–849	6
	CDMA	BC0	824–849	6
		BC1	1850–1910	6
		BC10	816–824	6

4. (WP8548) 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:
 - 4.0 dBi in Cellular band
 - 3.0 dBi in PCS band
5. The AirPrime WP7504/AirPrime WP8548 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.

Note: Gain values are preliminary and subject to change.

- (WP7504) The output power of a collocated transmitter must not exceed the EIRP limit stipulated in [Table 8-2 on page 108](#).

Table 8-2: WP7504 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.)

- (WP8548) The output power and antenna gain in a collocated configuration must not exceed the limits and configurations stipulated in [Table 8-3 on page 108](#).

Table 8-3: WP8548 Collocated Configuration Specifications

Device	Technology	Band	Frequency (MHz)	Antenna Gain Limits (dBi)		EIRP Limits (dBm)
				Standalone	Collocated	
AirPrime WP8548	UMTS	2	1850–1910	3	3	—
		5	824–849	4	3	—
	GPRS/EDGE	850	824–849	4	3	—
		1900	1850–1910	3	3	—
Collocated transmitters ^a	WLAN	2.4 GHz	2400–2500	—	—	27
		5 GHz	5150–5850	—	—	27
	WiMAX		2300–2400	—	—	27
			2500–2700	—	—	27
			3300–3800	—	—	27
	BT		2400–2500	—	—	20

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

6. A label must be affixed to the outside of the end product into which the AirPrime WP7504/AirPrime WP8548 module is incorporated, with a statement similar to the following:
 - **(WP7504)— This device contains FCC ID: N7NWP7/IC:2417C-WP7.**
 - **(WP8548)— This device contains FCC ID: N7NWP8/IC:2417C-WP8.**

7. 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 WP7504/AirPrime WP8548 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.

8.6.2 EU Regulatory Conformity

Sierra Wireless hereby declares that the AirPrime WP7502 modem conforms with all essential requirements of Directive 1999/5/EC.



The Declaration of Conformity made under Directive 1999/5/EC will be available for viewing at <http://source.sierrawireless.com/resources/airprime/wp/wpx5xx/airprime-wpx5xx-approvals/>.

>> 9: Pinout

The system interface of the AirPrime WP75xx/AirPrime WP8548 is through the LGA pattern on the bottom of the PCB.

AirPrime WP75xx/AirPrime WP8548 pins are divided into three functional categories:

- Core functions and associated pins—Cover all the mandatory features for M2M connectivity and will be available by default across all CF3 family of modules. These Core functions are always available and always at the same physical pin locations. A customer platform using only these functions and associated pins is guaranteed to be forward and/or backward compatible with the next generation of CF3 modules.
- Extension functions and associated pins—Bring additional capabilities to the customer. Whenever an Extension function is available on a module, it is always at the same pin location.
- Custom functions and associated pins—These are module-specific and make use of specific chipset functions and I/Os.

Warning: *Custom features should be used with caution as there is no guarantee that the custom functions available on a given module will be available on other CF3 modules.*

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

9.1 Pin Configuration

Figure 9-1 illustrates the pin configuration of the AirPrime WP75xx/AirPrime WP8548 module.

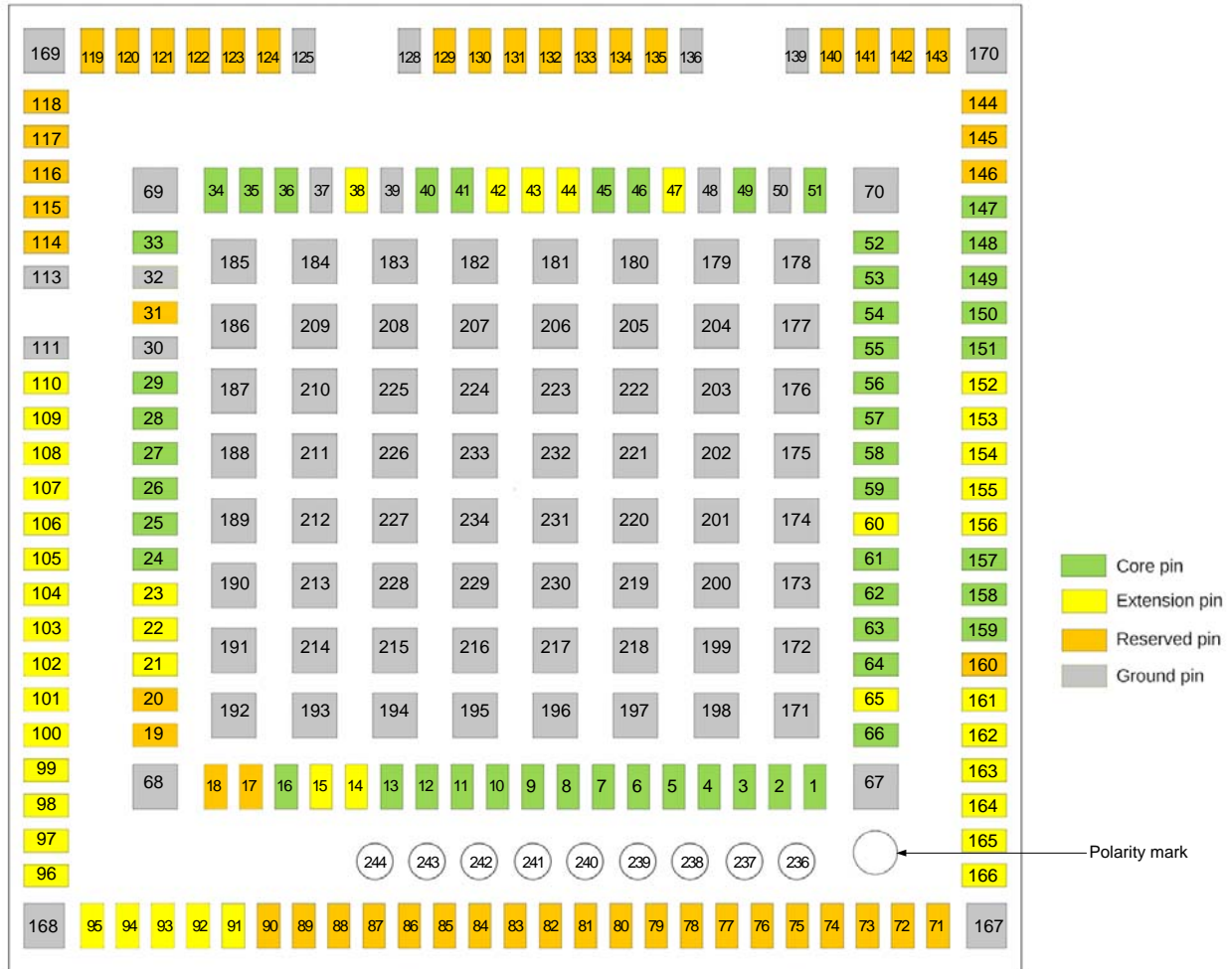


Figure 9-1: Pin Configuration (Bottom View)

9.2 Pin Description

Table 9-1 on page 112 lists detailed information for the LGA pins.

Note: Some pin numbers (112, 126, 127, 137, 138, 235) do not appear in this table because there are no corresponding pads on the module's PCB.

Table 9-1: Pin Definitions

Pin	Signal name	Group	I/O ^a	Voltage	PU/ PD ^b	Active	If unused	Function	Type
1	I2C1_CLK	I2C	I/O	1.8V	PU		Leave open	I ² C clock	Core
2	UART1_RI	UART1	O ^c	1.8V		H	Leave open	UART1 Ring indicator	Core
3	UART1_RTS	UART1	I ^c	1.8V		L	Leave open	UART1 Request to send	Core
4	UART1_CTS	UART1	O ^c	1.8V		L	Leave open	UART1 Clear to send	Core
5	UART1_TX	UART1	I ^c	1.8V			Leave open	UART1 Transmit data	Core
6	UART1_RX	UART1	O ^c	1.8V			Leave open	UART1 Receive data	Core
7	UART1_DTR ^d	UART1	I	1.8V		L	Leave open	UART1 Data terminal ready	Core
8	UART1_DCD ^d	UART1	O ^c	1.8V		L	Leave open	UART1 Data carrier detect	Core
9	UART1_DSR ^d	UART1	O ^c	1.8V		L	Leave open	UART1 Data set ready	Core
10	GPIO2 ^e	GPIO	I/O	1.8V	PD		Leave open	General purpose I/O	Core
11	RESET_IN_N	Control signal	I	1.8V	PU	L	Leave open	Input reset signal	Core
12	USB_D-	USB	I/O				Leave open	USB Data negative	Core
13	USB_D+	USB	I/O				Leave open	USB Data positive	Core
14	HSIC_DATA	HSIC	I/O				Leave open	High Speed Inter-Chip Data	Extension
15	HSIC_STRB	HSIC	I/O				Leave open	High Speed Inter-Chip Strobe	Extension
16	USB_VBUS ^f	USB	I	5V			Mandatory connection (Connect to USB_VBUS, or if unavailable, connect to VBAT_BB)	USB power supply	Core
17–20	Reserved	No Connection					See footnote ^g .		Extension
21	BAT_RTC	Power	I/O				Leave open	Power supply for RTC backup	Extension
22	SYS_CLK	Clock	O				Leave open	19 MHz digital clock output	Extension
23	SLEEP_CLK	Clock	O				Leave open	32.768 kHz digital clock output	Extension
24	ADC1 ^d	ADC	I				Leave open	Analog to digital conversion	Core

Table 9-1: Pin Definitions (Continued)

Pin	Signal name	Group	I/O ^a	Voltage	PU/ PD ^b	Active	If unused	Function	Type
25	ADC0 ^d	ADC	I				Leave open	Analog to digital conversion	Core
26	UIM1_VCC	UIM1	O	1.8V/3V			Mandatory connection	1.8V/3V UIM1 Power supply	Core
27	UIM1_CLK	UIM1	O	1.8V/3V			Mandatory connection	UIM1 Clock	Core
28	UIM1_DATA	UIM1	I/O	1.8V/3V			Mandatory connection	UIM1 Data	Core
29	UIM1_RESET_N	UIM1	O	1.8V/3V		L	Mandatory connection	UIM1 Reset	Core
30	GND	Ground	0V	0V			Mandatory connection	(WP75xx) Diversity antenna ground	Extension
								(WP8548) Ground	
31	(WP75xx) RF_DIV	RF					See footnote ^g .		Extension
	(WP8548) Reserved								
32	GND	Ground	0V	0V			Mandatory connection	(WP75xx) Diversity antenna ground	Extension
								(WP8548) Ground	
33	PCM_OUT	PCM	O	1.8V			Leave open	PCM data out	Core
	I2S_OUT	I2S	O	1.8V			Leave open	I2S data out	
34	PCM_IN	PCM	I	1.8V			Leave open	PCM data in	Core
	I2S_IN	I2S	I	1.8V			Leave open	I2S data in	
35	PCM_SYNC	PCM	Pri: I/O Aux: O	1.8V			Leave open	PCM sync	Core
	I2S_WS	I2S	O	1.8V			Leave open	I2S word select	
36	PCM_CLK	PCM	Pri: I/O Aux: O	1.8V			Leave open	PCM clock	Core
	I2S_CLK	I2S	O	1.8V			Leave open	I2S clock	
37	GND	RF	0V	0V			Mandatory connection	GNSS antenna ground	Core
38	RF_GNSS ^h	RF					Mandatory connection	RF GNSS input	Extension
39	GND	RF	0V	0V			Mandatory connection	GNSS antenna ground	Core
40	GPIO7	GPIO	I/O	1.8V	PD		Leave open	General purpose I/O	Core
41	GPIO8	GPIO	I/O	1.8V	PD		Leave open	General purpose I/O	Core
42	DR_SYNC ^h	GPS	O	1.8V			Leave open	GPS dead reckoning sync	Extension
43	EXT_GPS_LNA_EN	Control signal	O	1.8V		H	Leave open	External GNSS LNA enable	Extension

Table 9-1: Pin Definitions (Continued)

Pin	Signal name	Group	I/O ^a	Voltage	PU/ PD ^b	Active	If unused	Function	Type
44	GPIO13	GPIO	I/O	1.8V	PD		Leave open	General purpose I/O	Extension
45	VGPIO	Voltage reference	O	1.8V			Leave open	GPIO voltage output	Core
46	RESET_OUT_N	Control signal	O	1.8V	PD	L	Leave open	Reset	Core
47	TP1 (Boot pin)	Boot	I	1.8V		L	Mandatory test point	Test point 1 <ul style="list-style-type: none"> 0—Download mode Open—Normal mode 	Extension
48	GND	RF	0V	0V			Mandatory connection	Main antenna ground	Core
49	RF_MAIN	RF					Mandatory connection	Main RF antenna	Core
50	GND	RF	0V	0V			Mandatory connection	Main antenna ground	Core
51	SPI1_MRDY	SPI1	O	1.8V			Leave open	SPI Master Ready	Core
52	SPI1_MISO	SPI1	I	1.8V			Leave open	SPI Master Input/Slave Output (output from slave)	Core
53	SPI1_CLK	SPI1	O	1.8V			Leave open	SPI serial clock (output from Master)	Core
54	SPI1_MOSI	SPI1	O	1.8V			Leave open	SPI Master Output/Slave Input (output from master)	Core
55	UIM2_VCC	UIM2	O	1.8V/3V			Optional connection	UIM2 Power supply	Core
56	UIM2_DATA	UIM2	I/O	1.8V/3V			Optional connection	UIM2 Data	Core
57	UIM2_RESET_N	UIM2	O	1.8V/3V		L	Optional connection	UIM2 Reset	Core
58	UIM2_CLK	UIM2	O	1.8V/3V			Optional connection	UIM2 Clock	Core
59	POWER_ON_N	Control	I	1.8V	PU	L	Mandatory connection	Power On control signal	Core
60	TX_ON	Indication	O	1.8V		H	Leave open	Tx activity indicator	Extension
61	VBAT_RF	Power	I	3.4V (min) 3.7V (typ) 4.3V (max)			Mandatory connection	RF power supply (see Power Supply Ratings on page 36)	Core
62	VBAT_RF	Power	I	3.4V (min) 3.7V (typ) 4.3V (max)			Mandatory connection	RF power supply (see Power Supply Ratings on page 36)	Core
63	VBAT_BB	Power	I	3.4V (min) 3.7V (typ) 4.3V (max)			Mandatory connection	Baseband power supply (see Power Supply Ratings on page 36)	Core

Table 9-1: Pin Definitions (Continued)

Pin	Signal name	Group	I/O ^a	Voltage	PU/ PD ^b	Active	If unused	Function	Type
64	UIM1_DET	UIM1		1.8V			Mandatory connection	Detect UIM1 insertion/removal. (Pin must be open to detect the UIM, or grounded if no UIM is present.)	Core
65	UIM2_DET	UIM2		1.8V			Ground	Detect UIM2 insertion/removal. (Pin must be open to detect the UIM, or grounded if no UIM is present.)	Extension
66	I2C1_Data	I2C	I/O	1.8V	PU		Leave open	I ² C data	Core
67–70	GND	Ground	0V	0V			Mandatory connection	Ground	Core
71–90	Reserved	No Connection					See footnote ^g .		
91	USB_ID	USB	I				Leave open	Reserved for use with USB OTG	Extension
92	GPIO38 ^{i,j}	GPIO	I/O	1.8V	NP		Leave open	General purpose I/O	Extension
93	GPIO39 ⁱ	GPIO	I/O	1.8V	NP		Leave open	General purpose I/O	Extension
94	GPIO40 ^{i,k}	GPIO	I/O	1.8V	NP		Leave open	General purpose I/O	Extension
95	GPIO41 ^{i,k}	GPIO	I/O	1.8V	NP		Leave open	General purpose I/O	Extension
96	UART2_TX	UART2	I ^c	1.8V			Leave open	UART2 Transmit data	Extension
97	UART2_RX	UART2	O ^c	1.8V			Leave open	UART2 Receive data	Extension
98	UART2_RTS ^d	UART2	I ^c	1.8V			Leave open	UART2 Request To Send	Extension
99	UART2_CTS ^d	UART2	O ^c	1.8V			Leave open	UART2 Clear To Send	Extension
100	GPIO34 ⁱ	GPIO	I/O	1.8V	NP		Leave open	General purpose I/O	Extension
101	GPIO35 ⁱ	GPIO	I/O	1.8V	NP		Leave open	General purpose I/O	Extension
102	GPIO36 ^{i,j}	GPIO	I/O	1.8V	NP		Leave open	General purpose I/O	Extension
103	GPIO37 ⁱ	GPIO	I/O	1.8V	NP		Leave open	General purpose I/O	Extension
104	GPIO32	GPIO	I/O	1.8V	PD		Leave open	General purpose I/O	Extension
105	GPIO33	GPIO	I/O	1.8V	PD		Leave open	General purpose I/O	Extension
106	WWAN_LED_N	Indication	O	VBAT_BB ^l		L	Leave open		Extension
107	ADC2 ^{d,m}	ADC	I				Leave open		Extension
108	ADC3 ^{d,m}	ADC	I				Leave open		Extension
109	GPIO42 ^e	GPIO	I/O	1.8V	PD		Leave open	General purpose I/O	Extension
110	WAKE_ON_WWAN	Indication	O	1.8V		H	Leave open	Driven high to wake the host when specific events occur.	Extension

Table 9-1: Pin Definitions (Continued)

Pin	Signal name	Group	I/O ^a	Voltage	PU/ PD ^b	Active	If unused	Function	Type
111	GND	Ground	0V	0V			Mandatory connection	(WP75xx) Diversity antenna ground	Core
								(WP8548) Ground	
113	GND	Ground	0V	0V			Mandatory connection	(WP75xx) Diversity antenna ground	Core
								(WP8548) Ground	
114–124	Reserved	No Connection					See footnote ⁹ .		
125	GND	RF	0V	0V			Mandatory connection	GNSS antenna ground	Core
128	GND	RF	0V	0V			Mandatory connection	GNSS antenna ground	Core
129–135	Reserved	No Connection					See footnote ⁹ .		
136	GND	RF	0V	0V			Mandatory connection	Main antenna ground	Core
139	GND	RF	0V	0V			Mandatory connection	Main antenna ground	Core
140–146	Reserved	No Connection					See footnote ⁹ .		
147	GPIO21 ^e	GPIO	I/O	1.8V	PD		Leave open	General purpose I/O	Core
148	GPIO22	GPIO	I/O	1.8V	PD		Leave open	General purpose I/O	Core
149	GPIO23	GPIO	I/O	1.8V	PD		Leave open	General purpose I/O	Core
150	GPIO24	GPIO	I/O	1.8V	PD		Leave open	General purpose I/O	Core
151	W_DISABLE_N	Control	I	1.8V		L		Wireless disable (main RF radio)	Core
152	SAFE_PWR_REMOVE	Indication	O	1.8V		H	Leave open	Indicate to host that Main DC power can be removed	Extension
153	ANT_CNTL0	Antenna control	O	1.8V			Leave open		Extension
154	ANT_CNTL1	Antenna control	O	1.8V			Leave open		Extension
155	ANT_CNTL2	Antenna control	O	1.8V			Leave open		Extension
156	ANT_CNTL3	Antenna control	O	1.8V			Leave open		Extension
157	VBAT_RF	Power	I	3.4V (min) 3.7V (typ) 4.3V (max)			Optional connection	RF power supply (see Power Supply Ratings on page 36)	Core
158	VBAT_BB	Power	I	3.4V (min) 3.7V (typ) 4.3V (max)			Optional connection	Baseband power supply (see Power Supply Ratings on page 36)	Core

Table 9-1: Pin Definitions (Continued)

Pin	Signal name	Group	I/O ^a	Voltage	PU/ PD ^b	Active	If unused	Function	Type
159	GPIO25	GPIO	I/O	1.8V	PD		Leave open	General purpose I/O	Core
160	Reserved	No Connection					See footnote ^g .		
161	SDIO_CMD	SDIO	O	2.95V			Leave open	SDIO command	Extension
162	SDIO_CLK	SDIO	O	2.95V			Leave open	SDIO clock	Extension
163	SDIO_DATA_3	SDIO	I/O	2.95V			Leave open	SDIO data bit 3	Extension
164	SDIO_DATA_2	SDIO	I/O	2.95V			Leave open	SDIO data bit 2	Extension
165	SDIO_DATA_1	SDIO	I/O	2.95V			Leave open	SDIO data bit 1	Extension
166	SDIO_DATA_0	SDIO	I/O	2.95V			Leave open	SDIO data bit 0	Extension
167– 234	GND	Ground	0V	0V			Mandatory connection	Ground	Core
236	J1 ⁿ			1.8V		L	Mandatory test point	Test point	Extension
237	J2 ⁿ			1.8V			Mandatory test point	Test point	Extension
238	J3 ⁿ			1.8V			Mandatory test point	Test point	Extension
239	J4 ⁿ			1.8V			Mandatory test point	Test point	Extension
240	J5 ⁿ			1.8V		L	Mandatory test point	Test point	Extension
241	J6 ⁿ			1.8V			Mandatory test point	Test point	Extension
242	J7 ⁿ			1.8V			Mandatory test point	Test point	Extension
243	J8 ⁿ			1.8V			Mandatory test point	Test point	Extension
244	J9 ⁿ			1.8V			Mandatory test point	Test point	Extension

- a. Signal direction with respect to the module (except for UART signals). Examples: PCM_OUT (pin 33) is an output from the module to the host; PCM_IN (pin 34) is an input to the module from the host.
- b. NP—No Pull; PD—Pull Down; PU—Pull Up
- c. (UART signals only) Signal direction with respect to the host. Examples: UART1_RTS (pin 3) is an input to the host from the module; UART1_CTS (pin 4) is an output from the host to the module.
- d. Software support for 8-wire UART1, 4-wire UART2, and ADCs will be available in a future firmware revision.
- e. Wakeable GPIO. See [Wakeup Interrupt \(USB-SS Mode\) on page 73](#) for details.
- f. Not currently connected internally, but customer solutions should provide this input for compatibility with future module revisions.
- g. Pins are not connected internally, but are reserved for future use. Leave them unconnected to ensure compatibility with other Sierra Wireless CF3 modules.
- h. (WP75xx) Support is SKU-dependent; (WP8548) Supported.
- i. Accessible via sysfs/Legato only.
- j. Can be configured as a wakeup trigger for ULPM. See [Power Consumption States on page 39](#) for details.
- k. GPIO40 and GPIO41 may be unavailable in future WP products.
- l. Maximum rating is VBAT_BB + 0.5V, with maximum current sink capability of 300 mA.
- m. Wakeable ADC (support available in a future firmware revision). See [Wakeup Interrupt \(USB-SS Mode\) on page 73](#) for details.
- n. Accessibility restricted to soldered-down modules. Not available for socket-mounted modules.

Table 9-2: RF Pin Information

Signal name	Pin #	Description
(WP75xx) RF_DIV	31	Diversity input
RF_GNSS ^a	38	RF GNSS input
RF_MAIN	49	Main RF port (input/output)

a. WP75xx—Support is SKU-dependent; WP8548—Supported

Table 9-3: Supply Pin Information

Signal name	Pin #	Description
VBAT_RF	61, 62, 157	RF power supply
VBAT_BB	63, 158	Baseband power supply
BAT_RTC	21	Power supply for RTC backup
USB_VBUS	16	Connected to VBAT_BB

Table 9-4: Ground & Reserved Pin Information

Signal name	Pin #	Description
Ground	30, 32, 37, 39, 48, 50, 67–70, 111, 113, 125, 128, 136, 139, 167–234	Ground connection
Reserved	17–20, (WP8548) 31, 71–90, 114–124, 129–135, 140–146, 160	Pins are not connected internally, but are reserved for future use. Leave them unconnected to ensure compatibility with other Sierra Wireless CF3 modules.

>> 10: Customization

Subject to commercial terms, Sierra Wireless can supply custom-configured modems to facilitate a carrier's network and performance requirements. Sierra Wireless also offers a standard configuration for each country.

Custom configurations are entered into a selector spreadsheet that Sierra supplies. A unique part number is assigned to each custom configuration to facilitate customer ordering.

Table 10-1: Customizable Features

Name	Description	Default
Display of IMSI	Display of International Mobile Subscriber Identity via AT+CIMI command	Display enabled
UART baud rate	Default UART speed	115200 bps
UART enabled	Defines whether UART port is enabled by default or not	UART disabled

>> 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 WP75xx/AirPrime WP8548.

11.2 Reference Documents

- [1] AirPrime WPx5xx AT Command Reference
Reference number: 4118047
- [2] Inter-Chip USB Supplement to the USB 2.0 Specification Revision 1.0
- [3] Legato.io for Legato API details
- [4] AirPrime WPx5 Series Customer Process Guidelines

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	Circular Error Probable
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 = $10 \times \log_{10} (P1/P2)$ <i>P1 is calculated power; P2 is reference power</i> Decibel = $20 \times \log_{10} (V1/V2)$ <i>V1 is calculated voltage, V2 is reference voltage</i>
dBm	A logarithmic (base 10) measure of relative power (dB for decibels); relative to milliwatts (m). A dBm value will be 30 units (1000 times) larger (less negative) than a dBW value, because of the difference in scale (milliwatts vs. watts).
DC	Direct Current
DCD	Data Carrier Detect

Table 12-1: Acronyms and Definitions (Continued)

Acronym or term	Definition
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
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 mini card during manufacturing.
Galileo	A European system that uses a series of satellites in middle earth orbit to provide navigational data.
GCF	Global Certification Forum
GLONASS	Global Navigation Satellite System—A Russian system that uses a series of 24 satellites in middle circular orbit to provide navigational data.

Table 12-1: Acronyms and Definitions (Continued)

Acronym or term	Definition
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	Industry Canada
IC	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
LNA	Low noise Amplifier
LTE	Long Term Evolution—a high-performance air interface for cellular mobile communication systems.

Table 12-1: Acronyms and Definitions (Continued)

Acronym or term	Definition
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 synchronisation signal
PST	Product Support Tools
PTCRB	PCS Type Certification Review Board
PWM	Pulse Width Modulation

Table 12-1: Acronyms and Definitions (Continued)

Acronym or term	Definition
QAM	Quadrature Amplitude Modulation. This form of modulation uses amplitude, frequency, and phase to transfer data on the carrier wave.
QPSK	Quadrature Phase-Shift Keying
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.
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
SW	Software
TBC	To Be Confirmed
TBD	To Be Determined

Table 12-1: Acronyms and Definitions (Continued)

Acronym or term	Definition
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

>> 13: Testing

13.1 Certification Testing

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

The AirPrime WP75xx Embedded Module/AirPrime WP8548 Embedded Module has been certified as described in [Regulatory Compliance and Industry Certifications on page 95](#).

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

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

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

13.2 Production Testing

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

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

Typical items to test include:

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

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

Use an appropriate test station and use AT commands to control the integrated module.

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

Note: The tests described in this chapter are done using a Linux O/S (e.g. Ubuntu 12.04).

13.3 Functional Production Test

This section presents a suggested procedure for performing a basic manual functional test on a laboratory bench using an AirPrime WP75xx Embedded Module/AirPrime WP8548 Embedded Module and a hardware development kit. When you have become familiar with the testing method, use it to develop your own automated production testing procedures.

13.3.1 Suggested Production Tests

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

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

13.3.2 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 module for obvious defects (such as tainted or damaged shields) before installing it in the test station.
2. Ensure that the module is powered off (no voltage on VBAT_BB/VBAT_RF) 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 `ttyUSBn` values that are returned; these are the currently connected USB devices. If the command returns “no such file or directory”, there are no devices currently connected.

4. Provide power to the module (voltage on VBAT_BB/VBAT_RF).
5. Test POWER_ON_N—Turn on the module by driving POWER_ON_N low, as shown in [Figure 4-1 on page 66](#).
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 `ttyUSBn` 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 130](#) for details.

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

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

```

Telnet 00.0.00.00
Welcome to minicom 2.2
OPTIONS: I18n
Compiled on Apr 27 2007, 15:50:20.
Port /dev/ttyUSB2
Press CTRL-A Z for help on special keys
AT S7=45 S0=0 L1 U1 X4 &c1 E1 Q0
OK
CTRL-A Z for help !115200 8N1 ! NOR ! Minicom 2.2 ! UT102 ! Offline
    
```

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 \(WCDMA\) RF Transmission Path Test on page 130](#).
 - (LTE) To test the LTE transmission path, use a call box.
14. Test RF reception, if desired:
 - (UMTS) See [UMTS \(WCDMA\) RF Receive Path Test on page 132](#).
 - (LTE) See [LTE RF Receive Path Test \(WP75xx\) on page 135](#).

15. Test standalone GNSS functionality—See [GNSS RF Receive Path Test on page 137](#).
16. Remove power from the module.

13.3.2.1 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 129 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 dfi**.
9. Select **Exit**.

13.4 UMTS (WCDMA) RF Transmission Path Test

Note: This procedure segment is performed in [Step 13](#) of the [Production Test Procedure on page 128](#).

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

Table 13-1: Test Settings—WP7502 UMTS Transmission Path

	Band	Band ID	Tx Channel ^a
2100 MHz	Band 1	9	9750
900 MHz	Band 8	29	2787

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

Table 13-2: Test Settings—WP7504 UMTS Transmission Path

	Band	Band ID	Tx Channel ^a
1900 MHz	Band 2	15 ^b	9400
1700 MHz	Band 4	28	1412
850 MHz	Band 5	22	4182

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

Table 13-3: Test Settings—WP8548 UMTS Transmission Path

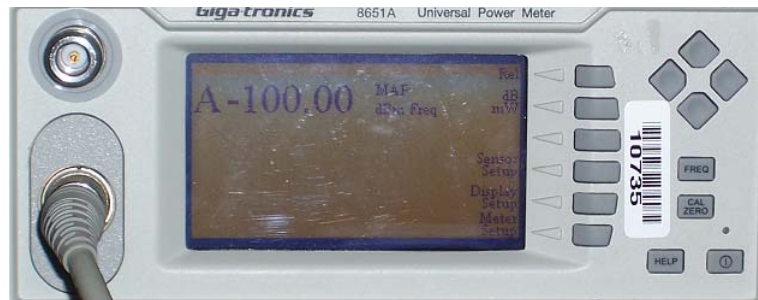
	Band	Band ID	Tx Channel ^a
2100 MHz	Band 1	9	9750
1900 MHz	Band 2	15 ^b	9400
850 MHz	Band 5	22	4182
900 MHz	Band 8	29	2787

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

To test the DUT's transmitter path:

1. Set up the power meter:

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



- 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+IDAFTMACT` (Enter test mode.)
 - c. `AT+IDASBAND=<bandValue>` (Set frequency band.)
 - See [Table 13-1 on page 130](#), [Table 13-2 on page 131](#), or [Table 13-3 on page 131](#) for appropriate <bandValue> values
 - d. `AT+IDASCHAN=<channel>` (Set modem channel)
 - See [Table 13-1 on page 130](#), [Table 13-2 on page 131](#), or [Table 13-3 on page 131](#) for appropriate <channel> values

- e. **ATIDASTXON** (Turns on the transmit path.)
 - f. **ATIDAWSTXCW=0** (Use a modulated carrier.)
ATIDASPDM=2, 75 (Set the power level. Repeat command with different offsets until desired Tx power is obtained.)
ATIDAWSPARANGE=3 (Set to high PA gain state.)
 - g. Offset the tracking (If necessary, repeat with different offsets until the desired frequency is obtained.)
ATIDASPDM=4,35100
 - h. Take the measurement.
 - i. **ATIDASTXOFF** (Turn off the transmitter.)
3. Test limits—Run ten or more good DUTs through this test procedure to obtain a nominal output power value.
 - Apply a tolerance of ± 5 to 6 dB to each measurement (assuming a good setup design).
 - Monitor these limits during mass-production ramp-up to determine if further adjustments are needed.

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.

13.5 UMTS (WCDMA) RF Receive Path Test

Note: This procedure segment is performed in [Step 14](#) of the [Production Test Procedure](#) on page 128.

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

Table 13-4: Test Settings—WP7502 UMTS Receive Path

	Band #	Frequency ^a (MHz)	Band ID	Rx Channel ^b
2100 MHz	Band 1	2141.20	9	9750
900 MHz	Band 8	948.60	29	2787

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

Table 13-5: Test Settings—WP7504 UMTS Receive Path

	Band #	Frequency ^a (MHz)	Band ID	Rx Channel ^b
1900 MHz	Band 2	1961.20	15 ^c	9400
1700 MHz	Band 4	2133.20	28	1412
850 MHz	Band 5	882.60	22	4182

- a. Receive frequencies shown are 1.2 MHz offset from center
- b. Channel values shown are at the center of the corresponding bands.
- c. Either 15 (WCDMA1900A) or 16 (WCDMA1900B) may be used for testing.

Table 13-6: Test Settings—WP8548 UMTS Receive Path

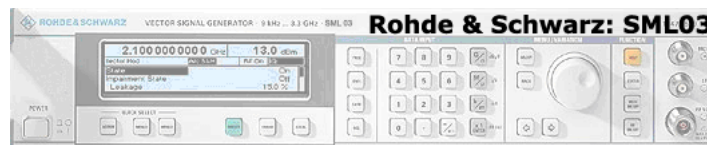
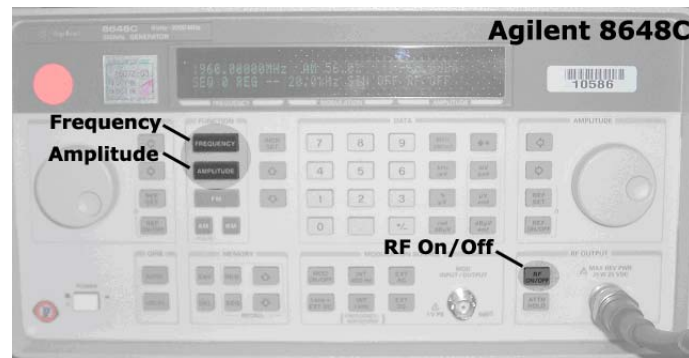
	Band #	Frequency ^a (MHz)	Band ID	Rx Channel ^b
2100 MHz	Band 1	2141.20	9	9750
1900 MHz	Band 2	1961.20	15 ^c	9400
850 MHz	Band 5	882.60	22	4182
900 MHz	Band 8	948.60	29	2787

- a. Receive frequencies shown are 1.2 MHz offset from center
- b. Channel values shown are at the center of the corresponding bands.
- c. Either 15 (WCDMA1900A) or 16 (WCDMA1900B) may be used for testing.

To test the DUT's receive path:

1. Set up the signal generator:

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



- a. Set the amplitude to:
 - -80 dBm
 - b. Set the frequency for the band being tested. See [Table 13-4 on page 132](#), [Table 13-5 on page 133](#), or [Table 13-6 on page 133](#) for frequency values.
2. Set up the DUT:
 - a. ATIENTERCND="**<password>**" (Unlock extended AT command set.)
 - b. ATIDAFTMACT (Put modem into factory test mode.)

- c. **ATIDASBAND=<band>** (Set frequency band.)
 - See [Table 13-4 on page 132](#), [Table 13-5 on page 133](#), or [Table 13-6 on page 133](#) for <band> values
 - d. **ATIDASCHAN=<channel>** (Set modem channel)
 - See [Table 13-4 on page 132](#), [Table 13-5 on page 133](#), or [Table 13-6 on page 133](#) for <channel> values
 - e. **ATIDASLNAGAIN=0** (Set the LNA to maximum gain.)
 - f. **ATIDAWGAVGAGC=9400,0** (For PCS1900, channel 9400 as an 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).

4. (WP75xx only) Test diversity paths:
- a. Set up the signal generator as in [Step 1](#).
 - b. Set up the DUT:
 - i. **ATIENTERCND="<password>"** (Unlock extended AT command set.)
 - ii. **ATIDAFTMACT** (Put modem into factory test mode.)
 - iii. **ATIDASBAND=<band>** (Set frequency band.)
 - See [Table 13-4 on page 132](#), [Table 13-5 on page 133](#), or [Table 13-6 on page 133](#) for <band> values
 - iv. **ATIDAWSSCHAIN=1** (Enable the secondary chain.)
 - v. **ATIDASCHAN=<channel>** (Set modem channel)
 - See [Table 13-4 on page 132](#), [Table 13-5 on page 133](#), or [Table 13-6 on page 133](#) for <channel> values
 - vi. **ATIDASLNAGAIN=0** (Set the LNA to maximum gain.)
 - vii. **ATIDAWGAVGAGC=9400,0,1** (The '1' indicates the diversity path is used.)
 - c. Test the limits as in [Step 3](#).

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

13.6 LTE RF Receive Path Test (WP75xx)

Note: This procedure segment is performed in Step 14 of the Production Test Procedure on page 128.

The suggested test procedure that follows uses the parameters in [Table 13-7](#) and [Table 13-8](#).

Table 13-7: Test Settings — WP7502 LTE Receive Path

	Band #	Frequency ^a (MHz)	Band ID	Rx Channel ^b
2100 MHz	Band 1	2142.00	34	18300
1800 MHz	Band 3	1844.50	44	19575
2600 MHz	Band 7	2657.00	35	21100
900 MHz	Band 8	944.50	47	21625
800 MHz	Band 20	808.00	56	24300

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

Table 13-8: Test Settings — WP7504 LTE Receive Path

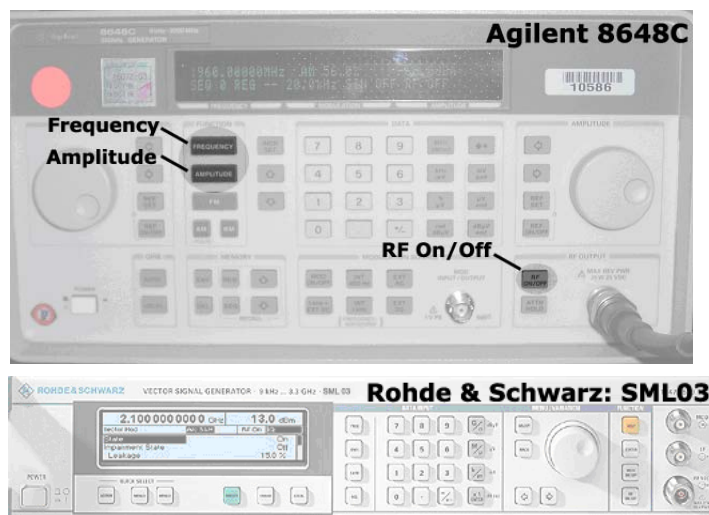
	Band #	Frequency ^a (MHz)	Band ID	Rx Channel ^b
1900 MHz	Band 2	1962.00	43	18900
1700 MHz	Band 4	2134.50	42	20175
850 MHz	Band 5	883.50	45	20525
700 MHz	Band 12	739.50	50	23095
700 MHz	Band 17	742.00	37	23790
1900 MHz (G Block)	Band 25	1964.50	61	26365
850 MHz	Band 26	878.50	62	26865

- a. Receive frequencies shown are 2 MHz 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 (or diversity path, while connected to the diversity antenna):

1. Set up the signal generator:



- a. Set the amplitude to -70 dBm
 - b. Set the frequency for the band being tested. See [Table 13-7](#) or [Table 13-8](#) for frequency values.
2. Set up the DUT:
 - a. ATIENTERCND="**<password>**" (Unlock extended AT command set.)
 - b. ATIDAFTMACT (Put modem into factory test mode.)
 - c. ATIDASBAND=**<band>** (Set frequency band.)
 - See [Table 13-7](#) or [Table 13-8](#) for **<band>** values
 - d. ATIDALSRXBW=2 (Set Rx LTE bandwidth to 5MHz.)
 - e. ATIDALSTXBW=2 (Set Tx LTE bandwidth to 5MHz.)
 - f. ATIDASCHAN=**<channel>** (Set modem channel)
 - See [Table 13-7](#) or [Table 13-8](#) for **<channel>** values
 - g. ATIDALGAVGAGC=**<channel>**,0 (Get averaged Rx AGC)
 - See [Table 13-7](#) or [Table 13-8](#) 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).

13.7 GNSS RF Receive Path Test

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

To test the GNSS receive path:

1. Inject a carrier signal at -110dBm, frequency 1575.52 MHz into the GNSS Rx path at the connector. (Note that this frequency is 100 kHz higher than the actual GPS L1 center frequency.)
2. Test the signal carrier-to-noise level at the GNSS receiver:
 - a. **AT+ENTERCND=<password>** (Unlock extended AT command set.)
 - b. **AT+IDAFTMACT** (Put modem into factory test mode.)
 - c. **AT+IDACGPSTESTMODE=1** (Start CGPS diagnostic task.)
 - d. **AT+IDACGPSSTANDALONE=1** (Enter standalone RF mode.)
 - e. **AT+IDACGPSMASKON** (Enable log mask.)
 - f. **AT+IDACGPSCTON** (Return signal-to-noise and frequency measurements.)
 - g. Repeat **AT+IDACGPSCTON** five to ten times to ensure the measurements are repeatable and stable.
3. Leave the RF connection to the embedded module intact, and turn off the signal generator.
4. Take several more **IDACGPSCTON** readings. This will demonstrate a 'bad' signal in order to set limits for testing, if needed. This frequency offset should fall outside of the guidelines in the note below, which indicates that the CtoN result is invalid.
5. (Optional) Turn the signal generator on again, and reduce the level to -120dBm. Take more **IDACGPSCTON** readings and use these as a reference for what a marginal/poor signal would be.

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

»» | 14: Safety Recommendations (For Information Only)

For the efficient and safe operation of your GSM application based on the AirPrime WP75xx Embedded Module/AirPrime WP8548 Embedded Module, please read the following RF safety information carefully.

14.1 RF Safety

14.1.1 General

Your GSM terminal is based on the GSM standard for cellular technology. The GSM standard is spread all over the world. It covers Europe, Asia and some parts of America and Africa. This is the most used telecommunication standard.

Your GSM terminal is actually a low power radio transmitter and receiver. It sends out as well as receives radio frequency energy. When you use your GSM application, the cellular system which handles your calls controls both the radio frequency and the power level of your cellular modem.

14.1.2 Exposure to RF Energy

There has been some public concern about possible health effects of using GSM terminals. Although research on health effects from RF energy has focused on the current RF technology for many years, scientists have begun research regarding newer radio technologies, such as GSM. After existing research had been reviewed, and after compliance to all applicable safety standards had been tested, it has been concluded that the product was fitted for use.

If you are concerned about exposure to RF energy, there are things you can do to minimize exposure. Obviously, limiting the duration of your calls will reduce your exposure to RF energy. In addition, you can reduce RF exposure by operating your cellular terminal efficiently by following the guidelines below.

14.1.3 Efficient Terminal Operation

For your GSM terminal to operate at the lowest power level, consistent with satisfactory call quality:

- If your terminal has an extendable antenna, extend it fully. Some models allow you to place a call with the antenna retracted. However your GSM terminal operates more efficiently with the antenna when it is fully extended.
- Do not hold the antenna when the terminal is "IN USE". Holding the antenna affects call quality and may cause the modem to operate at a higher power level than needed.

14.1.4 Antenna Care and Replacement

Do not use the GSM terminal with a damaged antenna. If a damaged antenna comes into contact with the skin, a minor burn may result. Replace a damaged antenna immediately. You may repair antenna to yourself by following the instructions provided to you. If so, use only a manufacturer-approved antenna. Otherwise, have your antenna repaired by a qualified technician.

Buy or replace the antenna only from the approved suppliers list. Using unauthorized antennas, modifications or attachments could damage the terminal and may contravene local RF emission regulations or invalidate type approval.

14.2 General Safety

14.2.1 Driving

Check the laws and the regulations regarding the use of cellular devices in the area where you have to drive as you always have to comply with them. When using your GSM terminal while driving, please:

- Give full attention to driving,
- Pull off the road and park before making or answering a call if driving conditions so require.

14.2.2 Electronic Devices

Most electronic equipment, for example in hospitals and motor vehicles is shielded from RF energy. However, RF energy may affect some improperly shielded electronic equipment.

14.2.3 Vehicle Electronic Equipment

Check with your vehicle manufacturer representative to determine if any on-board electronic equipment is adequately shielded from RF energy.

14.2.4 Medical Electronic Equipment

Consult the manufacturer of any personal medical devices (such as pacemakers, hearing aids, etc...) to determine if they are adequately shielded from external RF energy.

Turn your terminal **OFF** in health care facilities when any regulations posted in the area instruct you to do so. Hospitals or health care facilities may be using RF monitoring equipment.

14.2.5 Aircraft

Turn your terminal **OFF** before boarding any aircraft.

- Use it on the ground only with crew permission.
- Do not use it in the air.

To prevent possible interference with aircraft systems, Federal Aviation Administration (FAA) regulations require you should have prior permission from a crew member to use your terminal while the aircraft is on the ground. To prevent interference with cellular systems, local RF regulations prohibit using your modem while airborne.

14.2.6 Children

Do not allow children to play with your GSM terminal. It is not a toy. Children could hurt themselves or others (by poking themselves or others in the eye with the antenna, for example). Children could damage the modem, or make calls that increase your modem bills.

14.2.7 Blasting Areas

To avoid interfering with blasting operations, turn your unit OFF when you are in a "blasting area" or in areas posted "turn off two-way radio". Construction crew often uses remote control RF devices to set off explosives.

14.2.8 Potentially Explosive Atmospheres

Turn your terminal OFF when in any area with a potentially explosive atmosphere. Though it is rare, but your modem or its accessories could generate sparks. Sparks in such areas could cause an explosion or fire resulting in bodily injuries or even death.

Areas with a potentially explosive atmosphere are often, but not always, clearly marked. They include fuelling areas such as petrol stations; below decks on boats; fuel or chemical transfer or storage facilities; and areas where the air contains chemicals or particles, such as grain, dust, or metal powders.

Do not transport or store flammable gas, liquid, or explosives, in the compartment of your vehicle which contains your terminal or accessories.

Before using your terminal in a vehicle powered by liquefied petroleum gas (such as propane or butane) ensure that the vehicle complies with the relevant fire and safety regulations of the country in which the vehicle is used.