Product Technical Specification

AirPrime HL8518, HL8528 and HL8529

SIERRA WIRELESS®

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

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Document History

Version	Date	Updates
1.0	May 20, 2015	Creation
1.1	May 29, 2015	Updated: • 1 Introduction • 2 Pad Definition • Table 32 26Mhz Clock Interface Pin Description • Table 54 Ordering Information
		Deleted 4.1 Model Views
2.0	December 02, 2015	Added 8 Conformance with ATEX
		Updated: • Table 1 Supported Bands/Connectivity • 1.2 Physical Dimensions • Table 2 General Features • Table 3 ESD Specifications • 1.9 Environmental and Certifications • 2 Pad Definition • Table 8 Power Supply • 3.4 Current DC Power Consumption • 4 Mechanical Drawings • 6 Reliability Specification • 7 Legal Information • Table 54 Ordering Information
		Deleted HSIC
2.1	December 10, 2015	Updated Table 11 Current Consumption

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1. Introduction

This document is the Product Technical Specification for the AirPrime HL8518, HL8528 and HL8529 Embedded Modules. It defines high level features and illustrates the interfaces for these features. This document is intended to cover hardware aspects, including electrical and mechanical, of the AirPrime HL8518, HL8528 and HL8529.

The AirPrime HL8518, HL8528 and HL8529 modules belong to the AirPrime HL Series from the Essential Connectivity Module family. These are industrial grade Embedded Wireless Modules that provide voice and data connectivity on GPRS, EDGE RX, WCDMA, HSDPA and HSUPA networks (as listed in Table 1 Supported Bands/Connectivity).

The HL8518, HL8528 and HL8529 modules support a large variety of interfaces such as Digital Audio, GPIOs and UART to provide customers with the highest level of flexibility in implementing high-end solutions.

Table 1.   Supported Bands/Connectivity

RF Band	Transmit band (Tx)	Receive band (Rx)	Maximum Output Power	HL8518	HL8528	HL8529
UMTS B1	1922 to1978 MHz	2112 to 2168 MHz	22.5 dBm (± 1.5 dB)	✓		
UMTS B2	1852 to 1908 MHz	1932 to 1988 MHz	22.5 dBm (± 1.5 dB)		✓	✓
UMTS B5	826 to 847 MHz	871 to 892 MHz	22.5 dBm (± 1.5 dB)		✓	✓
UMTS B8	882 to 913 MHz	927 to 958 MHz	22.5 dBm (± 1.5 dB)	✓		
GSM 850	824 to 849 MHz	869 to 894 MHz	33 dBm ± 2 dB GSM, GPRS		✓	
E-GSM 900	880 to 915 MHz	925 to 960 MHz	33 dBm ± 2 dB GSM, GPRS	✓		
DCS 1800	1710 to 1785 MHz	1805 to 1880 MHz	30 dBm ± 2 dB GSM, GPRS	✓		
PCS 1900	1850 to 1910 MHz	1930 to 1990 MHz	30 dBm ± 2 dB GSM, GPRS		✓	

1.1.   Common Flexible Form Factor (CF³)

The AirPrime HL8518, HL8528 and HL8529 belong 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 2G to LTE advanced) and band groupings
- Supports bit-pipe (Essential Module Series) and value add (Smart Module Series) solutions
- Offers electrical and functional compatibility
- Provides Direct Mount as well Socketability depending on customer needs

1.2.   Physical Dimensions

The AirPrime HL8518, HL8528 and HL8529 modules are compact, robust, fully shielded modules with the following dimensions:

- Length: 23 mm
- Width: 22 mm
- Thickness: 2.5 mm
- Weight: 2.65 g

Note: Dimensions specified above are typical values.

1.3.   General Features

The table below summarizes the AirPrime HL8518, HL8528 and HL8529 features.

Table 2.   General Features

Feature	Description
Physical	• Small form factor (146-pin solderable LGA pad) – 23mm x 22mm x 2.5mm (nominal) • Metal shield can • RF connection pad • Baseband signals connection
Electrical	Single or double supply voltage (VBATT and VBATT_PA) – 3.2V – 4.5V
RF	HL8518 (dual-band UMTS and dual-band GSM): • UMTS B1 • UMTS B8 • E-GSM 900 • DCS 1800 HL8528 (dual-band UMTS and dual-band GSM): • UMTS B2 • UMTS B5 • GSM 850 • PCS 1900 HL8529 (dual-band UMTS): • UMTS B2 • UMTS B5
Audio interface	• Digital interface (ONLY) • 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

Feature	Description
SIM interface	- Dual SIM Single Standby (DSSS) with fast network switching capability 1.8V/3V support - SIM extraction / hot plug detection - SIM/USIM support - Conforms with ETSI UICC Specifications. - Supports SIM application tool kit with proactive SIM commands
Application interface	- NDIS NIC interface support (Windows XP, Windows 7, Windows 8, Windows CE, Linux) - Multiple non-multiplexed USB channel support - Dial-up networking - USB selective suspend to maximize power savings - CMUX multiplexing over UART - AT command interface – 3GPP 27.007 standard, plus proprietary extended AT commands
Protocol Stack	Dual-mode UMTS (WCDMA) / HSDPA / HSUPA / EDGE RX / GPRS / GSM operation - GSM/GPRS/EDGE RX - GPRS Class 12 - EDGE RX - CSD (Circuit-switched data bearers) - Release 4 GERAN Feature Package 1 - SAIC / DARP Phase 1 - Latency Reduction - Repeated FACCH and Repeated SACCH - GPRS ROHC - Enhanced Operator Name String (EONS) - Enhanced Network Selection (ENS) - WCDMA 3GPP WCDMA FDD Multimode Type II UE Protocol Stack - Configurable for data classes up to 384 kBit/s - Inter-RAT Handover and Cell Reselection - Supports two types of Compressed Mode - Network Assisted Cell Change from UTRAN to GERAN and GERAN to UTRAN - CSD (Circuit-switched data bearers) over WCDMA (transparent/non transparent up to 64 kBit/s; Support for Video Telephony) - HSDPA (High Speed Downlink Packet Access) - Compliant with 3GPP Release 5 - HSDPA Category 8 data rate – 7.2 Mbps (peak rate) - IPv6 support - HSUPA (High Speed Uplink Packet Access) - Compliant with 3GPP Release 6 - HSUPA Category 6 data rate - 5.76 Mbps (peak rate) - Robust Header Compression (RoHC) - Fractional DPCH

Feature	Description
Protocol Stack	• HSPA+ (Evolved High Speed Packet Access) ▪ Compliant with 3GPP Release 7 ▪ Higher-Order Modulation (HOM) ▪ MAC-ehs support ▪ Continuous Packet Connectivity (CPC) ▪ Enhanced F-DPCH ▪ Enhanced Cell FACH ▪ Circuit Switched Voice over HSPA
SMS	• SMS MO and MT • CS and PS support • SMS saving to SIM card or ME storage • SMS reading from SIM 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	• Call Barring • Call Forwarding • Call Hold • Caller ID • Call Waiting • Multi-party service • USSD • Automatic answer
Connectivity	• Multiple (up to 20) cellular packet data profiles • Sleep mode for minimum idle power draw • Automatic GPRS attach at power-up • GPRS detach • Mobile-originated PDP context activation / deactivation • Support QoS profile ▪ Release 97 – Precedence Class, Reliability Class, Delay Class, Peak Throughput, Mean Throughput ▪ Release 99 QoS negotiation – Background, Interactive, and Streaming • Static and Dynamic IP address. The network may assign a fixed IP address or dynamically assign one using DHCP (Dynamic Host Configuration Protocol). • Supports PAP and CHAP authentication protocols • PDP context type (IPv4, IPv6, IPv4v6). IP Packet Data Protocol context • RFC1144 TCP/IP header compression • Interaction with existing GSM services (MO/MT SMS voice calls) while: ▪ GPRS is attached, or ▪ In a GPRS data session (class B GPRS suspend / resume procedures)
Environmental	Operating temperature ranges (industrial grade): • Class A: -30°C to +70°C • Class B: -40°C to +85°C

Feature	Description
RTC	Real Time Clock (RTC) with calendar and alarm
Temperature Sensor	• Temperature monitoring • Alarms

1.4.   Encryption Support

The AirPrime HL8518, HL8528 and HL8529 supports the following encryption algorithms:

- Ciphering algorithms A51, A52 and A53
- GEA1/GEA2 and GEA3 algorithm for GPRS encryption
- Cyclic Redundancy Check (CRC) with programmable polynomial
- UMTS confidentiality algorithm f8 for message ciphering (Kasumi based UEA1)
- UMTS integrity algorithm f9 for message authentication (Kasumi based UIA1 and SNOW 3G based UIA2)

1.5.   Architecture

The figure below presents an overview of the AirPrime HL8518, HL8528 and HL8529 modules internal architecture and external interfaces.
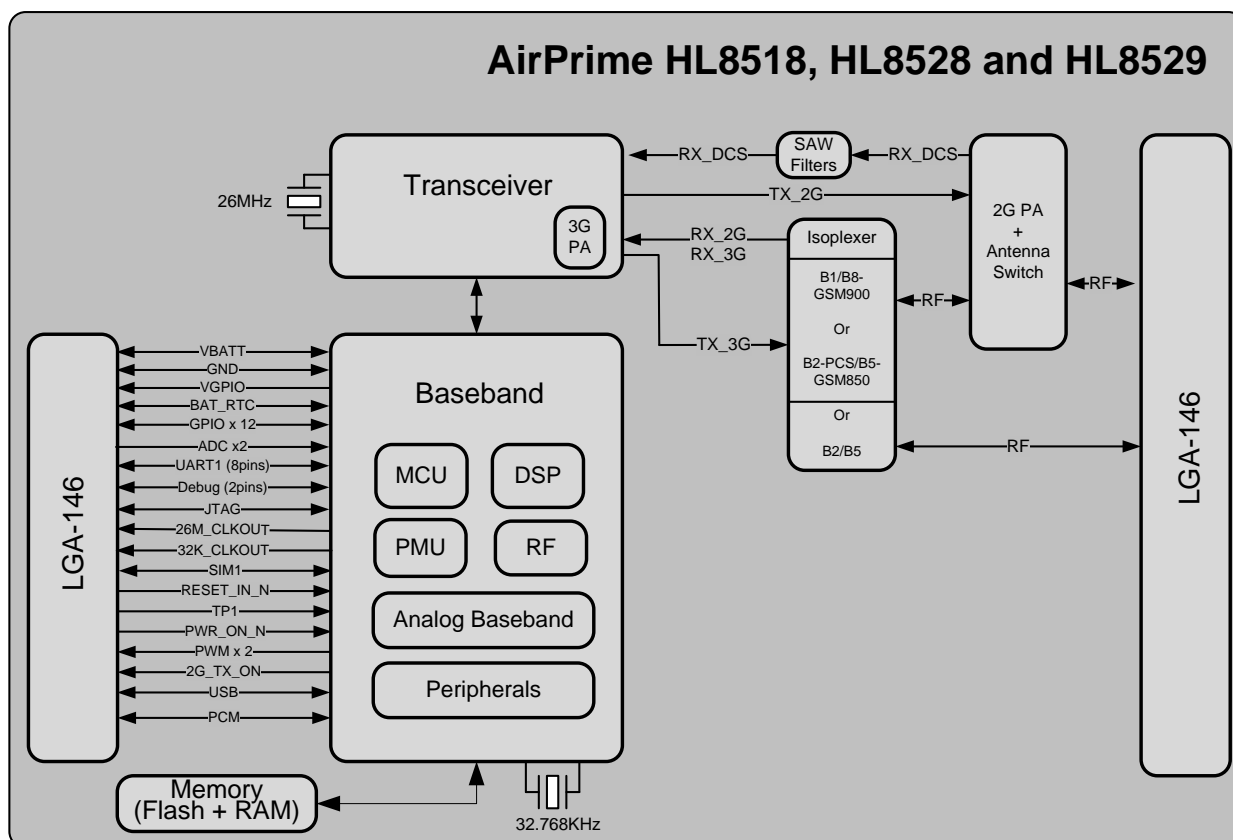
Figure 1.   Architecture Overview

1.6.   Interfaces

The AirPrime HL8518, HL8528 and HL8529 modules provide the following interfaces and peripheral connectivity:

- 1x – 8-pin UART
- 1x – Active Low RESET
- 1x – USB 2.0
- 1x – Backup Battery Interface
- 2x – System Clock Out
- 1x – Active Low POWER ON
- 1x – 1.8V/3V SIM
- 1x – Digital Audio
- 2x – ADC
- 1x – JTAG Interface
- 1x – Debug Interface
- 2x – PWM
- 12x – GPIOs
- 1x – 2G TX Burst Indicator
- 1x – GSM Antenna

1.7.   Connection Interface

The AirPrime HL8518, HL8528 and HL8529 modules are an LGA form factor device. All electrical and mechanical connections are made through the 146 Land Grid Array (LGA) pads on the bottom side of the PCB.
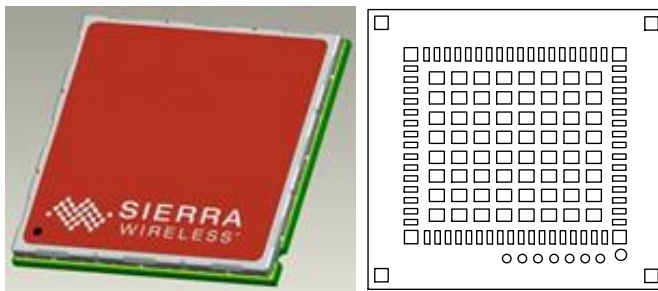
Figure 2.   Mechanical Overview

The 146 pads have the following distribution:

- 66 inner signal pads, 1x0.5mm, pitch 0.8mm
- 1 reference test point (Ground), 1.0mm diameter
- 7 test point (JTAG), 0.8mm diameter, 1.20mm pitch
- 64 inner ground pads, 1.0x1.0mm, pitch 1.825mm/1.475mm
- 4 inner corner ground pads, 1x1mm
- 4 outer corner ground pads, 1x0.9mm

1.8.   ESD

Refer to the following table for ESD Specifications.

Note: Information specified in the following table is preliminary and subject to change.

Table 3.   ESD Specifications

Category	Connection	Specification
Operational	RF ports	IEC-61000-4-2 — Level (Electrostatic Discharge Immunity Test)
Non-operational	Host connector interface	Unless otherwise specified: • JESD22-A114 +/- 1kV Human Body Model • JESD22-A115 +/- 200V Machine Model • JESD22-C101C +/- 250V Charged Device Model
Signals	SIM connector Other host signals	ESD protection is highly recommended at the point where the USIM contacts are exposed, and for any other signals that would be subjected to ESD by the user.

1.9.   Environmental and Certifications

1.9.1.   Environmental Specifications

The environmental specification for both operating and storage conditions are defined in the table below.

Table 4.   Environmental Specifications

Conditions	Range
Operating Class A	-30°C to +70°C
Operating Class B	-40°C to +85°C
Storage	-40°C to +85°C

Note: The upper limit of Class A is subject to module PCB temperature. A progressive 3G output power reduction feature is implemented for when PCB temperatures are above +80°C. This leads to a calibrated 3G TX power output up to +80°C for the PCB temperature and automatic decrease at higher temperatures. Therefore, depending on module activity and customer design, the upper limit of Class A could be lower than 70°C.

Class A is defined as the operating temperature ranges that 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 ranges that the device:

• Shall remain fully functional during and after environmental exposure
• Shall exhibit the ability to establish a voice, SMS or DATA call (emergency call) 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.

1.9.2. Regulatory

The AirPrime HL8518, HL8528 and HL8529 modules are compliant with the following regulations:

- R&TTE directive 1999/5/EC
- FCC
- IC

These compliances will be reflected on the AirPrime HL8518, HL8528 and HL8529 modules labels when applicable.

Table 5.   Regulation Compliance

Document	Current Version	Title
NAPRD.03	v5.18 or later	Overview of PCS Type certification review board (PTCRB) Mobile Equipment Type Certification and IMEI control
GCF-CC	v3.51.1 or later	GCF Conformance Certification Criteria
TS 51.010-1	V10.0.0 (2012-03)	3rd Generation Partnership Project; Technical Specification Group GSM/EDGE Radio Access Network; Digital cellular telecommunications system (Phase 2+); Mobile Station (MS) conformance specification; Part 1: Conformance specification
TS 51.010-2	V10.0.0 (2012-03)	3rd Generation Partnership Project; Technical Specification Group GSM/EDGE Radio Access Network; Mobile Station (MS) conformance specification; Part 2: Protocol Implementation Conformance Statement (PICS) proforma specification
EN 301511	V9.0.2 (2003-03)	Global System for Mobile Communications (GSM); Harmonized EN for Mobile Stations in the GSM 900 and GSM 1800 Bands Covering Essential Requirements Under Article 3.2 of the R&TTE Directive (1999/5/EC)
EN 301489-1	V1.9.2 (2011-09)	Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements
EN 301489-3	V1.4.1 (2002-08)	Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 3: Specific conditions for Short-Range Devices (SRD) operating on frequencies between 9 kHz and 40 GHz
EN 301489-7	V1.3.1 (2005-11)	Electromagnetic Compatibility and Radio Spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) Standard for Radio Equipment and Services; Part 7: Specific Conditions for Mobile and Portable Radio and Ancillary Equipment of Digital Cellular Radio Telecommunications Systems (GSM and DCS)
EN 60950-1	NA	IEC 60950-1:2005/A1:2009 EN 60950-1:2006/A11:2009/A1:2010/A12:2011/AC :2011 Information technology equipment – safety- and general requirements
EN 300440-1	v1.6.1 (2012-08)	Electromagnetic compatibility and Radio spectrum Matters (ERM); Short range devices; Radio equipment to be used in the 1 GHz to 40 GHz frequency range; Part 1: Technical characteristics and test methods
EN 300440-2	V1.4.1 (2012-08)	Electromagnetic compatibility and Radio spectrum Matters (ERM); Short range devices; Radio equipment to be used in the 1 GHz to 40 GHz frequency range; Part 2: Harmonized EN under article 3.2 of the R&TTE Directive

Document	Current Version	Title
FCC Part 22H	NA	Cellular Radiotelephone Service; Subpart H: Cellular Radiotelephone Service
FCC Part 24E	NA	Personal Communications Service; Subpart E: Broadband PCS.

1.9.3. RoHS Directive Compliant

The AirPrime HL8518, HL8528 and HL8529 modules are compliant with RoHS Directive 2011/65/EU which sets limits for the use of certain restricted hazardous substances. This directive states that "from 1st July 2006, new electrical and electronic equipment put on the market does not contain lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE)".

1.9.4. 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.

1.10. References

[1]   AirPrime HL Series Customer Process Guidelines
      Reference Number: 4114330

[2]   AirPrime HL6 and HL8 Series AT Commands Interface Guide
      Reference Number: 4114680

[3]   AirPrime HL Series Dual SIM Single Standby Application Note
      Reference Number: 2174034

2. Pad Definition

AirPrime HL8518, HL8528 and HL8529 pins are divided into 3 functional categories.

- **Core functions and associated pins** cover all the mandatory features for M2M connectivity and will be available by default across all CF[3] 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 CF[3] 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** are specific to a given module, and make an opportunistic use of specific chipset functions and I/Os. 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 CF[3] modules.

Other pins marked as "not connected" or "reserved" should not be used.

Table 6.   Pad Definition

Pin #	Signal Name	Function	I/O	I/O HW Reset State**	Driver Pad Class*	Active Low / High	Power Supply Domain	Recommendation for Unused Pins	Type
1	GPIO1	General purpose input/output	I/O	I, T	E		1.8V	Left Open	Extension
2	UART1_RI	UART1 Ring indicator	O	I, T/PD	A		1.8V	Left Open	Core
3	UART1_RTS	UART1 Request to send	I	I, T/PD		L	1.8V	Connect to UART1_CTS	Core
4	UART1_CTS	UART1 Clear to send	O	I, T/PD	A	L	1.8V	Connect to UART1_RTS	Core
5	UART1_TX	UART1 Transmit data	I	I, T/PD			1.8V	Mandatory connection	Core
6	UART1_RX	UART1 Receive data	O	I, T/PD	A		1.8V	Mandatory connection	Core
7	UART1_DTR	UART1 Data terminal ready	I	I, T/PD		L	1.8V	Connect to UART1_DSR	Core
8	UART1_DCD	UART1 Data carrier detect/	O	I, L	A	L	1.8V	Left Open	Core
9	UART1_DSR	UART1 Data set ready	O	I, T/PD	A	L	1.8V	Connect to UART1_DTR	Core
10	GPIO2	General purpose input/output	I/O	I, T/PD	A		1.8V	Left Open	Core

Pin #	Signal Name	Function	I/O	I/O HW Reset State**	Driver Pad Class*	Active Low / High	Power Supply Domain	Recommendation for Unused Pins	Type
11	RESET_IN_N	Input reset signal	I	I, T/PU		L	1.8V	Left Open	Core
12	USB_D-	USB Data Negative (Low / Full Speed)	I/O	T			3.3V	Left Open	Extension
		USB Data Negative (High Speed)					0.38V		
13	USB_D+	USB Data Positive (Low / Full Speed)	I/O	T			3.3V	Left Open	Extension
		USB Data Positive (High Speed)					0.38V		
14	NC	Not Connected (Reserved for future use)	-	-	-	-	-	Left Open	Not connected
15	NC	Not Connected (Reserved for future use)	-	-	-	-	-	Left Open	Not connected
16	USB_VBUS	USB VBUS	I				5V	Left Open	Extension
17	NC	Not Connected (Reserved for future use)	-	-	-	-	-	Left Open	Not connected
18	NC	Not Connected (Reserved for future use)	-	-	-	-	-	Left Open	Not connected
19	NC	Not Connected (Reserved for future use)	-	-	-	-	-	Left Open	Not connected
20	NC	Not Connected (Reserved for future use)	-	-	-	-	-	Left Open	Not connected
21	BAT_RTC	Power supply for RTC backup	I/O	N/A			1.8V	Left Open	Extension
22	26M_CLKOUT	26MHz System Clock Output	O	I, T/PD	B		1.8V	Left Open	Extension
23	32K_CLKOUT	32.768kHz System Clock Output	O	I, T/PD	B		1.8V	Left Open	Extension
24	ADC1	Analog to digital conversion	I	N/A			1.2V	Left Open	Extension
25	ADC0	Analog to digital conversion	I	N/A			1.2V	Left Open	Extension
26	UIM1_VCC	1.8V/3V SIM1 Power supply	O	N/A			1.8V/3V	Mandatory connection	Core
27	UIM1_CLK	1.8V/3V SIM1 Clock	O	O, L	E		1.8V/3V	Mandatory connection	Core
28	UIM1_DATA	1.8V/3V SIM1 Data	I/O	O, L/PD	E		1.8V/3V	Mandatory connection	Core
29	UIM1_RESET	1.8V/3V SIM1 Reset	O	O, L	E	L	1.8V/3V	Mandatory connection	Core

Pin #	Signal Name	Function	I/O	I/O HW Reset State**	Driver Pad Class*	Active Low / High	Power Supply Domain	Recommendation for Unused Pins	Type
30	NC	Not Connected (Reserved for future use)	-	-	-	-	-	Left Open	Not connected
31	NC	Not Connected (Reserved for future use)	-	-	-	-	-	Left Open	Not connected
32	NC	Not Connected (Reserved for future use)	-	-	-	-	-	Left Open	Not connected
33	PCM_OUT	PCM data out	O	I, T/PD	C		1.8V	Left Open	Extension
34	PCM_IN	PCM data in	I	I, T/PD			1.8V	Left Open	Extension
35	PCM_SYNC	PCM sync out	I/O	I, T/PD	C		1.8V	Left Open	Extension
36	PCM_CLK	PCM clock	I/O	I, T/PD	C		1.8V	Left Open	Extension
37	GND	Ground	0V				0V	Mandatory connection	Core
38	NC	Not Connected	-	-	-	-	-	Left Open	Not connected
39	GND	Ground	0V				0V	Mandatory connection	Core
40	GPIO7	General purpose input/output	I/O	O, L	A		1.8V	Left Open	Core
41	GPIO8	General purpose input/output	I/O	I, T/PD	A		1.8V	Left Open	Core
42	NC	Not Connected	-	-	-	-	-	Left Open	Not connected
43	NC	Not Connected	-	-	-	-	-	Left Open	Not connected
44	DEBUG_TX	Debug transmit data	O	I, T/PD	A		1.8V	Left Open	Extension
45	VGPIO	GPIO voltage output	O	N/A			1.8V	Left Open	Core
46	GPIO6	General purpose input/output	I/O	O, L	A		1.8V	Left Open	Core
47	TP1	Test Point 1 0 - Download Mode Open - Normal Mode	I	O, L		L	1.8V	Left Open	Extension
48	GND	Ground	0V				0V	Mandatory connection	Core
49	RF_MAIN	RF GSM Input/output		N/A				Mandatory connection	Core
50	GND	Ground	0V				0V	Mandatory connection	Core
51	DEBUG_RX	Debug receive data	I	I, T/PD			1.8V	Left Open	Extension

Pin #	Signal Name	Function	I/O	I/O HW Reset State**	Driver Pad Class*	Active Low / High	Power Supply Domain	Recommendation for Unused Pins	Type
52	GPIO10	General purpose input/output	I/O	I, T/PD	A		1.8V	Left Open	Extension
53	GPIO11	General purpose input/output	I/O	I, T/PD	A		1.8V	Left Open	Extension
54	GPIO15	General purpose input/output	I/O	I, T/PD	A		1.8V	Left Open	Extension
55	NC1	Reserved for future use						Left Open	Not connected
56	NC2	Reserved for future use						Left Open	Not connected
57	PWM1	Pulse Width Modulation	O	I, T/PD	A		1.8V	Left Open	Extension
58	PWM2 / GPIO12	Pulse Width Modulation / General purpose input/output	I/O	L	A		1.8V	Left Open	Extension
59	PWR_ON_N	Active Low Power On control signal	I			L	1.8V	Mandatory connection	Core
60	2G_TX_ON	2G TX burst indicator	O	I, T/PD	A	H	1.8V	Left Open	Extension
61	VBATT_PA	Power supply (refer to section 3.1 Power Supply for more information)	I	N/A			3.2V (min) 3.7V (typ) 4.5V (max)	Mandatory connection	Core
62	VBATT_PA	Power supply (refer to section 3.1 Power Supply for more information)	I	N/A			3.2V (min) 3.7V (typ) 4.5V (max)	Mandatory connection	Core
63	VBATT	Power supply	I	N/A			3.2V (min) 3.7V (typ) 4.5V (max)	Mandatory connection	Core
64	UIM1_DET / GPIO3	UIM1 Detection / General purpose input/output	I/O	I, T/PD	A	H	1.8V	Left Open	Core
65	GPIO4	General purpose input/output	I/O	I, T/PD	A	H	1.8V	Left Open	Extension
66	GPIO5	General purpose input/output	I/O	I, T/PU	E		1.8V	Left Open	Extension
67-70	GND	Ground	0V				0V		Core
71 - 166	*Note:* *These pins are not available on the AirPrime HL8518, HL8528 and HL8529 modules.*								
167-234	GND	Ground	0V				0V		Core
236	JTAG_RESET	JTAG RESET	I	I, T		L	1.8V	Left Open	Extension

Pin #	Signal Name	Function	I/O	I/O HW Reset State**	Driver Pad Class*	Active Low / High	Power Supply Domain	Recommendation for Unused Pins	Type
237	JTAG_TCK	JTAG Test Clock	I	I, PD			1.8V	Left Open	Extension
238	JTAG_TDO	JTAG Test Data Output	O	O, T	A		1.8V	Left Open	Extension
239	JTAG_TMS	JTAG Test Mode Select	I	I, PU			1.8V	Left Open	Extension
240	JTAG_TRST	JTAG Test Reset	I	I, PU		L	1.8V	Left Open	Extension
241	JTAG_TDI	JTAG Test Data Input	I	I, PU			1.8V	Left Open	Extension
242	JTAG_RTCK	JTAG Returned Test Clock	O	O, L	A		1.8V	Left Open	Extension

*   Refer to Table 22 Digital I/O Electrical Characteristics for more information.

**   I = Input, O = Output, PU = Pull up, PD = Pull down, H = High, L = Low, T = High impedance, N/A = Not applicable

2.1.   Pin Types

Table 7.   Pin Type Codes

Type	Definition
I	Digital Input
O	Digital Output
I/O	Digital Input / Output
L	Active High
H	Active Low
T	Tristate
T/PU	Tristate with pull-up enabled
T/PD	Tristate with pull-down enabled

2.2.   Pin Configuration (Top View, Through Module)

Figure 3.   Pin Configuration

3. Detailed Interface Specifications

Note: *If not specified, all electrical values are given for VBATT=3.7V and an operating temperature of 25°C.*

For standard applications, VBATT and VBATT_PA must be tied externally to the same power supply. For some specific applications, AirPrime HL8518, HL8528 and HL8529 modules support separate VBATT and VBATT_PA connection if requirements below are fulfilled.

3.1. Power Supply

The AirPrime HL8518, HL8528 and HL8529 modules are supplied through the VBATT signal.

3.1.1. Electrical Characteristics

The following table describes the electrical characteristics of the Power Supply interface.

Table 8.   Power Supply

Supply	Minimum	Typical	Maximum
VBATT voltage (V)	3.2[1]	3.7	4.5
VBATT_PA voltage (V) Full Specification	3.2[1]	3.7	4.5
VBATT_PA voltage (V) Extended Range	2.8[2]	3.7	4.5

1	This value has to be guaranteed during the burst
2	No guarantee of 3GPP performances over extended range

Note: *Load capacitance for VBATT is around 30µF ± 20% embedded inside the module.*
Load capacitance for VBATT_PA is around 20µF ± 20% embedded inside the module.

3.1.2. Pin Description

The following table describes the pin description of the Power Supply interface.

Table 9.   Power Supply Pin Description

Pin Number	Signal Name	I/O	Description
63	VBATT	I	Power supply (base band)
61, 62	VBATT_PA	I	Power supply (radio frequency)
37, 39, 48, 67-70, 167-234	GND		Ground

3.1.3.   Burst Transmission Current Requirements

The power supply must be able to deliver high current peaks in a short time due to the burst transmission nature of GSM. For supply filtering recommendations, please refer to section 3.3 Decoupling of Power Supply Signals.

The following table describes radio burst rates in connected mode. For detailed power consumption figures, refer to section 3.4 Current DC Power Consumption.

Table 10.   Radio Burst Rates – Connected Mode

GSM/GPRS Multislot Class	RF Power Amplifier Current	Slot Duration	Period	Rising Time
Class 10	2.2A peak	577 µs	4.615 ms	10 µs
Class 12				

The corresponding radio burst rates in connected mode are as follows:

- GSM/GPRS class 2 terminals emit 577 µs radio bursts every 4.615 ms
- GPRS class 10 terminals emit 1154 µs radio bursts every 4.615 ms
- GPRS class 12 terminals emit 2308 µs radio bursts every 4.615 ms

In connected mode, the RF Power Amplifier current (2.2A peak in GSM /GPRS mode) flows with a ratio of:

- 1/8 of the time (around 577 µs every 4.615 ms for GSM /GPRS cl 2 – 2RX/1TX), and
- 4/8 of the time (around 2308 µs every 4.615 ms for GSM /GPRS cl 12 – 4RX/1TX) with the rising time at around 10 µs.
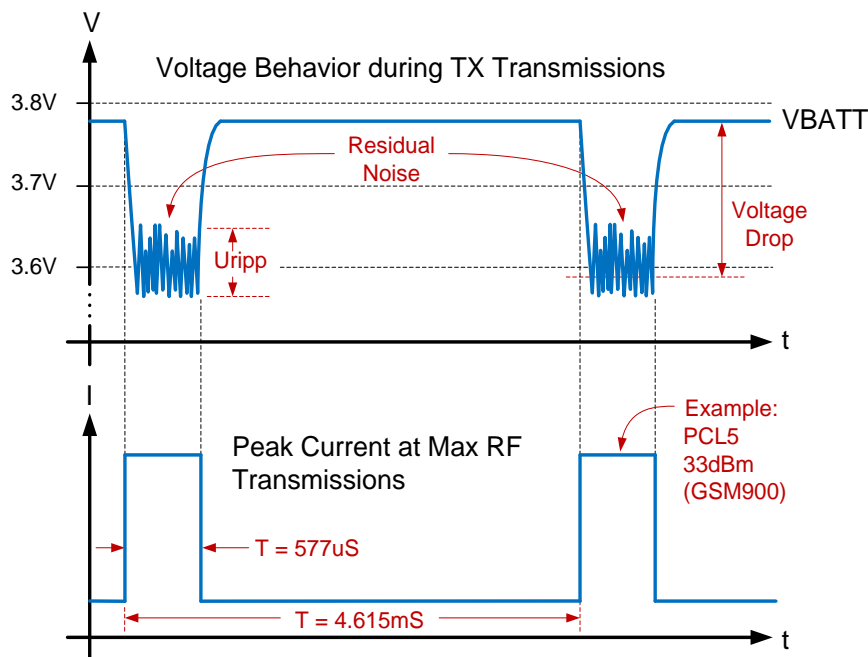
Figure 4.   Power Supply During Burst Transmission

3.1.4.   Power Input (VBATT)

An external power supply uses the VBATT pins to:

- Supply the AirPrime HL8518, HL8528 and HL8529 modules.
- Directly supply the RF components.
  - It is essential to keep the voltage ripple to a minimum at this connection to avoid any phase error or spectrum modulation degradation.
  - An inadequate power supply can significantly affect RF performance (TX power, modulation spectrum, EMC performance, spurious emission, frequency error, etc.).
- Provide reference voltage VGPIO (through internal regulators) for the baseband signals.

When the AirPrime HL8518, HL8528 and HL8529 modules are supplied with a battery, the total impedance (battery + protections + PCB) should be such that the supply will be >= 3.2 V during GSM burst mode operation drawing a maximum peak current of 2.2 A for 577 μs (one slot) or 1154 μs (two slots) TX.

3.2.   Ground Connection

The AirPrime HL8518, HL8528 and HL8529 modules shielding case is the grounding. The ground must be connected on the motherboard through a complete layer on the PCB.

The ground connection is made by soldering the LGA ground pins and rectangular ground pad to the ground plane of the application board.

3.3.   Decoupling of Power Supply Signals

The ETSI standard defines specific requirements for phase error and spectrum modulation. Both are mandatory and can be affected by the choice of power supply filtering. It is highly recommended to provide multiple capacitor values to solve an eventual Amplitude and Phase Modulation issue.

AirPrime HL8518, HL8528 and HL8529 modules already here embedded decoupling capacitors on the VBATT lines, but additional external decoupling may be required.

- EMI/RFI issues – Add a capacitor (10pF~33pF) close to the VBATT pins.
- TDMA noise (217 Hz) – Place a low ESR decoupling capacitors (at least 100 μF) as close to the module as possible to reduce noise.
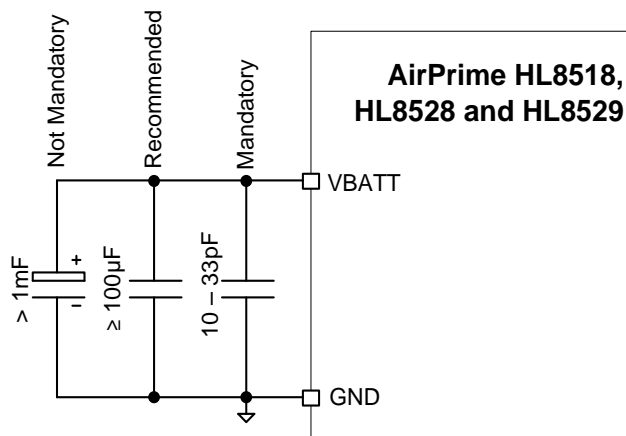
Figure 5.   Power Supply Requirements

The figure below shows the power supply voltage drop shapes during GSM 2G transmission.
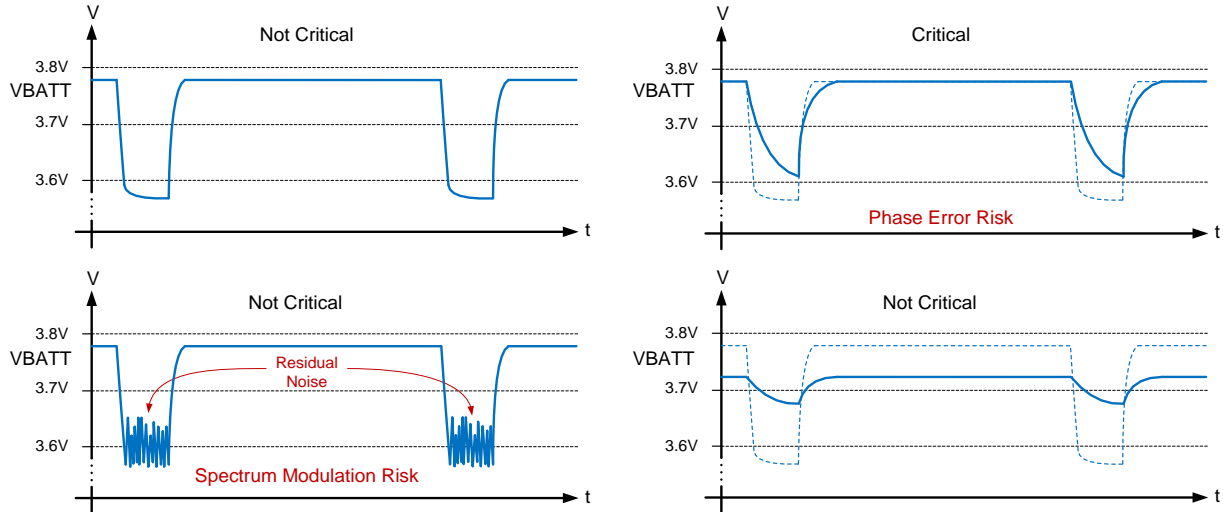
Figure 6.   Power Supply Voltage Drops Shapes During Burst Transmission

3.4.   Current DC Power Consumption

The following table lists the current consumption of the AirPrime HL8518, HL8528 and HL8529 modules at different conditions.

Note: The following data is under the setup recommended in section 5.5 Power Supply Design. The USB is disconnected for the lowest current consumption.

Typical values are measured at ambient temperature, and maximum values are measured over the entire operating temperature range. (The measurements are done with a CMU200 and with a 50Ω load.) For a description of input voltage requirements, see section 3.1 Power Supply.

Table 11.   Current Consumption (at nominal voltage, 3.7V)

Parameters		Typical	Maximum
Off mode		50 µA	
Sleep mode - GSM DRX2 (registered to the network)	GSM900	1.5 mA	3.15 mA
	DCS1800	1.5 mA	3.15 mA
	GSM850	1.6 mA	3.4 mA
	PCS1900	1.6 mA	3.4 mA
Sleep mode - GSM DRX9 (registered to the network)	GSM900	1.15 mA	2.7 mA
	DCS1800	1.0 mA	2.7 mA
	GSM850	1.3 mA	2.9 mA
	PCS1900	1.25 mA	2.95 mA
Sleep mode - WCDMA DRX6 (registered to the network)	Band 1	1.75 mA	3.45 mA
	Band 2	2 mA	3.75 mA
	Band 5	2 mA	3.8 mA
	Band 8	1.75 mA	3.5 mA

Parameters		Typical	Maximum
Sleep mode - WCDMA DRX9 (registered to the network)	Band 1	1.1 mA	2.7 mA
	Band 2	1.3 mA	2.9 mA
	Band 5	1.3 mA	3.2 mA
	Band 8	1.1 mA	2.7 mA
WCDMA in communication mode (Voice Call)	Band 1	620 mA	735 mA
	Band 2	620 mA	735 mA
	Band 5	500 mA	650 mA
	Band 8	500 mA	650 mA
WCDMA in communication mode (HSDPA)	Band 1	700 mA	880 mA
	Band 2	680 mA	900 mA
	Band 5	550 mA	760 mA
	Band 8	580 mA	800 mA
WCDMA in communication mode (HSUPA)	Band 1	700 mA	880 mA
	Band 2	665 mA	900 mA
	Band 5	550 mA	760 mA
	Band 8	580 mA	800 mA
GSM in communication mode	GSM900 / GSM850 (PCL=5)	220 mA	250 mA
	DCS / PCS (PCL=0)	165 mA	175 mA
GPRS (2 TX,3 RX)	GSM900 / GSM850 (PCL=5)	425 mA	460 mA
	DCS / PCS (PCL=0)	300 mA	335 mA
Peak current consumption	GSM900 / GSM850	1.9 A	2.2A
	DCS / PCS	1.8 A	2.0A

Table 12.   Current Consumption per Power Supply (VBATT_PA and VBATT)

Parameters			Typical	Maximum
VBATT_PA	Average current GSM in communication mode	E-GSM 900 / GSM 850 (PCL=5)	185 mA	210 mA
		DCS 1800/ PCS 1900 (PCL=0)	130 mA	135 mA
	Average current GPRS (2 TX,3 RX)	E-GSM 900 / GSM 850 (PCL=5)	370 mA	395 mA
		DCS 1800/ PCS 1900 (PCL=0)	245 mA	270 mA
	Average current WCDMA in communication mode (Voice Call)	Band 1	520 mA	615 mA
		Band 2	520 mA	615 mA
		Band 5	405 mA	530 mA
		Band 8	405 mA	530 mA
VBATT	Average current GSM in communication mode	E-GSM 900 / GSM 850 (PCL=5)	35 mA	40 mA
		DCS 1800/ PCS 1900 (PCL=0)	35 mA	40 mA
	Average current GPRS (2 TX,3 RX)	E-GSM 900 / GSM 850 (PCL=5)	55 mA	65 mA
		DCS 1800/ PCS 1900 (PCL=0)	55 mA	65 mA
	Average current WCDMA in communication mode (Voice Call)	Band 1	100 mA	120 mA
		Band 2	100 mA	120 mA
		Band 5	95 mA	120 mA
		Band 8	95 mA	120 mA

3.5.   VGPIO

The VGPIO output can be used to:

- Pull-up signals such as I/Os
- Supply the digital transistors driving LEDs
- Act as a voltage reference for the ADC interfaces, ADC0 and ADC1

The VGPIO output is available when the AirPrime HL8518, HL8528 and HL8529 module is switched ON.

3.5.1.   Electrical Characteristics

The following table describes the electrical characteristics of the VGPIO interface.

Table 13.   VGPIO Electrical Characteristics

Parameter	Min	Typ	Max	Remarks
Voltage level (V)	1.7	1.8	1.9	Both active mode and sleep mode
Current capability active mode (mA)	-	-	50	Power Management support up to 50mA output.
Rise Time(ms)	-	-	1.5	Start-Up time from 0V

3.5.2.   Pin Description

The following table describes the pin description of the VGPIO interface.

Table 14.   VGPIO Pin Description

Pin Number	Signal Name	I/O	I/O Type	Function
45	VGPIO	O	1.8V	(Power supply) GPIO voltage output

3.6.   BAT_RTC

The AirPrime HL8518, HL8528 and HL8529 modules provide an input/output to connect a Real Time Clock power supply.

This pin is used as a back-up power supply for the internal Real Time Clock. The RTC is supported when VBATT is available but a back-up power supply is needed to save date and hour when VBATT is switched off.

If VBATT is available, the back-up battery can be charged by the internal 1.8V power supply regulator.

3.6.1.   Electrical Characteristics

The following table describes the electrical characteristics of the BAT_RTC interface.

Table 15.   BAT_RTC Electrical Characteristics

Parameter	Minimum	Typical	Maximum	Unit
Input voltage	-5%	1.8	+5%	V
Input current consumption	-	2.5	-	µA
Output current capability	7	-	-	mA
Output voltage	-5%	1.8	+5%	V
Max charging current (@VBATT=3.7V)	-	25	-	mA

Note: *When used with the HL Series snap-in socket, or when compatibility with HL6528x is needed, Sierra Wireless recommends adding a 10µF capacitor to the BAT_RTC pin.*

3.6.2.   Pin Description

The following table describes the pin description of the BAT_RTC interface.

Table 16.   BAT_RTC Pin Description

Pin Number	Signal Name	I/O	Function
21	BAT_RTC	I/O	Power supply for RTC backup

3.7.   SIM Interface

The AirPrime HL8518, HL8528 and HL8529 modules have one physical SIM interface, UIM1, which has optional support for dual SIM application with an external SIM switch. Refer to Section 5.8 Dual SIM Application for more information regarding dual SIM.

The UIM1 interface allows control of a 1.8V/3V SIM and is fully compliant with GSM 11.11 recommendations concerning SIM functions.

The five signals used by this interface are as follows:

- UIM1_VCC: power supply
- UIM1_CLK: clock
- UIM1_DATA: I/O port
- UIM1_RST: reset
- UIM1_DET:SIM detection (optional)

3.7.1.   Electrical Characteristics

The following table describes the electrical characteristics of the UIM1 interface.

Table 17.   Electrical Characteristics of UIM1

Parameter		Min	Typ	Max	Remarks
UIM1 Interface Voltage : (V) (VCC, CLK, IO, RST)		2.7	3.0	3.15	The appropriate output voltage is auto detected and selected by software.
		1.65	1.80	1.95	
UIM1 Interface Voltage: (V) (VCC, CLK, IO, RESET)	V_{IH} : Input Voltage-High (VDD=1.8V)	VDD*0.7	-	1.95	
	V_{IL} : Input Voltage-Low (VDD=1.8V)	0	-	VDD*0.2	
	V_{OH} : Output Voltage-High (VDD=1.8V)	VDD*0.7	-	1.95	
	V_{OL} : Output Voltage-Low (VDD=1.8V)	0	-	VDD*0.2	
	V_{IH} : Input Voltage-High (VDD=3.0V)	VDD*0.7	-	3.15	
	V_{IL} : Input Voltage-Low (VDD=3.0V)	0	-	VDD*0.2	
	V_{OH} : Output Voltage-High (VDD=3.0V)	VDD*0.7	-	3.15	
	V_{OL} : Output Voltage-Low (VDD=3.0V)	0	-	VDD*0.2	
UIM1 DET		1.33	1.80	2.1	High active
UIM1_VCC Current (mA)		-	-	10	Max output current in sleep mode = 3 mA
UIM1_VCC Line Regulation (mV/V)		-	-	50	At Iout Max.
UIM1_VCC Power-up Setting Time (µs) from power down		-	10	-	

3.7.2.   Pin Description

The following table describes the pin description of the UIM1 interface.

Table 18.   UIM1 Pin Description

Pin Number	Signal Name	I/O	I/O Type	Function	Multiplex
26	UIM1_VCC	O	1.8V/3V	UIM1 Power supply	
27	UIM1_CLK	O	1.8V/3V	UIM1 Clock	
28	UIM1_DATA	I/O	1.8V/3V	UIM1 Data	
29	UIM1_RESET	O	1.8V/3V	UIM1 Reset	
64	UIM1_DET	I	1.8V	UIM1 detection	GPIO3

3.7.3.   UIM1_DET

UIM1_DET is used to detect and notify the application about the insertion and removal of a SIM device in the SIM socket connected to the main SIM interface (UIM1). When a SIM is inserted, the state of UIM1_DET transitions from logic 0 to logic 1. Inversely, when a SIM is removed, the state of UIM1_DET transitions from logic 1 to logic 0.

The GPIO used for UIM1_DET is GPIO3.

Enabling or disabling this SIM detect feature can be done using the **AT+KSIMDET** command. For more information about this command, refer to document [2] AirPrime HL6 and HL8 Series AT Commands Interface Guide.

3.7.4.   Application

3.7.4.1.   Reference Schematic
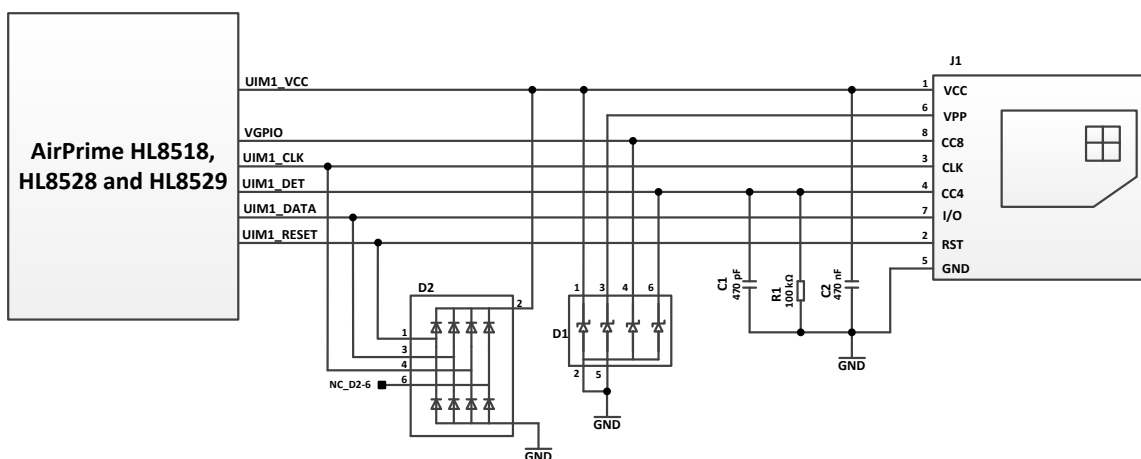
Figure 7.   UIM1 Application Reference Schematic

3.7.4.2.   USIM Socket Pin Description

The following table describes the required USIM socket pins.

Table 19.   USIM Socket Pin Description

Pin Number	Signal Name	Description
1	UIM1_VCC	UIM1 Power supply
2	UIM1_RESET	UIM1 Reset
3	UIM1_CLK	UIM1 Clock
4	UIM1_DET	UIM1 detection
5	GROUND	GND
6	-	-
7	UIM1_DATA	UIM1 Data
8	VGPIO	Power supply

3.8. USB

The AirPrime HL8518, HL8528 and HL8529 modules have one USB interface.

3.8.1. Electrical Characteristics

The following table describes the electrical characteristics of the USB interface.

Table 20. Electrical Characteristics of USB

Signal	I/O	I/O Type	Parameter	Min.	Typ.	Max.	Unit
USB_D+	I/O	Analog		3.06	3.3	3.6	V
USB_D-	I/O	Analog		3.06	3.3	3.6	V
USB data (DP, DM)	I/O	Analog	V_{IH}: Input Voltage-High	2	-	3.2	V
			V_{IL}: Input Voltage-Low	-0.3	-	0.8	V
			V_{OL}: Static Output Voltage-Low	-	-	0.45	V
			V_{OH}: Static Output Voltage-High	2.45	-	-	V
USB_VBUS	I	Analog	Voltage input	4.75	5.0	5.25	V
			USB_VBUS Input current consumption				mA

3.8.2. Pin Description

The following table describes the pin description of the USB interface.

Table 21. USB Pin Description

Pin Number	Signal Name	I/O	I/O Type	Function
12	USB_D-	I/O	3.3V	USB data negative line pad
13	USB_D+	I/O	3.3V	USB data positive line pad
16	USB_VBUS	I	5V	USB VBUS

Note: When the 5V USB supply is not available, connect USB_VBUS to VBATT to supply the USB interface.

3.9. Electrical Information I/O

The AirPrime HL8518, HL8528 and HL8529 modules support different groups of digital interfaces with varying current drain limits. The following table enumerates these interface groupings and enumerates the electrical characteristics of each digital interface.

The DC characteristics of the pads are compatible with CMOS JEDEC standard EIA/JESD8-5.

Table 22. Digital I/O Electrical Characteristics

Parameter	Min	Typ	Max	Conditions
V_{IL}: Input voltage for general digital pad (V)	-0.2	-	VDD*0.2	

Parameter	Min	Typ	Max	Conditions
V_{IH}: Input voltage for general digital pad (V)	VDD*0.7	-	VDD + 0.2	
Input / Output leakage Current (µA)	-	-	±0.7	
VDD (V)	1.7	1.8	1.9	
Driver Pad Class A				
V_{OLA}: Output Voltage-Low (V)	-	-	0.2	I_{OL} = + 0.1mA
	-	-	0.35	I_{OL} = +6.0mA
V_{OHA}: Output Voltage-High (V)	VDD-0.35	-	-	I_{OH} = - 6.0mA
	VDD-0.2	-	-	I_{OH} = - 0.1mA
Driver Pad Class B				
V_{OLB}: Output Voltage-Low (V)	-	-	0.2	I_{OL} = + 0.1mA
	-	-	0.35	I_{OL} = +4.0 mA
V_{OHB}: Output Voltage-High (V)	VDD-0.35	-	-	I_{OH} = - 4.0mA
	VDD-0.2	-	-	I_{OH} = - 0.1mA
Driver Pad Class C				
V_{OLC}: Output Voltage-Low (V)	-	-	0.2	I_{OL} = + 0.1mA
	-	-	0.35	I_{OL} = +2.0mA
V_{OHC}: Output Voltage-High (V)	VDD-0.35	-	-	I_{OH} = - 2.0mA
	VDD-0.2	-	-	I_{OH} = - 0.1mA
Driver Pad Class D				
V_{OLD}: Output Voltage-Low (V)	-	-	0.2	I_{OL} = + 0.1mA
	-	-	0.35	I_{OL} = +1.0mA
V_{OHD}: Output Voltage-High (V)	VDD-0.35	-	-	I_{OH} = - 1.0mA
	VDD-0.2	-	-	I_{OH} = - 0.1mA
Driver Pad Class E				
V_{OLE}: Output Voltage-Low (V)	-	-	0.2	I_{OL} = + 0.1mA
	-	-	0.35	I_{OL} = +1.0mA
V_{OHE}: Output Voltage-High (V)	VDD-0.35	-	-	I_{OH} = - 1.0mA
	VDD-0.2	-	-	I_{OH} = - 0.1mA

3.10. General Purpose Input/Output (GPIO)

The AirPrime HL8518, HL8528 and HL8529 modules provide 12 GPIOs, 2 of which have multiplexes.

Table 23.   GPIO Pin Description

Pin Number	Signal Name	Multiplex	I/O	Power Supply Domain
1	GPIO1		I/O	1.8V
10	GPIO2*		I/O	1.8V
40	GPIO7		I/O	1.8V
41	GPIO8		I/O	1.8V
46	GPIO6		I/O	1.8V
52	GPIO10		I/O	1.8V

Pin Number	Signal Name	Multiplex	I/O	Power Supply Domain
53	GPIO11		I/O	1.8V
54	GPIO15		I/O	1.8V
58	GPIO12	PWM2	I/O	1.8V
64	GPIO3	UIM1_DET	I/O	1.8V
65	GPIO4		I/O	1.8V
66	GPIO5		I/O	1.8V

*   This pin can be used to trigger the module to wake up from Sleep Mode.

3.11. Main Serial Link (UART1)

The main serial link (UART1) is used for communication between the AirPrime HL8518, HL8528 and HL8529 modules and a PC or host processor. It consists of a flexible 8-wire serial interface that complies with RS-232 interface.

The supported baud rates of the UART1 are 300, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400, 460800, 500000, 750000, 921600, 1843200, 3000000, 3250000 and 6000000 bit/s.

The signals used by UART1 are as follows:

- TX data (UART1_TX)
- RX data (UART1_RX)
- Request To Send (UART1_RTS)
- Clear To Send (UART1_CTS)
- Data Terminal Ready (UART1_DTR)
- Data Set Ready (UART1_DSR)
- Data Carrier Detect (UART1_DCD)
- Ring Indicator (UART1_RI)

Note: Signal names are according to PC view.

3.11.1. Pin Description

The following table describes the pin description of the UART1 interface.

Table 24.   UART1 Pin Description

Pin #	Signal Name*	I/O*	Description
2	UART1_RI	O	Signal incoming calls (voice and data), SMS, etc.
3	UART1_RTS	I	Wakes the module up when **AT+KSLEEP=1** is used
4	UART1_CTS	O	Ready to receive AT commands
5	UART1_TX	I	Transmit data
6	UART1_RX	O	Receive data
7	UART1_DTR	I (active low)	Prevents the module from entering sleep mode, switches between data mode and command mode, and wakes the module up.
8	UART1_DCD	O	Signal data connection in progress
9	UART1_DSR	O	Signal UART interface is ON

*   According to PC view.

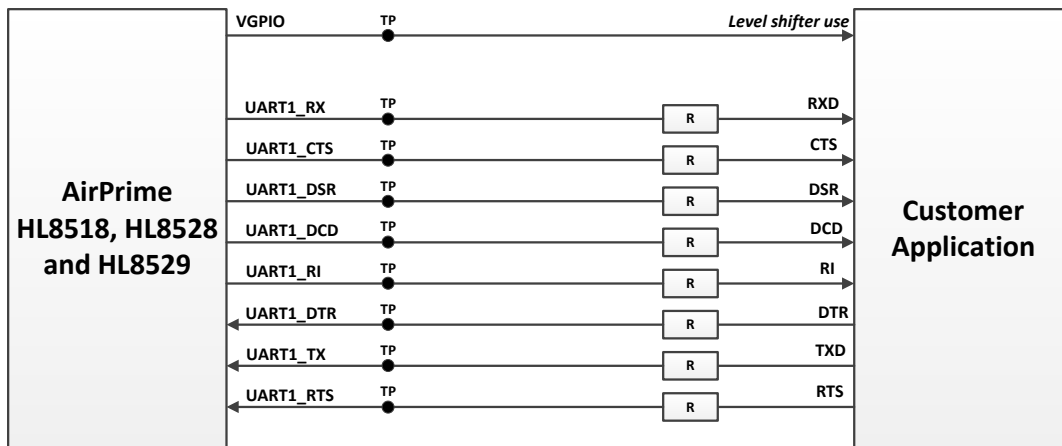## 3.11.2. 8-wire Application

Figure 8.   8-wire UART Application Example
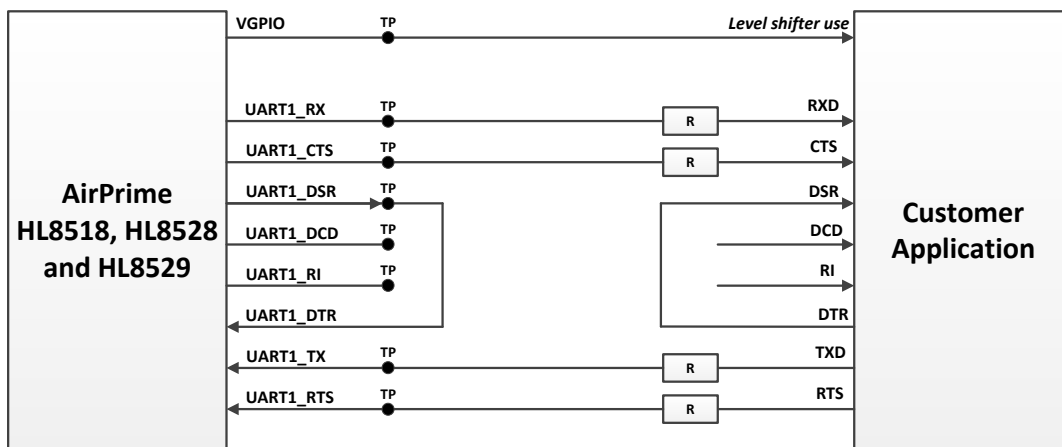
3.11.3. 4-wire Application

Figure 9.   4-wire UART Application Example
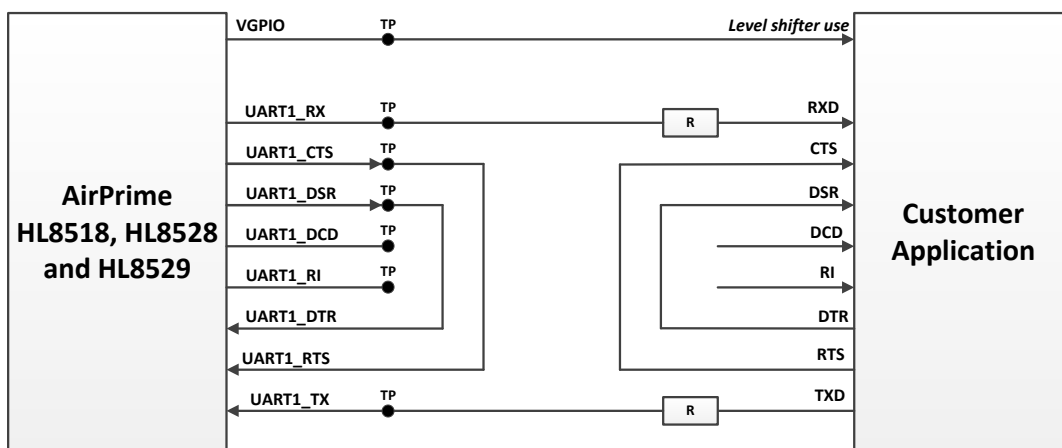
3.11.4. 2-wire Application

Figure 10.   2-wire UART Application Example

3.12. POWER ON Signal (PWR_ON_N)

A low level signal has to be provided to switch the AirPrime HL8518, HL8528 and HL8529 modules ON.

It is internally connected to the permanent 1.8V supply regulator inside the HL8518, HL8528 and HL8529 via a pull-up resistor. Once VBAT is supplied to the module, this 1.8V supply regulator will be enabled and so the PWR_ON_N signal is by default at high level.

The PWR_ON_N signal's characteristics are listed in the table below.

Table 25.   PWR_ON_N Electrical Characteristics

Parameter	Min	Typical	Max
Input Voltage-Low (V)		-	0.51
Input Voltage-High (V)	1.33	-	2.2
Power-up period (ms) from PWR_ON_N falling edge	2000	-	-
PWR_ON_N assertion time (ms)	25		

Note: *As PWR_ON_N is internally pulled up with 200kΩ, a simple open collector or open drain transistor must be used for ignition.*

The software starts operating when the module is ON, but "AT Command Ready" will depend on whether UART or USB is used.
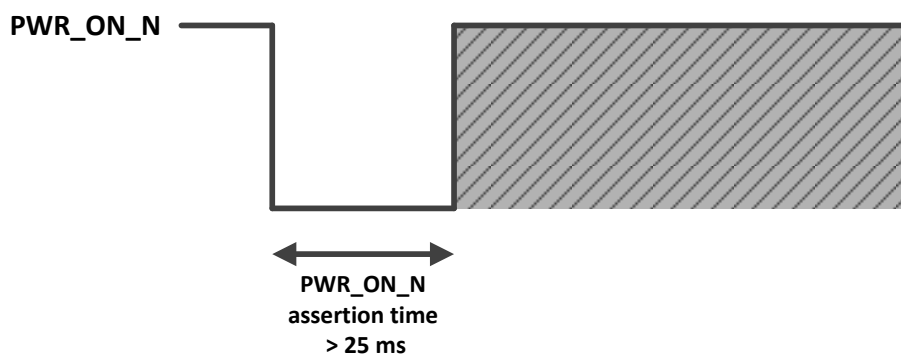
Figure 11.   PWR_ON_N Assertion Time

VGPIO is an output from the module that can be used to check if the module is active.

- When VGPIO = 0V, the module is OFF.
- When VGPIO = 1.8V, the module is ON (it can be in idle, communication or sleep mode)

Note: *PWR_ON_N cannot be used to power the module off. To power the module off, use AT command* `AT+CPOF`.

3.13. Reset Signal (RESET_IN_N)

To reset the module, a low level pulse must be sent on the RESET_IN_N pin for 10ms. This action will immediately restart the AirPrime HL8518, HL8528 and HL8529 modules with the PWR_ON_N signal at low level. (If the PWR_ON_N signal is at high level, the module will be powered off.) As RESET_IN_N is internally pulled up, a simple open collector or open drain transistor can be used to control it.

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: *As RESET_IN_N is referenced to the VGPIO domain (internally to the module), it is impossible to reset before the module starts or to try to use RESET_IN_N as a way to start the module.*

Another more costly solution would be to use MOS transistor to switch the power supply off and restart the power up procedure using the PWR_ON_N input line.

Table 26.   RESET_IN_N Electrical Characteristics

Parameter	Min	Typical	Max
Input Voltage-Low (V)		-	0.51
Input Voltage-High (V)	1.33	-	2.2
Power-up period (ms) from RESET_IN_N falling edge*	2000	-	-

*   With the PWR_ON_N Signal at low level

3.14. ADC

Two Analog to Digital Converter inputs, ADC0 and ADC1, are provided by the AirPrime HL8518, HL8528 and HL8529 modules. These converters are 10-bit resolution ADCs ranging from 0 to 1.2V.

Typically, the ADCx input can be used to monitor external temperature. This is very useful for monitoring the application temperature and can be used as an indicator to safely power the application OFF in case of overheating (for Li-Ion batteries).

3.14.1.   Electrical Characteristics

The following table describes the electrical characteristics of the ADC interface.

Table 27.   ADC Electrical Characteristics

Parameter	Min	Typ	Max	Remarks
ADC Resolution (bits)	-	10	-	
Input Voltage Range (V)	0	-	1.2	General purpose input
Update rate per channel (kHz)	-	-	125	
Integral Nonlinearity (bits)	-	-	±2	LSB
Offset Error (bits)	-	-	±1	LSB
Gain	849	853	858	
Input Resistance (MΩ)	1	-	-	
Input Capacitance (pF)	-	1	-	

3.14.2.   Pin Description

The following table describes the pin description of the ADC interface.

Table 28.   ADC Pin Description

Pin Number	Signal Name	I/O	I/O Type	Description
25	ADC0	I	1.2V	Analog to digital conversion

Pin Number	Signal Name	I/O	I/O Type	Description
24	ADC1	I	1.2V	Analog to digital conversion

3.15. PWM

The AirPrime HL8518, HL8528 and HL8529 modules provide two PWM signals that can be used in conjunction with an external transistor for driving a vibrator, or a backlight LED.

Each PWM uses two 7-bit unsigned binary numbers: one for the output period and one for the pulse width or the duty cycle.

The relative timing for the PWM output is shown in the figure below.
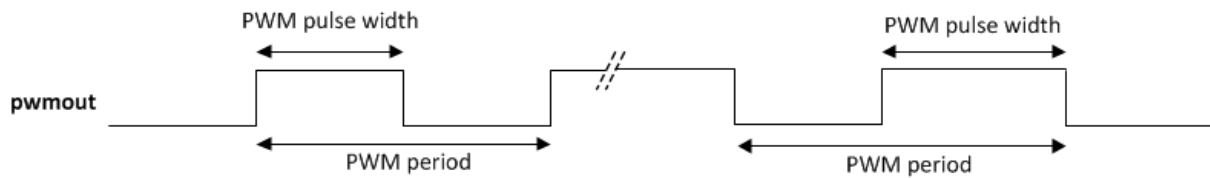
Figure 12.   Relative Timing for the PWM Output

3.15.1. Electrical Characteristics

The following table describes the electrical characteristics of the PWM interface.

Table 29.   PWM Electrical Characteristics

Parameter	Conditions	Minimum	Typical	Maximum	Unit
V_{OH}	High impedance load	--	1.8	-	V
V_{OL}	-	-	-	0.2	V
I_{PEAK}	-	-	-	8	mA
Frequency	-	25.6	-	1625	kHz
Duty cycle	-	1	-	99	%

3.15.2. Pin Description

The following table describes the pin description of the PWM interface.

Table 30.   PWM Pin Description

Pin Number	Signal Name	I/O	I/O Type	Description
57	PWM1	I/O	1.8V	PWM output
58	PWM2	I/O	1.8V	PWM output multiplexed with GPIO12

3.15.3. Application

Both PWM1 and PWM2 signals can be used in conjunction with an external transistor for driving a vibrator, or a backlight LED.
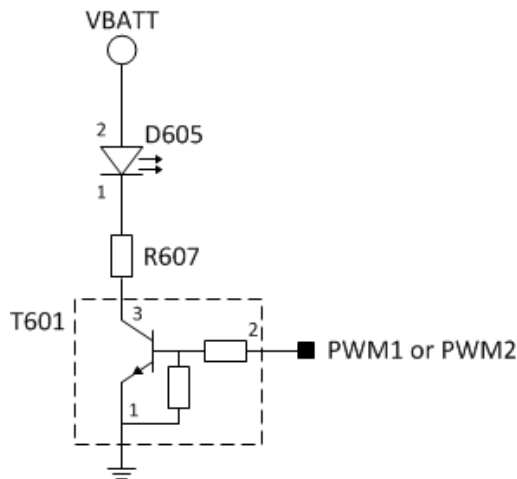
Figure 13.   Example of an LED Driven by either the PWM1 or PWM2 Output

The value of R607 can be harmonized depending on the LED (D605) characteristics.

The recommended digital transistor to use for T601 is the DTC144EE from ROHM.

Figure 14.   Example of a BUZZER Driven by either the PWM1 or PWM2 Output

The recommended MOS transistor to use for T1 is the RUM003N02 from ROHM; and the recommended diode to use for D1 is the BAS16W from NXP.

3.16.   Clock Interfaces

The AirPrime HL8518, HL8528 and HL8529 modules support two digital clock interfaces.
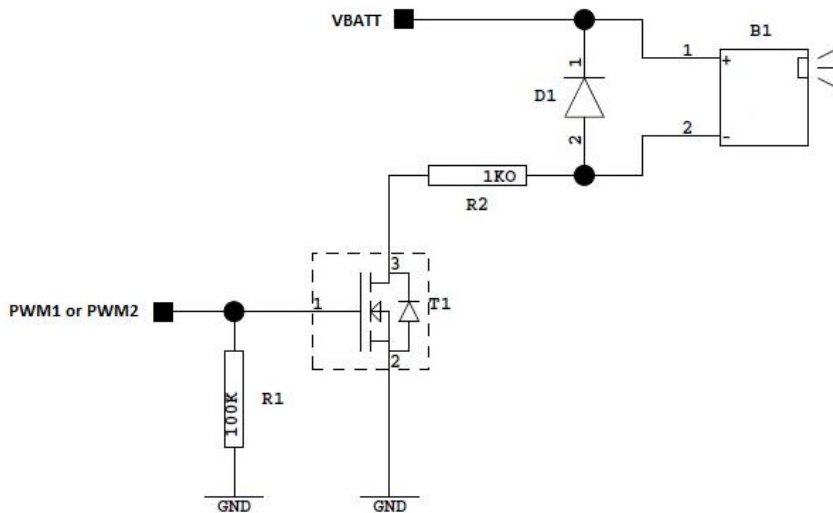
3.16.1.   Electrical Characteristics

The following table describes the pin description of the clock out interfaces.

Table 31.   32.768Khz Clock Interface Pin Description

Parameter	Conditions	Minimum	Typical	Maximum	Unit
Duty cycle	-	-	50	-	%
Clock frequency	-	-120ppm	32768	+120ppm	Hz

Table 32.   26Mhz Clock Interface Pin Description

Parameter	Conditions	Minimum	Typical	Maximum	Unit
Duty cycle	-	45	-	55	%
Clock frequency	-	-	26	-	MHz
Period	-	38.457	-	38.465	ns
Clock accuracy	-	-100	-	100	ppm

3.16.2.   Pin Description

Table 33.   Clock Interface Pin Description

Pin Number	Signal Name	I/O	I/O Type	Description
22	26M_CLKOUT	O	1.8V	26MHz Digital Clock output
23	32K_CLKOUT	O	1.8V	32.768kHz Digital Clock output

Enabling or disabling the clock out feature can be done using AT commands. For more information about AT commands, refer to document [2] AirPrime HL6 and HL8 Series AT Commands Interface Guide.

3.17.   PCM

The Digital Audio (PCM) Interface allows connectivity with standard audio peripherals. It can be used, for example, to connect an external audio codec.

The programmability of this interface allows addressing a large range of audio peripherals.

The signals used by the Digital Audio Interface are as follows:

- PCM_SYNC: The frame synchronization signal delivers an 8 kHz frequency pulse that synchronizes the frame data in and the frame data out.
- PCM_CLK: The frame bit clock signal controls data transfer with the audio peripheral.
- PCM_OUT: The frame "data out" relies on the selected configuration mode.
- PCM_IN: The frame "data in" relies on the selected configuration mode.

The PCM interface is a high speed full duplex interface that can be used to send and receive digital audio data to external audio ICs. The Digital Audio Interface also features the following:

- PCM master or slave
- 16 bits data word length, linear mode
- MSB first
- Configurable PCM bit clock rate on 256kHz, 384kHz or 512kHz
- Long frame sync

Refer to the following table for the electrical characteristics of the digital audio interface.

3.17.1. Electrical Characteristics

Table 34.   Digital Audio PCM Electrical Characteristics

Signal	Description	Minimum	Typical	Maximum	Unit
Tsync_low + Tsync_high	PCM_SYNC frequency		8		Khz
Tsync_low + Tsync_high	PCM_SYNC period		125		µs
Tsync_low	PCM_SYNC low time		124		µs
Tsync_high	PCM_SYNC high time		1		µs
$T_{CLK-cycle}$	PCM_CLK period	-	3.9	-	µs
$T_{IN-setup}$	PCM_IN setup time	59.6	-	-	ns
$T_{IN-hold}$	PCM_IN hold time	12	-	-	ns
$T_{OUT-delay}$	PCM_OUT delay time	-	-	21.6	ns
$T_{SYNC-delay}$	PCM_SYNC output delay	-24	-	31.2	ns
VDD	PCM Signaling Voltage	1.1	1.2	1.3	V
V_{IH}	I/O Voltage input low	0.65*VDD	-	VDD+0.3	V
V_{IL}	I/O Voltage input high	-0.3	-	0.35*VDD	V
V_{OL}	I/O Voltage output low	-	-	0.45	V
V_{OH}	I/O Voltage output high	VDD-0.45	-	-	V
I_{L}	I/O Leakage current	-	-	±0.7	µA

3.17.2.   PCM Waveforms

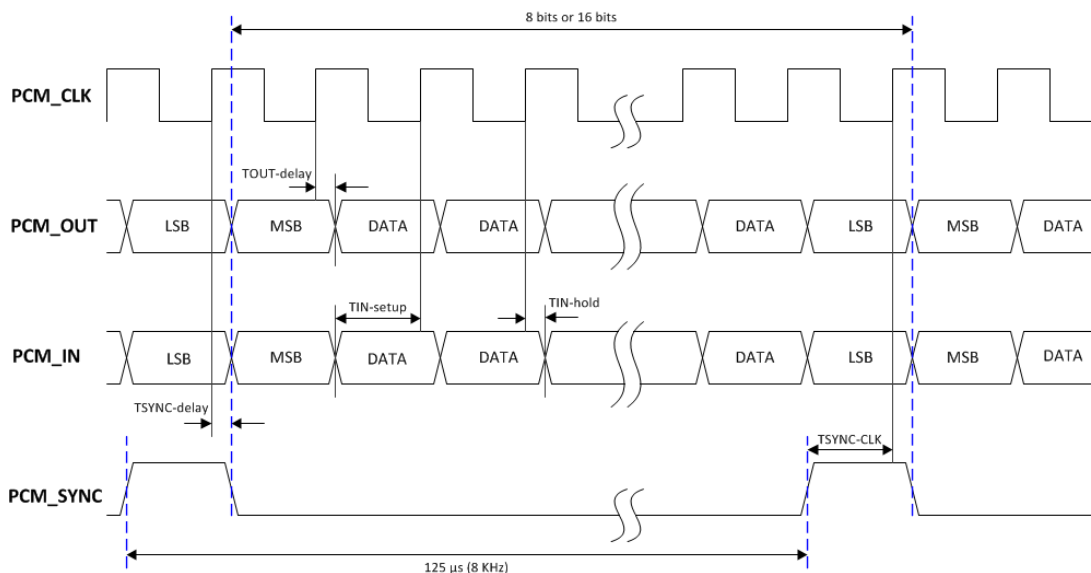The following figure shows the PCM timing waveform.

Figure 15.   PCM Timing Waveform

3.17.3.   PCM Master Mode
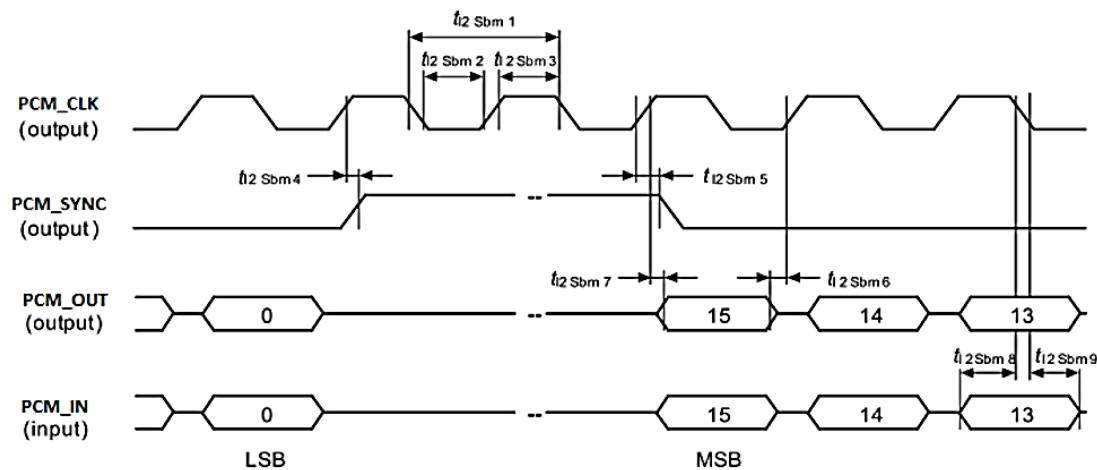
Figure 16.   PCM Master Mode Timing

Table 35.   PCM Master Mode Parameters

Symbol	Description	Min	Typ	Max	Unit
t_{I2Sbs1}	PCM_CLK clock period	T-4	T	-	ns
t_{I2Sbs2}	PCM_CLK low time	T/2 – 20	T/2	-	ns
t_{I2Sbs3}	PCM_CLK high time	T/2 – 20	T/2	-	ns
t_{I2Sbs4}	PCM_SYNC high begin after clock PCM_CLK high begin	-24	-	2 x tCP + 12	ns
t_{I2Sbs5}	PCM_SYNC high end after PCM_CLK how end	-24	-	2 x tCP + 12	ns
t_{I2Sbs6}	PCM_OUT invalid before PCM_CLK low-end	-	-	24	ns

Symbol	Description	Min	Typ	Max	Unit
t_{I2Sbs7}	PCM_OUT valid after PCM_CLK high begin	-	-	tCP + 12	ns
t_{I2Sbs8}	PCM_IN setup time before PCM_CLK high end	tCP + 50	-	-	ns
t_{I2Sbs9}	PCM_IN hold time after PCM_CLK low begin	12	-	-	ns

Note: *T corresponds to the audio sampling rate (48 kHz, 44.1 kHz, 32 kHz, 24 kHz, 22.05 kHz, 16 kHz, 12 kHz, 11.025 kHz and 8 kHz) and to the frame length (17 bit, 18bit, 32bit, 48bit or 64 bit).*

3.17.4.   PCM Slave Mode

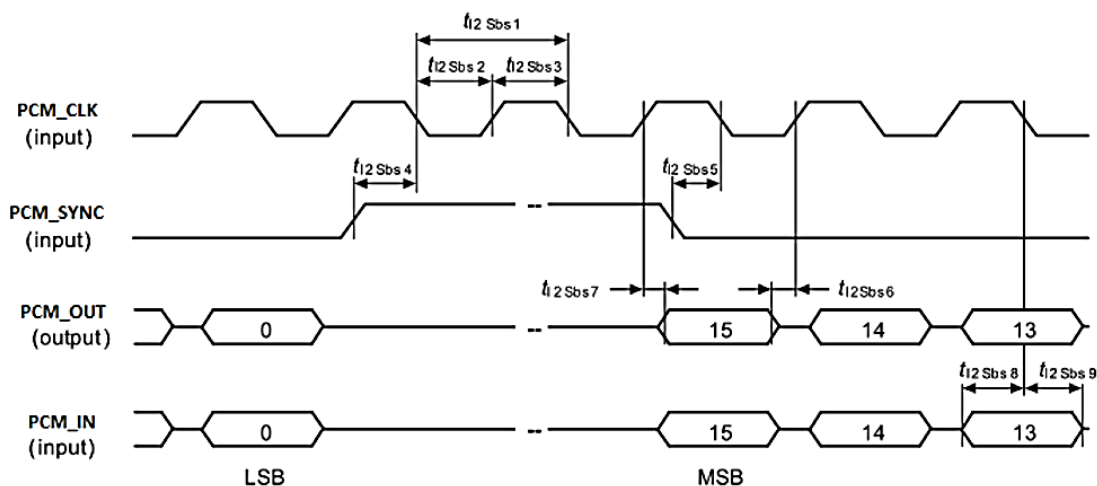*Figure 17.   PCM Master Mode Timing*

Table 36.   PCM Slave Mode Parameters

Symbol	Description	Min	Typ	Max	Unit
t_{I2Sbs1}	PCM_CLK clock period	T	-	-	n
t_{I2Sbs2}	PCM_CLK low time	120	-	-	ns
t_{I2Sbs3}	PCM_CLK high time	120	-	-	ns
t_{I2Sbs4}	PCM_SYNC high begin before PCM_CLK low begin (latching edge of PCM_CLK)	2 x tCP + 17	-	-	ns
t_{I2Sbs5}	PCM_SYNC low begin before PCM_CLK low begin (latching edge of PCM_CLK)	2 x tCP + 17	-	-	ns
t_{I2Sbs6}	PCM_OUT invalid before PCM_CLK rising edge (shifting edge of PCM_CLK)	-	-	12	ns
t_{I2Sbs7}	PCM_OUT valid after PCM_CLK rising edge (shifting edge of PCM_CLK)	-	-	3 x tCP + 12	ns
t_{I2Sbs8}	PCM_IN setup time before PCM_CLK falling edge	tCP + 12	-	-	ns
t_{I2Sbs9}	PCM_IN hold time after PCM_CLK falling edge	24	-	-	ns

Note: *T corresponds to the audio sampling rate (48 kHz, 44.1 kHz, 32 kHz, 24 kHz, 22.05 kHz, 16 kHz, 12 kHz, 11.025 kHz and 8 kHz) and to the frame length (17 bit, 18bit, 32bit, 48bit or 64 bit).*

3.17.5.   Pin Description

Table 37.   Digital Audio PCM Pin Description

Pin Number	Signal Name	I/O	I/O Type	Description
36	PCM_CLK	O	1.8V	PCM clock
35	PCM_SYNC	O	1.8V	PCM synchronization
34	PCM_IN	I	1.8V	PCM data in
33	PCM_OUT	O	1.8V	PCM data out

3.18.   Debug Interfaces

The AirPrime HL8518, HL8528 and HL8529 modules provide 2 interfaces for a powerful debug system.

3.18.1.   Debug Port

The AirPrime HL8518, HL8528 and HL8529 modules provides a 2-wire debug port interface, providing real-time instruction and data trace of the Modem Core.

Table 38.   SW Trace Pin Description

Pin Number	Signal Name*	I/O*	I/O Type	Function
44	DEBUG_TX	O	1.8V	Debug Transmit Data
51	DEBUG_RX	I	1.8V	Debug Receive Data

*   According to module view.

Note: It is strongly recommended to provide access through Test Points to this interface.

3.18.2.   JTAG

The JTAG interface provides debug access to the core of the AirPrime HL8518, HL8528 and HL8529 modules. These JTAG signals are accessible through solder-able test points.

3.18.2.1.   Electrical Characteristic

Table 39.   JTAG Pin Connection

Symbol	Parameter	Min	Typ	Max	Unit
t_{c1}	JTAG_TCK clock period	--	38	-	ns
t_{c2}	JTAG_TCK clock period high	12	-	-	ns
t_{c3}	JTAG_TCK clock period low	12	-	-	ns
t_{c4}	JTAG_TDI setup time to JTAG_TCK	12	-	-	ns
t_{c5}	JTAG_TDI hold time from JTAG_TCK	10	-	-	ns

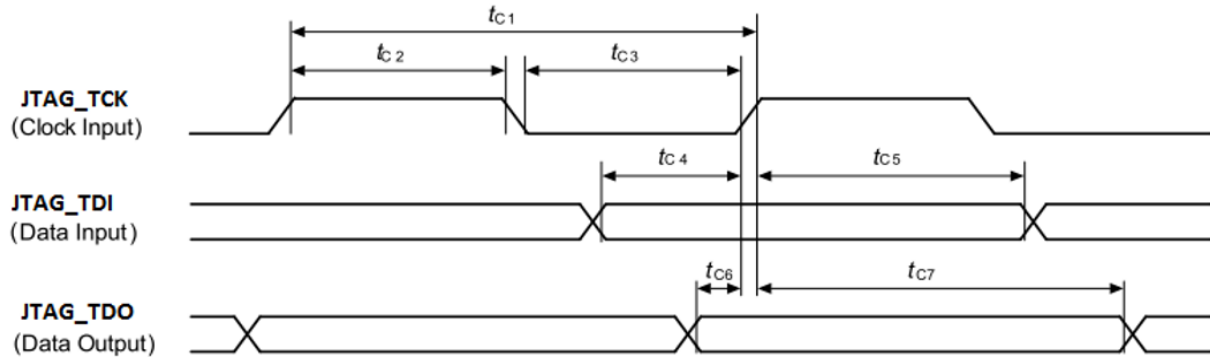| Symbol	Parameter	Min	Typ	Max	Unit
t_{c6}	JTAG_TDO valid before JTAG_TCK low-end	-	0	-	s
t_{c7}	JTAG_TDO valid after JTAG_TCK high begin	-	20	-	ns

3.18.2.2. JTAG Waveforms

Figure 18.   JTAG Timing Waveform

3.18.2.3. Pin Description

Table 40.   JTAG Pin Description

Pin Number	Signal Name	I/O	I/O Type	Function
47	TP1	O	1.8V	Test Point 1
236	JTAG_RESET	I	1.8V	JTAG RESET
237	JTAG_TCK	I	1.8V	JTAG Test Clock
238	JTAG_TDO	O	1.8V	JTAG Test Data Output
239	JTAG_TMS	I	1.8V	JTAG Test Mode Select
240	JTAG_TRST	I	1.8V	JTAG Test Reset
241	JTAG_TDI	I	1.8V	JTAG Test Data Input
242	JTAG_RTCK	O	1.8V	JTAG Returned Test Clock

Note: It is recommended to provide access through Test Points to this interface (for Failure Analysis debugging). All signals listed in table above shall be outputs on the customer board to allow JTAG debugging.

3.19. RF Interface

The GSM RF interface of the AirPrime HL8518, HL8528 and HL8529 modules allows the transmission of RF signals. This interface has a 50Ω nominal impedance.

3.19.1. RF Connection

A 50Ω (with maximum VSWR 1.1:1, and 0.5dB loss) RF track is recommended to be connected to standard RF connectors such as SMA, UFL, etc. for antenna connection.

Table 41.   RF Pin Connection

Pin Number	RF Signal	Impedance	VSWR Rx (max)	VSWR Tx (max)
49	RF_MAIN	50Ω	3:1	3:1

3.19.2.   RF Performances

RF performances are compliant with the ETSI recommendation GSM 05.05.

Table 42.   RF Performance

Frequency Band	Typical Sensitivity (dBm)
GSM850/EGSM	-109
DCS/PCS	-108
UMTS B1	-110
UMTS B2	-110
UMTS B5	-110
UMTS B8	-110

3.19.3.   TX Burst Indicator (2G_TX_ON)

The AirPrime HL8518, HL8528 and HL8529 modules provide a signal, 2G_TX_ON, for TX Burst indication. The 2G_TX_ON is a 1.8V signal and its status signal depends on the module transmitter state.

Refer to the following table for the status of the 2G_TX_ON signal depending on the embedded module's state.

Table 43.   Burst Indicator States

Embedded Module State	2G_TX_ON
During TX burst	High
No TX	Low

During TX burst, there is a higher current drain from the VBATT_PA power supply which causes a voltage drop. This voltage drop from VBATT_PA is a good indication of a high current drain situation during TX burst.

The blinking frequency is about 217Hz.

The output logic high duration, $T_{duration}$, depends on the number of TX slots and is computed as follows:

```
T duration = T advance + (0.577ms x number of TX slots) + T delay
```

Table 44.   2G_TX_ON Burst Characteristics

Parameter	Minimum	Typical	Maximum
Tadvance	30µs		

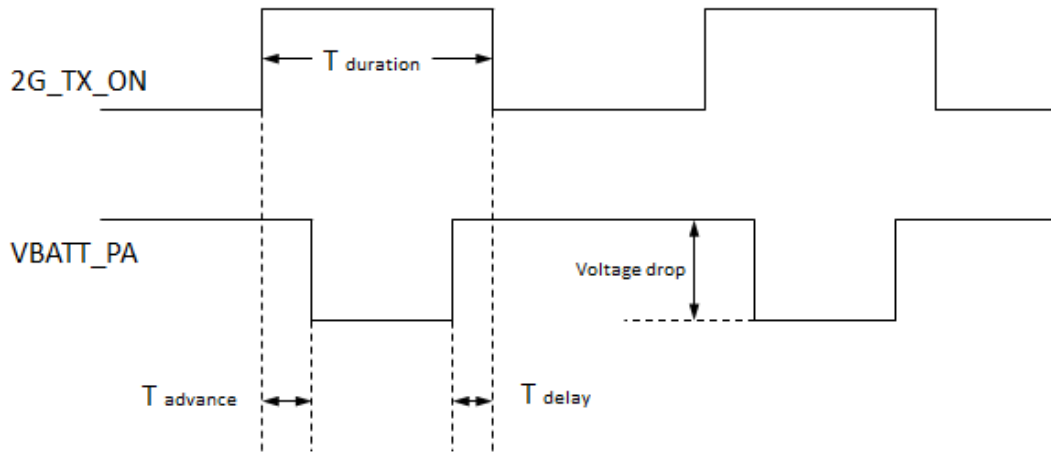| Parameter	Minimum	Typical	Maximum
Tdelay	5µs		

Figure 19.   2G_TX_ON State during TX Burst

Table 45.   2G_TX_ON Burst Pin Description

Pin Number	Signal Name	I/O	I/O Type	Function
60	2G_TX_ON	O	1.8V	2G TX burst indicator

4. Mechanical Drawings

NOTES:
1. DESCRIPTION AND APPLICATION: EMBEDDED MODULE TO BE USED IN WIRELESS COMMUNICATION DEVICES.

2. PARTS SHALL BE CLEAN AND FREE OF ALL FOREIGN MATTER.

3. PART/ASSEMBLY SHALL CONTAIN NO HAZARDOUS SUBSTANCES PER RoHS DIRECTIVE 2011/65/EU. PART/ASSEMBLY SHALL CONFORM TO REACH REGULATION (EC) 1907/2006. PART/ASSEMBLY WASTE DISPOSAL CONTROL SHALL CONFORM TO WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT DIRECTIVE 2012/19/EU (WEEE).

4. INSPECTION DIMENSIONS MARKED BY X SHALL BE PRODUCED WITH STATISTICAL PROCESS CONTROL OR 100% INSPECTION. PRODUCTION LOT SAMPLES MUST DEMONSTRATE A Cpk VALUE OF 1.33 OR HIGHER. IF THE Cpk DROPS BELOW 1.33 AT ANY TIME DURING THE MANUFACTURE OF THIS PART, THEN THE SUPPLIER MUST 100% SCREEN ALL THOSE PARTS TO THOSE SPECIFIED CRITICAL PARAMETERS.

5. DURING THE DE-PANELIZTION PROCESS IT IS ALLOWABLE TO REOVE UP TO A MAXIMUM OF 0.30mm OF PCB MATERIAL INSIDE THE BOARD EDGE AND THE MAXIMUM BURR SHOULD BE ALWAYS WITHIN THE BOARD EDGE. THERE SHOULD BE NO COPPER EXPOSURE AT THE MILD AREA.

6. MODULE CO-PLANARITY 0.10MM MAXIMUM.

11 NOTES APPLICATION TO CONTRACT MANUFACTURER:
1. IN-PROCESS INSPECTION DIMENSION MARKED BY [X] IN-PROCESS INSPECTION MEASUREMENTS DONE ON WELDED SHIELD. REFER TO QUALITY PLAN FOR INSPECTION FREQUENCY.

2. SAMPLE INSPECTION PER QEI-11-0000-18

3. CONTRACT MANUFACTURER SHALL REQUIRE PART MANUFACTURER TO PROVIDE SPC DATA AND REVIEW WITH SIERRA WIRELESS.

DO NOT SCALE PRINT

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE PER THE FOLLOWING TOLERANCES:

	INCHES	MM	ANGLES
.X	± .05	± .25	X ± 5°
.XX	± .01	± .13	X.x ± 1°
.XXX	± .005	± .05	

PIN 1

LASER MARKING

TOP SIDE
SCALE 5,000

PART DESCRIPTION: HLxxxx CCA DRAWING

SIERRA WIRELESS™
13811 Wireless Way
Richmond, British Columbia
Canada, V6V 3A4
Tel: 604.231.1100
Fax: 604.231.1109

PROJECT NAME: HL85xx
SIZE B UNITS MM SCALE 5,000
DRAWING NO. 2103001
REV 4
SHEET 1 OF 2

REV	DESCRIPTION	ECO	DATE	DRAWN	APPD
1	INITIAL RELEASE		22 APR 2015	JPM	PYK
2	REMOVE TOP SIDE MARKING, UPDATE NOTE 5.		30 JUN 2015	JPM	PYK
3	UPDATE NOTE 7		16 JUL 2015	JPM	PYK
4	REMOVE NOTE 7		30 OCT 2015	JPM	PYK

Figure 20. Schematic Diagram

Figure 21.   Footprint

5. Design Guidelines

5.1. Power-Up Sequence

Apply a LOW level logic to the PWR_ON_N pin (pin 59); within 25ms, VGPIO will appear to be at 1.8V. Either a USB or UART1 interface could be used to send AT commands. Note that for USB connections, the time when AT commands can be sent will depend on the initialization time used for the USB connection with the USB host.
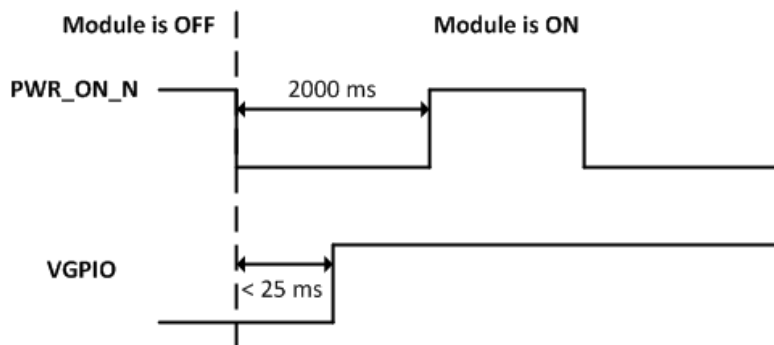

Figure 22.   PWR_ON_N Sequence with VGPIO Information

Note: As PWR_ON_N is internally pulled up with 200kΩ, a simple open collector or open drain transistor must be used for ignition.

The PWR_ON_N pin has the minimum assertion time requirement of 25ms, with LOW active. Once the valid power on trigger is detected, the PWR_ON_N pin status can be left open.

VBATT has to ramp up within 32 ms to reach the value of 3.2V; otherwise, the module may not power up.
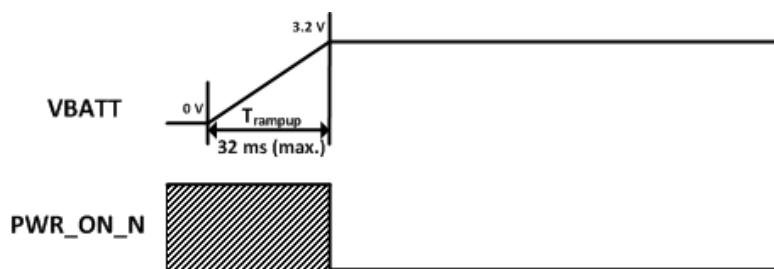
Figure 23.   PWR_ON_N Sequence with T_{rampup}

5.2. Module Switch-Off

AT command **AT+CPOF** enables the user to properly switch the AirPrime HL8518, HL8528 and HL8529 modules off. The PWR_ON signal must be set to high (inactive) before the **AT+CPOF** command is sent.

*Note: If the PWR_ON signal is active (low level) when the **AT+CPOF** command is sent, the module will not power off.*

If required, the module can be switched off by controlling the power supply. This can be used, for example, when the system freezes and no reset line is connected to the AirPrime HL8518, HL8528 and HL8529 modules. In this case, the only way to get control over the module back is to switch off the power line.
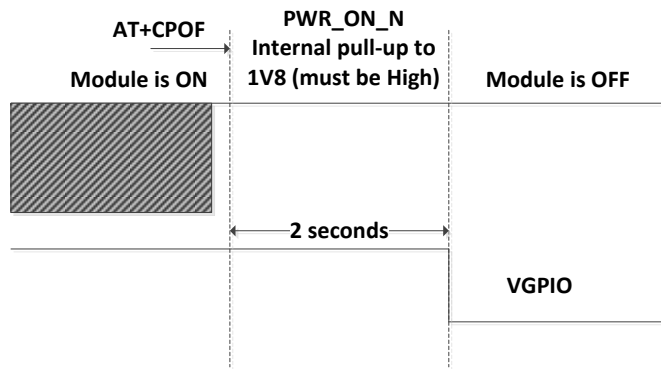
Figure 24.   Power OFF Sequence for PWR_ON_N, VGPIO

Note: *PWR_ON_N is internally pulled up by 200kΩ to 1.8V.*

Caution: *Ensure that no external pull-ups are applied on IO pins while the module is OFF.*

5.3.   Emergency Power OFF

If required, the module can be switched off by controlling the RESET_IN_N pin (pin 11). This must only be used in emergency situations if the system freezes (not responding to AT commands).

To perform an emergency power off, a low level pulse must be sent on the RESET_IN_N pin for 10ms while the PWR_ON signal is inactive (high level). This action will immediately shut the HL8518, HL8528 and HL8529 modules down and the registers of the CPU and RAM memory will be reset for the next power on.

5.4.   Sleep Mode Management

5.4.1.   Using UART

AT command **AT+KSLEEP** enables sleep mode configuration.

AT+KSLEEP=0:

- The module is active when DTR signal is active (low electrical level).
- When DTR is deactivated (high electrical level), the module will enter sleep mode after a while.
- On DTR activation (low electrical level), the module wakes up.

AT+KSLEEP=1:

- The module determines when it enters sleep mode (when no more tasks are running).
- "0x00" character on the serial link wakes the module up.

AT+KSLEEP=2:

- The module never enters sleep mode.

5.4.2.   Using USB

Use **AT+KSLEEP=1** to allow the module to automatically enter sleep mode while the USB interface is in use.

5.5.   Power Supply Design

The AirPrime HL8518, HL8528 and HL8529 modules should not be supplied with voltage over 4.5V even temporarily or however briefly.

If the system's main board power supply unit is unstable or if the system's main board is supplied with over 4.5V, even in the case of transient voltage presence on the circuit, the module's power amplifier may be severely damaged.

To avoid such issues, add a voltage limiter to the module's power supply lines so that VBATT and VBATT_PA signal pads will never receive a voltage surge over 4.5V. The voltage limiter can be as simple as a Zener diode with decoupling capacitors as shown in the diagram below.
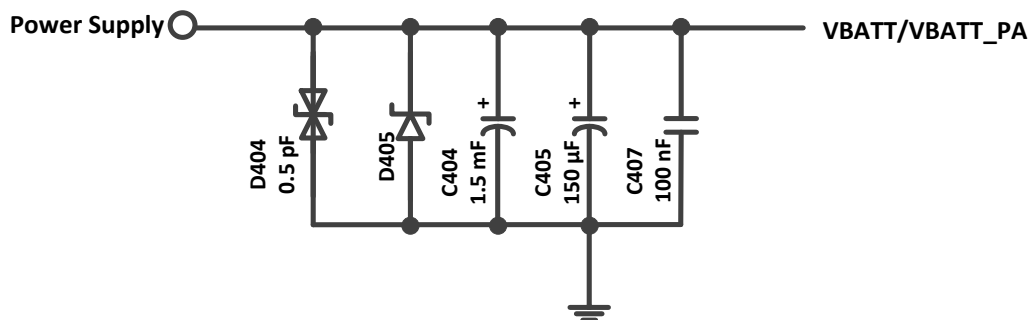
Figure 25.   Voltage Limiter Example

5.6.   ESD Guidelines for SIM Card

Decoupling capacitors must be added as close as possible to the SIM card connectors on UIM1_CLK, UIM1_RST, UIM1_VCC and UIM1_DATA signals to avoid EMC issues and to pass the SIM card type approval tests, according to the drawings below.

A typical schematic for hardware SIM detection is provided below.
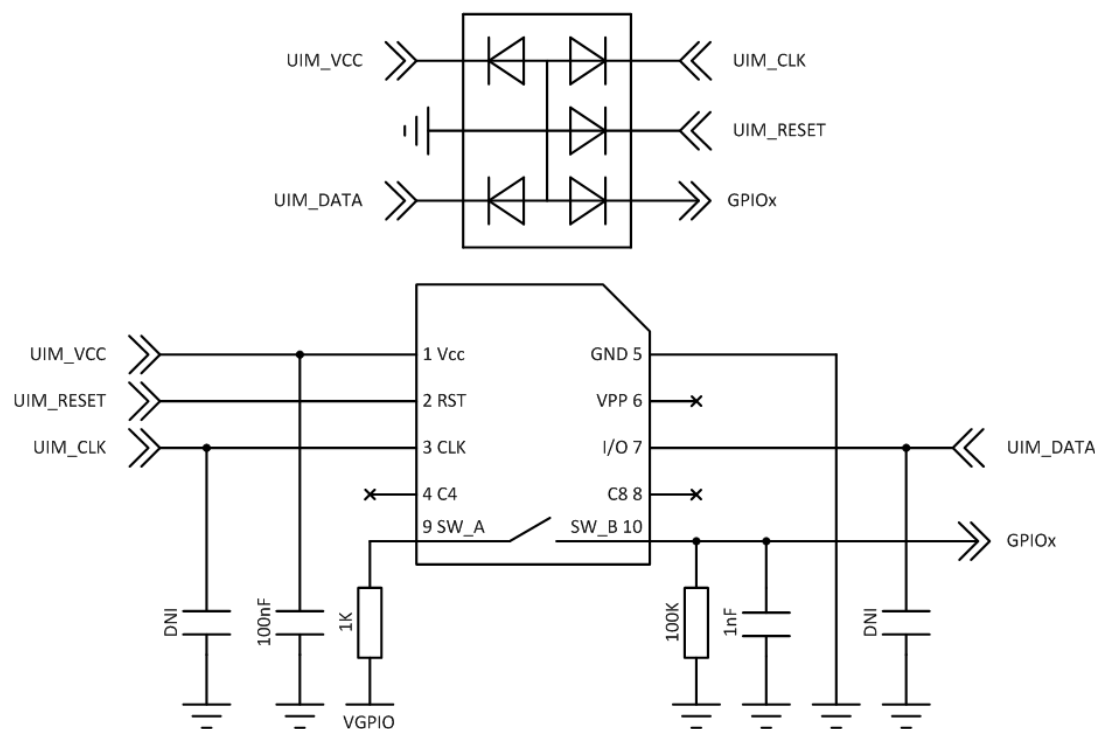
Figure 26.   EMC and ESD Components Close to the SIM

5.7.   ESD Guidelines for USB

When the USB interface is externally accessible, it is required to have ESD protection on the USB_VBUS, USB_D+ and USB_D- signals.
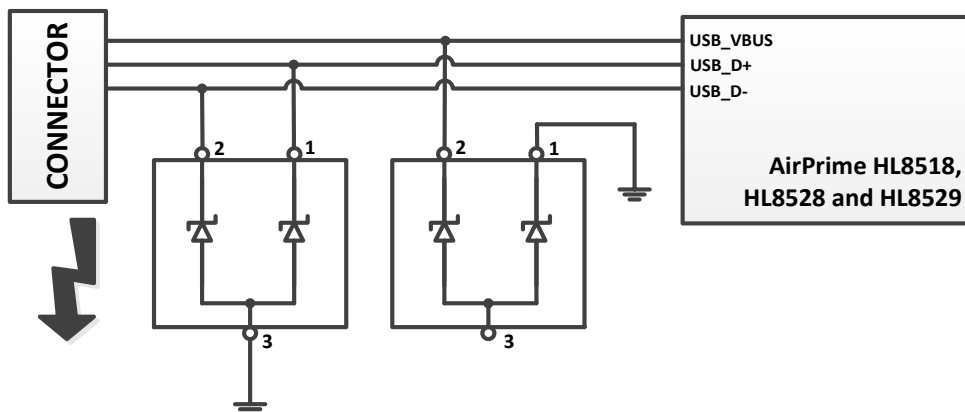
Figure 27.   ESD Protection for USB

Note: *It is not recommended to have an ESD diode with feedback path from USB_VBUS to either USB_D+ or USB_D-.*

5.8.   Dual SIM Application

Using an external switch and GPIOs, the AirPrime HL8518, HL8528 and HL8529 modules can support Dual SIM Single Standby with fast network switching. Refer to document [2] AirPrime HL6 and HL8 Series AT Commands Interface Guide for related AT commands.
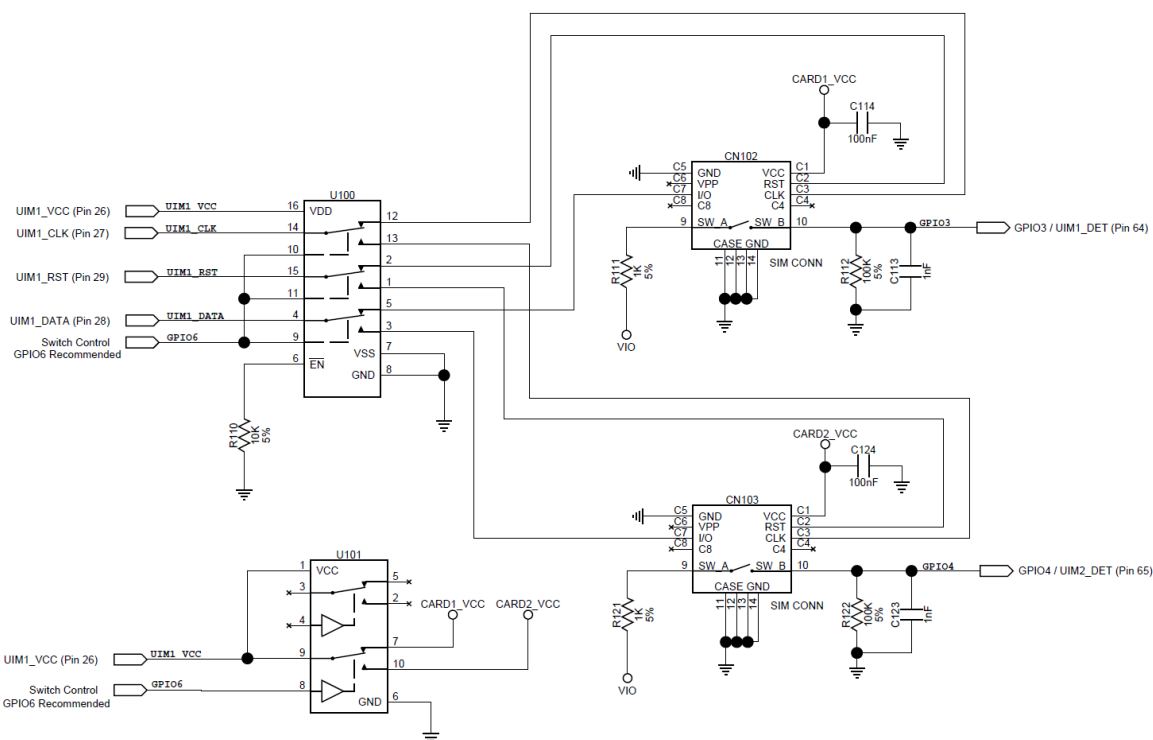
Figure 28.   Reference Design for Dual SIM Application

5.9.   Radio Frequency Integration

The AirPrime HL8518, HL8528 and HL8529 modules are equipped with an external antenna. A 50Ω line matching circuit between the module, the customer's board and the RF antenna is required, for GSM feed path, as shown in the example below.
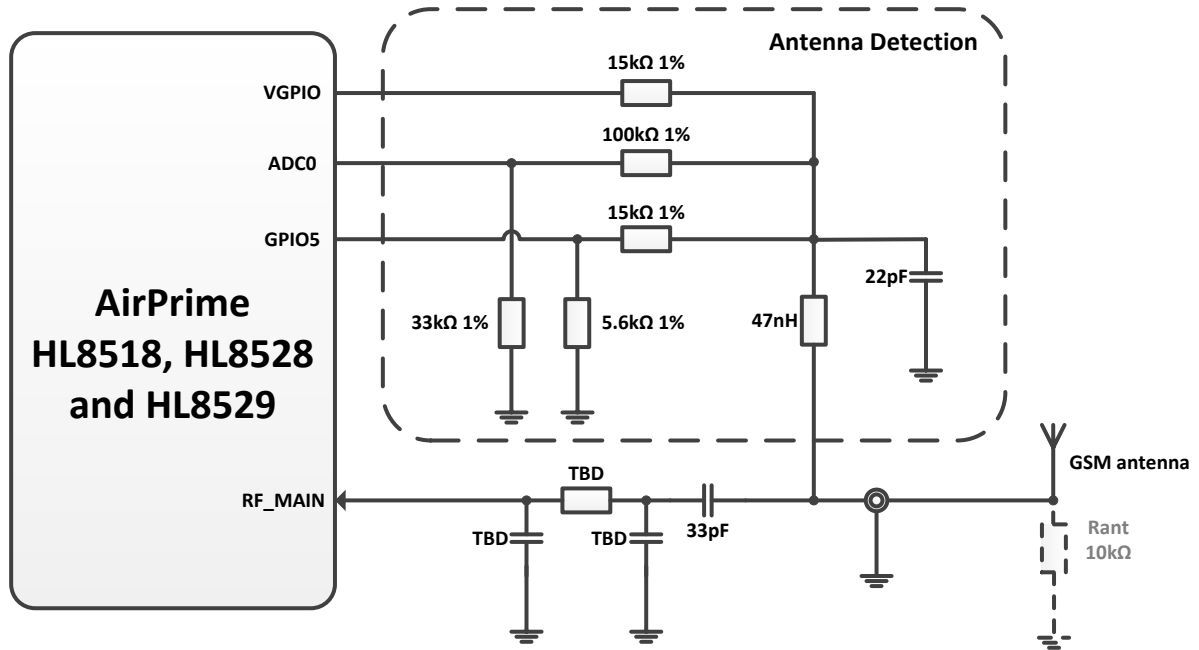
Figure 29.   GSM Antenna Connection with Antenna Detection

Note: Antenna detection circuit is optional. Rant is the equivalent DC terminating resistor of the antenna. Rant should be close to 10KΩ.

6. Reliability Specification

The AirPrime HL8518, HL8528 and HL8529 modules are tested against the Sierra Wireless Automotive Reliability Specification defined below.

6.1. Reliability Compliance

The AirPrime HL8518, HL8528 and HL8529 modules connected on a development kit board application is compliant with the following requirements.

Table 46.   Standards Conformity

Abbreviation	Definition
IEC	International Electro technical Commission
ISO	International Organization for Standardization

6.2. Reliability Prediction Model

6.2.1. Life Stress Test

The following tests the AirPrime HL8518, HL8528 and HL8529 modules' product performance.
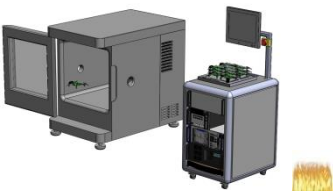
Table 47.   Life Stress Test

Designation	Condition
Performance Test PT3T° & PT	Standard: N/A

	Special conditions:
	• Temperature:
	  ▪ Class A: -30°C to +70°C
	  ▪ Class B: -40°C to +85°C
	• Rate of temperature change: ± 3°C/min
	• Recovery time: 3 hours

	Operating conditions: Powered
	Duration: 14 days

6.2.2.   Environmental Resistance Stress Tests

The following tests the AirPrime HL8518, HL8528 and HL8529 modules' resistance to extreme temperature.
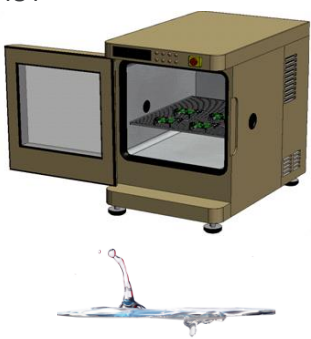
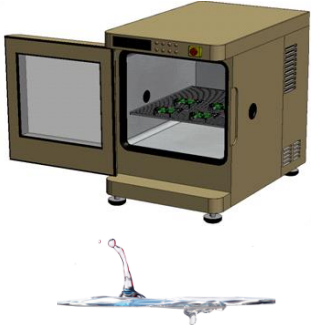**Table 48.   Environmental Resistance Stress Tests**

Designation	Condition
Cold Test Active **COTA** 	Standard: IEC 680068-2-1, Test Ad
	Special conditions: • Temperature: -40°C • Temperature variation: 1°C/min
	Operating conditions: Powered ON with a power cycle of 1 minute ON and 2 minutes OFF
	Duration: 3 days
Resistance to Heat Test **RH** 	Standard: IEC 680068-2-2, Test Bb
	Special conditions: • Temperature: +85°C • Temperature variation: 1°C/min
	Operating conditions: Powered ON with a power cycle of 15 minutes ON and 15 minutes OFF
	Duration: 50 days

6.2.3.   Corrosive Resistance Stress Tests

The following tests the AirPrime HL8518, HL8528 and HL8529 modules' resistance to corrosive atmosphere.

Table 49.   Corrosive Resistance Stress Tests

Designation	Condition
Humidity Test HUT 	Standard: IEC 60068-2-3, Test Ca
	Special conditions: • Temperature: +65°C • RH: 95% • Temperature variation: 3 ± 0.6°C/min
	Operating conditions: Powered on, DUT is powered up for 15 minutes and OFF for 15 minutes
	Duration: 10 days

Designation	Condition
Moist Heat Cyclic Test MHCT 	Standard: IEC 60068-2-30, Test Db

	Special conditions:
	• Upper temperature: +40 ± 2°C
	• Lower temperature: +25 ± 5°C
	• RH:
	  ▪ Upper temperature: 93%
	  ▪ Lower temperature: 95%
	• Number of cycles: 21 (1 cycle/24 hours)

	Operating conditions: Powered ON for 15 minutes during each 3 hours ramp up and 3 hours ramp down (in middle) for every cycle
	Duration: 21 days

6.2.4.   Thermal Resistance Cycle Stress Tests

The following tests the AirPrime HL8518, HL8528 and HL8529 modules' resistance to extreme temperature cycling.
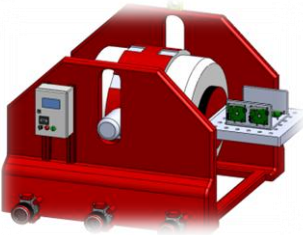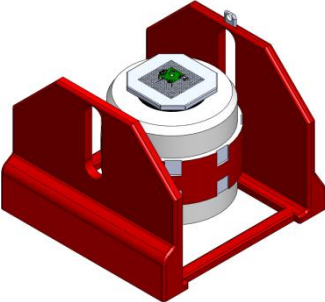
Table 50.   Thermal Resistance Cycle Stress Tests

Designation	Condition
Thermal Shock Test TSKT 	Standard: IEC 60068-2-14, Test Na
	Special conditions: • Temperature: -30°C to +80°C • Temperature Variation: less than 30s • Number of cycles: 600 • Dwell Time: 10 minutes
	Operating conditions: Un-powered
	Duration: 9 days
Temperature Change TCH 	Standard: IEC 60068-2-14, Test Nb
	Special conditions: • Temperature: -40°C to +90°C • Temperature Variation: 3 ± 0.6°C/min • Number of cycles: 400 • Dwell Time: 10 minutes
	Operating conditions: Un-powered
	Duration: 29 days

6.2.5.   Mechanical Resistance Stress Tests

The following tests the AirPrime HL8518, HL8528 and HL8529 modules' resistance to vibrations and mechanical shocks.
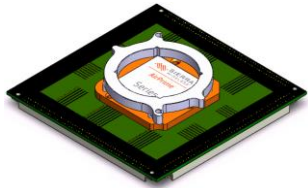
Table 51.   Mechanical Resistance Stress Tests

Designation	Condition
Sinusoidal Vibration Test SVT	Standard: IEC 60068-2-6, Test Fc

	Special conditions:
	
	• Frequency range: 16 Hz to 1000 Hz
	• Displacement: 0.35mm (peak-peak)
	• Acceleration:
	  ▪ 5G from 16 to 62 Hz
	  ▪ 3G from 62 to 200 Hz
	  ▪ 1G from 200 to 1000 Hz
	• Sweep rate: 1 octave / cycle
	• Number of Sweep: 20 sweeps / axis
	• Sweep direction: ± X, ± Y, ± Z

	Operating conditions: Un-powered
	Duration: 42 days
Random Vibration Test RVT	Standard: IEC 60068-2-64, Test Fh

	Special conditions:
	
	• Frequency range: 10 Hz – 2000 Hz
	• Power Spectral Density in [(m/s²)²/Hz]
	  ▪ 0.1 g2/Hz at 10Hz
	  ▪ 0.01 g2/Hz at 250Hz
	  ▪ 0.005 g2/Hz at 1000Hz
	  ▪ 0.005 g2/Hz at 2000Hz
	• Peak factor : 3
	• Duration per Axis : 1 hr / axis

	Operating conditions: Un-powered
	Duration: 1 day
Mechanical Shock Test MST	Standard: IEC 60068-2-27, Test Ea

	Special conditions:
	
	• Shock Test 1:
	  ▪ Wave form: Half sine
	  ▪ Peak acceleration: 30g
	  ▪ Duration: 11ms
	  ▪ Number of shocks: 8
	  ▪ Direction: ±X, ±Y, ±Z
	• Shock Test 2:
	  ▪ Wave form: Half sine
	  ▪ Peak acceleration: 100g
	  ▪ Duration: 6ms
	  ▪ Number of shocks: 3
	  ▪ Direction: ±X, ±Y, ±Z

	Operating conditions: Un-powered
	Duration: 72 hours

6.2.6.   Handling Resistance Stress Tests

The following tests the AirPrime HL8518, HL8528 and HL8529 modules' resistance to handling malfunctions and damage.

Table 52.   Handling Resistance Stress Tests

Designation	Condition
ESDC Test	Standard: JESD22-A114, JESD22-A115, JEDEC JESD 22 – C101C
	Special conditions: • HBM (Human Body Model) : 1kV (Class 1C) • MM (Machine Model): 200V (Class B) • CDM (Charged Device Model) : 250V (Class C1)
	Operating conditions: Powered
	Duration: 3 days
Free Fall Test **FFT**	Standard : IEC 60068-2-32, Test Ed
	Special conditions: • Number of drops: 2 drops per unit and per axis (total 12 drops) • Height: 1m
	Operating conditions: Un-powered
	Duration: 6 hours

7. Legal Information

7.1.   FCC Regulations

FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

IMPORTANT NOTE – FCC Radiation Exposure Statement:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

The AirPrime HL8528 and HL8529 modules are currently pending modular approval for mobile applications. Once approved, integrators may use the AirPrime HL8528 and HL8529 in their final products without additional FCC certification if they meet the following conditions. Otherwise, additional FCC approvals must be obtained.

1. At least 20 cm separation distance between the antenna and the user's body must be maintained at all times.
2. To comply with FCC 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:
   ▪ TBD dBi in the cellular band
   ▪ TBD dBi in the PCS band
3. The AirPrime HL8528 and HL8529 must not transmit simultaneously with other collocated radio transmitters within a host device.
4. The RF signal must be routed on the application board using tracks with a 50Ω characteristic impedance. Basically, the characteristic impedance depends on the dielectric, the track width and the ground plane spacing. In order to respect this constraint, Sierra Wireless recommends using MicroStrip or StripLine structure and computing the Tracks width with a simulation tool (like AppCad shown in the figure below and that is available free of charge at http://www.agilent.com).
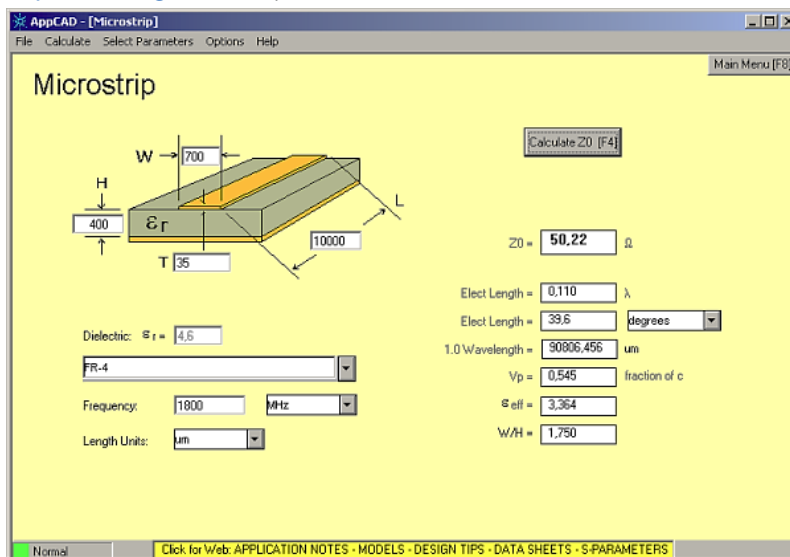
If a multi-layered PCB is used, the RF path on the board must not cross any signal (digital, analog or supply).

If necessary, use StripLine structure and route the digital line(s) "outside" the RF structure. An example of proper routing is shown in the figure below.

Stripline and Coplanar design requires having a correct ground plane at both sides. Consequently, it is necessary to add some vias along the RF path. 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 signal (when transmitting) may interfere with neighbouring electronics (AF amplifier, etc.). In the same way, the neighbouring electronics (micro-controllers, etc.) may degrade the reception performances. The GSM/GPRS connector is intended to be directly connected to a 50Ω antenna and no matching is needed.

5. A label must be affixed to the outside of the end product into which the AirPrime HL8528 and HL8529 modules are incorporated, with a statement similar to the following:

    This device contains FCC ID: **N7NHL8528** (for devices using the HL8528)

    This device contains FCC ID: **N7NHL8529** (for devices using the HL8529)

6. 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 RF exposure guidelines.

The end product with an AirPrime HL8528 and HL8529 modules 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.*

7.2. IC Regulations

IC Radiation Exposure Statement:

This equipment complies with IC RSS-102 radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

This device and its antenna(s) must not be co-located or operating in conjunction with any other antenna or transmitter.

This Class B digital apparatus complies with Canadian ICES-003.

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p) is not more than necessary for successful communication.

Labeling Requirements for the Host Device (from Section 7.2 of RSP-100, Issue 10, November 2014): The host device shall be properly labeled to identify the module within the host device. The Industry Canada certification label of a module shall be clearly visible at all times when installed in the host device, otherwise the host device must be labeled to display the Industry Canada certification number of the module, preceded by the words – Contains

transmitter module, or the word – Contains, or similar wording expressing the same meaning, as follows:

Contains transmitter module IC: **2417C-HL8528** (for devices using the HL8528)

Contains transmitter module IC: **2417C-HL8529** (for devices using the HL8529)

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device. Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence.

This radio transmitter (identify the device by certification number, or model number if Category II) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

- TBD dBi in Band 2
- TBD dBi in Band 5

Antenna types having a gain greater than the maximum gain indicated for that type are strictly prohibited for use with this device.

7.3.   CE Regulation

The minimum distance between the user and/or any bystander and the radiating structure of the transmitter is 20 cm.

Assessment of compliance of the product with the requirements relating to the Radio and Telecommunication Terminal Equipment Directive (EC Directive 1999/5/EC) was performed by PHOENIX TESTLAB (Notified Body No.0700).

$C\epsilon$ 0700

8. Conformance with ATEX

The AirPrime HL8518, HL8528 and HL8529 modules are intended for use in telecommunication equipment.

Table 53.   ATEX Conformance

Module	2G Bands	3G Bands	Sum of All Capacitors*	Sum of All Inductors*
HL8518	EGSM/DCS	Band I, Band VIII	140 μF	9.8 μH
HL8528	GSM850/PCS	Band II, Band V	142 μF	9.8 μH
HL8529	N/A	Band II, Band V	130 μF	9.8 μH

*   Including worst case tolerance rating 20%.

The AirPrime HL8518, HL8528 and HL8529 modules have a maximum potential difference, internally generated, of 30 V. This voltage may be reached under fault conditions; for example, on the RF feed in 850 and 900 MHz bands when the module is emitting at its maximum power, and only under certain circumstances (for instance very poor VSWR).

There are no cells, batteries or piezo electric devices (with the exception of commonly used radio parts such as quartz filters and SAW filters) inside the module.

The maximum RF output is 2W/1W in bands 850/900 and 1800/1900 at the RF output of the module when connected to a 50 Ω load.

Note: The AirPrime HL8518, HL8528 and HL8529 are not certified for ATEX environment usage.

9. Ordering information

Table 54.   Ordering Information

Model Name	Part Number	Designation
HL8518	1102589	HL8518
HL8528	1102576	HL8528
HL8529	1102578	HL8529
DEV-KIT	6000620	DEV-KIT, HL series

10. Terms and Abbreviations

Abbreviation	Definition
ADC	Analog to Digital Converter
AGC	Automatic Gain Control
AT	Attention (prefix for modem commands)
CDMA	Code Division Multiple Access
CF3	Common Flexible Form Factor
CLK	Clock
CODEC	Coder Decoder
CPU	Central Processing Unit
DAC	Digital to Analog Converter
DTR	Data Terminal Ready
EGNOS	European Geostationary Navigation Overlay Service
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EN	Enable
ESD	Electrostatic Discharges
ETSI	European Telecommunications Standards Institute
FDMA	Frequency-division multiple access
GAGAN	GPS aided geo augmented navigation
GLONASS	Global Navigation Satellite System
GND	Ground
GNSS	Global Navigation Satellite System
GPIO	General Purpose Input Output
GPRS	General Packet Radio Service
GSM	Global System for Mobile communications
Hi Z	High impedance (Z)
IC	Integrated Circuit
IMEI	International Mobile Equipment Identification
I/O	Input / Output
LED	Light Emitting Diode
LNA	Low Noise Amplifier
MAX	Maximum
MIN	Minimum
MSAS	Multi-functional Satellite Augmentation System
N/A	Not Applicable
PA	Power Amplifier
PC	Personal Computer
PCB	Printed Circuit Board
PCL	Power Control Level
PLL	Phase Lock Loop
PWM	Pulse Width Modulation

Abbreviation	Definition
QZSS	Quasi-Zenith Satellite System
RF	Radio Frequency
RFI	Radio Frequency Interference
RMS	Root Mean Square
RST	Reset
RTC	Real Time Clock
RX	Receive
SCL	Serial Clock
SDA	Serial Data
SIM	Subscriber Identification Module
SMD	Surface Mounted Device/Design
SPI	Serial Peripheral Interface
SW	Software
PSRAM	Pseudo Static RAM
TBC	To Be Confirmed
TBD	To Be Defined
TP	Test Point
TX	Transmit
TYP	Typical
UART	Universal Asynchronous Receiver-Transmitter
UICC	Universal Integrated Circuit Card
USB	Universal Serial Bus
UIM	User Identity Module
VBATT	Main Supply Voltage from Battery or DC adapter
VSWR	Voltage Standing Wave Ratio
WAAS	Wide Area Augmentation System