Product Technical Specification

AirPrime HL8518, HL8528 and HL8529

SIERRA WIRELESS®

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2.2
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Document History

Version	Date	Updates
1.0	May 20, 2015	Creation
1.1	May 29, 2015	Updated: • 1 Introduction • **Error! Reference source not found. Error! Reference source not found.** • **Error! Reference source not found. Error! Reference source not found.** • **Error! Reference source not found. Error! Reference source not found.**
		Deleted 4.1 Model Views
2.0	December 02, 2015	Added **Error! Reference source not found. Error! Reference source not found.**
		Updated: • Table 1 Supported Bands/Connectivity • 1.2 Physical Dimensions • Table 2 General Features • Table 3 ESD Specifications • 1.9 Environmental and Certifications • **Error! Reference source not found. Error! Reference source not found.** • Table 5 Power Supply • 2.4 Current DC Power Consumption • **Error! Reference source not found. Error! Reference source not found.** • **Error! Reference source not found. Error! Reference source not found.** • **Error! Reference source not found. Error! Reference source not found.** • **Error! Reference source not found. Error! Reference source not found.**
		Deleted HSIC
2.1	December 10, 2015	Updated Table 8 Current Consumption (at nominal voltage, 3.7V)
2.2	December 18, 2015	Updated Chapter 7 Regulatory Legal Information

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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)	HL8518	HL8528	HL8529
UMTS B1	1922 to1978 MHz	2112 to 2168 MHz	✓		
UMTS B2	1852 to 1908 MHz	1932 to 1988 MHz		✓	✓
UMTS B5	826 to 847 MHz	871 to 892 MHz		✓	✓
UMTS B8	882 to 913 MHz	927 to 958 MHz	✓		
GSM 850	824 to 849 MHz	869 to 894 MHz		✓	
E-GSM 900	880 to 915 MHz	925 to 960 MHz	✓		
DCS 1800	1710 to 1785 MHz	1805 to 1880 MHz	✓		
PCS 1900	1850 to 1910 MHz	1930 to 1990 MHz		✓	

1.1. Common Flexible Form Factor (CF^3)

The AirPrime HL8518, HL8528 and HL8529 belong to the Common Flexible Form Factor (CF^3) 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 CF^3 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.

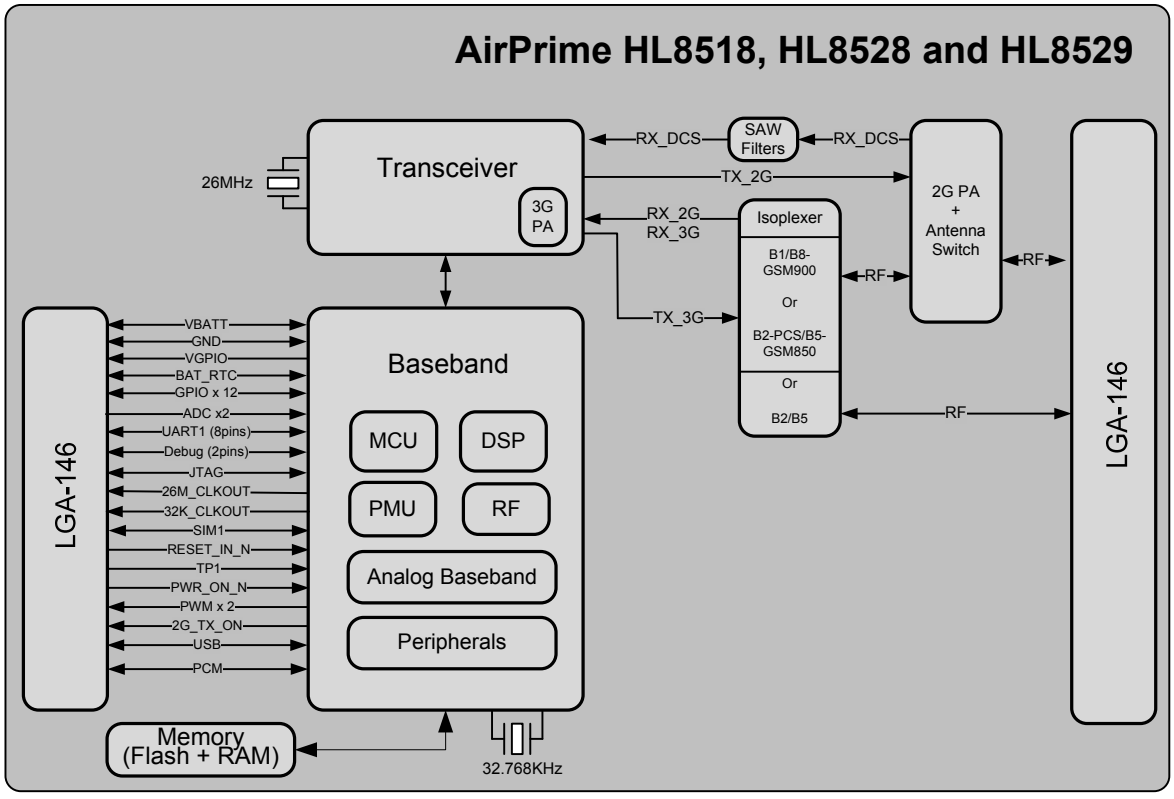

Figure 1. Architecture Overview

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.

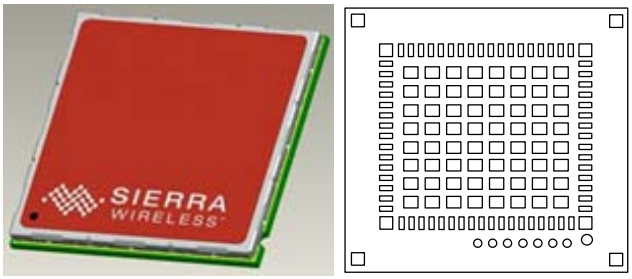

Figure 2. Mechanical Overview

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	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.
	Other host signals	

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.

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. 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.

2.1. Power Supply

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

2.1.1. Electrical Characteristics

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

Table 5. 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.

2.1.2. Pin Description

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

Table 6. 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

2.1.3. 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 2.3 Decoupling of Power Supply Signals.

The following table describes radio burst rates in connected mode. For detailed power consumption figures, refer to section 2.4 Current DC Power Consumption.

Table 7. 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.

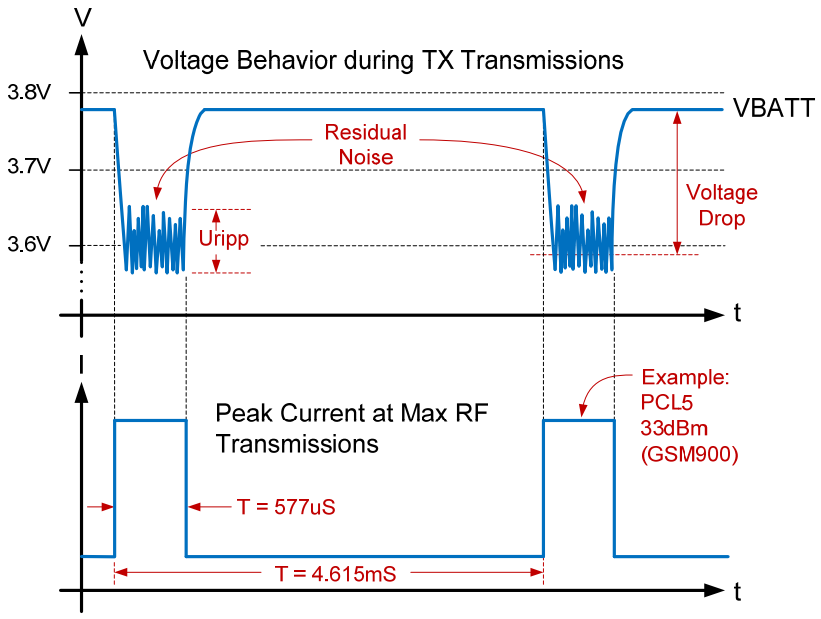

Figure 3. Power Supply During Burst Transmission

2.1.4. 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.

2.2. 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.

2.3. 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.

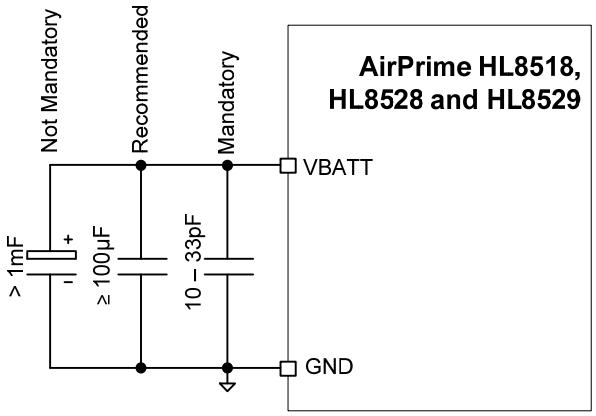

Figure 4. Power Supply Requirements

The figure below shows the power supply voltage drop shapes during GSM 2G transmission.

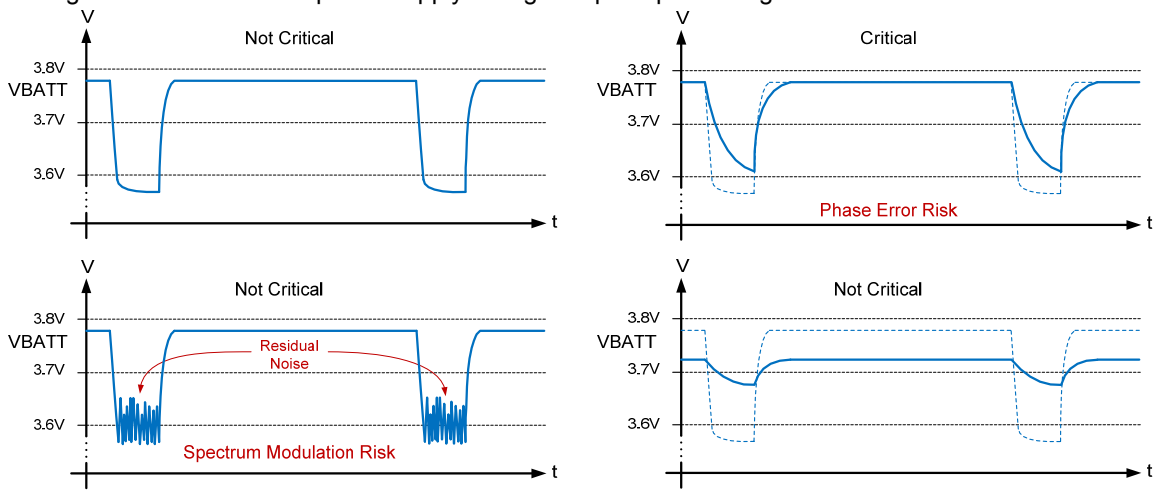

Figure 5. Power Supply Voltage Drops Shapes During Burst Transmission

2.4. 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 3.5 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 2.1 Power Supply.

Table 8. 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 9. 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

2.5. 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.

2.5.1. Electrical Characteristics

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

Table 10. 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

2.5.2. Pin Description

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

Table 11. VGPIO Pin Description

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

2.6. 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.

2.6.1. Electrical Characteristics

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

Table 12. 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.

2.6.2. Pin Description

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

Table 13. BAT_RTC Pin Description

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

2.7. 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 3.8 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)

2.7.1. Electrical Characteristics

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

Table 14. 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	-	

2.7.2. Pin Description

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

Table 15. 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

2.7.3. 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.

2.7.4. Application

2.7.4.1. Reference Schematic

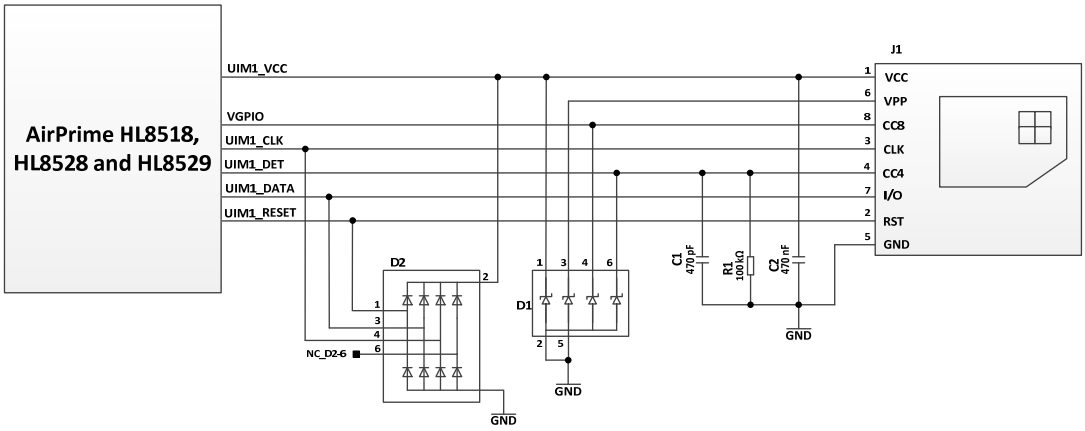

Figure 6. UIM1 Application Reference Schematic

2.7.4.2. USIM Socket Pin Description

The following table describes the required USIM socket pins.

Table 16. 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

2.8. USB

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

2.8.1. Electrical Characteristics

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

Table 17. 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

2.8.2. Pin Description

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

Table 18. 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.

2.9. 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 19. 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

2.10. General Purpose Input/Output (GPIO)

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

Table 20. 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.

2.11. 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.

2.11.1. Pin Description

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

Table 21. 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.

2.11.2. 8-wire Application

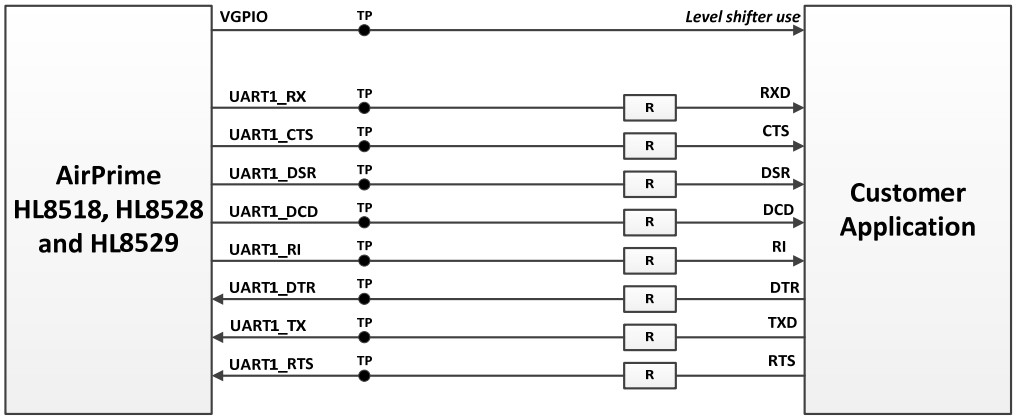

Figure 7. 8-wire UART Application Example

2.11.3. 4-wire Application

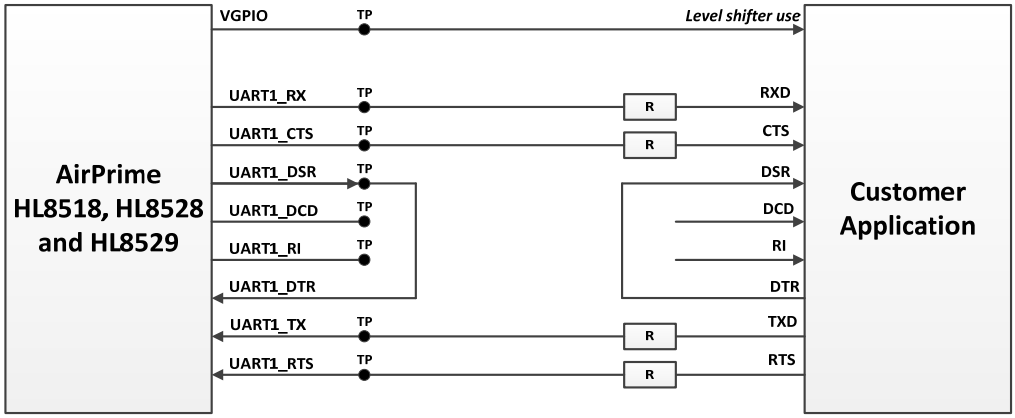

Figure 8. 4-wire UART Application Example

2.11.4. 2-wire Application

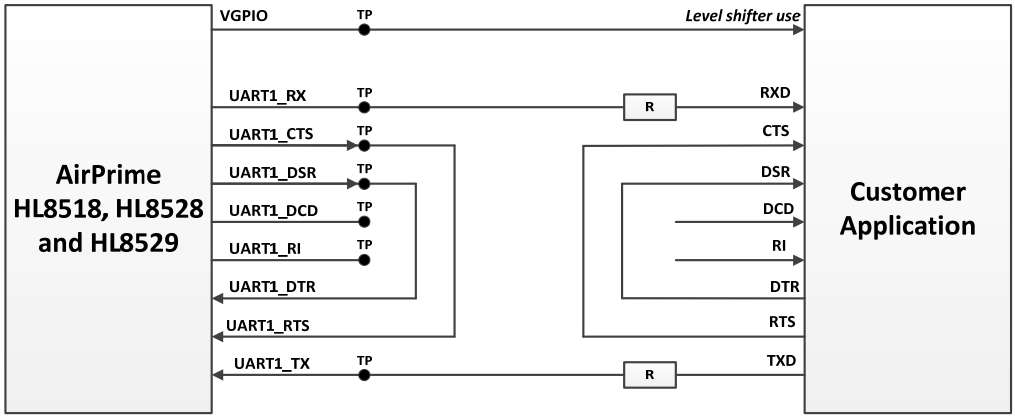

Figure 9. 2-wire UART Application Example

2.12. 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 22. 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.

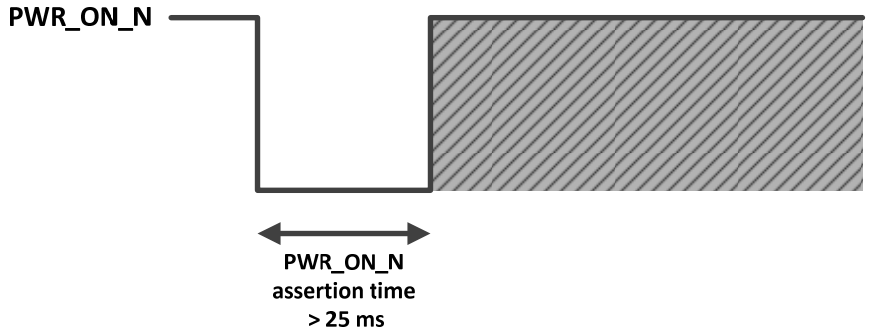

Figure 10. PWR_ON_N Assertion Time

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**.*

2.13. 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 23. 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. Design Guidelines

3.1. 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.

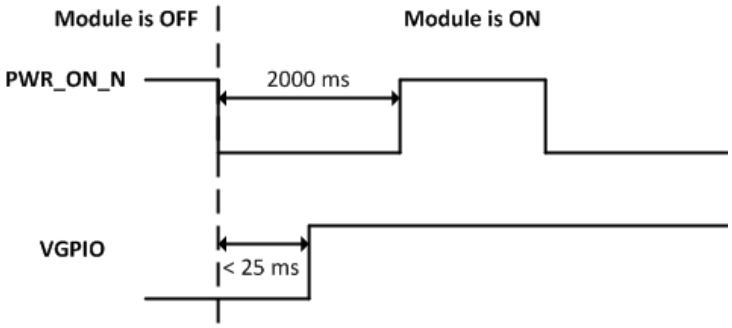

Figure 11. PWR_ON_N Sequence with VGPIO Information

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.

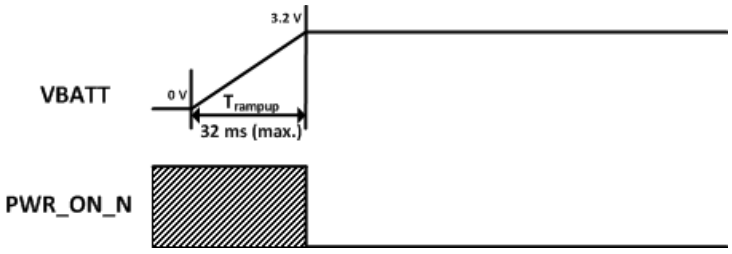

Figure 12. PWR_ON_N Sequence with T_{rampup}

3.2. 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.

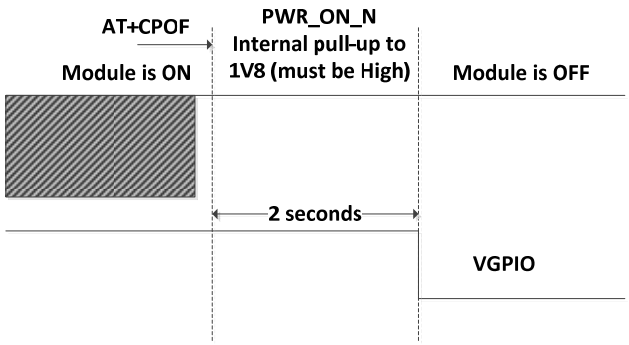

Figure 13. Power OFF Sequence for PWR_ON_N, VGPIO

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.*

3.3. 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.

3.4. Sleep Mode Management

3.4.1. 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.

3.4.2. Using USB

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

3.5. 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.

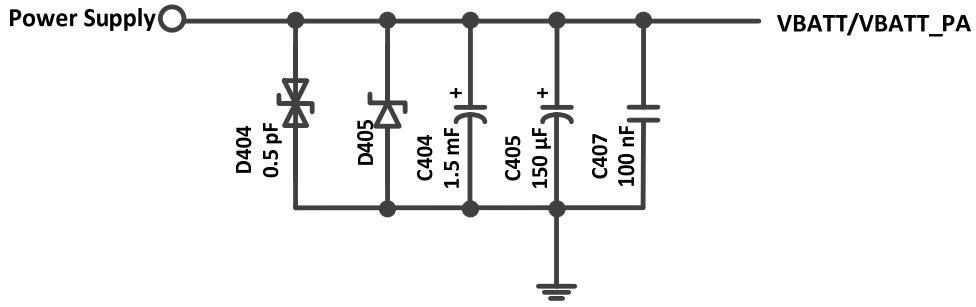

Figure 14. Voltage Limiter Example

3.6. 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.

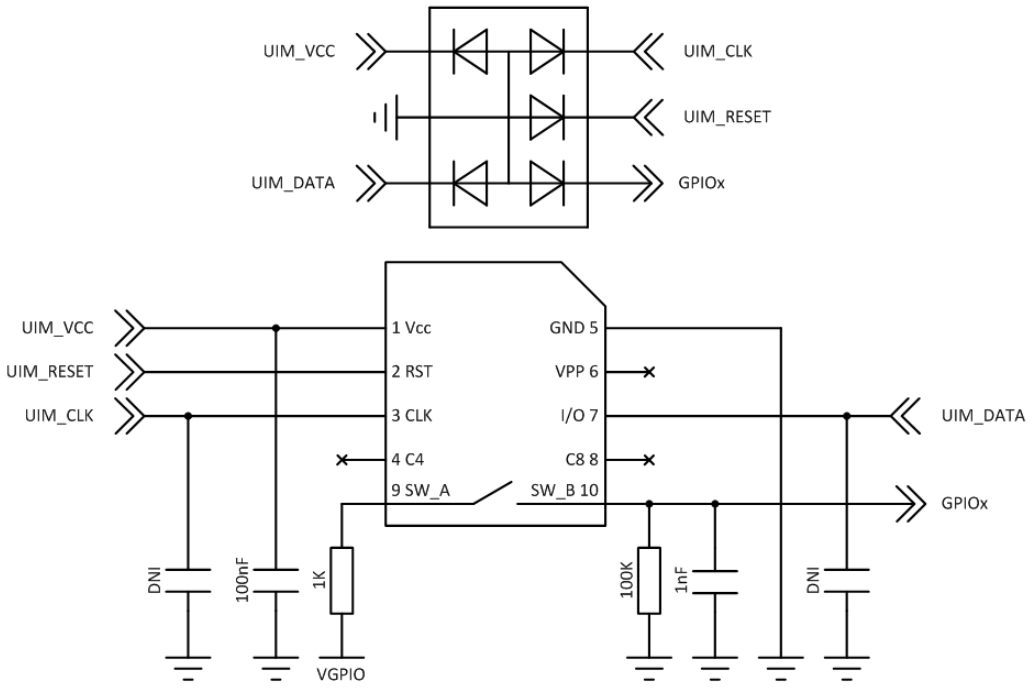

Figure 15. EMC and ESD Components Close to the SIM

3.7. 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.

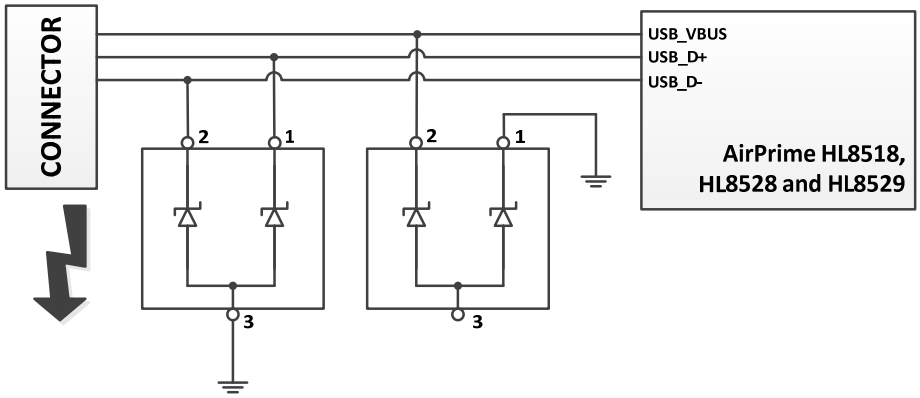

Figure 16. ESD Protection for USB

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

3.8. 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.

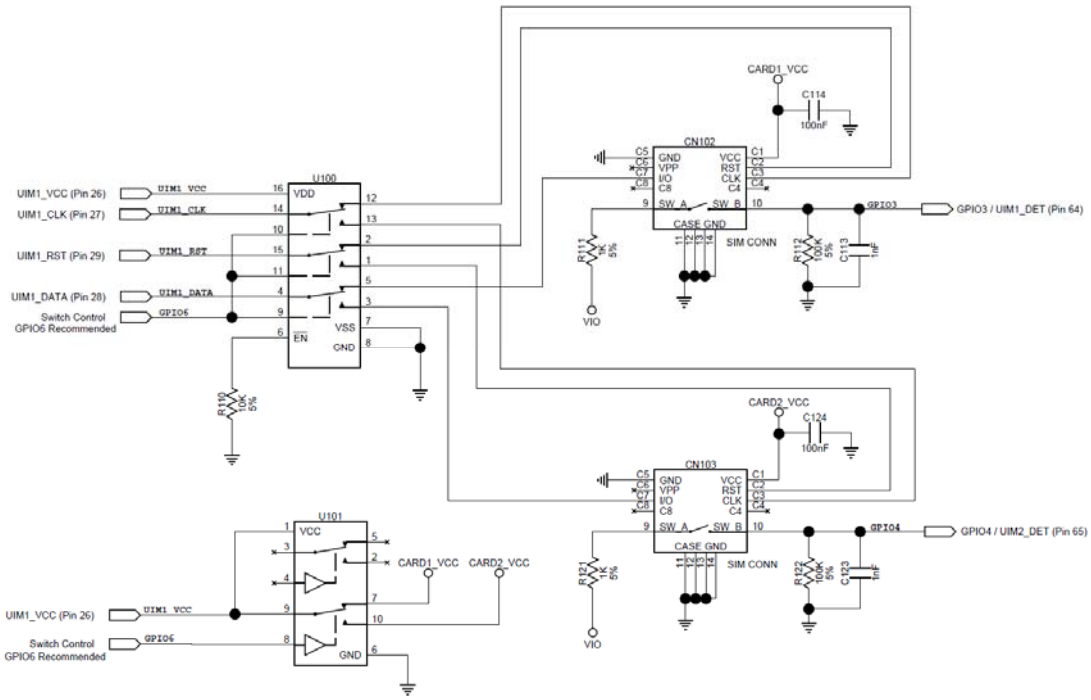

Figure 17. Reference Design for Dual SIM Application

3.9. 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.

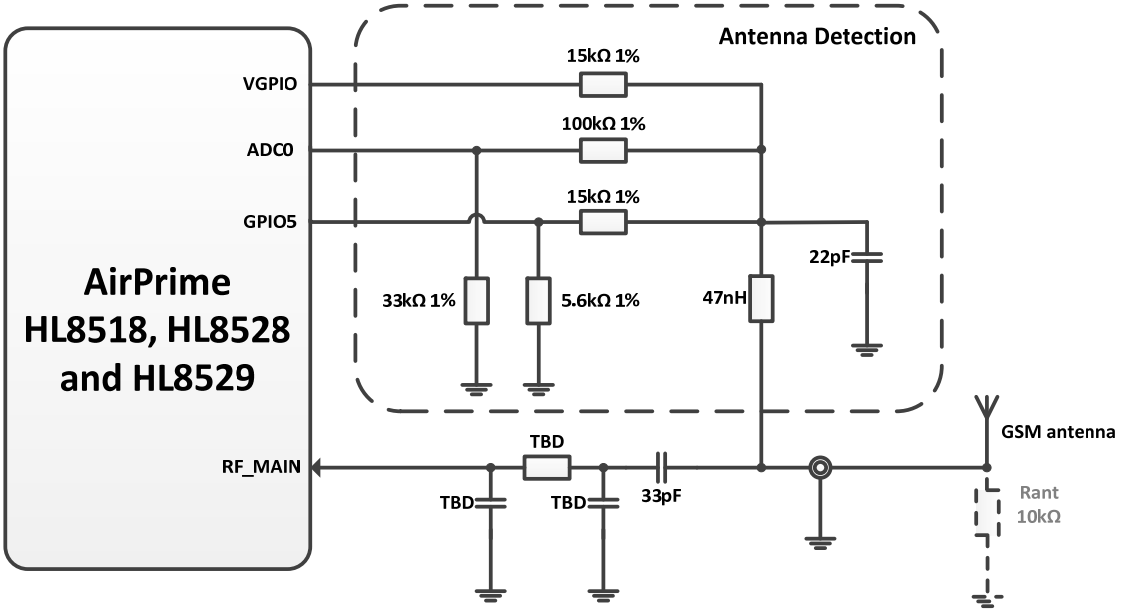

Figure 18. GSM Antenna Connection with Antenna Detection

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

4. Regulatory Legal Information

4.1. Label

The AirPrime HL852x module is labeled with its own FCC ID on the shield side. Each HL852x variant has its own FCC ID as listed in the table below.

Table 24. AirPrime HL852x FCC IDs

Model Name	FCC ID
HL8528	N7NHL8528
HL8529	N7NHL8529

When the module is installed in a customer's product, the FCC ID label on the module will not be visible. To avoid this case, an exterior label must be stuck on the surface of the customer's product to indicate the FCC ID of the enclosed module. This label can use wording such as the following: "Contains Transmitter module FCC ID: <FCC ID as listed in Table 24 AirPrime HL852x FCC IDs>" or "Contains FCC ID: <FCC ID as listed in Table 24 AirPrime HL852x FCC IDs>".

4.2. FCC Regulations

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

This device has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

1. Reorient or relocate the receiving antenna
2. Increase the separation between the equipment and receiver.
3. Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
4. Consult the dealer or an experienced radio/TV technician for help.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

4.3. RF Exposure Information

This Modular Approval is limited to OEM installation for mobile and fixed applications only. The antenna installation and operating configurations of this transmitter, including any applicable source-based time-averaging duty factor, antenna gain and cable loss must satisfy MPE categorical Exclusion Requirements of §2.1091.

The antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons, must not be collocated or operating in conjunction with any other antenna or transmitter, except in accordance with FCC multi-transmitter product procedures.

The end user has no manual instructions to remove or install the device and a separate approval is required for all other operating configurations, including portable configurations with respect to 2.1093 and different antenna configurations.

When the module is installed in the host device, the FCC ID label must be visible through a window on the final device or it must be visible when an access panel, door or cover is easily removed. Otherwise, a second label must be placed on the outside of the final device that contains the following text: —Contains FCC ID: <FCC ID as listed in Table 24 AirPrime HL852x FCC IDs>

4.4. IC Regulations

IC Radiation Exposure Statement:

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions:

a. this device may not cause interference, and
b. 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. L'exploitation est autorisée aux deux conditions suivantes:

(1) l'appareil ne doit pas produire de brouillage, et
(2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'entrainer des comportements non-desirés

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

Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.

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, RSS 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: <IC as listed below>.

Table 25. AirPrime HL852x IC

Model Name	IC
HL8528	2417C-HL8528
HL8529	2417C-HL8529

This device complies with IC radiation exposure limits set forth for an uncontrolled environment. In order to avoid the possibility of exceeding the IC radio frequency exposure limits, human proximity to the antenna shall not be less than 20cm (8 inches) during normal operation.

Cet appareil est conforme aux limites d'exposition aux rayonnements de la IC CNR-102 définies pour un environnement non contrôlé. Afin d'éviter la possibilité de dépasser les limites d'exposition aux fréquences radio de la IC CNR-102, la proximité humaine à l'antenne ne doit pas être inférieure à 20 cm (8 pouces) pendant le fonctionnement normal.

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.

4.5. CE Warning

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

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 Telefication BV (Notified Body No.0560)

CE 0560

5. 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