



Product Technical Specification

AirPrime HL6528-G



SIERRA
WIRELESS®

4114016
3.0
January 28, 2014

Important Notice

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

Safety and Hazards

Do not operate the Sierra Wireless modem in areas where cellular modems are not advised without proper device certifications. These areas include environments where cellular radio can interfere such as explosive atmospheres, medical equipment, or any other equipment which may be susceptible to any form of radio interference. The Sierra Wireless modem can transmit signals that could interfere with this equipment. Do not operate the Sierra Wireless modem in any aircraft, whether the aircraft is on the ground or in flight. In aircraft, the Sierra Wireless modem **MUST BE POWERED OFF**. When operating, the Sierra Wireless modem can transmit signals that could interfere with various onboard systems.

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

The driver or operator of any vehicle should not operate the Sierra Wireless modem while in control of a vehicle. Doing so will detract from the driver or operator's control and operation of that vehicle. In some states and provinces, operating such communications devices while in control of a vehicle is an offence.

Limitations of Liability

This manual is provided "as is". Sierra Wireless makes no warranties of any kind, either expressed or implied, including any implied warranties of merchantability, fitness for a particular purpose, or noninfringement. The recipient of the manual shall endorse all risks arising from its use.

The information in this manual is subject to change without notice and does not represent a commitment on the part of Sierra Wireless. SIERRA WIRELESS AND ITS AFFILIATES SPECIFICALLY DISCLAIM LIABILITY FOR ANY AND ALL DIRECT, INDIRECT, SPECIAL, GENERAL, INCIDENTAL, CONSEQUENTIAL, PUNITIVE OR EXEMPLARY DAMAGES INCLUDING, BUT NOT LIMITED TO, LOSS OF PROFITS OR REVENUE OR ANTICIPATED PROFITS OR REVENUE ARISING OUT OF THE USE OR INABILITY TO USE ANY SIERRA WIRELESS PRODUCT, EVEN IF SIERRA WIRELESS AND/OR ITS AFFILIATES HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES OR THEY ARE FORESEEABLE OR FOR CLAIMS BY ANY THIRD PARTY.

Notwithstanding the foregoing, in no event shall Sierra Wireless and/or its affiliates aggregate liability arising under or in connection with the Sierra Wireless product, regardless of the number of events, occurrences, or claims giving rise to liability, be in excess of the price paid by the purchaser for the Sierra Wireless product.

Customer understands that Sierra Wireless is not providing cellular or GPS (including A-GPS) services. These services are provided by a third party and should be purchased directly by the Customer.

SPECIFIC DISCLAIMERS OF LIABILITY: CUSTOMER RECOGNIZES AND ACKNOWLEDGES SIERRA WIRELESS IS NOT RESPONSIBLE FOR AND SHALL NOT BE HELD LIABLE FOR ANY DEFECT OR DEFICIENCY OF ANY KIND OF CELLULAR OR GPS (INCLUDING A-GPS) SERVICES.

Patents

This product may contain technology developed by or for Sierra Wireless Inc.

This product includes technology licensed from QUALCOMM®.

This product is manufactured or sold by Sierra Wireless Inc. or its affiliates under one or more patents licensed from InterDigital Group and MMP Portfolio Licensing.

Copyright

© 2014 Sierra Wireless. All rights reserved.

Trademarks

Sierra Wireless®, AirPrime®, AirLink®, AirVantage®, WISMO® and the Sierra Wireless and Open AT logos are registered trademarks of Sierra Wireless, Inc. or one of its subsidiaries.

Watcher® is a registered trademark of NETGEAR, Inc., used under license.

Windows® and Windows Vista® are registered trademarks of Microsoft Corporation.

Macintosh® and Mac OS X® are registered trademarks of Apple Inc., registered in the U.S. and other countries.

QUALCOMM® is a registered trademark of QUALCOMM Incorporated. Used under license.

Other trademarks are the property of their respective owners.

Contact Information

Sales Desk:	Phone:	1-604-232-1488
	Hours:	8:00 AM to 5:00 PM Pacific Time
	Contact:	http://www.sierrawireless.com/sales
Post:	Sierra Wireless 13811 Wireless Way Richmond, BC Canada V6V 3A4	
Technical Support:	support@sierrawireless.com	
RMA Support:	repairs@sierrawireless.com	
Fax:	1-604-231-1109	
Web:	http://www.sierrawireless.com/	

Consult our website for up-to-date product descriptions, documentation, application notes, firmware upgrades, troubleshooting tips, and press releases: www.sierrawireless.com

Document History

Version	Date	Updates
0.1	April 4th, 2013	Creation
0.2	May 13, 2013	Footprint definition update
0.3	May 24, 2013	Mechanical definition change,
0.4	May 31, 2013	Padout definition change Mechanical definition change
0.5	June 7, 2013	Add product label Correct max current Correct padout definition
0.6	June 8, 2013	Add 2G_TX_ON information Add VBATT_PA information
0.7	July 12, 2013	Added: <ul style="list-style-type: none"> 4 pin UART0 UIM1_DET and UIM2_DET signal on default pins References section Terms and Abbreviations chapter Corrected Module Tolerance Changed HL6528-G VBATT Max to 4.5V
1.0	July 23, 2013	Major changes to pin definitions: <ul style="list-style-type: none"> UART0 removed Add SPI for SW Traces Change I²C location Add TP1, TP2 pins Added customer guidelines including: <ul style="list-style-type: none"> Power_on sequence ESD Audio design Radio design
2.0	October 24, 2013	Added: <ul style="list-style-type: none"> CF3 pin information New product variants (HL6528-2.8V and HL6528-G2.8V) Antenna detection circuitry
		Updated: <ul style="list-style-type: none"> Module thickness from 2.55mm to 2.50mm Pin 57 to support BUZZER output Section 2 Pad Definition
3.0	January 28, 2014	Added: <ul style="list-style-type: none"> Weight in section 1.2 Physical Dimensions 1.4 Feature Restriction Table 38 AirPrime HL6528x FCC IDs Table 39 AirPrime HL6528x IC
		Updated: <ul style="list-style-type: none"> 3.2 Current Consumption 3.5 UIM Interface 3.18 GNSS Interface



Contents

1. INTRODUCTION	10
1.1. Common Flexible Form Factor (CF ³)	10
1.2. Physical Dimensions	11
1.3. General Features.....	11
1.4. Feature Restriction	12
1.5. GNSS Features	12
1.6. Architecture	13
1.7. Interfaces.....	13
1.8. Connection Interface	14
1.9. ESD	14
1.10. Environmental and Certifications.....	15
1.10.1. Environmental Specifications	15
1.10.2. Regulatory	15
1.10.3. RoHS Directive Compliant	17
1.10.4. Disposing of the Product	17
1.10.5. References	17
2. PAD DEFINITION	18
2.1.1. Pin Configuration (Top View)	23
3. DETAILED INTERFACE SPECIFICATIONS	24
3.1. Power Supply	24
3.2. Current Consumption	24
3.3. VGPIIO	26
3.4. BAT_RTC	27
3.5. UIM Interface	27
3.5.1. UIM1 Interface.....	27
3.5.2. UIM2 Interface.....	28
3.6. Electrical Information for Digital I/O.....	29
3.7. Main Serial Link (UART1).....	30
3.8. Power On Signal (PWR_ON)	31
3.9. Reset Signal (RESET).....	32
3.10. ADC	32
3.11. Analog Audio Interfaces	32
3.11.1. Analog Audio Input.....	33
3.11.2. Analog Audio Outputs	33
3.12. PCM.....	34
3.13. I ² C Interface.....	35
3.14. Debug Interfaces	35
3.14.1. SW Traces.....	35

3.14.2.	JTAG	36
3.15.	PPS (HL6528-G and HL6528-G2.8V only).....	36
3.16.	EXT_LNA_GPS_EN (HL6528-G and HL6528-G2.8V only)	37
3.17.	RF Interface.....	37
3.17.1.	RF Connection	37
3.17.2.	RF Performances	37
3.17.3.	TX Burst Indicator (2G_TX_ON)	37
3.18.	GNSS Interface	38
3.18.1.	GNSS Performances.....	39
3.18.2.	GNSS Antenna Interface.....	39
3.18.3.	GNSS Antenna Recommendations	40
3.19.	GPIO RESET/ DEFAULT states	40
4.	MECHANICAL DRAWINGS.....	43
5.	DESIGN GUIDELINES	46
5.1.	Power-Up Sequence	46
5.2.	Module Switch-Off	46
5.3.	Sleep Mode Management	47
5.4.	ESD Guidelines for UIM Cards.....	47
5.5.	Audio Integration	48
5.5.1.	Microphone Audio Design	48
5.5.2.	Speaker Audio Design	50
5.5.3.	Audio Layout Guidelines	51
5.6.	Radio Integration	53
5.6.1.	RF Routing Recommendations.....	53
5.6.2.	GSM Antenna Integration with Antenna Detection Circuitry	55
5.6.3.	GNSS Active Antenna Integration.....	56
6.	X-RAY EXPOSURE.....	57
7.	FLASH MEMORY ENDURANCE	57
8.	FCC/IC LEGAL INFORMATION.....	57
8.1.	Label.....	57
8.2.	FCC Regulations	58
8.3.	RF Exposure Information	58
8.4.	IC Regulations	59
9.	ORDERING INFORMATION	60
10.	TERMS AND ABBREVIATIONS	61



List of Figures

Figure 1.	AirPrime HL6528x Architecture Overview	13
Figure 2.	AirPrime HL6528x Module Mechanical Overview	14
Figure 3.	Pin Configuration	23
Figure 4.	UIM2 with an Analog Switch.....	29
Figure 5.	PWR_ON Sequence	31
Figure 6.	PCM Timing Waveform	35
Figure 7.	2G_TX_ON State during TX Burst	38
Figure 8.	AirPrime HL6528x (angular view).....	43
Figure 9.	AirPrime HL6528x (side view)	44
Figure 10.	AirPrime HL6528x Module (top view).....	44
Figure 11.	AirPrime HL6528x Module (bottom view with dimensions).....	45
Figure 12.	UART Signals during the Power ON Sequence.....	46
Figure 13.	Power OFF Sequence for PWR_ON, VGPIO and CTS.....	46
Figure 14.	EMC and ESD Components Close to the UIM.....	47
Figure 15.	Example of a MIC Input Connection with LC Filter	48
Figure 16.	Example of a MIC Input Connection without LC Filter	48
Figure 17.	Example of a Single-Ended MIC Input Connection with LC Filter.....	49
Figure 18.	Example of a Single-Ended MIC Input Connection without LC Filter.....	49
Figure 19.	Example of a Differential Connection for SPKR.....	50
Figure 20.	Example of a Single-Ended Speaker Connection (typical implementation).....	51
Figure 21.	Audio Track Design	51
Figure 22.	Differential Audio Connection.....	52
Figure 23.	Single-Ended Audio Connection	52
Figure 24.	AppCAD Screenshot for Microstrip Design Power Mode Diagram	53
Figure 25.	RF Routing Examples	54
Figure 26.	Coplanar Clearance Example	54
Figure 27.	Antenna Microstrip Routing Example.....	55
Figure 28.	GSM Antenna Connection with Antenna Detection	55
Figure 29.	GNSS Application with Active Antenna.....	56



List of Tables

Table 1.	Supported Frequencies	10
Table 2.	AirPrime HL6528x Features	11
Table 3.	GNSS Capabilities	12
Table 4.	AirPrime HL6528x Module Environmental Specifications	15
Table 5.	Regulation Compliance	15
Table 6.	Pad Description	18
Table 7.	Power Supply	24
Table 8.	Current Consumption	24
Table 9.	Current Consumption per power supply VBATT / VBATT_PA	25
Table 10.	VGPIO Electrical Characteristics.....	26
Table 11.	BAT_RTC Electrical Characteristics.....	27
Table 12.	Electrical Characteristics of UIM1	27
Table 13.	Electrical Characteristics of UIM2	28
Table 14.	UIM2_VCC_CTRL Analog Switch Truth Table	29
Table 15.	Digital I/O Electrical Characteristics	29
Table 16.	UART1 Pin Description	30
Table 17.	PWR_ON Electrical Characteristics	31
Table 18.	ADC Electrical Characteristics	32
Table 19.	Analog Audio Interface Input	33
Table 20.	Analog Audio Interface Output	33
Table 21.	Recommended Speaker Characteristics.....	33
Table 22.	Digital Audio Interface Electrical Characteristics.....	34
Table 23.	I ² C Pin Description	35
Table 24.	SPI Pin Description	36
Table 25.	JTAG Pin Description	36
Table 26.	PPS Electrical Characteristics.....	36
Table 27.	EXT_LNA_GPS_EN Electrical Characteristics	37
Table 28.	RF Connection.....	37
Table 29.	Burst Indicator States	38
Table 30.	TX Burst Characteristics.....	38
Table 31.	GNSS Interface Specifications	39
Table 32.	GNSS Antenna Specifications.....	39
Table 33.	GNSS Antenna Recommendations.....	40
Table 34.	Pad Description	40
Table 35.	Recommended Components for a Microphone Connection	49
Table 36.	Recommended Components for a Single-Ended Microphone Connection	50
Table 37.	Speaker Details	50

Table 38.	AirPrime HL6528x FCC IDs	58
Table 39.	AirPrime HL6528x IC number	59



1. Introduction

This document defines the high level product features and illustrates the interfaces for the AirPrime HL6528x series of embedded modules. This document is intended to cover the hardware aspects of the product series, including electrical and mechanical.

Variants covered in this document are:

- HL6528
- HL6528-G
- HL6528-2.8V
- HL6528-G2.8V

The AirPrime HL6528 and HL6528-G modules are 1.8V IO modules as defined in section 2 Pad Definition. 2.8V IO variants are also available, and defined throughout this document as HL6528-2.8V and HL6528-G2.8V. HL6528x denotes applicability to all four variants.

The AirPrime HL6528x belongs to the AirPrime HL Series from Essential Connectivity Module family. This is an Industrial Grade quad-band GSM/GPRS Embedded Wireless Module, designed for the automotive market and any other market with similar quality and life-time support requirements. The following table enumerates the frequencies supported by the HL6528x module.

Table 1. Supported Frequencies

RF Band	Transmit band (Tx)	Receive band (Rx)	Maximum Output Power
GSM 850	824 to 849 MHz	869 to 894 MHz	2 Watts GSM & GPRS
E-GSM 900	880 to 915 MHz	925 to 960 MHz	2 Watts GSM & GPRS
DCS 1800	1710 to 1785 MHz	1805 to 1880 MHz	1 Watt GSM & GPRS
PCS 1900	1850 to 1910 MHz	1930 to 1990 MHz	1 Watt GSM & GPRS

This module supports a large variety of interfaces such as Analog & Digital Audio and Dual UIM Dual Standby to provide customers with the highest level of flexibility in implementing high-end solutions.

In addition to having the same features as AirPrime HL6528 and HL6528-2.8V modules, the AirPrime HL6528-G and HL6528-G2.8V modules also embed a high-performance GNSS receiver.

1.1. Common Flexible Form Factor (CF³)

The AirPrime HL6528x module belongs to the Common Flexible Form Factor (CF³) family of modules. This family consists of a series of WWAN modules that share the same mechanical dimensions (same width and length with varying thicknesses) and footprint. The CF³ form factor provides a unique solution to a series of problems faced commonly in the WWAN module space as it:

- Accommodates multiple radio technologies (from 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 HL6528x modules are compact size, robust, fully shielded modules with:

- Length: 23 mm
- Width: 22 mm
- Thickness: 2.50 mm (including the label)
- Weight : 2.25g

Note: *Dimensions specified above are typical values.*

1.3. General Features

The table below summarizes the AirPrime HL6528x module features.

Table 2. AirPrime HL6528x Features

Feature	Description
GSM/DCS Output Power	<ul style="list-style-type: none"> • Class 4 (2 W) for GSM 850 and E-GSM • Class 1 (1 W) for DCS and PCS
GPRS	<ul style="list-style-type: none"> • Quad-band GSM850/E-GSM/DCS/PCS • GPRS Multi-slot class 10 • R99 support • PBCCH support • Coding schemes: CS1 to CS4
Audio Interface	<ul style="list-style-type: none"> • Analog and Digital interfaces • Supports Full Rate (FR), Enhanced Full Rate (EFR), Half Rate (HR) and Adaptive Multi Rate (AMR) • Noise reduction and echo cancellation • DTMF generation
UIM Interface	<ul style="list-style-type: none"> • Dual UIM Dual Standby support • 1.8V/3.0V support for UIM1 • 3V interface for UIM2 • Supports UIM application tool kit with proactive UIM commands
Application Interface	<ul style="list-style-type: none"> • Full set of AT commands for GSM/GPRS including GSM 07.07 and 07.05 AT command sets • Comprehensive set of dedicated AT commands for M2M applications
SMS	<ul style="list-style-type: none"> • SMS class 0,1 and 2 • SMS MT, MO • SMS storage into UIM card or Flash memory • Concatenation of MT SMS
Supplementary Services	<ul style="list-style-type: none"> • Call Forwarding • Call Barring • Multiparty Service • Call Waiting • Call Hold • USSD • Automatic answer

Feature	Description
RTC	Real Time Clock (RTC) with calendar and alarm
Temperature Sensor	<ul style="list-style-type: none"> • Temperature monitoring • Alarms

1.4. Feature Restriction

The AirPrime HL6528-G and HL6528-G2.8V modules are not compatible with TTS (Text To Speech) feature, which is part of AVL (Automatic Vehicle Location) feature.

1.5. GNSS Features

The table below summarizes the GNSS capabilities of the AirPrime HL6528-G and HL6528-G2.8V modules.

Table 3. GNSS Capabilities

Feature	Description
GPS	L1 band (CDMA 1575.42 MHz)
GLONASS	L1 Band (FDMA 1602MHz)
SBAS	WAAS, EGNOS, MSAS, GAGAN, QZSS
Channels	52
Antenna	Passive or active antenna support
Assistance data	Server-generated Extended Ephemeris

1.6. Architecture

The figure below presents an overview of the AirPrime HL6528x module internal architecture and external interfaces.

Note: Dotted parts are only supported on the AirPrime HL6528-G and HL6528-G2.8V.

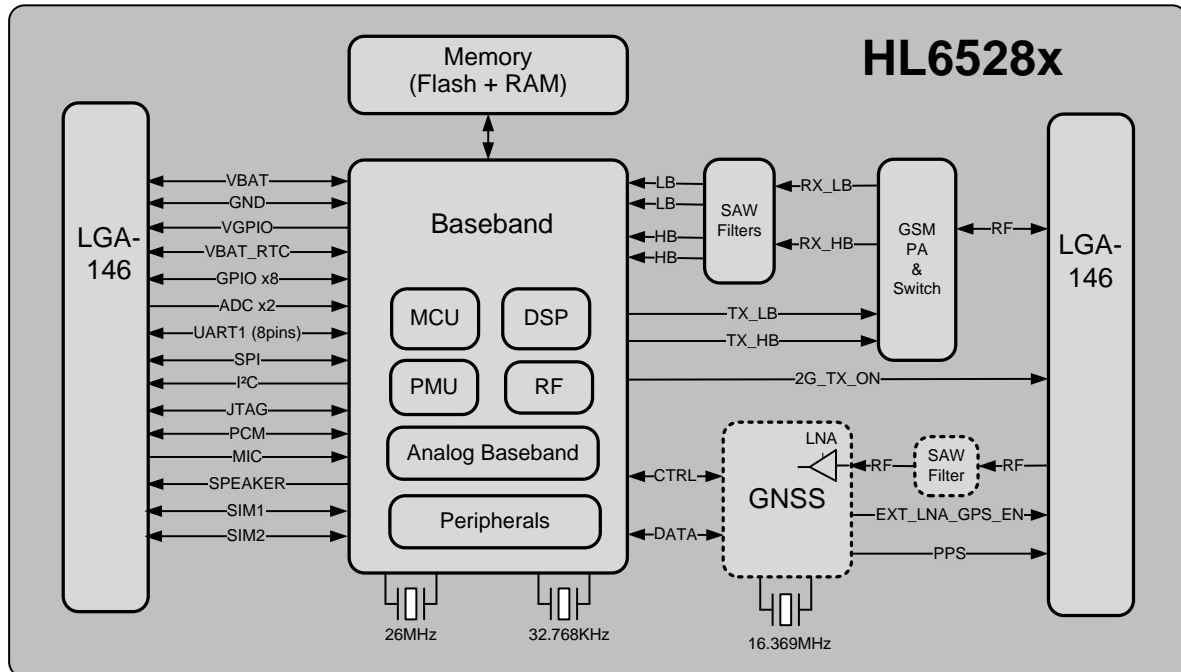


Figure 1. AirPrime HL6528x Architecture Overview

1.7. Interfaces

The AirPrime HL6528 and HL6528-2.8V modules provide the following interfaces and peripheral connectivity:

- 1 8-pin UART
- Active Low RESET
- Active Low POWER-ON
- 1 1.8V/3V UIM
- 1 UIM 3V
- 1 Analog Audio Interface (Differential input/output)
- 1 Digital Audio
- 2 ADC
- 1 JTAG Interface
- 8 GPIOs with I²C multiplexes
- 2G TX Burst Indicator
- GSM Antenna

Note: SPI interface is ONLY dedicated to SW traces debug.

In addition to the interfaces above, the AirPrime HL6528-G and HL6528-G2.8V modules also provide the following interfaces and peripheral connectivity:

- GPS Antenna
- External LNA Enable/Disable
- Pulse Per Second

1.8. Connection Interface

The AirPrime HL6528x module is an LGA form factor device. All electrical and mechanical connections are made through the 146 pads Land Grid Array (LGA) on the bottom side PCB.

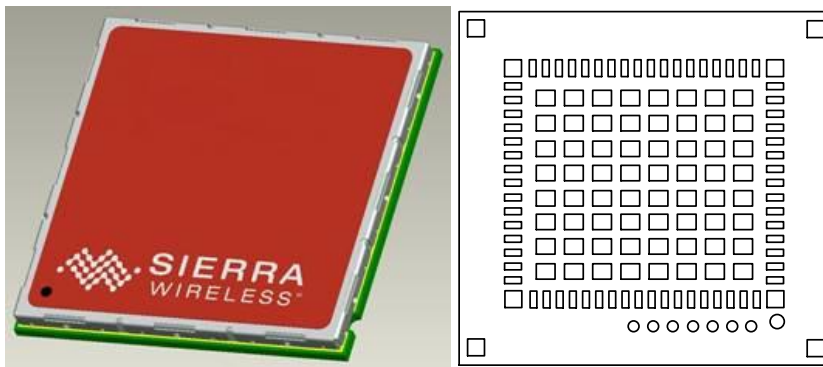


Figure 2. AirPrime HL6528x Module Mechanical Overview

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

1.9. ESD

According to IEC61000-4-2 model, the AirPrime HL6528x module can stand for:

- +/-2kV ESD on all the LGA pins
- +/-8kV ESD on RF pins

1.10. Environmental and Certifications

1.10.1. Environmental Specifications

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

Table 4. AirPrime HL6528x Module Environmental Specifications

Conditions	Range
Operating Class A	-30°C to +70°C
Operating Class B	-40°C to +85°C
Storage	-40°C to +90°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.

1.10.2. Regulatory

The AirPrime HL6528x module is compliant with the following regulations: R&TTE directive, GCF-CC, CE marking, FCC, and PTCRB.

Table 5. Regulation Compliance

Document	Current Version	Title
NAPRD.03	v5.10 (2012-01)	Overview of PCS Type certification review board (PTCRB) Mobile Equipment Type Certification and IMEI control
GCF-CC	v3.45.1 (2012-03)	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

Document	Current Version	Title
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 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
FCC Part 15B	NA	Subpart B - Radio frequency devices subpart B – Unintentional Radiators
FCC Part 22H	NA	Cellular Radiotelephone Service; Subpart H: Cellular Radiotelephone Service
FCC Part 24E	NA	Personal Communications Service; Subpart E: Broadband PCS.
RSS-132	Issue 2:2005	Cellular telephones employing new technologies operating in the 824-849 MHz and 869-894 MHz bands.
RSS-133	Issue 5:2009	2 GHz personal communications services
AS/ACIF S042.1	2008	Requirements for connection to an air interface of a telecommunications network Part 1; General
AS/ACIF S042.3	2005	Requirements for connection to an air interface of a Telecommunications Network - Part 3: GSM Customer Equipment
AS/NZS 60950.1	2011	Safety of information technology equipment (IEC 60950-1, Ed.2.0: 2005, MOD)
SRRC	NA	State Radio Regulation Center - China Type Approval

1.10.3. RoHS Directive Compliant

The AirPrime HL6528x module is 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)”.

1.10.4. 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.



1.10.5. References

- [1] AirPrime HL Series Customer Process Guidelines
Reference Number: 4114330
- [2] AirPrime HL6 and HL8 Series AT Commands Interface Guide
Reference Number: 4114680

2. >

Pad Definition

AirPrime HL6528x module 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 CF³ family of modules. These Core functions are always available and always at the same physical pin locations. A customer platform using only these functions and associated pins is guaranteed to be forward and/or backward compatible with the next generation of CF³ modules.
- **Extension functions and associated pins** bring additional capabilities to the customer. Whenever an Extension function is available on a module, it is always at the same pin location.
- **Custom functions and associated pins** 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 CF³ modules.

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

Table 6. Pad Description

Pin #	Signal Name	Function	I/O	Active Low/ High	IO Voltage Domain for HL6528 and HL6528-G	IO Voltage Domain for HL6528-2.8V and HL6528-G2.8V	Recommendation for Unused Pins	Type
1	GPIO1/I2C1_CLK	General purpose input/output/I ² C Clock	I/O		1.8V	2.8V	Left Open	Extension
2	UART1_RI	UART1: Ring indicator	O		1.8V	2.8V	Left Open	Core
3	UART1_RTS	UART1: Request to send	I	L	1.8V	2.8V	Connect to UART1_CTS	Core
4	UART1_CTS	UART1: Clear to send	O	L	1.8V	2.8V	Connect to UART1_RTS	Core
5	UART1_TX	UART1: Transmit data	I		1.8V	2.8V	Mandatory connection	Core
6	UART1_RX	UART1: Receive data	O		1.8V	2.8V	Mandatory connection	Core
7	UART1_DTR	UART1: Data terminal ready	I	L	1.8V	2.8V	Connect to UART1_DSR	Core
8	UART1_DCD	UART1: Data carrier detect	O	L	1.8V	2.8V	Left Open	Core

Pin #	Signal Name	Function	I/O	Active Low/ High	IO Voltage Domain for HL6528 and HL6528-G	IO Voltage Domain for HL6528-2.8V and HL6528-G2.8V	Recommendation for Unused Pins	Type
9	UART1_DSR	UART1: Data set ready	O	L	1.8V	2.8V	Connect to UART1_DTR	Core
10	GPIO2/UIM2_VCC_CTL	General purpose input/output (UIM2 VCC Control	I/O		1.8V	2.8V	Left Open	Core
11	RESET_IN	Input reset signal	I	L	1.8V	2.8V	Left Open (Test point recommended)	Core
12	NC	Not Connected						Not Connected
13	NC	Not Connected						Not Connected
14	NC	Not Connected						Not Connected
15	NC	Not Connected						Not Connected
16	NC	Not Connected						Not Connected
17	SPKR_N	Speaker negative output (32Ω impedance)	O		2.8V	2.8V	Left Open	Extension
18	SPKR_P	Speaker positive output (32Ω impedance)	O		2.8V	2.8V	Left Open	Extension
19	MIC_P	Microphone positive input	I		2.8V	2.8V	Left Open	Extension
20	MIC_N	Microphone negative input	I		2.8V	2.8V	Left Open	Extension
21	BAT_RTC	Power supply for RTC backup	I/O		3.0V	3.0V	C=10μF	Extension
22	TP2	Factory use only	I	L	1.8V	2.8V	Mandatory Left Open	Custom
23	NC	Not Connected						Not Connected
24	ADC1	Analog to digital conversion	I		2.8V	2.8V	Connected to Ground	Extension
25	ADC0	Analog to digital conversion	I		2.8V	2.8V	Connected to Ground	Extension
26	UIM1_VCC	1.8V/3V UIM1 Power supply	O		1.8V/3V	1.8V/3V	Mandatory connection	Core

Pin #	Signal Name	Function	I/O	Active Low/ High	IO Voltage Domain for HL6528 and HL6528-G	IO Voltage Domain for HL6528-2.8V and HL6528-G2.8V	Recommendation for Unused Pins	Type
27	UIM1_CLK	1.8V/3V UIM1 Clock	O		1.8V/3V	1.8V/3V	Mandatory connection	Core
28	UIM1_DATA	1.8V/3V UIM1 Data	I/O		1.8V/3V	1.8V/3V	Mandatory connection	Core
29	UIM1_RESET	1.8V/3V UIM1 Reset	O	L	1.8V/3V	1.8V/3V	Mandatory connection	Core
30	NC	NC (Reserved for 3G compatibility)						Not Connected
31	NC	NC (Reserved for 3G compatibility)						Not Connected
32	NC	NC (Reserved for 3G compatibility)						Not Connected
33	PCM_OUT	PCM data out	O		2.8V	2.8V	Left Open	Extension
34	PCM_IN	PCM data in	I		2.8V	2.8V	Left Open	Extension
35	PCM_SYNC	PCM sync out	I/O		2.8V	2.8V	Left Open	Extension
36	PCM_CLK	PCM clock	I/O		2.8V	2.8V	Left Open	Extension
37	GND	Ground	GND		0V	0V	Mandatory connection	Core
38	RF_GPS*	RF GPS Input	I				Mandatory connection	Extension
39	GND	Ground	GND		0V	0V	Mandatory connection	Core
40	GPIO7	General purpose input/output	I/O		1.8V	2.8V	Left Open	Core
41	GPIO8	General purpose input/output	I/O		1.8V	2.8V	Left Open	Core
42	PPS*	GPS Pulse Per Second	O		1.8V	2.8V	Left Open	Extension
43	EXT_LNA_GPS_EN*	External GPS LNA enable	O	H	1.8V	2.8V	Left Open	Extension
44	SPI1_SRDY	Debug use only SPI Slave Ready	I		1.8V	2.8V	Left Open (Test point mandatory)	Extension
45	VGPIO	GPIO voltage output	O		1.8V	2.8V	Left Open	Core

Pin #	Signal Name	Function	I/O	Active Low/ High	IO Voltage Domain for HL6528 and HL6528-G	IO Voltage Domain for HL6528-2.8V and HL6528-G2.8V	Recommendation for Unused Pins	Type
46	GPIO6	General purpose input/output	I/O		1.8V	2.8V	Left Open	Core
47	TP1	Test Point 1 0- JTAG Enable Open-Normal Mode	I	L	1.8V	2.8V	Left Open	Extension
48	GND	Ground	GND		0V	0V	Mandatory connection	Core
49	RF_MAIN	RF GSM Input/output	I/O				Mandatory connection	Core
50	GND	Ground	GND		0V	0V	Mandatory connection	Core
51	SPI1_MRDY	Debug use only SPI Master Ready	O		1.8V	2.8V	Left Open (Test point mandatory)	Extension
52	SPI1_MISO	Debug use only SPI Master In Slave Out	I		1.8V	2.8V	Left Open (Test point mandatory)	Extension
53	SPI1_CLK	Debug use only SPI Clock	O		1.8V	2.8V	Left Open (Test point mandatory)	Extension
54	SPI1_MOSI	Debug use only SPI Master Out Slave In	O		1.8V	2.8V	Left Open (Test point mandatory)	Extension
55	UIM2_VCC	UIM2 Power supply	O		2.8V	2.8V	Left Open	Extension
56	UIM2_DATA	UIM2 Data	I/O		2.8V	2.8V	Left Open	Extension
57	UIM2_RESET/BUZZER	UIM2 Reset/Buzzer	O		2.8V	2.8V	Left Open	Extension
58	UIM2_CLK/PWM	UIM2 Clock/PWM	O		2.8V	2.8V	Left Open	Extension
59	PWR_ON	Active Low Power On control signal	I/O	L	3.0V	3.0V	Mandatory connection	Core
60	2G_TX_ON	2G TX burst indicator	O	H	2.8V	2.8V	Left Open	Extension
61	VBATT_PA	3.7V Power Amplifier Power supply	I		3.7V	3.7V	Mandatory connection	Core

Pin #	Signal Name	Function	I/O	Active Low/ High	IO Voltage Domain for HL6528 and HL6528-G	IO Voltage Domain for HL6528-2.8V and HL6528-G2.8V	Recommendation for Unused Pins	Type
62	VBATT_PA	3.7V Power Amplifier Power supply	I		3.7V	3.7V	Mandatory connection	Core
63	VBATT	3.7V Power supply	I		3.7V	3.7V	Mandatory connection	Core
64	UIM1_DET/GPIO3	UIM1 Detection/General purpose input/output	I/O	H	1.8V	2.8V	Left Open	Core
65	UIM2_DET/GPIO4	UIM2 Detection/General purpose input/output	I/O	H	1.8V	2.8V	Left Open	Extension
66	GPIO5/I2C1_DATA	General purpose input/output/I ² C DATA	I/O		1.8V	2.8V	Left Open	Extension
67-70	GND	Ground	GND		0V	0V	Mandatory connection	Core
71-166	<i>Note: These pins are not available on the AirPrime HL6548x modules</i>							
167-234	GND	GND	GND		0V	0V	Mandatory connection	Core
235	TEST_PIN	Ground (Test Point)	GND		0V	0V	Left Open	Not connected
236	JTAG_RESET	JTAG RESET	I	L	1.8V	2.8V	Left Open	Extension
237	JTAG_TCK	JTAG Test Clock	I		1.8V	2.8V	Left Open	Extension
238	JTAG_TDO	JTAG Test Data Output	O		1.8V	2.8V	Left Open	Extension
239	JTAG_TMS	JTAG Test Mode Select	I		1.8V	2.8V	Left Open	Extension
240	JTAG_TRST	JTAG Test Reset	I	L	1.8V	2.8V	Left Open	Extension
241	JTAG_TDI	JTAG Test Data Input	I		1.8V	2.8V	Left Open	Extension
242	JTAG_RTCK	JTAG Returned Test Clock	O		1.8V	2.8V	Left Open	Extension

* This pin is only available on the HL6528-G and H6528-G2.8V.

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 HL6528x module supports separate VBATT and VBATT_PA connection if requirements below are fulfilled.

3.1. Power Supply

The AirPrime HL6528x module is supplied through the VBATT signal with the following characteristics.

Table 7. Power Supply

	Minimum	Typical	Maximum
VBATT voltage (V)	3.2 ¹	3.7	4.5
VBATT_PA voltage (V) Full Specification	3.0 ¹	3.7	4.5
VBATT_PA voltage (V) Extended Range ²	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

3.2. Current Consumption

The following table lists the current consumption of the AirPrime HL6528x module at different conditions.

Note: Typical values are defined for VBATT/VBATT_PA at 3.7V, for a 50ohms impedance at all RF ports. Max values are provided for a VSWR 3:1.

Table 8. Current Consumption

Parameters		Min.	Typ.	Max.
Off mode (HL6528 and HL6528-2.8V) (µA)		TBD	40	TBD
Off mode (HL6528-G and HL6528-G2.8V) (µA)		TBD	40	TBD
GSM Sleep mode (mA) Single UIM operation	DRX2	1.3	1.4	2.5
	DRX5	0.9	1.1	2.2
	DRX9	0.8	1.0	2.0
GSM Sleep mode (mA) Dual UIM operation	DRX2	3.0	3.1	4.5
	DRX5	1.8	2.0	3.1
	DRX9	1.5	1.7	2.6
GSM in communication mode (mA)	GSM900 / GSM850 (PCL=5)	TBD	220	TBD
	DCS / PCS (PCL=0)	TBD	160	TBD
GPRS (2 TX, 3 RX) (mA)	GSM900 / GSM850 (PCL=5)	TBD	380	TBD
	DCS / PCS (PCL=0)	TBD	270	TBD

Parameters		Min.	Typ.	Max.
Peak Current consumption (A)	GSM900 / GSM850	TBD	1.50	TBD
	DCS / PCS	TBD	0.90	TBD
GNSS Acquisition ¹ (mA) GSM registered on network	Max value ³	43	51	64
	Min value ⁴	TBD	28	TBD
GNSS Navigation (1Hz) ¹ (mA) GSM registered on network	Max value ³	39	45	57
	Min value ⁴	TBD	25	TBD
GNSS Navigation (1Hz) ¹ (mA) GSM in Flight mode	Max value ³	TBD		TBD
	Min value ⁴	TBD		TBD
GNSS Hibernate mode ² (mA) GSM registered on network	Max value ³	18	20	26
	Min value ⁴	TBD	1.5	TBD

1 Maximum SVs in view, signal level @-130dBm, high gain configuration

2 Hot start conditions are maintained in Hibernate mode3 Baseband is running (or no sleep mode allowed) in max value condition. Refer to document [2] AirPrime HL6 and HL8 Series AT Commands Interface Guide for sleep mode description.

4 Baseband is in sleep mode in min value condition. Refer to document [2] AirPrime HL6 and HL8 Series AT Commands Interface Guide for sleep mode description.

Table 9. Current Consumption per power supply VBATT / VBATT_PA

Parameters			Min.	Typ.	Max.
VBATT_PA	Peak current (A) GSM communication mode, 2TX	GSM900 / GSM850 (PCL=5)			
		DCS / PCS (PCL=0)			
	Peak current (A) GSM communication mode, 1TX	GSM900 / GSM850 (PCL=5)		1.30	
		DCS / PCS (PCL=0)		0.80	
	Average current (mA) GSM communication mode, 1TX	GSM900 / GSM850 (PCL=5)		150	
		DCS / PCS (PCL=0)		90	
VBATT (HL6528 and HL6528-2.8V)	Peak current (A) GSM communication mode, 2TX	GSM900 / GSM850 (PCL=5)			
		DCS / PCS (PCL=0)			
	Peak current (A) GSM communication mode, 1TX	GSM900 / GSM850 (PCL=5)		290	
		DCS / PCS (PCL=0)		125	
	Average current (mA) GSM communication mode, 1TX	GSM900 / GSM850 (PCL=5)		70	
		DCS / PCS (PCL=0)		70	
VBATT (HL6528-G and HL6528-G2.8V)	Peak current (A) GSM communication mode, 2TX GNSS Navigation mode	GSM900 / GSM850 (PCL=5)			
		DCS / PCS (PCL=0)			
	Peak current (A) GSM communication mode, 1TX GNSS Navigation mode	GSM900 / GSM850 (PCL=5)			
		DCS / PCS (PCL=0)			

Parameters			Min.	Typ.	Max.
	Average current (mA) GSM communication mode, 1TX	GSM900 / GSM850 (PCL=5)			
	GNSS Navigation mode	DCS / PCS (PCL=0)			

3.3. 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 HL6528x module is switched ON.

Table 10. VGPIO Electrical Characteristics

Parameter	HL6528, HL6528G			HL6528-2.8V, HL6528-G2.8V			Remarks
	Min	Typ	Max	Min	Typ	Max	
Voltage level (V)	1.70	1.80	1.90	2.65	2.80	2.95	Both active mode and sleep mode
Current capability active mode (mA)	-	-	50	-	-	50	
Current capability sleep mode (mA)	-	-	3	-	-	3	32KHz system clock enable
Line regulation (mV/V)	-	-	50	-	-	50	Iout = MAX
Rise Time(ns)	-	-	6	-	-	6	Test load capacitor = 30 pF

3.4. BAT_RTC

The AirPrime HL6528x module provides 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 3.0V power supply regulator.

Table 11. BAT_RTC Electrical Characteristics

Parameter	Minimum	Typical	Maximum
Input voltage (V)	-	3.0	-
Input current consumption (μ A)	-	2.5	-
Output voltage (V)	2.82	3.0	3.18
Max charging current (@VBATT=3.6V) (mA)	-	0.6	-

3.5. UIM Interface

The AirPrime HL6528x module has two physical UIM interfaces – one main UIM interface (UIM1), and a second UIM interface (UIM2) reserved for Dual UIM Dual Standby option.

3.5.1. UIM1 Interface

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

The five signals used by this interface are as follows:

- UIM1_VCC: power supply
- UIM1_CLK: clock
- UIM1_IO: I/O port
- UIM1_RST: reset
- UIM1_DET: UIM detection (optional)

Table 12. Electrical Characteristics of UIM1

Parameter	Minimum	Typical	Maximum	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_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 (us) from power down	-	10	-	

3.5.1.1. UIM1_DET

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

The GPIO for UIM1_DET is GPIO3..

3.5.2. UIM2 Interface

The UIM2 interface is optional and only intended to be used with Dual UIM Dual Standby feature.

Note: This is the preferred interface for when MFF2 UIM cards are used.

The five signals used by this interface are as follows:

- UIM2_VCC: power supply
- UIM2_CLK: clock
- UIM2_IO: I/O port
- UIM2_RST: reset
- UIM2_DET: HW detection (optional)
- UIM2_VCC_CTRL: control signal for external analog switch (mandatory)

Table 13. Electrical Characteristics of UIM2

Parameter	Minimum	Typical	Maximum	Remarks
UIM2 Interface Voltage (V) (VCC, CLK, IO, RST)	2.7	2.85	3.0	
UIM2 Interface Voltage (V) (VCC_CTRL)		1.8 or 2.8		UIM2_VCC_CTRL is on VGPIIO power domain
UIM2_VCC Current (mA)	-	-	10	Max output current in sleep mode = 3 mA

Note: The UIM2 interface is fixed at 3V; do not use a direct connection with a 1.8V-only UIM card.

3.5.2.1. UIM2_DET

UIM2_DET is used to detect and notify the application about the insertion and removal of a UIM device in the UIM socket connected to the second UIM interface (UIM2). When a UIM is inserted, the state of UIM2_DET transitions from logic 0 to logic 1. Inversely, when a UIM is removed, the state of UIM2_DET transitions from logic 1 to logic 0.

The GPIO for UIM2_DET is GPIO4..

3.5.2.2. UIM2_VCC_CTRL

An analog switch must be added on the customer board when using the UIM2 interface. This analog switch is controlled by GPIO2.

Table 14. UIM2_VCC_CTRL Analog Switch Truth Table

GPIO2 (UIM2_VCC_CTRL)	Function
Low	UIM2_VCC connected to UIM2_VCC
High	UIM2_VCC disconnected from UIM2_VCC

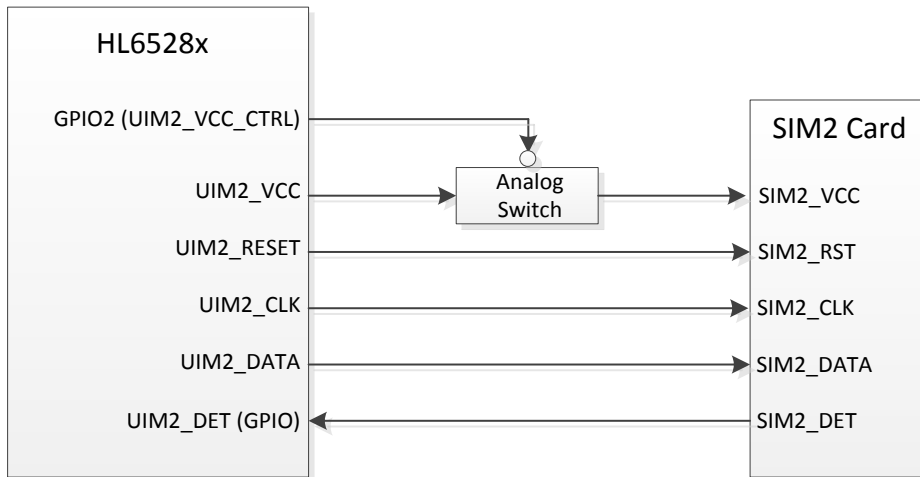


Figure 4. UIM2 with an Analog Switch

3.6. Electrical Information for Digital I/O

The table below enumerates the electrical characteristics of the following digital interfaces:

- UART
- PCM
- GPIOs
- I²C
- SPI
- JTAG
- RESET

Depending on the AirPrime HL6528x module variant, digital IOs are either 2.8V or 1.8V power domain.

Note: The PCM interface only supports 2.8V even with 1.8V configuration.

Table 15. Digital I/O Electrical Characteristics

Parameter	HL6528, HL6528G			HL6528-2.8V, HL6528-G2.8V			Remarks
	Min	Typ	Max	Min	Typ	Max	
Input Current-High(μA)	-10	-	10	-10	-	10	
Input Current-Low(μA)	-10	-	10	-10	-	10	
DC Output Current-High(mA)*	-	-	15	-	-	15	Pin driving a "1" with output set at "0"

Parameter	HL6528, HL6528G			HL6528-2.8V, HL6528-G2.8V			Remarks
	Min	Typ	Max	Min	Typ	Max	
DC Output Current-Low(mA)*	-15	-	-	-15	-	-	Pin driving a "0" with output set at "1"
Input Voltage-High(V)	1.4		2.2	2.4		3.2	
Input Voltage-Low(V)	-0.2	-	0.4	-0.2	-	0.4	
Output Voltage-High(V)	1.7	-	1.9	2.7	-	2.95	
Output Voltage-Low(V)	0	-	0.1	0	-	0.1	

* The maximum current for one GPIO is 15mA, but all GPIOs can't provide 15mA at a time since the VIO is limited to 50mA

3.7. Main Serial Link (UART1)

The main serial link (UART1) is used for communication between the AirPrime HL6528x module 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 1200, 2400, 4800, 9600, 19200, 38400, 57600 and 115200 bit/s, with autobauding and up to 1Mbit/s at maximum baud rate.

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)

UART1 pin description is summarized below.

Table 16. UART1 Pin Description

Signal Name (Module side)	I/O (Module side)	Description
UART1_DTR	I (active low)	Prevents the AirPrime HL6528x from entering sleep mode, switches between data mode and command mode, and wakes the module up.
UART1_DCD	O	Signal data connection in progress
UART1_RX	O	Receive data
UART1_RTS	I	Wakes the module up when KSLEEP=1 is used
UART1_TX	I	Transmit data
UART1_CTS	O	AirPrime HL6528x is ready to receive AT commands
UART1_RI	O	Signal incoming calls (voice and data), SMS, etc.
UART1_DSR	O	Signal UART interface is ON

3.8. Power On Signal (PWR_ON)

A low level signal has to be provided to switch the AirPrime HL6528x module ON.

It is internally connected to the permanent 3.0V supply regulator inside the HL6528x via a pull-up resistor. Once VBATT is supplied to the HL6528x module, this 3.0V supply regulator will be enabled and so PWR_ON signal is by default at high level.

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

Table 17. PWR_ON Electrical Characteristics

Parameter	Minimum	Typical	Maximum
Input Voltage-Low (V)		-	0.4
Input Voltage-High (V)	2.4	-	3.3
Power-up period (ms) from PWR_ON falling edge	2000	-	-

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

The PWR_ON signal will become low after the module is ready. It cannot be directly driven by a GPIO signal.

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 = 2.8V or 1.8V the module is ON (it can be in Idle, Communication or Sleep mode)

After a few seconds, the UART1_CTS enters active state and the module is ready to receive AT commands.

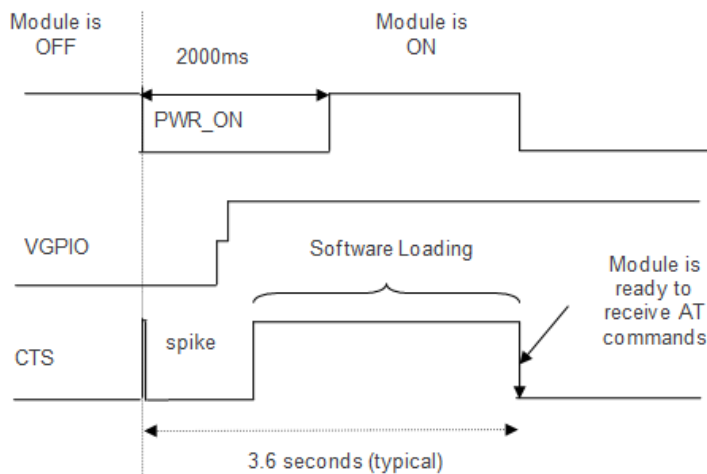


Figure 5. PWR_ON Sequence

Note: PWR_ON cannot be used to power the module off. The module is powered off with AT command "AT+PSCPOF".

3.9. Reset Signal (RESET)

To reset the module, a low level pulse must be sent on RESET pin for at least 10ms. This action will immediately restart the AirPrime HL6528x module. It is therefore useless to perform a new ignition sequence (PWR_ON) afterwards.

As RESET is internally pulled up, a simple open collector or open drain transistor can be used to control it.

The RESET signal will reset the registers of the CPU and reset the RAM memory as well.

Note: As RESET is referenced to the VGPIIO domain (internally to the module) it is impossible to reset before the module starts or to try to use the RESET as a way to start the module.

Parameter	HL6528, HL6528G			HL6528-2.8V, HL6528-G2.8V		
	Min	Typ	Max	Min	Typ	Max
Input Voltage-Low (V)		-	0.4		-	0.4
Input Voltage-High (V)	1.4	-		2.4	-	
Power up Period (ms) from RESET falling edge	38	-	-	38	-	-

3.10. ADC

Two Analog to Digital Converter input, ADC0 and ADC1 are provided by the AirPrime HL6528x module. These converters are 10-bit resolution ADCs ranging from 0 to 3V.

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 OFF the application in case of overheating (for Li-Ion batteries).

Both ADCs have the characteristics listed in the table below.

Table 18. ADC Electrical Characteristics

Parameter	Minimum	Typical	Maximum	Remarks
ADC Resolution (bits)	-	10	-	
Input Voltage Range (V)	0	-	3	General purpose input
Update rate per channel (KHz)	-	-	200	
Differential Nonlinearity (bits)	-1	-	+3	
Integral Nonlinearity (bits)	-2.5	-	+2.5	LSB
Offset Error (mV)	-	5	-	
Gain Error (mV/LSB)	-	0.02	-	
Input Resistance (kΩ)	120	150	-	
Input Capacitance (pF)	-	-	10	

3.11. Analog Audio Interfaces

The AirPrime HL6528x module supports one differential microphone input and one differential speaker output. It also includes a noise suppression and echo cancellation feature which allows for an enhanced voice call quality.

3.11.1. Analog Audio Input

The microphone input can either have a single-ended or a differential connection. However, performance with common mode noise and TDMA noise varies depending on the connection mode and PCB layout.

When connecting a microphone to the AirPrime HL6528x module, ensure to have a very good ground plane, very good filtering as well as shielding in order to avoid any disturbance on the audio path.

The gain of the microphone input can be tuned using AT commands.

The AirPrime HL6528x module microphone pins already include suitable biasing for an electret microphone. The electret microphone can then be connected directly on the inputs for easy connection.

AC coupling is also already embedded in the HL6528x embedded module.

Table 19. Analog Audio Interface Input

Parameter	Minimum	Typical	Maximum	Test Conditions
MIC_P DC Biasing (V)		2.4		Through internal 2.2k Ω
MIC_N DC Biasing (V)		0		Through internal 2.2k Ω
Maximum input range (V)		1.4		Gain = - 6dB
Nominal reference level (mVrms)		16		Gain = + 34dB
Input Micro amplifier gain (dB)	-6		+ 50	

Note: It is recommended to add ESD protection to the microphone when it is exposed to the external environment. The ESD protection should be connected between the audio lines and a good ground, and placed as close to the microphone as possible.

3.11.2. Analog Audio Outputs

Table 20. Analog Audio Interface Output

Parameter	Min	Typ	Max	Test Conditions
Maximum output range (Vrms)		1.65		Load=32 Ω , THD=1%, Output gain = 8 dB
Load resistance (Ω)		32		
Output amplifier gain (dB)	-28	-	8	

Note: It is recommended to add ESD protection to the speaker when it is exposed to the external environment. The ESD protection should be connected between the audio lines and a good ground, and placed as close to the speaker as possible.

It's important to select an appropriate speaker. The following enumerates the recommended speaker characteristics.

Table 21. Recommended Speaker Characteristics

Characteristic	Value
Input power: rated / max	0.1W (Rate)
Audio chain impedance	32 Ω +/- 10% at 1V 1KHz
Frequency Range	300 Hz ~ 4.0 KHz

Characteristic	Value
Sensitivity (S.P.L)	>105 dB at 1KHz with IEC318 coupler
Distortion	5% max at 1K Hz, nominal input power

3.12. PCM

The Digital Audio Interface (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 8KHz frequency pulse that synchronizes the frame “data in” and the frame “data out” (short frame synchronization only).
- 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 mode
- 8 bits or 16 bits data word length
- MSB or LSB first
- Rising or falling sampling clock edge
- Configurable PCM bit clock rate up to 1MHz

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

Table 22. Digital Audio Interface Electrical Characteristics

Signal	Description	Minimum	Typical	Maximum
Tsync_low + Tsync_high	PCM-SYNC period (μ s)		125	
Tsync_low	PCM-SYNC low time (μ s)		124	
Tsync_high	PCM-SYNC high time (μ s)		1	
TSYNC-CLK	PCM-SYNC to PCM-CLK time (ns)		651	
TCLK-cycle	PCM-CLK period (ns)		1302	
TIN-setup	PCM-IN setup time (ns)	50		
TIN-hold	PCM-IN hold time (ns)	50		
TOUT-delay	PCM-OUT delay time (ns)			20
TSYNC-delay	PCM-SYNC output delay (ns)	-11		9

The following figure shows the PCM timing waveform.

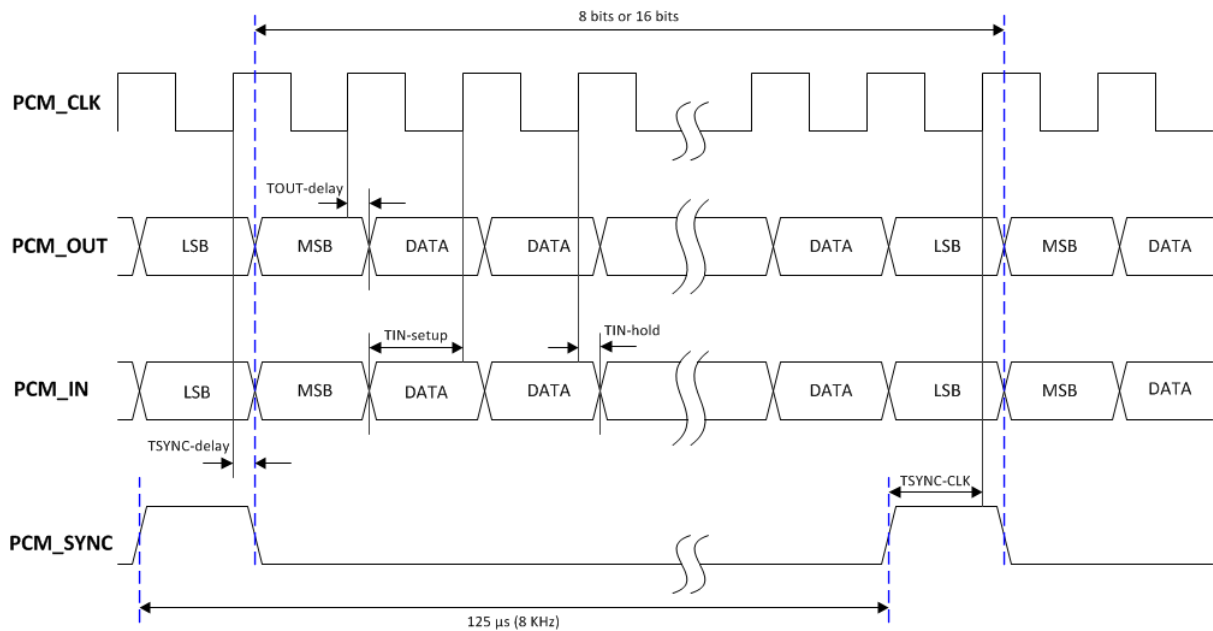


Figure 6. PCM Timing Waveform

3.13. I²C Interface

NMEA frames can be output from the UART or through a dedicated serial port (I²C).

Table 23. I²C Pin Description

Pad #	Name	Function
1	I2C1_CLK	I ² C Serial Clock Line
66	I2C1_DATA	I ² C Serial Data Line

Note: I²C pins are multiplexed with GPIO features.

The main characteristics of the I²C interface are as follows:

- Master mode (I2C1_CLK is an output of the AirPrime HL6528x module)

I²C clock is set at 400KHz

As AirPrime HL6528x module is master only, devices connected to the I2C bus shall be slave devices. In order for AirPrime HL6528x module to communicate with the slave device, the slave 7-bit address shall be loaded inside the module before activating the GPS NMEA output. See [2] for AT command description.

3.14. Debug Interfaces

The AirPrime HL6528x module provides two interfaces for a powerful debug system.

3.14.1. SW Traces

The AirPrime HL6528x module provides a SW TRACE interface, providing real-time instruction and data trace of the modem core. The SW TRACE interface is accessible through the SPI port.

Table 24. SPI Pin Description

Pad #	Name	Function
44	SPI1_SRDY	SPI Slave Ready
51	SPI1_MRDY	SPI Master Ready
52	SPI1_MISO	SPI Master In Slave Out
53	SPI1_CLK	SPI Clock
54	SPI1_MOSI	SPI Master Out Slave In

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

3.14.2. JTAG

The JTAG interface provides debug access to the core of the AirPrime HL6528x module. These JTAG signals are accessible through solderable Test Points.

Table 25. JTAG Pin Description

Pad #	Name	Function
47	TP1	Test Point 1
236	JTAG_RESET	JTAG RESET
237	JTAG_TCK	JTAG Test Clock
238	JTAG_TDO	JTAG Test Data Output
239	JTAG_TMS	JTAG Test Mode Select
240	JTAG_TRST	JTAG Test Reset
241	JTAG_TDI	JTAG Test Data Input
242	JTAG_RTCK	JTAG Returned Test Clock

Note: *It's recommended to provide access through Test Points to the JTAG interface pins (for failure analysis and HL6528x debugging). All signals listed in the table above shall be outputs on the customer board to allow JTAG debugging.*

3.15. PPS (HL6528-G and HL6528-G2.8V only)

The PPS signal is an output pulse related to GPS receiver time.

Table 26. PPS Electrical Characteristics

Parameter		Minimum	Typical	Maximum	Conditions
Voltage Level (V)	HL6528-G	1.70	1.80	1.90	
	HL6528-G2.8V	2.65	2.8	2.95	
Frequency (Hz)			1		
Pulse width (ms)			250		
Synchronization to GPS time (μ s)				1	

Note: *This output is available only when GNSS is in tracking mode.*

3.16. EXT_LNA_GPS_EN (HL6528-G and HL6528-G2.8V only)

EXT_LNA_GPS_EN ON indicates whether the GNSS receiver is active and can be used to enable an external LNA (or active antenna), especially during GNSS low power mode.

Table 27. EXT_LNA_GPS_EN Electrical Characteristics

Parameter		Minimum	Typical	Maximum	Conditions
Voltage Level (V)	HL6528-G	1.70	1.80	1.90	
	HL6528-G2.8V	2.65	2.8	2.95	

3.17. RF Interface

The GSM RF interface of the AirPrime HL6528x module allows the transmission of RF signals. This interface has a 50Ω nominal impedance.

3.17.1. RF Connection

A 50Ω stripline can be used to connect to standard RF connectors such as SMA, UFL, etc. for antenna connection.

Table 28. RF Connection

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

3.17.2. RF Performances

RF performances are compliant with the ETSI recommendation GSM 05.05.

Frequency Band	Typical Sensitivity	Minimum Sensitivity
GSM850 (dBm)	-109.9	-107
EGSM (dBm)	-109.7	-107
DCS (dBm)	-109.5	-106
PCS (dBm)	-108.2	-106

Note: Values given above are average values across the frequency band.

3.17.3. TX Burst Indicator (2G_TX_ON)

The AirPrime HL6528x module provides a signal, 2G_TX_ON, for TX burst indication. 2G_TX_ON is a 2.8V signal and its status 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 29. 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:

$$T_{duration} = T_{advance} + (0.577ms \times \text{number of TX slots}) + T_{delay}$$

Table 30. TX Burst Characteristics

Parameter	Minimum	Typical	Maximum
Output voltage (V)	2.65	2.80	2.95
Tadvance (µs)	30	180	
Tdelay (µs)	0	10	

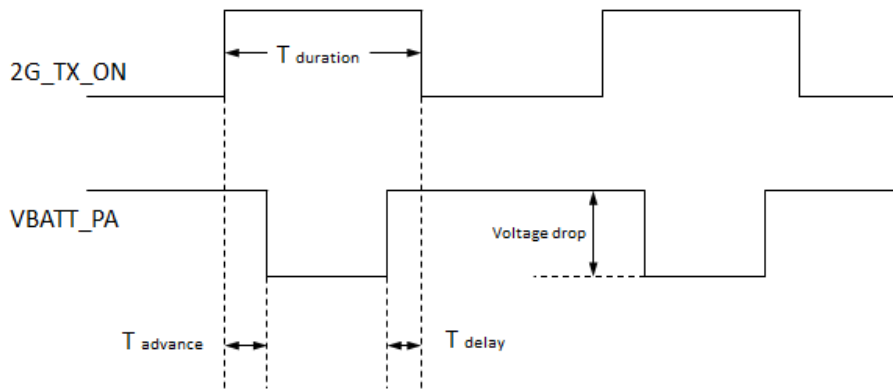


Figure 7. 2G_TX_ON State during TX Burst

3.18. GNSS Interface

The AirPrime HL6528-G and HL6528-G2.8V modules embed an integrated and high-sensitivity Global Navigation Satellite System (GNSS) solution.

Based on SiRFstarV™ from CSR, the AirPrime HL6528-G and HL6528-G2.8V modules combine GPS and GLONASS reception to improve navigation capabilities and position accuracy in obstructed view environments such as urban canyons. GNSS performances are improved by CW jammer and interference mitigation system and automated hardware blanking capabilities.

In addition, it supports Downloaded Extended Ephemeris Assisted-GNSS, for enhanced time to acquire or reacquire a fix.

The operation of GNSS is offloaded to a GNSS standalone solution to guarantee the availability of modem resources for best performance.

The GNSS implementation supports GPS L1 signal (1575.42 ± 20 MHz) and GLONASS L1 FDMA signals for frequency -7 to 6 (1597.5 – 1605.8 MHz), with 50Ω connection on the RF_GPS pad.

3.18.1. GNSS Performances

Table 31. GNSS Interface Specifications

Test	Parameters	Typical Value	
Sensitivity	GPS Autonomous Acquisition (dBm) Cold and Warm start conditions	-147	
	GPS Autonomous Acquisition (dBm) Hot start conditions	-159	
	GPS Navigation (dBm)	-161	
	GLONASS Navigation (dBm)	-158	
	GNSS Navigation (dBm)	-161	
	GPS Tracking (dBm)	-165	
	GLONASS Tracking (dBm)	-165	
Autonomous Cold Start	Time To First Fix (s)	50%	23.3
		95%	34.3
	2D Position Error (m)	50%	0.86
		95%	1.63
Autonomous Warm Start	Time To First Fix (s)	50%	19.5
		95%	34.4
	2D Position Error (m)	50%	0.16
		95%	0.41
Autonomous Hot Start	Time To First Fix (s)	50%	0.7
		95%	1
	2D Position Error (m)	50%	3.8
		95%	8.4
Aiding Warm Start	Time To First Fix (s)	50%	TBD
		95%	TBD
	2D Position Error (m)	50%	TBD
		95%	TBD

Note: Values in the table above are based on static conditions, RF GNSS level @-130dBm. Cold start does not include internal GNSS firmware download on first GNSS start.

3.18.2. GNSS Antenna Interface

Specifications for the GNSS antenna interface are defined in the table below.

Table 32. GNSS Antenna Specifications

Characteristics	GNSS	
Frequency (MHz)	GPS L1	1575.42±20
	GLONASS L1 FDMA	1597.5-1605.8

Characteristics		GNSS
RF Impedance (Ω)		50
VSWR max		2:1

The minimum isolation between GNSS and GSM antennas should be 20dB.

3.18.3. GNSS Antenna Recommendations

Both passive and active antennas are supported by the AirPrime HL6528-G and HL6528-G2.8V modules.

The table below describes the expected performance function as input signal power.

Table 33. GNSS Antenna Recommendations

GNSS Signal Level Description	Input Signal Power (dBm)	Expected Performances
Absolute maximum	-110	Maximum to input level
Good	>-134	Best performance in TTFF and position accuracy
Acceptable	>-147	Minimum input level to allow initial acquisition without aiding
Poor	<-147	No signal acquisition without aiding
Minimum usable signal	-161	Below this level, no fix with reasonable error
Minimum tracking level	-165	Minimum level to lock the signal for fast recovery when the signal returns to the minimum usable level

For passive antennas, the internal LNA should be set in high gain mode.

For active antennas, the internal LNA gain should be set to low gain if external net gain is higher than 16dB. If the external net gain is lower than 16dB, it is advised to set the internal LNA gain in high gain. In any case, the external net gain should not exceed 24dB.

3.19. GPIO RESET/ DEFAULT states

Table 34. Pad Description

Pin #	Signal Name	Function	I/O	RESET STATE	RESET VALUE	DEFAULT STATE	DEFAULT VALUE
1	GPIO1/I2C1_C LK	General purpose input/output/I ² C Clock	I/O				
2	UART1_RI	UART1: Ring indicator	O				
3	UART1_RTS	UART1: Request to send	I				
4	UART1_CTS	UART1: Clear to send	O				
5	UART1_TX	UART1: Transmit data	I				
6	UART1_RX	UART1: Receive data	O				
7	UART1_DTR	UART1: Data terminal ready	I				

Pin #	Signal Name	Function	I/O	RESET STATE	RESET VALUE	DEFAULT STATE	DEFAULT VALUE
8	UART1_DCD	UART1: Data carrier detect	O				
9	UART1_DSR	UART1: Data set ready	O				
10	GPIO2	General purpose input/output	I/O				
11	RESET_IN	Input reset signal	I				
12	NC	Not Connected					
13	NC	Not Connected					
14	NC	Not Connected					
15	NC	Not Connected					
16	NC	Not Connected					
17	SPKR_N	Speaker negative output (32Ω impedance)	O				
18	SPKR_P	Speaker positive output (32Ω impedance)	O				
19	MIC_P	Microphone positive input	I				
20	MIC_N	Microphone negative input	I				
21	BAT_RTC	Power supply for RTC backup	I/O				
22	TP2	Factory use only 0 – JTAG Boundary Scan Mode Open – Normal Mode	I				
23	NC	Not Connected					
24	ADC1	Analog to digital conversion	I				
25	ADC0	Analog to digital conversion	I				
26	UIM1_VCC	1.8V/3V UIM1 Power supply	O				
27	UIM1_CLK	1.8V/3V UIM1 Clock	O				
28	UIM1_DATA	1.8V/3V UIM1 Data	I/O				
29	UIM1_RESET	1.8V/3V UIM1 Reset	O				
30	NC	NC (Reserved for 3G compatibility)					
31	NC	NC (Reserved for 3G compatibility)					
32	NC	NC (Reserved for 3G compatibility)					
33	PCM_OUT	PCM data out	O				
34	PCM_IN	PCM data in	I				
35	PCM_SYNC	PCM sync out	I/O				

Pin #	Signal Name	Function	I/O	RESET STATE	RESET VALUE	DEFAULT STATE	DEFAULT VALUE
36	PCM_CLK	PCM clock	I/O				
37	GND	Ground	GND				
38	RF_GPS*	RF GPS Input	I				
39	GND	Ground	GND				
40	GPIO7	General purpose input/output	I/O				
41	GPIO8	General purpose input/output	I/O				
42	PPS*	GPS Pulse Per Second	O				
43	EXT_LNA_GPS_EN*	External GPS LNA enable	O				
44	SPI1_SRDY	Debug use only SPI Slave Ready	I				
45	VGPI0	GPIO voltage output	O				
46	GPIO6	General purpose input/output	I/O				
47	TP1	Test Point 1 0- JTAG Enable Open-Normal Mode	I				
48	GND	Ground	GND				
49	RF_MAIN	RF GSM Input/output	I/O				
50	GND	Ground	GND				
51	SPI1_MRDY	Debug use only SPI Master Ready	O				
52	SPI1_MISO	Debug use only SPI Master In Slave Out	I				
53	SPI1_CLK	Debug use only SPI Clock	O				
54	SPI1_MOSI	Debug use only SPI Master Out Slave In	O				
55	UIM2_VCC	UIM2 Power supply	O				
56	UIM2_DATA	UIM2 Data	I/O				
57	UIM2_RESET/BUZZER	UIM2 Reset/Buzzer	O				
58	UIM2_CLK/PWM	UIM2 Clock/PWM	O				
59	PWR_ON	Active Low Power On control signal	I/O				
60	2G_TX_ON	2G TX burst indicator	O				
61	VBATT_PA	3.7V Power Amplifier Power supply	I				
62	VBATT_PA	3.7V Power Amplifier Power supply	I				
63	VBATT	3.7V Power supply	I				

Pin #	Signal Name	Function	I/O	RESET STATE	RESET VALUE	DEFAULT STATE	DEFAULT VALUE
64	UIM1_DET/GPIO3	UIM1 Detection/General purpose input/output	I/O				
65	UIM2_DET/GPIO4	UIM2 Detection/General purpose input/output	I/O				
66	GPIO5/I2C1_DATA	General purpose input/output/I ² C DATA	I/O				
67-70	GND	Ground	GND				
167-234	GND	GND	GND				
235	TEST_PIN	Ground (Test Point)	GND				
236	JTAG_RESET	JTAG RESET	I				
237	JTAG_TCK	JTAG Test Clock	I				
238	JTAG_TDO	JTAG Test Data Output	O				
239	JTAG_TMS	JTAG Test Mode Select	I				
240	JTAG_TRST	JTAG Test Reset	I				
241	JTAG_TDI	JTAG Test Data Input	I				
242	JTAG_RTCK	JTAG Returned Test Clock	O				

4. Mechanical Drawings

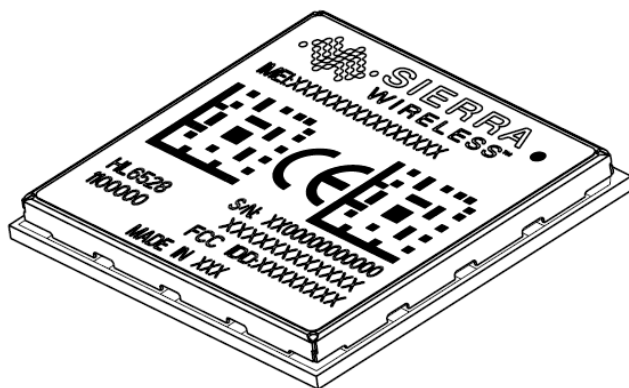


Figure 8. AirPrime HL6528x (angular view)

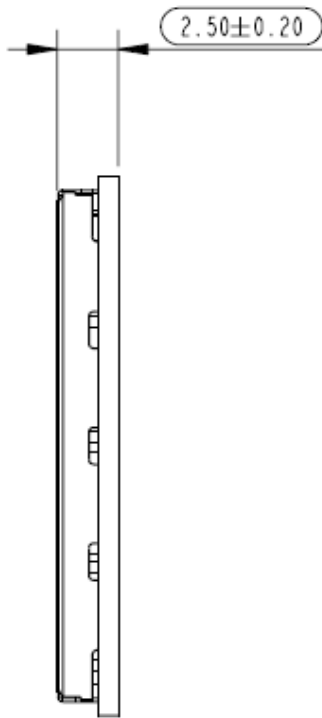


Figure 9. AirPrime HL6528x (side view)

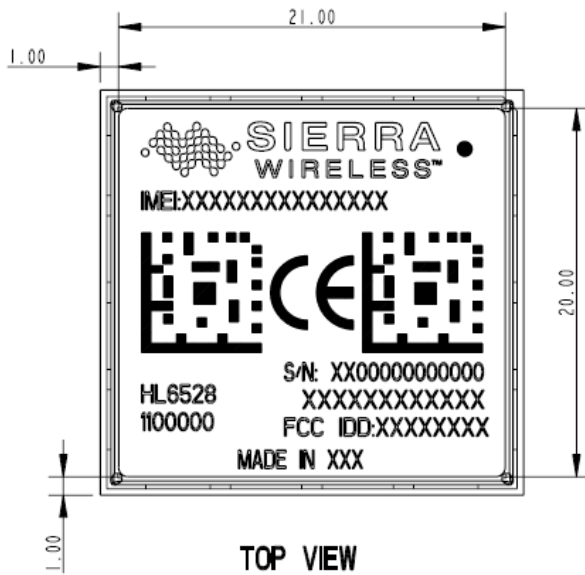


Figure 10. AirPrime HL6528x Module (top view)

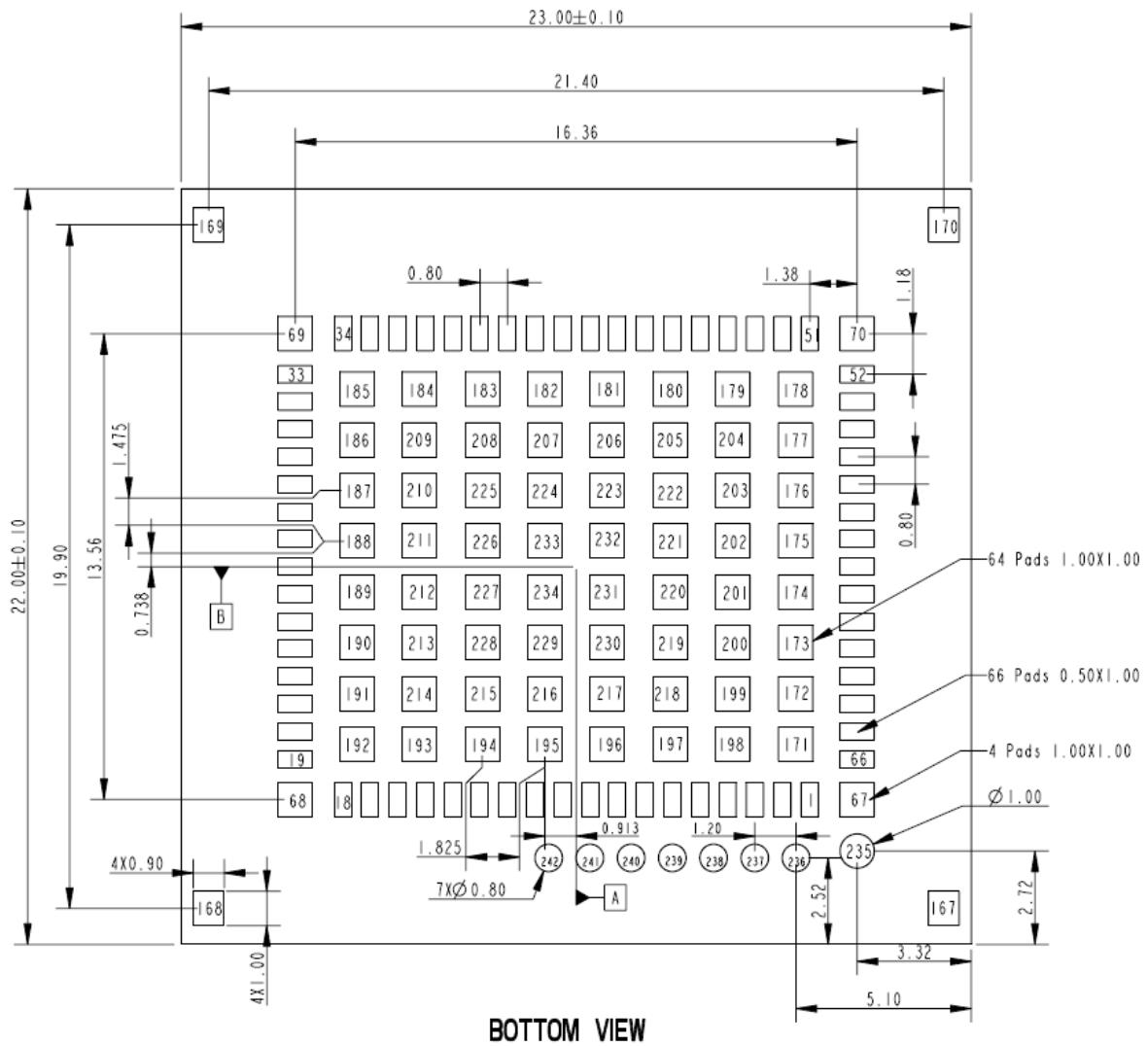


Figure 11. AirPrime HL6528x Module (bottom view with dimensions)

5.

Design Guidelines

5.1. Power-Up Sequence

Apply a LOW level logic to the PWR_ON pin (pin 59). When CTS is toggling to low level, the module is ready to receive AT commands.

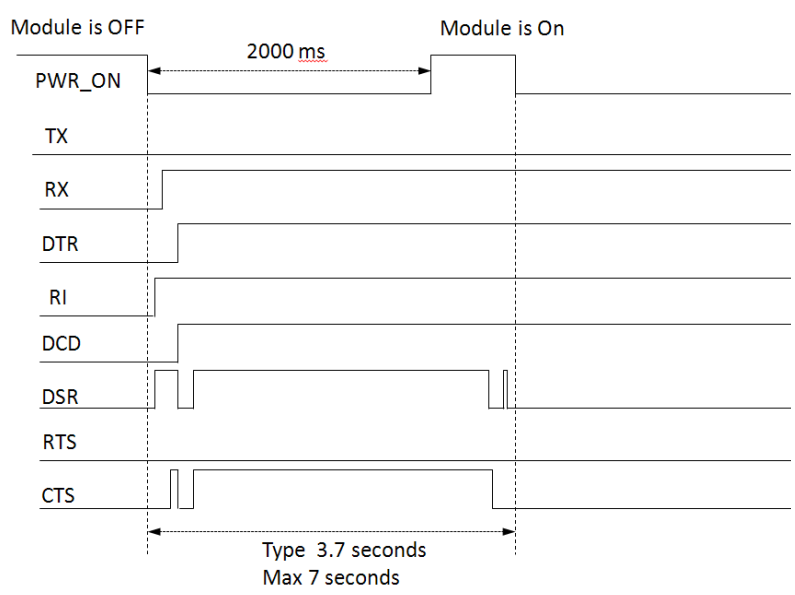


Figure 12. UART Signals during the Power ON Sequence

5.2. Module Switch-Off

AT command `AT+PSCPOF` enables the user to properly switch the AirPrime HL6528x module 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 HL6528x module. In this case, the only way to get control back over the module is to switch off the power line.

VGPIO, PWR_ON and CTS signal behavior during the power off sequence is described in the figure below.

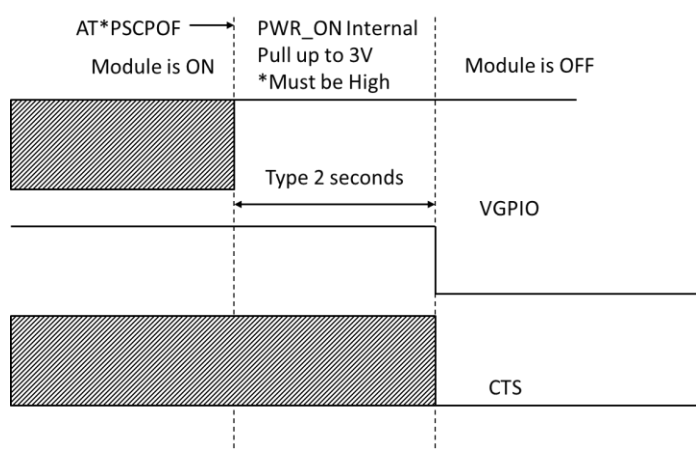


Figure 13. Power OFF Sequence for PWR_ON, VGPIO and CTS

5.3. Sleep Mode Management

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

AT+KSLEEP=0:

- The AirPrime HL6528x module is active when DTR signal is active (low electrical level).
- When DTR is deactivated (high electrical level), the AirPrime HL6528x module enters sleep mode after a while.
- On DTR activation (low electrical level), the AirPrime HL6528x module wakes up.

AT+KSLEEP=1:

- The AirPrime HL6528x module determines when it enters sleep mode (when no more tasks are running).
- "0x00" character on the serial link wakes the AirPrime HL6528x module up.

AT+KSLEEP=2:

- The AirPrime HL6528x module never enters sleep mode.

In sleep mode, the module reduces its power consumption and remains waiting for the wake up signals either from the network (i.e. read paging block depending on the DRX value of the network) or the operating system (i.e. timers wake up timers activated) or the host controller (i.e. character on serial link or DTR signal).

5.4. ESD Guidelines for UIM Cards

Decoupling capacitors must be added as close as possible to the UIM card connectors on UIM_CLK, UIM_RST, UIM_VCC and UIM_DATA signals to avoid EMC issues and to pass the UIM card type approval tests, according to the drawings below (this applies to both UIM slots, UIM1 and UIM2).

A typical schematic for hardware UIM detection is provided below.

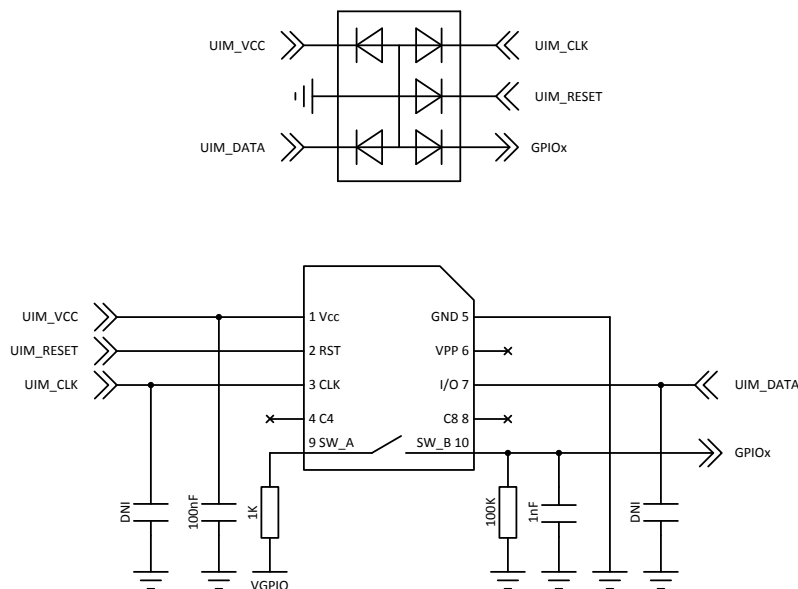


Figure 14. EMC and ESD Components Close to the UIM

5.5. Audio Integration

5.5.1. Microphone Audio Design

5.5.1.1. Differential Connection Example

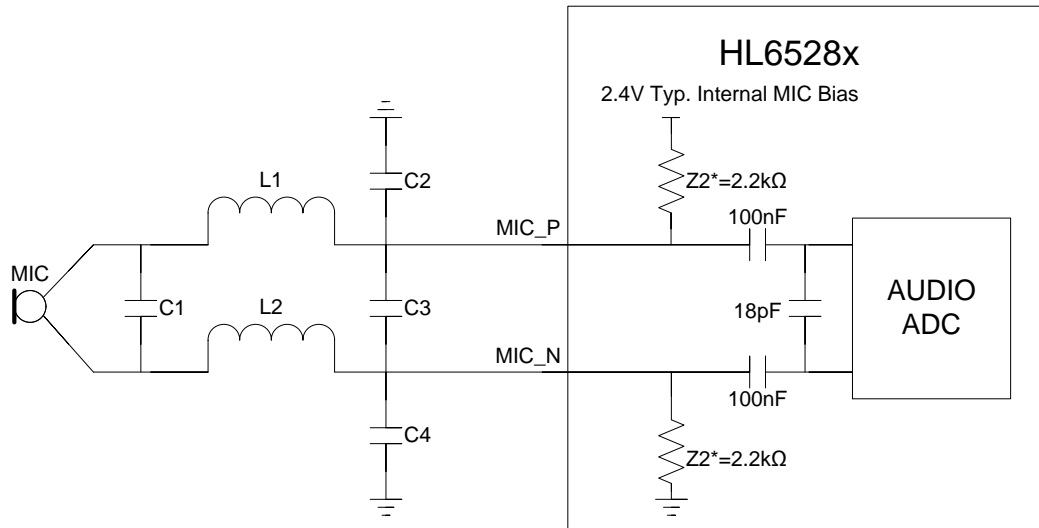


Figure 15. Example of a MIC Input Connection with LC Filter

The LC filter (L1, L2, C2, C3, and C4) is used to reduce EMI perturbation created by TDMA noise, but it is not mandatory. Good quality audio can be achieved without an LC filter depending on the design.

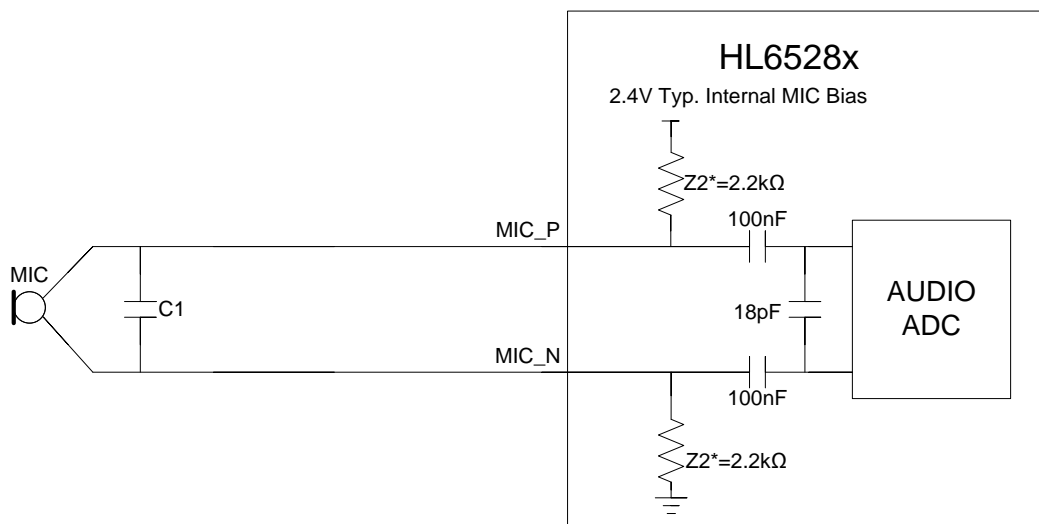


Figure 16. Example of a MIC Input Connection without LC Filter

Capacitor C1 is highly recommended to eliminate TDMA noise. Note that C1 must be close to the microphone.

Refer to the table below for the recommended components to use with a microphone connection.

Table 35. Recommended Components for a Microphone Connection

Component	Description/Details	Notes
C1	12pF to 33pF	Needs to be tuned depending on the design
C2, C3, C4	47pF	Needs to be tuned depending on the design
L1, L2	100nH	Needs to be tuned depending on the design

5.5.1.2. Single-Ended Connection Example

When a single-ended connection is used for MIC, MIC_N is just left open.

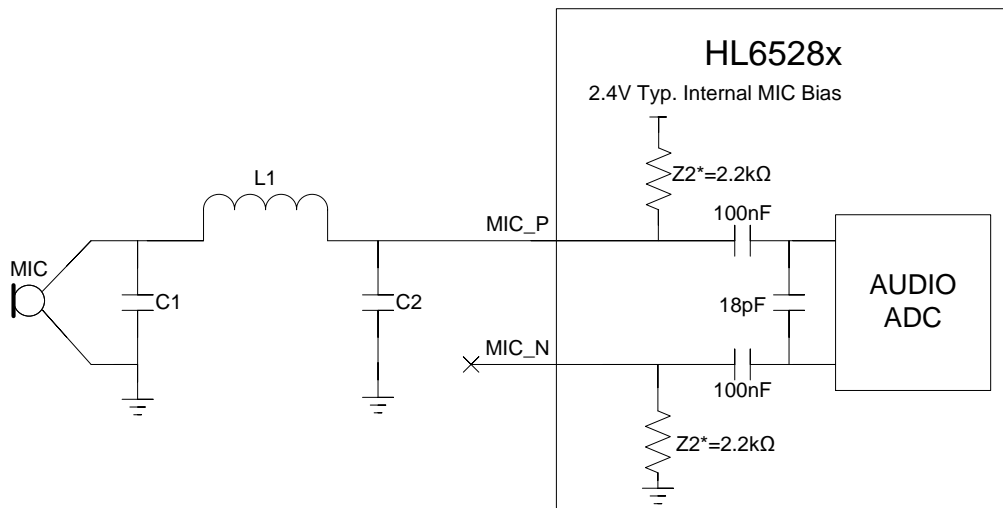


Figure 17. Example of a Single-Ended MIC Input Connection with LC Filter

The internal input impedance value becomes 1100Ω due to the connection of the other end to ground.

The single-ended design is very sensitive to TDMA noise; it is recommended to add L1 and C2 footprint as an LC filter to try to eliminate TDMA noise. Very good grounding on the MIC is required in order to ensure good performance against TDMA. Also, special care on the PCB layout must be taken.

When not used, the filter can be removed by replacing L1 with a 0Ω resistor and by disconnecting C2, as shown in the following figure.

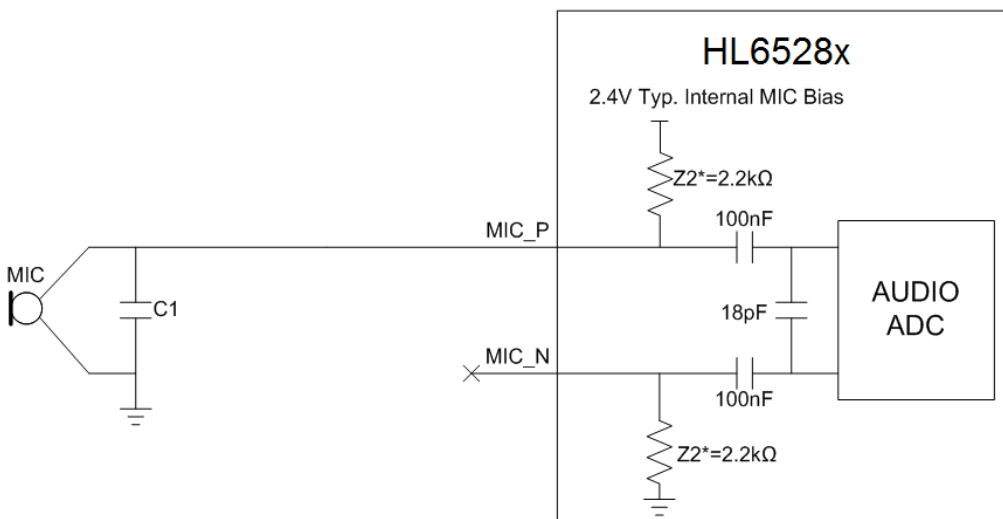


Figure 18. Example of a Single-Ended MIC Input Connection without LC Filter

The capacitor C1 is highly recommended to eliminate TDMA noise, and it must be placed close to the microphone.

Refer to the table below for the recommended components to use with a single-ended microphone connection.

Table 36. Recommended Components for a Single-Ended Microphone Connection

Component	Description/Details	Notes
C1	12pF to 33pF	Needs to be tuned depending on the design
C2	12pF to 33pF	Needs to be tuned depending on the design
L1	100nH	Needs to be tuned depending on the design

5.5.2. Speaker Audio Design

The SPKR interface can be used in a single-ended or a differential connection. However, it is strongly recommended to use a differential connection in order to reject common mode noise and TDMA noise. Moreover, in single-ended mode, half (1/2) of the power is lost.

When using a single-ended connection, be sure to have a very good ground plane, very good filtering as well as shielding in order to avoid any disturbance on the audio path.

The following table lists the typical values of both speaker output.

Table 37. Speaker Details

Parameter	Typical Value	Connection
Z (SPKR_P, SPKR_N) (Ω)	32	Differential mode
Z (SPKR_P, SPKR_N) (Ω)	32	Single-ended mode

It is recommended to add ESD protection to the speaker when it is exposed to the external environment. The ESD protection should be connected between the audio lines and a good ground, and placed as close to the speaker as possible.

It is important to select an appropriate speaker and filtering components to avoid TDMA noise.

5.5.2.1.1. SPKR Differential Connection

Note: Add a 33pF capacitor between the SPKR_P and SPKR_N pins to reduce TDMA noise.

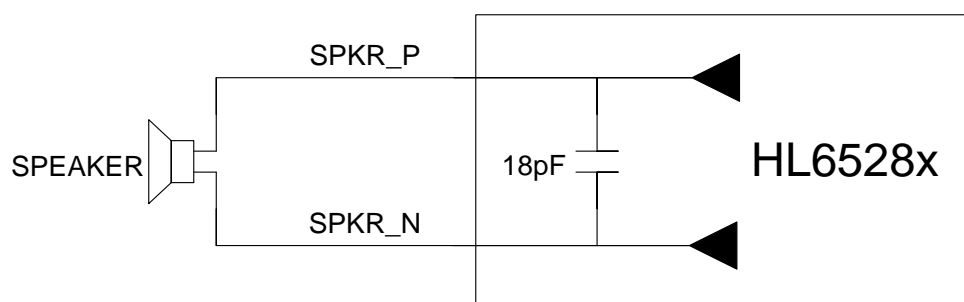


Figure 19. Example of a Differential Connection for SPKR

5.5.2.1.2. SPKR Single-Ended Connection

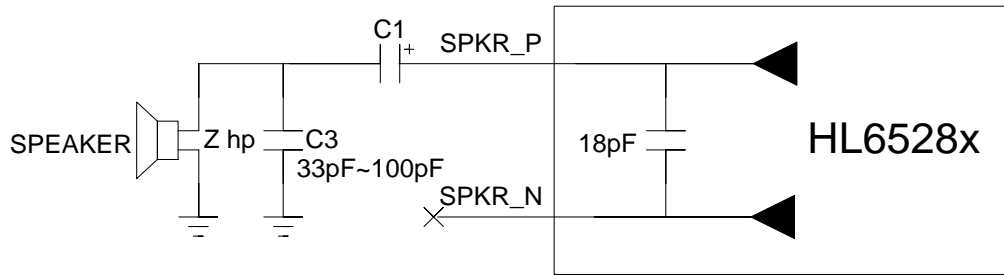


Figure 20. Example of a Single-Ended Speaker Connection (typical implementation)

In a single-ended connection:

- $4.7\mu\text{F} < C1 < 47\mu\text{F}$, depending on the speaker characteristics and output power
- the connection between the AirPrime HL6528x module pins and the speaker must be designed to keep the serial impedance lower than 1.5Ω
- SPKR_N can be left open
- output power is lost (-6dB) as compared to a differential connection

5.5.3. Audio Layout Guidelines

To avoid TDMA noise, it is recommended to surround the audio tracks with ground as shown in the following figure.

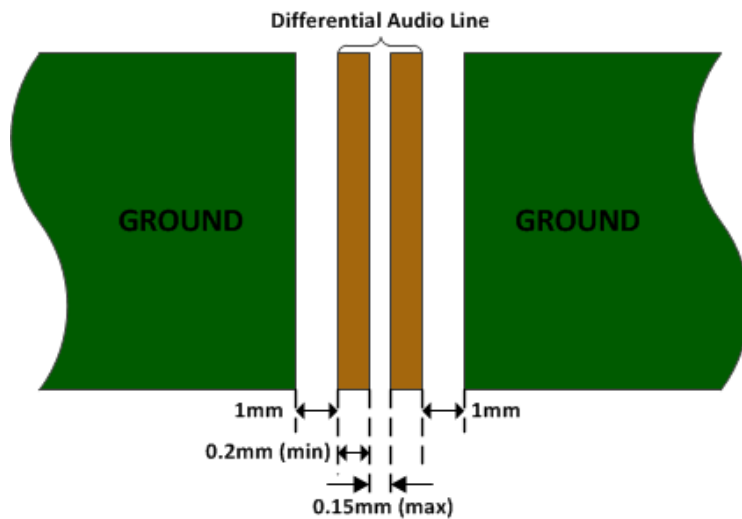


Figure 21. Audio Track Design

For differential connections, refer to the on following figure. Note that the differential audio line is always in parallel.

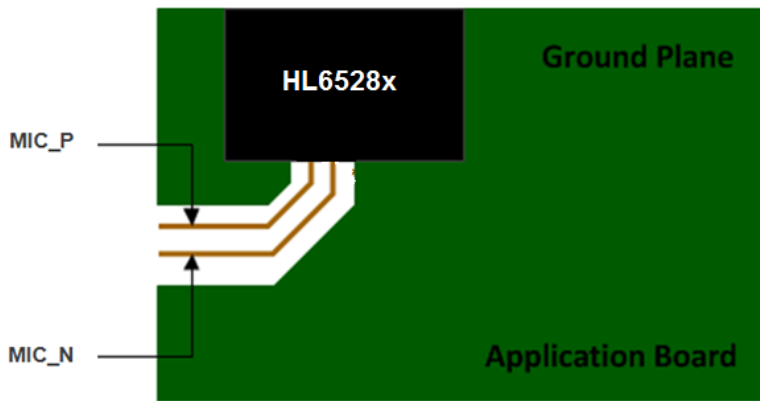


Figure 22. Differential Audio Connection

For single-ended connections, the negative pole of the microphone, MIC_N, should be connected to GND. Refer to the following figure.

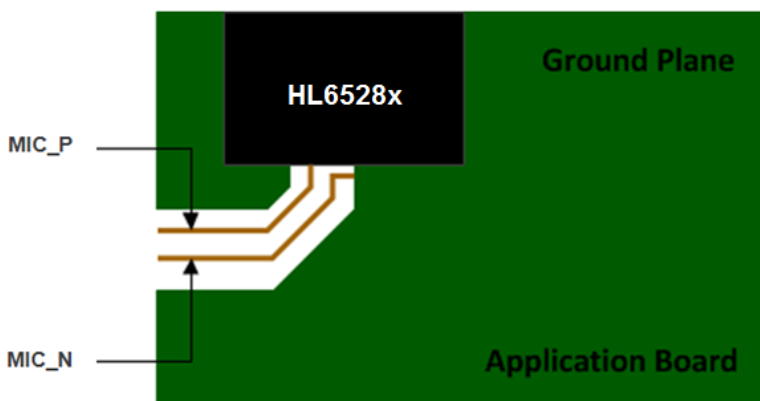


Figure 23. Single-Ended Audio Connection

Caution: Avoid digital tracks crossing under and over the audio tracks.

It is highly recommended to have the MIC ground and the LC filter ground to act as an audio analog ground during the PCB layout. This audio ground, together with the MIC_P signal, should act as the differential line pair; and this audio ground should only be connected to the AirPrime HL6528x module ground, as close as possible to the LGA GND pad of the AirPrime HL6528x module. It is the same case for SPKR_P and SPKR_N.

Also, the audio interface is ESD sensitive. ESD protection **MUST** be added to the interface once it is externally accessible.

To avoid distortion and burst noise, the following guidelines should be followed:

- Audio signals must be symmetric (same components on each path)
- Differential signals must be routed in parallel
- Audio layer must be surrounded by 2 ground layers
- The link from one component to the ground must be as short as possible
- Separate the PCBs for the microphone and the speaker if possible
- Reduce the number of electronic components as much as possible (to avoid loss of quality and greater dispersion)
- Audio tracks must be wider than 0.5 mm

5.6. Radio Integration

5.6.1. RF Routing Recommendations

To route the RF antenna signals, the following recommendations must be observed for PCB layout:

The RF signals must be routed using traces with a $50\ \Omega$ characteristic impedance.

Basically, the characteristic impedance depends on the dielectric constant (ϵ_r) of the material used, trace width (W), trace thickness (T), and height (H) between the trace and the reference ground plane.

In order to respect this constraint, Sierra Wireless recommends that a MicroStrip structure be used and trace width be computed with a simulation tool (such as AppCAD, shown in the figure below and available free of charge at <http://www.avagotech.com>).

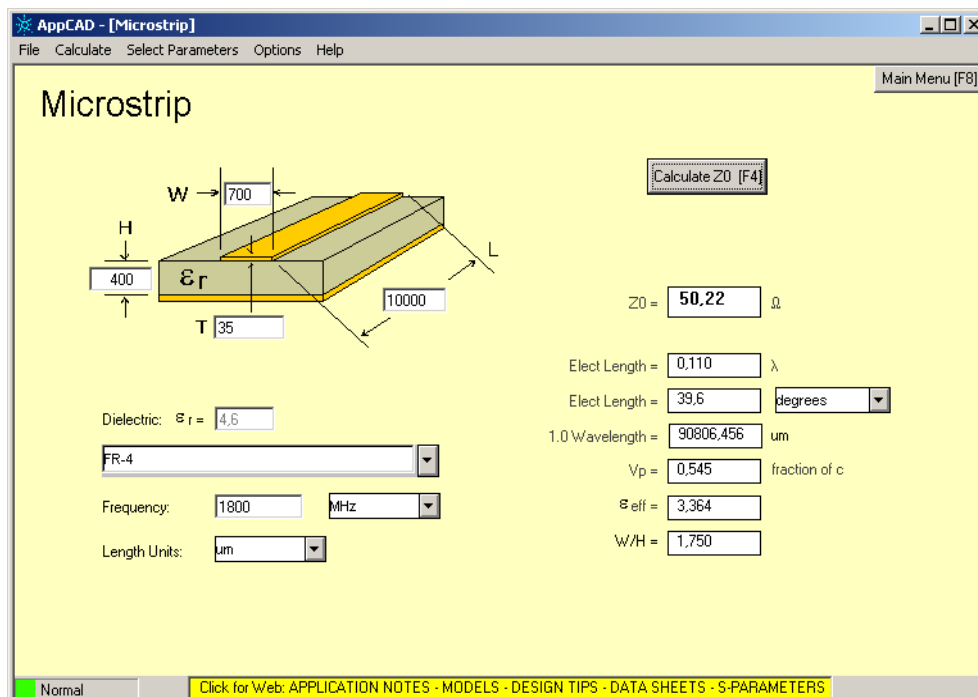


Figure 24. AppCAD Screenshot for Microstrip Design Power Mode Diagram

The trace width should be wide enough to maintain reasonable insertion loss and manufacturing reliability. Cutting out inner layers of ground under the trace will increase the effective substrate height; therefore, increasing the width of the RF trace.

Caution: *It is critical that no other signals (digital, analog, or supply) cross under the RF path. The figure below shows a generic example of good and poor routing techniques.*

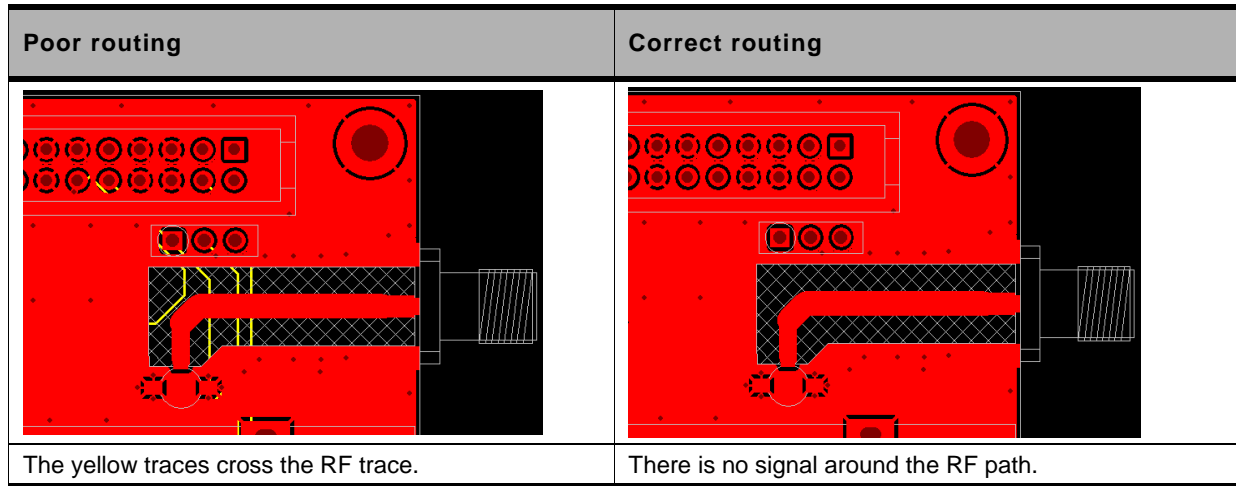


Figure 25. RF Routing Examples

- Fill the area around the RF traces with ground and ground vias to connect inner ground layers for isolation.
- Cut out ground fill under RF signal pads to reduce stray capacitance losses.
- Avoid routing RF traces with sharp corners. A smooth radius is recommended. E.g. Use of 45° angles instead of 90°.
- The ground reference plane should be a solid continuous plane under the trace.
- The coplanar clearance (G, below) from the trace to the ground should be at least the trace width (W) and at least twice the height (H). This reduces the parasitic capacitance, which potentially alters the trace impedance and increases the losses. E.g. If W = 100 microns then G = 200 microns in an ideal setup. G = 150 microns would also be acceptable is space is limited.

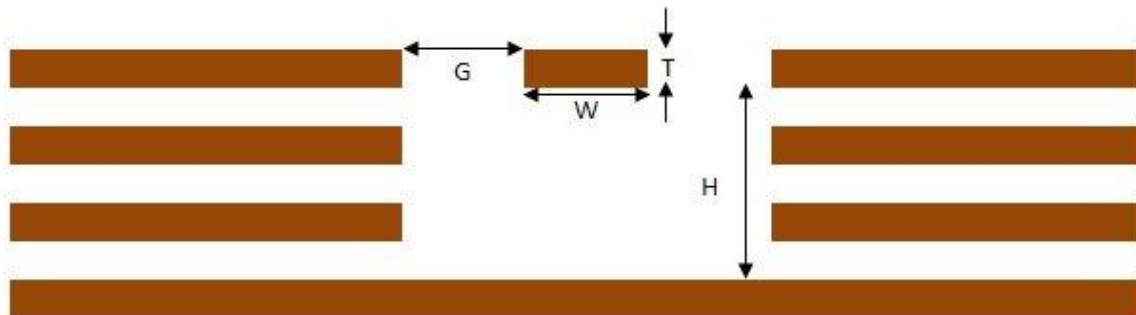


Figure 26. Coplanar Clearance Example

Note: The figure above shows several internal ground layers cut out, which may not be necessary for every application.

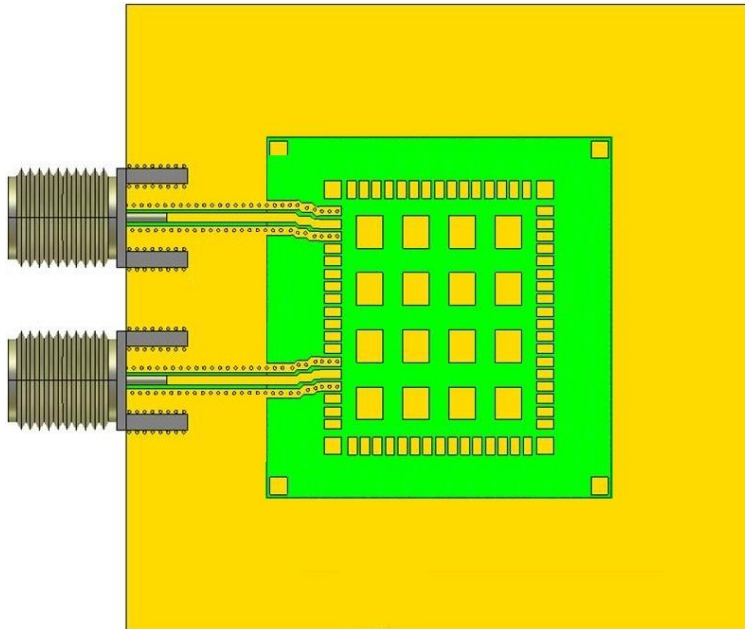


Figure 27. Antenna Microstrip Routing Example

5.6.2. GSM Antenna Integration with Antenna Detection Circuitry

The AirPrime HL6528x module is equipped with external antennas. A 50Ω line matching circuit between the module, the customer’s board and the RF antennas is required, for GSM and GPS feed path, as shown in the example below.

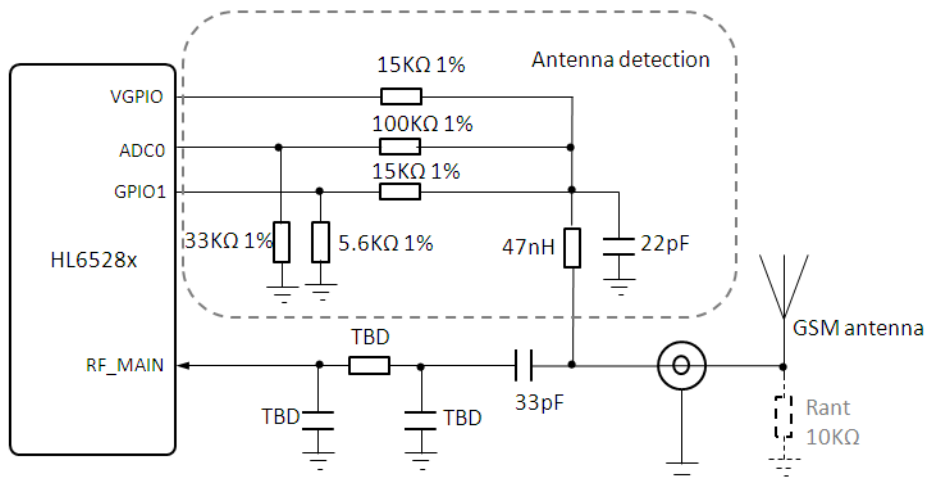


Figure 28. GSM Antenna Connection with Antenna Detection

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

5.6.3. GNSS Active Antenna Integration

The AirPrime HL6528-G and HL6528-G2.8V modules embed a GPS/GLONASS receiver inside. A possible implementation with an active GNSS antenna is defined below.

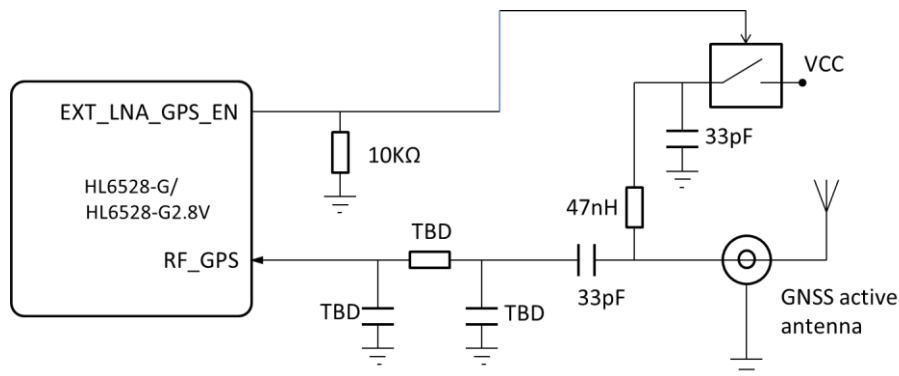


Figure 29. GNSS Application with Active Antenna

EXT_LNA_GPS_EN is a specific signal that automatically sets the AirPrime HL6528-G and HL6528-G2.8V modules' internal LNA to low gain when an external pull-down resistor is detected.

Note: When the application needs to monitor the active antenna current, current monitor devices can be connected to any of the module's GPIOs, and read with a dedicated AT command.



6. X-Ray Exposure

X-ray exposure results in an undesirable shift in programmed bit threshold voltage of the Flash memory.

As a result, Sierra Wireless recommends avoiding any X-ray exposure during customer manufacturing process to ensure software integrity and long term reliability.

In case X- ray inspection could not be eliminated from the customer manufacturing process, a variety of mitigation methods should be implemented to lower the risk of potential failure:

- Use of filter between source and module to minimize exposure to harmful soft X- ray
 - 300 μ m Zn filter or 1mm Al filter are optimal
 - Zn and Al absorb soft X-ray to which silicon is particularly vulnerable, and transmit soft and medium energy X-rays required to obtain good imaging
- Minimize X-Ray dose
 - should be less than 10 RADs
 - KV peak should be less than 50KV peak
 - tube current should be less than 20 μ A
- Maximize distance between source and the module
- Minimize the X-ray time
 - use the shortest exposure time possible
 - sampling only, not 100% inspection

Note that these mitigation guidelines are for information only as it's NOT possible to provide accurate acceptable or unacceptable X- ray exposure criteria, e.g. maximum safe dose rate, maximum safe exposure time, etc.

7. Flash memory endurance

As many embedded device, the AirPrime HL6528x module is using flash memory which are guaranteed for a limited number of program/erasing cycles per sector (100,000 cycles). Although state-of-the-art mechanism has been implemented to limit the number of writing/erasing cycles, Sierra Wireless recommends using "writing" AT commands appropriately and with caution. Those AT commands are identified in the AirPrime HL6 and HL8 Series AT Commands Interface Guide [2].

8. FCC/IC Legal Information

8.1. Label

The AirPrime HL6528x module is labeled with its own FCC ID on the shield side. Each HL6528x variant has its own FCC ID as listed in the table below.

Table 38. AirPrime HL6528x FCC IDs

Model Name	FCC ID
HL6528	N7NHL6528
HL6528-G	N7NHL6528G
HL6528-2.8V	N7NHL652828V
HL6528-G2.8V	N7NHL6528G28V

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 38 AirPrime HL6528x FCC IDs>" or "Contains FCC ID: <FCC ID as listed in Table 38 AirPrime HL6528x FCC IDs>".

8.2. 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.

8.3. 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.

According to the MPE RF explore report, maximum antenna gain allowed for use with this device is 4.5dBi for GSM850 and 1.0dBi for PCS1900 for HL6528-G;

6.5dBi for GSM850 and 3.0dBi for PCS1900 for HL6528-G2.8V, HL6528, HL6528-2.8V;

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 38 AirPrime HL6528x FCC IDs>

8.4. 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 3.2.1, RSS-Gen, Issue 3, December 2010): 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 I, or the word — Contains II, or similar wording expressing the same meaning, as follows: Contains transmitter module IC: <IC number as listed below>.

Table 39. AirPrime HL6528x IC number

Model Name	IC number
HL6528	2417C-HL6528
HL6528-G	2417C-HL6528G
HL6528-2.8V	2417C-HL652828V
HL6528-G2.8V	2417C-HL6528G28V

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.



Ordering Information

Model Name	Part Number	Designation
HL6528	1102044	HL6528, GENERIC 1.8V
HL6528-G	1102045	HL6528-G, GENERIC 1.8V
HL6528-2.8V	1102047	HL6528-2.8V, GENERIC 2.8V
HL6528-G2.8V	1102048	HL6528-G2.8V, GENERIC 2.8V
DEV-KIT	6000575	DEV-KIT, HL6 series

10.

Terms and Abbreviations

Abbreviation	Definition
ADC	Analog to Digital Converter
AGC	Automatic Gain Control
AT	Attention (prefix for modem commands)
AVL	Automatic Vehicle Location
CCB	Customer Carrier Board
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

Abbreviation	Definition
PLL	Phase Lock Loop
PWM	Pulse Width Modulation
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
SV	Satellite Vehicle
SW	SoftWare
PSRAM	Pseudo Static RAM
TBC	To Be Confirmed
TBD	To Be Defined
TP	Test Point
TTS	Text To Speech
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