Scalability Guide

AirPrime HL Series

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Document History

Version	Date	Updates
1.0	April 03, 2014	Creation
2.0	January 07, 2015	Added information for HL75xx and HL8549x
3.0	December 07, 2015	Added information for HL6528RDx, HL7618, HL8518, HL8528 and HL8529
3.1	December 08, 2015	Updated 5.4.5.2 UIM2

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1. Overview

This document aims to provide a guideline for designing applications based on the HL series embedded module, which has three main product lines – the HL6528xx, HL7xxx and HL85xxx. This document enumerates the differences between these HL series embedded modules, and provides solutions to maximize the scalability between the products.

The following table tabulates the product naming convention used throughout this document.

Table 1. Product Naming Convention

Naming Convention Used	Applicable HL Variant
HL Series	All HL series embedded modules
HL6528xx	HL6528x HL6528RDx
HL6528x	HL6528 HL6528-G HL6528-2.8V HL6528-G2.8V
HL6528RDx	HL6528RD HL6528RD-G HL6528RD-2.8V HL6528RD-G2.8V
HL85xxx	HL8518 HL8528 HL8529 HL854xx
HL854xx	HL8548x HL8549x
HL8548x	HL8548 HL8548-G
HL8549x	HL8549 HL8549-G
HL7xxx	HL7618 HL75xx
HL75xx	HL7519 HL7548 HL7588

This document does not cover all specifications and characteristics of the HL series modules. For detailed specifications, refer to the documents listed in section 2 Reference Documents, which can be downloaded from the Source.

2. Reference Documents

2.1. List of References

[1]   AirPrime HL6528x Product Technical Specification
      Reference number: 4114016

[2]   AirPrime HL6528RDx Product Technical Specification
      Reference number: 4117701

[3]   AirPrime HL8548 and HL8548-G Product Technical Specification
      Reference number: 4114663

[4]   AirPrime HL8549 and HL8549-G Product Technical Specification
      Reference number: 4115653

[5]   AirPrime HL7519, HL7548 and HL7588 Product Technical Specification
      Reference number: 4116369

[6]   AirPrime HL7618 Product Technical Specification
      Reference number: 4117929

[7]   AirPrime HL8518, HL8528 and HL8529 Product Technical Specification
      Reference number: 4117047

[8]   AirPrime HL Series Customer Process Guidelines
      Reference number: 4114330

2.2. Glossary
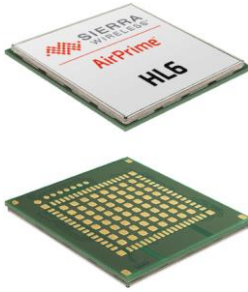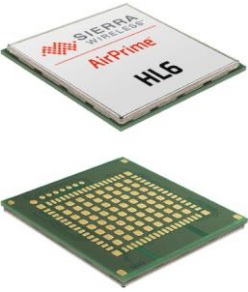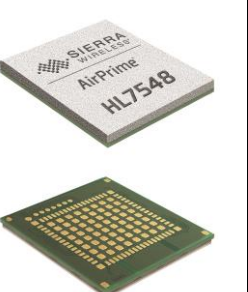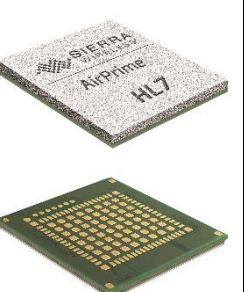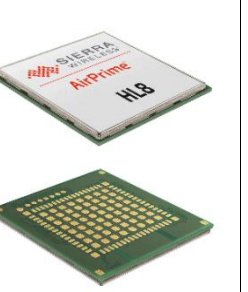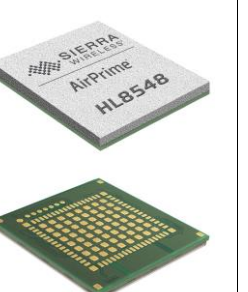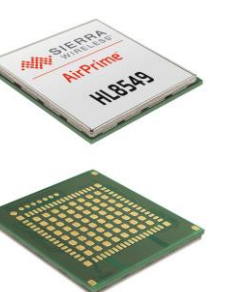
Term	Definition
GND	Ground
NC	Not Connected When a pin is marked as not connected, it means that no connection should be made from the pin to the application board.
Reserved	When a pin is marked as Reserved, it means that no connection should be made from the module pin to the application board; and that there might be a connection to the pin from within the module.

3. General Description

This section provides a general description of the features supported by the AirPrime HL series.

The following tables enumerate the main features, power domain and frequencies supported by the HL series modules; as well as specifies whether GNSS option is supported.

Table 2.   AirPrime HL Series Main Feature List

HL6528x	HL6528RDx	HL75xx	HL7618	HL8518, HL8528, HL8529	HL8548x	HL8549x
Quad band GSM GPRS	Quad band GSM GPRS	Up to Penta Band LTE*	Dual band LTE	Dual band UMTS* Dual band GSM*	Quad band GSM EDGE Penta Band UMTS	Quad band GSM EDGE Penta Band UMTS
GSM/GPRS Class 10	GSM/GPRS Class 10	LTE Cat 3/Cat4 HSPA+ Cat 24**	LTE Category 1	GSM/GPRS/EDGE RX Class 12 HSDPA 7.2Mbps HSUPA 5.76Mbps	GSM/GPRS/EDGE Class 12 GPRS/EDGRS up to class 33 (AT command selectable) HSDPA 7.2Mbps HSUPA 5.76Mbps	GSM/GPRS/EDGE Class 12 GPRS/EDGRS up to class 33 (AT command selectable) HSDPA 7.2Mbps HSUPA 5.76Mbps
GPS and GLONASS	GPS and GLONASS	No GNSS	No GNSS	No GNSS	GPS and GLONASS	GPS and GLONASS

HL6528x	HL6528RDx	HL75xx	HL7618	HL8518, HL8528, HL8529	HL8548x	HL8549x
Class A: -30°C to +70°C Class B: -40°C to +85°C Storage: -40°C to +90°C	Class A: -30°C to +70°C Class B: -40°C to +85°C Storage: -40°C to +90°C	Class A: -30°C to +70°C Class B: -40°C to +85°C Storage: -40°C to +85°C	Class A: -30°C to +70°C Class B: -40°C to +85°C Storage: -40°C to +85°C	Class A: -30°C to +70°C Class B: -40°C to +85°C Storage: -40°C to +85°C	Class A: -30°C to +70°C Class B: -40°C to +85°C Storage: -40°C to +85°C	Class A: -30°C to +70°C Class B: -40°C to +85°C Storage: -40°C to +85°C
1 x Full UART interface 1 x SPI interface (for trace only) 1 x I²C interface (for NMEA frame only) 1 x 1.8V/3V SIM interface 1 x 3V SIM interface 1 x Differential Analog Audio output 1 x Differential Analog Audio input 1 x PCM 2 x ADCs 8 x GPIOs 1 x RTC 1 x Buzzer 1 x PWM 1 x JTAG	1 x Full UART interface 1 x 2-wire UART interface (for trace only) 1 x USB 2.0 interface (full speed) 1 x I²C interface (for NMEA frame only) 2 x 1.8V/3V SIM interface 1 x Differential Analog Audio output 1 x Differential Analog Audio input 1 x PCM 2 x ADCs 8 x GPIOs 2 x clocks outputs 1 x RTC	1 x Full UART interface 1 x USB 2.0 interface (high speed) 1 x HSIC interface 1 x 5-wire trace/debug interface 1 x 1.8V/3V SIM interface 1 x PCM 1 x ADC 12 x GPIOs 2 x clocks outputs 1 x RTC 1 x JTAG	1 x Full UART interface 1 x USB 2.0 interface (high speed) 1 x 5-wire trace/debug interface 1 x 1.8V/3V SIM interface 1 x ADC 12 x GPIOs 2 x clocks outputs 1 x RTC 1 x JTAG	1 x Full UART interface 1 x USB 2.0 interface (high speed) 1 x 2-wire UART interface (for trace only) 1 x 1.8V/3V SIM interface 1 x PCM 2 x ADCs 12 x GPIOs 2 x clocks outputs 1 x RTC 2 x PWMs 1 x JTAG	1 x Full UART interface 1 x USB 2.0 interface (high speed) 1 x HSIC interface 1 x I²C interface (for NMEA frame only) 1 x 2-wire UART interface (for trace only) 1 x 1.8V/3V SIM interface 1 x PCM 2 x ADCs 12 x GPIOs 2 x clocks outputs 1 x RTC 2 x PWMs 1 x JTAG	1 x Full UART interface 1 x USB 2.0 interface (high speed) 1 x HSIC interface 1 x I²C interface (for NMEA frame only) 1 x 2-wire UART interface (for trace only) 1 x 1.8V/3V SIM interface 1 x PCM 2 x ADCs 12 x GPIOs 2 x clocks outputs 1 x RTC 2 x PWMs 1 x JTAG
23mm x 22 mm x 2.5mm (typ)	23mm x 22 mm x 2.5mm (typ)	23mm x 22 mm x 2.5mm (typ)	23mm x 22 mm x 2.5mm (typ)	23mm x 22 mm x 2.5mm (typ)	23mm x 22 mm x 2.5mm (typ)	25mm x 24 mm x 2.5mm (typ)

*   Depends on the variant; refer to Table 5 Supported Frequencies for detailed information.

**   Only available on the AirPrime HL7588.

Table 3. **Supported Power Domains**

Module Variant	1.8V Power Domain	2.8V Power Domain
HL6528, HL6528RD	✓	
HL6528-G, HL6528RD-G	✓	
HL6528-2.8V, HL6528RD-2.8V		✓
HL6528-G2.8V, HL6528RD-G2.8V		✓
HL7xxx	✓	
HL85xxx	✓	

Table 4. **GNSS Option Support**

Module Variant	GNSS Option
HL6528, HL6528RD	
HL6528-G, HL6528RD-G	✓
HL6528-2.8V, HL6528RD-2.8V	
HL6528-G2.8V, HL6528RD-G2.8V	✓
HL7xxx	
HL85xxx	
HL854x-G	✓

**Table 5.		Supported Frequencies**

Air Interface Standard	Band	Description	Frequency (MHz)	HL6528xx	HL7519	HL7548	HL7588	HL7618	HL8518	HL8528	HL8529	HL854xx
GSM	1900	PCS 1900	1850-1910 / 1930-1990	✓						✓		✓
	1800	DCS 1800	1710-1785 / 1805-1880	✓					✓			✓
	850	GSM 850	824-849 / 869-894	✓						✓		✓
	900	EGSM 900	880-915 / 925-960	✓					✓			✓
WCDMA	1	IMT Core Band	1920-1980 / 2110-2170						✓			✓
	2	PCS 1900	1850-1910 / 1930-1990				✓			✓	✓	✓
	4	AWS 1700	1710-1755 / 2110-2155				✓					
	5	CLR 850	824-849 / 869-894							✓	✓	✓
	6	850 MHz	830-840 / 875-885									✓
	8	EGSM 900	880-915 / 925-960						✓			✓
FDD LTE	2	PCS 1900	1850-1910 / 1930-1990		✓	✓	✓					
	4	AWS 1700	1710-1755 / 2110-2155		✓	✓	✓	✓				
	5	CLR 850	824-849 / 869-894			✓	✓					
	13	700 MHz	777-787 / 746-756		✓	✓	✓	✓				
	17	700 MHz	704-716 / 734-746			✓	✓					

4. Hardware Compatibility

4.1. Block Level Functional Compatibility
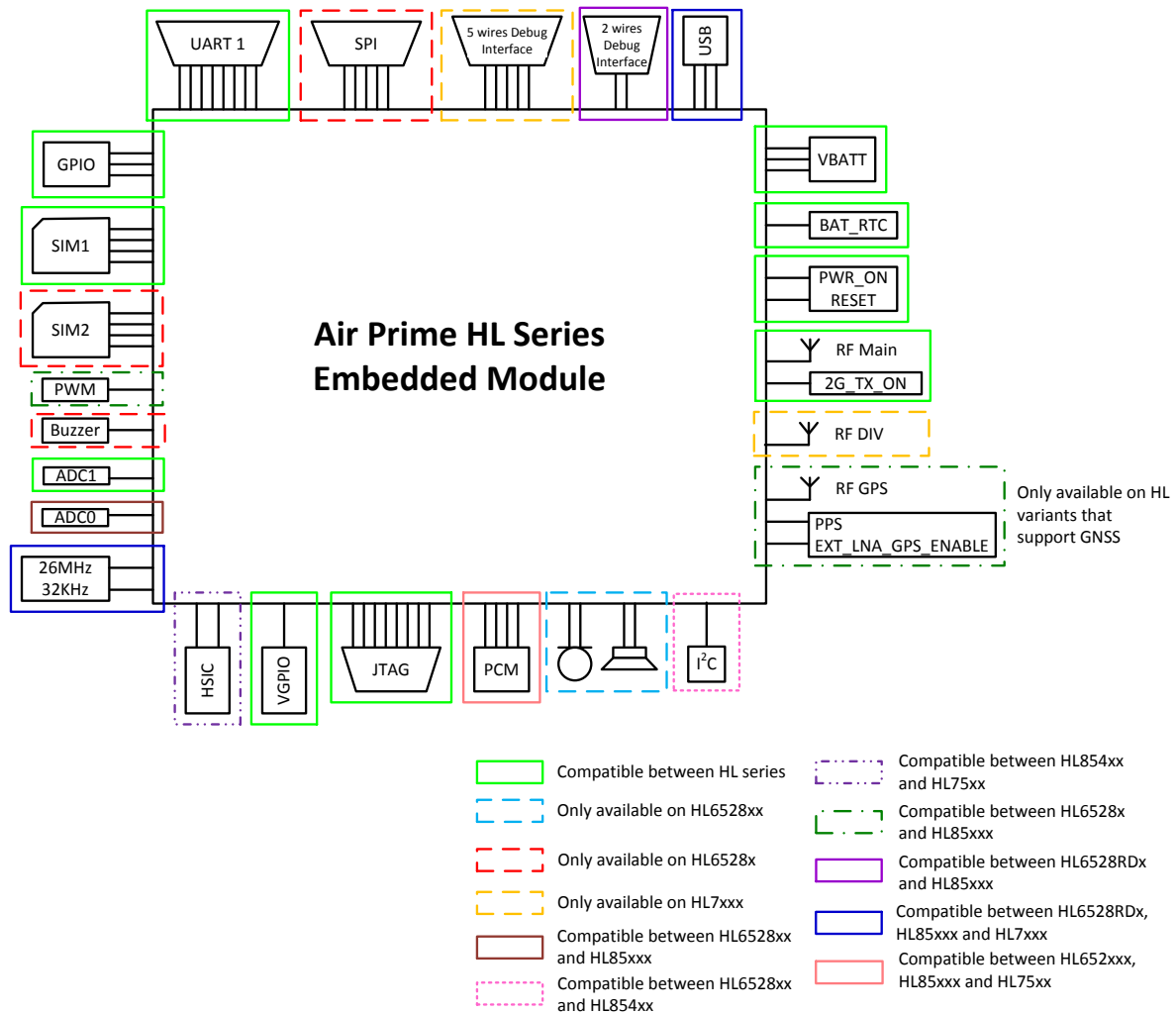
Figure 1. Block Level Functional Compatibility

4.2.   CF³ Connector Pad Configuration
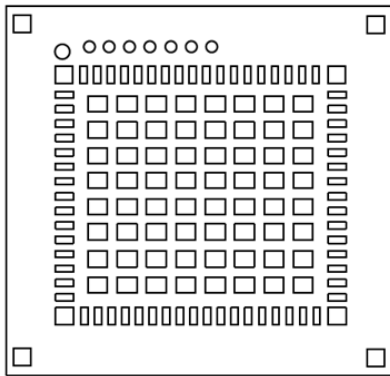
Figure 2.   AirPrime HL Series Connector Pad

The AirPrime HL series modules have the following pad configuration:

- 66 inner signal pads, 1x0.5mm, pitch 0.8mm
- 1 reference test point (Ground),1.0mm diameter
- 7 test point (JTAG), 0.8mm diameter, 1.2mm 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

4.3. Pinout

AirPrime HL6528xx 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 module. These Core functions are always available and always at the same physical pin locations. A customer platform using only these functions and associated pins is guaranteed to be forward and/or backward compatible with the next generation of CF^3 modules.
- **Extension functions and associated pins** bring additional capabilities to the customer. Whenever an Extension function is available on a module, it is always at the same pin location.
- **Custom functions and associated pins** are specific to a given module, and make an opportunistic use of specific chipset functions and I/Os. Custom features should be used with caution as there is no guarantee that the custom functions available on a given module will be available on other CF^3 modules.

The AirPrime HL7xxx and HL85xxx module pins on the other hand, only support Core and Extension function pins.

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

For recommendations for unused pins, power domains and other pin-specific information, refer to the corresponding HL Series product technical specification listed in section 2.1 List of References.

Table 6. Pad Definition

Pin #	CF^3 Pin Type	HL6528x		HL6528RDx		HL75xx		HL7618		HL8518, HL8528, HL8529		HL854xx	
		Signal Name	Description	Signal Name	Description	Signal Name	Description	Signal Name	Description	Signal Name	Description	Signal Name	Description
1	Extension	GPIO1 / I2C1_ CLK	General purpose input/output / I²C Clock	GPIO1 / I2C1_ CLK	General purpose input/output / I²C serial clock line	GPIO1	General purpose input/output	GPIO1	General purpose input/output	GPIO1	General purpose input/output	GPIO1 / I2C_ CLK	General purpose input/output / I²C Clock
2	Core	UART1_ RI	UART1 Ring indicator	UART1_ RI	UART1 Ring indicator	UART1_ RI / TRACE_ DATA3	UART1 Ring indicator / Trace data 3	UART1_ RI / TRACE_ DATA3	UART1 Ring indicator / Trace data 3	UART1_ RI	UART1 Ring indicator	UART1_ RI	UART1 Ring indicator

Pin #	CF³ Pin Type	HL6528x		HL6528RDx		HL75xx		HL7618		HL8518, HL8528, HL8529		HL854xx	
		Signal Name	Description	Signal Name	Description	Signal Name	Description	Signal Name	Description	Signal Name	Description	Signal Name	Description
3	Core	UART1_RTS	UART1 Request to send	UART1_RTS	UART1 Request to send	UART1_RTS	UART1 Request to send	UART1_RTS	UART1 Request to send	UART1_RTS	UART1 Request to send	UART1_RTS	UART1 Request to send
4	Core	UART1_CTS	UART1 Clear to send	UART1_CTS	UART1 Clear to send	UART1_CTS	UART1 Clear to send	UART1_CTS	UART1 Clear to send	UART1_CTS	UART1 Clear to send	UART1_CTS	UART1 Clear to send
5	Core	UART1_TX	UART1 Transmit data	UART1_TX	UART1 Transmit data	UART1_TX	UART1 Transmit data	UART1_TX	UART1 Transmit data	UART1_TX	UART1 Transmit data	UART1_TX	UART1 Transmit data
6	Core	UART1_RX	UART1 Receive data	UART1_RX	UART1 Receive data	UART1_RX	UART1 Receive data	UART1_RX	UART1 Receive data	UART1_RX	UART1 Receive data	UART1_RX	UART1 Receive data
7	Core	UART1_DTR	UART1 Data terminal ready	UART1_DTR	UART1 Data terminal ready	UART1_DTR	UART1 Data terminal ready	UART1_DTR	UART1 Data terminal ready	UART1_DTR	UART1 Data terminal ready	UART1_DTR	UART1 Data terminal ready
8	Core	UART1_DCD	UART1 Data carrier detect	UART1_DCD	UART1 Data carrier detect	UART1_DCD / TRACE_DATA1	UART1 Data carrier detect / Trace data 1	UART1_DCD / TRACE_DATA1	UART1 Data carrier detect / Trace data 1	UART1_DCD	UART1 Data carrier detect/	UART1_DCD	UART1 Data carrier detect
9	Core	UART1_DSR	UART1 Data set ready	UART1_DSR	UART1 Data set ready	UART1_DSR / TRACE_DATA0	UART1 Data set ready / Trace data 0	UART1_DSR / TRACE_DATA0	UART1 Data set ready / Trace data 0	UART1_DSR	UART1 Data set ready	UART1_DSR	UART1 Data set ready
10	Core	GPIO2	General purpose input/output	GPIO2 / UIM2_VCC_CTRL	General purpose input/output / UIM2 VCC Control	GPIO2 / TRACE_DATA2	General purpose input/output / Trace data 2	GPIO2 / TRACE_DATA2	General purpose input/output / Trace data 2	GPIO2	General purpose input/output	GPIO2	General purpose input/output
11	Core	RESET_IN	Input reset signal	RESET_IN_N	Input reset signal	RESET_IN_N	Input reset signal	RESET_IN_N	Input reset signal	RESET_IN_N	Input reset signal	RESET_IN_N	Input reset signal
12	Extension	NC	Not Connected	USB_D-	USB Data Negative	USB_D-	USB Data Negative	USB_D-	USB Data Negative	USB_D-	USB Data Negative	USB_D-	USB Data Negative
13	Extension	NC	Not Connected	USB_D+	USB Data Positive	USB_D+	USB Data Negative	USB_D+	USB Data Negative	USB_D+	USB Data Negative	USB_D+	USB Data Positive
14	Extension	NC	Not Connected	NC	Not Connected	HSIC_DATA	High Speed Inter-Chip Data	NC	Not Connected	NC	Not Connected	HSIC_DATA	High Speed Inter-Chip Data

Pin #	CF³ Pin Type	HL6528x		HL6528RDx		HL75xx		HL7618		HL8518, HL8528, HL8529		HL854xx	
		Signal Name	Description	Signal Name	Description	Signal Name	Description	Signal Name	Description	Signal Name	Description	Signal Name	Description
15	Extension	NC	Not Connected	NC	Not Connected	HSIC_STRB	High Speed Inter-Chip Strobe	NC	Not Connected	NC	Not Connected	HSIC_STRB	High Speed Inter-Chip Strobe
16	Extension	NC	Not Connected	USB_VBUS	USB VBUS	USB_VBUS	USB VBUS	USB_VBUS	USB VBUS	USB_VBUS	USB VBUS	USB_VBUS	USB VBUS
17	Extension	SPKR_N	Speaker negative output	SPKR_N	Speaker negative output	NC	Not Connected	NC	Not Connected	NC	Not Connected	NC	Not Connected
18	Extension	SPKR_P	Speaker positive output	SPKR_P	Speaker positive output	NC	Not Connected	NC	Not Connected	NC	Not Connected	NC	Not Connected
19	Extension	MIC_P	Microphone positive input	MIC_P	Microphone positive input	NC	Not Connected	NC	Not Connected	NC	Not Connected	NC	Not Connected
20	Extension	MIC_N	Microphone negative input	MIC_N	Microphone negative input	NC	Not Connected	NC	Not Connected	NC	Not Connected	NC	Not Connected
21	Extension	BAT_RTC	Power supply for RTC backup	BAT_RTC	Power supply for RTC backup	BAT_RTC	Power supply for RTC backup	BAT_RTC	Power supply for RTC backup	BAT_RTC	Power supply for RTC backup	BAT_RTC	Power supply for RTC backup
22	Extension	TP2**	Internal SWI use only	26M_CLKOUT	26MHz System Clock Output	26M_CLKOUT	26MHz System Clock Output	26M_CLKOUT	26MHz System Clock Output	26M_CLKOUT	26MHz System Clock Output	26M_CLKOUT	26MHz System Clock Output
23	Extension	NC	Not Connected	32K_CLKOUT	32.768kHz System Clock Output	32K_CLKOUT	32.768kHz System Clock Output	32K_CLKOUT	32.768kHz System Clock Output	32K_CLKOUT	32.768kHz System Clock Output	32K_CLKOUT	32.768kHz System Clock Output
24	Extension	ADC1	Analog to digital conversion	ADC1	Analog to digital conversion	ADC1	Analog to digital converter	ADC1	Analog to digital converter	ADC1	Analog to digital conversion	ADC1	Analog to digital conversion
25	Extension	ADC0	Analog to digital conversion	ADC0	Analog to digital conversion	NC		NC	Not Connected	ADC0	Analog to digital conversion	ADC0	Analog to digital conversion
26	Core	UIM1_VCC	1.8V/3V SIM1 Power supply	UIM1_VCC	1.8V/3V UIM1 Power supply	UIM1_VCC	1.8V/3V SIM1 Power supply	UIM1_VCC	1.8V/3V SIM1 Power supply	UIM1_VCC	1.8V/3V SIM1 Power supply	UIM1_VCC	1.8V/3V SIM1 Power supply
27	Core	UIM1_CLK	1.8V/3V SIM1 Clock	UIM1_CLK	1.8V/3V UIM1 Clock	UIM1_CLK	1.8V/3V SIM1 Clock	UIM1_CLK	1.8V/3V SIM1 Clock	UIM1_CLK	1.8V/3V SIM1 Clock	UIM1_CLK	1.8V/3V SIM1 Clock

Pin #	CF³ Pin Type	HL6528x		HL6528RDx		HL75xx		HL7618		HL8518, HL8528, HL8529		HL854xx	
		Signal Name	Description	Signal Name	Description	Signal Name	Description	Signal Name	Description	Signal Name	Description	Signal Name	Description
28	Core	UIM1_DATA	1.8V/3V SIM1 Data	UIM1_DATA	1.8V/3V UIM1 Data	UIM1_DATA	1.8V/3V SIM1 Data	UIM1_DATA	1.8V/3V SIM1 Data	UIM1_DATA	1.8V/3V SIM1 Data	UIM1_DATA	1.8V/3V SIM1 Data
29	Core	UIM1_RESET	1.8V/3V SIM1 Reset	UIM1_RESET	1.8V/3V UIM1 Reset	UIM1_RESET	1.8V/3V SIM1 Reset	UIM1_RESET	1.8V/3V SIM1 Reset	UIM1_RESET	1.8V/3V SIM1 Reset	UIM1_RESET	1.8V/3V SIM1 Reset
30	Extension	NC	Not Connected	NC	Not Connected	GND	Ground	GND	Ground	NC	Not Connected	NC	Not Connected
31	Extension	NC	Not Connected	NC	Not Connected	RF_DIV	RF Input - Diversity	RF_DIV	RF Input - Diversity	NC	Not Connected	NC	Not Connected
32	Extension	NC	Not Connected	NC	Not Connected	GND	Ground	GND	Ground	NC	Not Connected	NC	Not Connected
33	Extension	PCM_OUT	PCM data out	PCM_OUT	PCM data out	PCM_OUT	PCM data out	PCM_OUT***	PCM data out	PCM_OUT	PCM data out	PCM_OUT	PCM data out
34	Extension	PCM_IN	PCM data in	PCM_IN	PCM data in	PCM_IN	PCM data in	PCM_IN***	PCM data in	PCM_IN	PCM data in	PCM_IN	PCM data in
35	Extension	PCM_SYNC	PCM sync out	PCM_SYNC	PCM sync out	PCM_SYNC	PCM sync out	PCM_SYNC***	PCM sync out	PCM_SYNC	PCM sync out	PCM_SYNC	PCM sync out
36	Extension	PCM_CLK	PCM clock	PCM_CLK	PCM clock	PCM_CLK	PCM clock	PCM_CLK***	PCM clock	PCM_CLK	PCM clock	PCM_CLK	PCM clock
37	Core	GND	Ground	GND	Ground	GND	Ground	GND	Ground	GND	Ground	GND	Ground
38	Extension	RF_GPS*	RF GPS Input	RF_GPS*	RF GPS Input	NC	Not connected	NC	Not Connected	NC	Not Connected	RF_GPS*	RF GPS Input
39	Core	GND	Ground	GND	Ground	GND	Ground	GND	Ground	GND	Ground	GND	Ground
40	Core	GPIO7	General purpose input/output	GPIO7	General purpose input/output	GPIO7	General purpose input/output	GPIO7	General purpose input/output	GPIO7	General purpose input/output	GPIO7	General purpose input/output
41	Core	GPIO8	General purpose input/output	GPIO8	General purpose input/output	GPIO8 / TRACE_CLK	General purpose input/output	GPIO8 / TRACE_CLK	General purpose input/output / Trace clock	GPIO8	General purpose input/output	GPIO8	General purpose input/output
42	Extension	PPS*	GPS Pulse Per Second	PPS*	GPS Pulse Per Second	NC	Not connected	NC	Not Connected	NC	Not Connected	PPS*	GPS Pulse Per Second

Pin #	CF³ Pin Type	HL6528x		HL6528RDx		HL75xx		HL7618		HL8518, HL8528, HL8529		HL854xx	
		Signal Name	Description	Signal Name	Description	Signal Name	Description	Signal Name	Description	Signal Name	Description	Signal Name	Description
43	Extension	EXT_ LNA_ GPS_ EN*	External GPS LNA enable	EXT_ LNA_ GPS_ EN*	External GPS LNA enable	NC	Not connected	NC	Not Connected	NC	Not Connected	EXT_ LNA_ GPS_ EN*	External GPS LNA enable
44	Extension	SPI_ SRDY	SPI Slave Ready	DEBUG _TX	Debug Transmit Data	GPIO13	General purpose input/output	GPIO13	General purpose input/output	DEBUG _TX	Debug transmit data	DEBUG_ TX	Debug transmit data
45	Core	VGPIO	GPIO voltage output	VGPIO	GPIO voltage output	VGPIO	GPIO voltage output	VGPIO	GPIO voltage output	VGPIO	GPIO voltage output	VGPIO	GPIO voltage output
46	Core	GPIO6	General purpose input/output	GPIO6	General purpose input/output	GPIO6	General purpose input/output	GPIO6	General purpose input/output	GPIO6	General purpose input/output	GPIO6	General purpose input/output
47	Extension	TP1	Test Point 1	TP1	Test Point 1	NC	Not connected	NC	Not Connected	TP1	Test Point 1	TP1	Test Point 1
48	Core	GND	Ground	GND	Ground	GND	Ground	GND	Ground	GND	Ground	GND	Ground
49	Core	RF_ MAIN	RF GSM Input/output	RF_ MAIN	RF GSM Input/output	RF_ MAIN	RF Input/output	RF_ MAIN	RF Input/output	RF_ MAIN	RF GSM Input/output	RF_ MAIN	RF GSM Input/output
50	Core	GND	Ground	GND	Ground	GND	Ground	GND	Ground	GND	Ground	GND	Ground
51	Extension	SPI_ MRDY	SPI Master Ready	DEBUG _RX	Debug Receive Data	GPIO14	General purpose input/output	GPIO14	General purpose input/output	DEBUG _RX	Debug receive data	DEBUG_ RX	Debug receive data
52	Extension	SPI_ MISO	SPI Master In Slave Out	Reserved	Reserved	GPIO10	General purpose input/output	GPIO10	General purpose input/output	GPIO10	General purpose input/output	GPIO10	General purpose input/output
53	Extension	SPI_ CLK	SPI Clock	Reserved	Reserved	GPIO11	General purpose input/output	GPIO11	General purpose input/output	GPIO11	General purpose input/output	GPIO11	General purpose input/output
54	Extension	SPI_ MOSI	SPI Master Out Slave In	NC	Not connected	GPIO15	General purpose input/output	GPIO15	General purpose input/output	GPIO15	General purpose input/output	GPIO15	General purpose input/output
55	Extension	UIM2_ VCC	SIM2 Power supply	UIM2_ VCC	UIM2 Power supply	NC	Not connected	NC	Not connected	NC1	Reserved for future use	NC1	Reserved for future use
56	Extension	UIM2_ DATA	SIM2 Data	UIM2_ DATA	UIM2 Data	NC	Not connected	NC	Not connected	NC2	Reserved for future use	NC2	Reserved for future use

Pin #	CF³ Pin Type	HL6528x		HL6528RDx		HL75xx		HL7618		HL8518, HL8528, HL8529		HL854xx	
		Signal Name	Description	Signal Name	Description	Signal Name	Description	Signal Name	Description	Signal Name	Description	Signal Name	Description
57	Extension	UIM2_RESET/BUZZER	SIM2 Reset/Buzzer	UIM2_RESET	UIM2 Reset	NC	Not connected	NC	Not connected	PWM1	Pulse Width Modulation	PWM1	Pulse Width Modulation
58	Extension	UIM2_CLK / PWM	SIM2 Clock / PWM	UIM2_CLK	UIM2 Clock	NC	Not connected	NC	Not connected	PWM2 / GPIO12	Pulse Width Modulation / General purpose input/output	PWM2 / GPIO12	Pulse Width Modulation / General purpose input/output
59	Core	PWR_ON	Active Low Power On control signal	PWR_ON_N	Active Low Power On control signal	PWR_ON	Active Low Power On control signal	PWR_ON_N	Active Low Power On control signal	PWR_ON_N	Active Low Power On control signal	PWR_ON_N	Active Low Power On control signal
60	Extension	2G_TX_ON	2G TX burst indicator	2G_TX_ON	2G TX burst indicator	TX_ON	TX indicator	TX_ON	TX indicator	2G_TX_ON	2G TX burst indicator	2G_TX_ON	2G TX burst indicator
61	Core	VBATT_PA	3.7V Power Amplifier Power supply	VBATT_PA	3.7V Power Amplifier Power supply	VBATT_PA	3.7V Power Amplifier Power supply	VBATT_PA	Power supply	VBATT_PA	Power supply	VBATT_PA	3.7V Power Amplifier Power supply
62	Core	VBATT_PA	3.7V Power Amplifier Power supply	VBATT_PA	3.7V Power Amplifier Power supply	VBATT_PA	3.7V Power Amplifier Power supply	VBATT_PA	Power supply	VBATT_PA	Power supply	VBATT_PA	3.7V Power Amplifier Power supply
63	Core	VBATT	3.7V Power supply	VBATT	3.7V Power supply	VBATT	3.7V Power supply	VBATT	Power supply	VBATT	Power supply	VBATT	3.7V Power supply
64	Core	UIM1_DET / GPIO3	UIM1 Detection / General purpose input/output	UIM1_DET / GPIO3	UIM1 Detection / General purpose input/output	UIM1_DET	UIM1 Detection / General purpose input/output	UIM1_DET	UIM1 Detection	UIM1_DET / GPIO3	UIM1 Detection / General purpose input/output	GPIO3 / UIM1_DET	General purpose input/output / UIM1 Detection
65	Extension	UIM2_DET / GPIO4	UIM2 Detection / General purpose input/output	UIM2_DET / GPIO4	UIM2 Detection / General purpose input/output	GPIO4	General purpose input/output	GPIO4	General purpose input/output	GPIO4	General purpose input/output	GPIO4	General purpose input/output
66	Extension	GPIO5 / I2C1_DATA	General purpose input/output / I²C DATA	GPIO5 / I2C1_DATA	General purpose input/output / I²C serial data line	GPIO5	General purpose input/output	GPIO5	General purpose input/output	GPIO5	General purpose input/output	GPIO5 / I2C_SDA	General purpose input/output / I²C Data

Pin #	CF³ Pin Type	HL6528x		HL6528RDx		HL75xx		HL7618		HL8518, HL8528, HL8529		HL854xx	
		Signal Name	Description	Signal Name	Description	Signal Name	Description	Signal Name	Description	Signal Name	Description	Signal Name	Description
67-70	Core	GND	Ground	GND	Ground	GND	Ground	GND	Ground	GND	Ground	GND	Ground
71-166	*Note:*	*These pins are not available on the AirPrime HL Series.*											
167-234	Core	GND	Ground	GND	GND	GND	Ground	GND	Ground	GND	Ground	GND	Ground
236	Extension	JTAG_RESET	JTAG RESET	JTAG_RESET	JTAG RESET	JTAG_RESET	JTAG RESET	JTAG_RESET	JTAG RESET	JTAG_RESET	JTAG RESET	JTAG_RESET	JTAG RESET
237	Extension	JTAG_TCK	JTAG Test Clock	JTAG_TCK	JTAG Test Clock	JTAG_TCK	JTAG Test Clock	JTAG_TCK	JTAG Test Clock	JTAG_TCK	JTAG Test Clock	JTAG_TCK	JTAG Test Clock
238	Extension	JTAG_TDO	JTAG Test Data Output	JTAG_TDO	JTAG Test Data Output	JTAG_TDO	JTAG Test Data Output	JTAG_TDO	JTAG Test Data Output	JTAG_TDO	JTAG Test Data Output	JTAG_TDO	JTAG Test Data Output
239	Extension	JTAG_TMS	JTAG Test Mode Select	JTAG_TMS	JTAG Test Mode Select	JTAG_TMS	JTAG Test Mode Select	JTAG_TMS	JTAG Test Mode Select	JTAG_TMS	JTAG Test Mode Select	JTAG_TMS	JTAG Test Mode Select
240	Extension	JTAG_TRST	JTAG Test Reset	JTAG_TRST	JTAG Test Reset	JTAG_TRST	JTAG Test Reset	JTAG_TRST	JTAG Test Reset	JTAG_TRST	JTAG Test Reset	JTAG_TRST	JTAG Test Reset
241	Extension	JTAG_TDI	JTAG Test Data Input	JTAG_TDI	JTAG Test Data Input	JTAG_TDI	JTAG Test Data Input	JTAG_TDI	JTAG Test Data Input	JTAG_TDI	JTAG Test Data Input	JTAG_TDI	JTAG Test Data Input
242	Extension	JTAG_RTCK	JTAG Returned Test Clock	JTAG_RTCK	JTAG Returned Test Clock	JTAG_RTCK	JTAG Returned Test Clock	JTAG_RTCK	JTAG Returned Test Clock	JTAG_RTCK	JTAG Returned Test Clock	JTAG_RTCK	JTAG Returned Test Clock

*   These pins are only available on the HL6528-G, HL6528RD-G, HL6528-G2.8V, HL6528RD-G2.8V and HL854x-G.

**   Custom pin for HL6528x; it is mandatory for this pin to be left open.

***   This signal is not supported on the HL7618.

5. Application Notes for Scalability

5.1. RF Antenna Interface

5.1.1. RF_MAIN

The main antenna port of the HL6528xx, HL7xxx and HL85xxx are identical.

Table 7. RF_Main Pin Description

Pin #	Signal Name	Description
48	GND	Ground
49	RF_MAIN	RF GSM Input/Output
50	GND	Ground

The following figure shows a typical schematic diagram of an RF path with an antenna detection circuit. Note that this figure is the same regardless of power domain (can be used for either 1.8V or 2.8V).
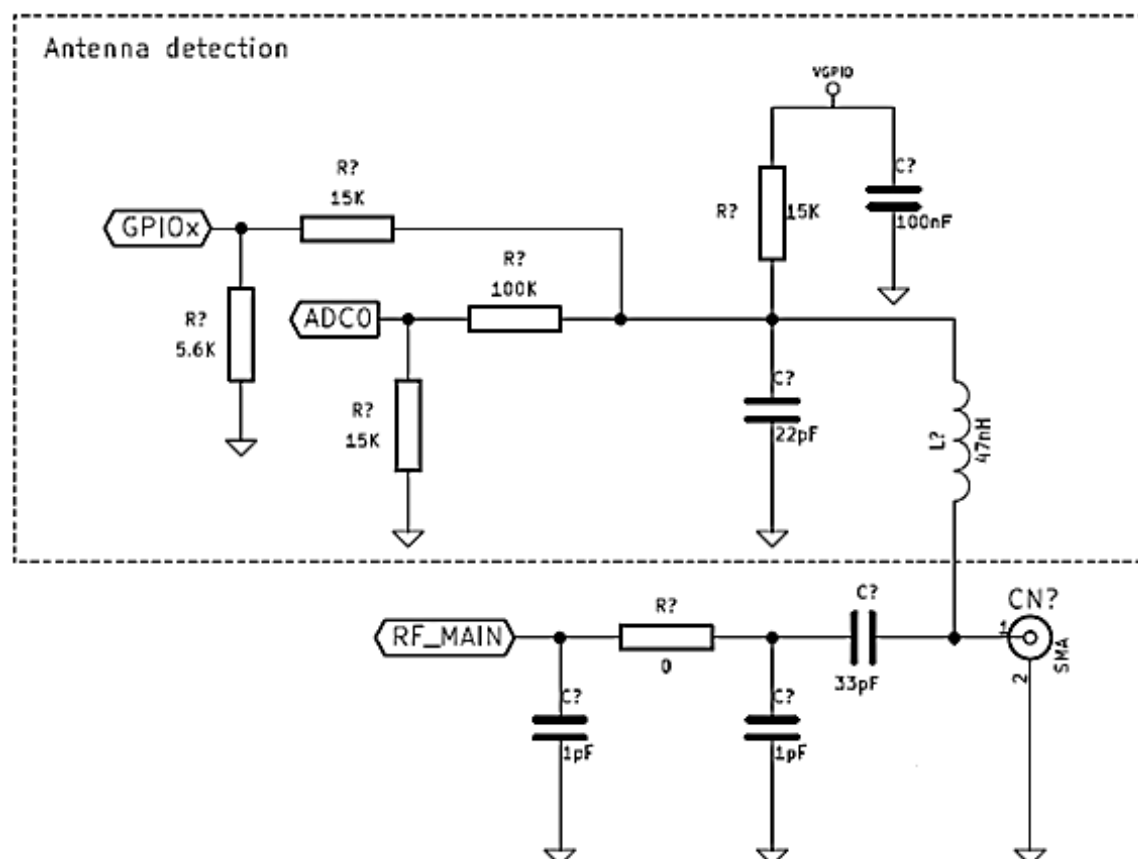
Figure 3. Antenna Detection Feature Reference Schematic

Figure 4.   Direct Connection to Main Antenna Reference Schematic

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Note: When using a direct connection, always ensure that the circuit matches that on the customer board. Adjustments might be needed during RF qualification.

5.1.2.   RF_DIV

The RF diversity antenna port is only available on the HL7xxx; its corresponding pin (pin 31) is not connected on the HL6528xx and HL85xxx.

Table 8.   RF_DIV Pin Description for HL7xxx

Pin #	HL6528xx and HL85xxx		HL7xxx	
	Signal Name	Description	Signal Name	Description
30	NC	Not Connected	GND	Ground
31	NC	Not Connected	RF_DIV	RF Diversity Input/Output
32	NC	Not Connected	GND	Ground
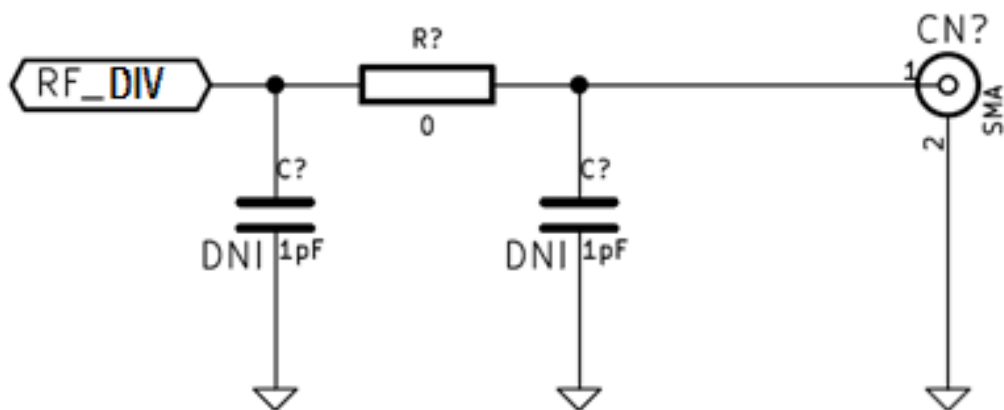
Figure 5.   Direct Connection to Diversity Antenna Reference Schematic

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Note: When using a direct connection, always ensure that the circuit matches that on the customer board. Adjustments might be needed during RF qualification.

5.1.3. RF_GPS

The HL6528-G, HL6528RD-G, HL6528-G2.8V, HL6528RD-G2.8V, HL8548-G and HL8549-G variants provide GNSS functionality through an embedded GNSS chip.

The HL7xxx, HL8518, HL8528 and HL8529 do not support GNSS functionality; their corresponding pin (pin 38) is not connected.

Table 9. RF_GPS Pin Description for HL6528x-G, HL6528x-G2.8V and HL854x-G

Pin #	HL6528-G, HL6528RD-G, H6528-G2.8V, H6528RD-G2.8V and HL854x-G		HL7xxx, HL8518, HL8528 and HL8529	
	Signal Name	Description	Signal Name	Description
37	GND	Ground	GND	Ground
38	RF_GPS	RF GPS input	NC	Not connected
39	GND	Ground	GND	Ground

The following figure shows a typical schematic diagram for a direct connection to a GPS antenna. Note that the power domain depends on the HL embedded module variant.
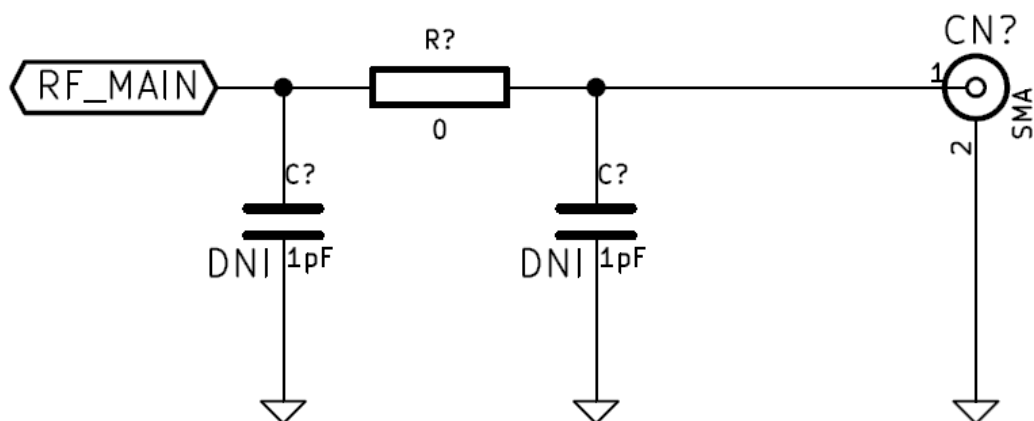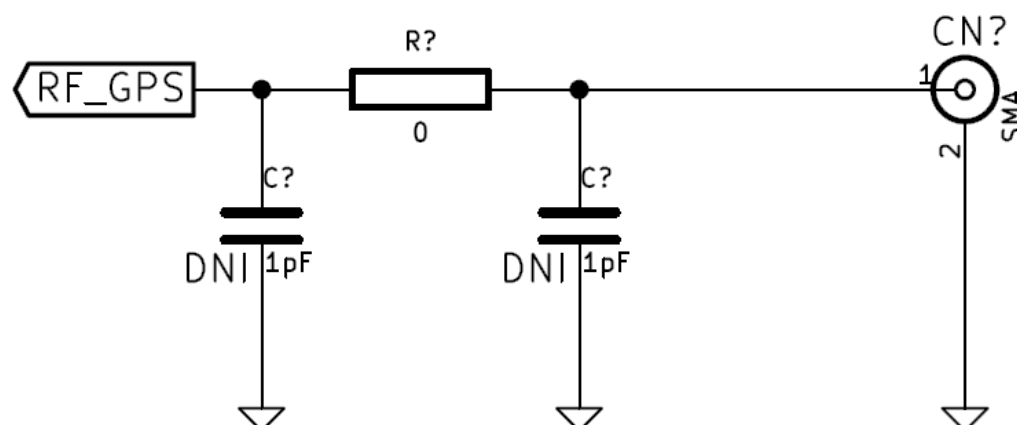

Figure 6.   Direct Connection to GPS Antenna Reference Schematic

Note: When using a direct connection, always ensure that the circuit matches that on the customer board. Adjustments might be needed during RF qualification.

5.1.3.1. EXT_LNA_GPS_EN

AirPrime HL series variants that support GNSS provide a signal, EXT_LNA_GPS_EN, that 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.

This signal automatically sets the AirPrime HL6528-G, HL6528RD-G, HL6528-G2.8V, HL6528RD-G2.8V, HL8548-G and HL8549-G modules' internal LNA to low gain when an external pull-down resistor is detected.

The HL7xxx, HL8518, HL8528 and HL8529 do not support this signal; their corresponding pin (pin 43) is not connected.

Table 10.   EXT_LNA_GPS_EN Pin Description

Pin #	Signal Name	Description	Power Domain for HL6528-G, HL6528RD-G	Power Domain for HL6528-G2.8V, HL6528RD-G2.8V	Power Domain for HL854x-G
43	EXT_LNA_GPS_EN	External GPS LNA enable	1.8 V	2.8 V	1.8 V

Note: *To ensure HL series scalability, it is recommended that the 1.8V variant be used for applications that use this signal/feature.*
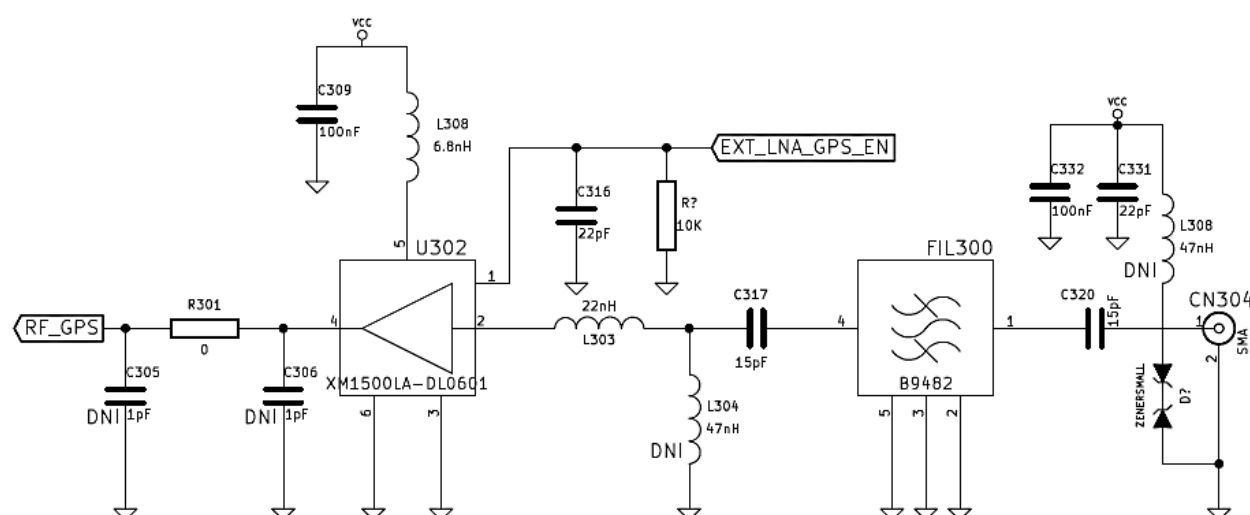
Figure 7.   Active Antenna and External LNA Reference Schematic

5.1.3.2.   PPS

The PPS signal is an output pulse related to GNSS receiver time available on HL series variants that support GNSS.

The HL7xxx, HL8518, HL8528 and HL8529 do not support this signal; their corresponding pin (pin 42) is not connected.

Table 11.   PPS Pin Description

Pin #	Signal Name	Description	Power Domain for HL6528-G, HL6528RD-G	Power Domain for HL6528-G2.8V, HL6528RD-G2.8V	Power Domain for HL854x-G
42	PPS	GNSS pulse per second	1.8V	2.8V	1.8V

Note: *To ensure HL series scalability, it is recommended that the 1.8V variant be used for applications that use this signal/feature.*

5.1.3.3. I²C Interface

AirPrime HL series variants that support GNSS embed an I²C interface dedicated to NMEA frames. (Note that NMEA frames can also be output from the UART1 interface, as well as the USB interface for the HL6528RD-G, HL6528RD-G2.8V and HL8548-G.)

Table 12. I²C Pin Description

Pin #	Signal Name	Description	Power Domain for HL6528-G, HL6528RD-G	Power Domain for HL6528-G2.8V, HL6528RD-G2.8V	Power Domain for HL854x-G
1	GPIO1/ I2C1_CLK	General purpose input/output / I²C Clock	1.8V	2.8V	1.8V
66	GPIO5/ I2C1_DATA	General purpose input/output / I²C Data	1.8V	2.8V	1.8V

Note: *As most microprocessor customer applications do not operate at 1.8V or 2.8V, and to ensure full scalability, customers need to use an integrated dual bi-directional I²C voltage level translator (for example, PCA9306) or a bi-directional level shifter based on MOSFET (for example, BSS138).*
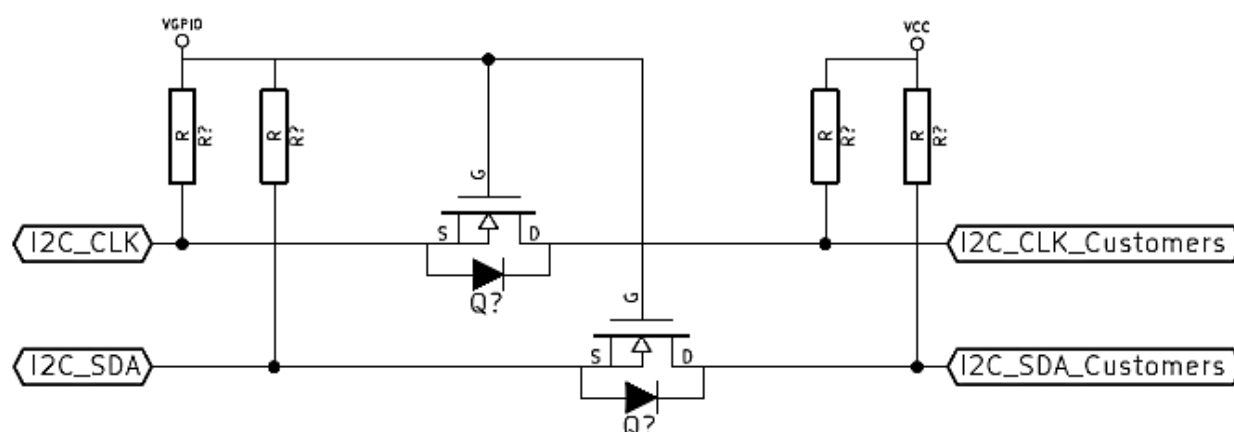
Figure 8. *Bi-directional Level Shifter for I²C*

For more information about this example, refer to NXP Application Note AN10441.

5.2.   Power Supply

5.2.1.   VBATT and VBATT_PA

For standard applications, VBATT and VBATT_PA must be tied externally to the same power supply. However, for some specific applications, the HL series modules support separate VBATT and VBATT_PA connections. For more information, refer to the specific technical specifications specified in section 2 Reference Documents.

Table 13.   Power Supply Pin Description

Pin #	Signal Name	Description	Voltage
61	VBATT_PA	3.7 V Power Amplifier Power Supply	3.7 V
62	VBATT_PA	3.7 V Power Amplifier Power Supply	3.7 V
63	VBATT	3.7 V Power Supply	3.7 V

Table 14.   Power Supply Electrical Characteristics

Module		VBATT_PA (V) – Full Specification	VBATT_PA (V) – Extended Range	VBATT (V)
HL6528x	Minimum	3.0 V	2.8 V	3.2 V
	Typical	3.7 V	3.7 V	3.7 V
	Maximum	4.5 V	4.5 V	4.5 V
HL6528RDx	Minimum	3.35 V	2.8 V	3.35 V
	Typical	3.7 V	3.7 V	3.7 V
	Maximum	4.3 V	4.3 V	4.3 V
HL7xxx and HL85Xxx	Minimum	3.2 V	2.8 V	3.2 V
	Typical	3.7 V	3.7 V	3.7 V
	Maximum	4.5 V	4.5 V	4.5 V

5.2.2.   BAT-RTC

The BAT-RTC voltage of the HL6528xx is different from that of the HL7xxx and HL85xxx. Customers should use a super capacitor to ensure scalability between the two products.

If BAT-RTC is not used in the customer application, a 10µF capacitor must be connected to the ground.

Table 15.   BAT_RTC Pin Description for HL series

Pin #	Signal Name	Description	Voltage for HL6528x	Voltage for HL6528RDx	Voltage for HL7xxx and HL85xxx
21	BAT-RTC	Power Supply for RTC backup	3 V	2.8 V	1.8 V
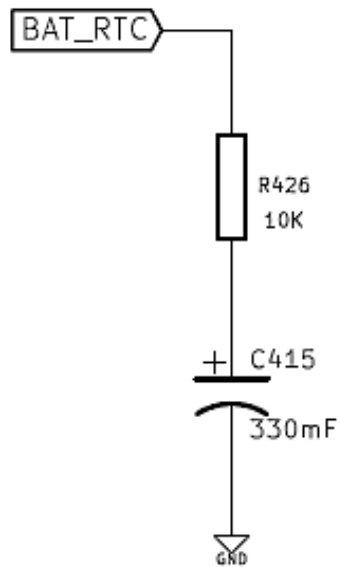
Figure 9.   BAT_RTC with Super Capacitor Reference Schematic

Caution: *If customers want to use a non-rechargeable battery or a rechargeable battery cell, BOM modification must be anticipated.*

5.2.3. VGPIO

Although the pin number is the same, the GPIO voltage output and current capability of the HL6528x is different from that of other HL variants.

Table 16.   VGPIO Pin Description

Pin #	Signal Name	Description	Voltage for HL6528-G, HL6528RD-G	Voltage for HL6528-G2.8V, HL6528RD-G2.8V	Voltage for HL7xxx	Voltage for HL85xxx
45	VGPIO	GPIO voltage output	1.8 V	2.8 V	1.8 V	1.8 V

Table 17.   VGPIO Electrical Characteristics

Parameter	HL6528x			HL6528RD, HL6528RD-G			HL6528RD-2.8V, HL6528RD-G2.8V			HL75xx			HL7618			HL85xxx		
	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max
Voltage level (V) (Both active mode and sleep mode)	2.65	2.80	2.95	1.70	1.80	1.90	2.7	2.80	2.95	1.70	1.80	1.90	1.7	1.8	1.9	1.70	1.80	1.90
Current capability active mode (mA)	-	-	50	-	-	50	-	-	50	-	-	50	-	-	50	-	-	50
Current capability sleep mode (mA) (32KHz system clock enable)	-	-	3	-	-	3 TBC	-	-	3 TBC	-	-	3	-	-	3	-	-	TBC
Line regulation (mV/V)	-	-	50	-	-	50 TBC	-	-	50 TBC	-	-	TBC	-	-	-	-	-	TBC
Rise Time (ns) (Test load capacitor = 30 pF)	-	-	6	-	-	6 TBC	-	-	6 TBC	-	-	1.5	-	-	1.5	-	-	1.5

5.3.   Digital Control Signals

5.3.1.   Power On

A low level signal has to be provided to pin 59, PWR_ON (or PWR_ON_N), to switch the AirPrime HL series module on.

Table 18.   PWR_ON Pin Description

Pin #	Signal Name	Description	Voltage for HL6528xx	Voltage for HL7xxx and HL85xxx
59	PWR_ON	Active low power on control signal	3 V	1.8 V

The PWR_ON pin is internally pulled up and an open collector or open drain transistor can be used for ignition. This signal will become low after the module is ready and it cannot be directly driven by a GPIO signal, so an open collector or open drain transistor should be used.
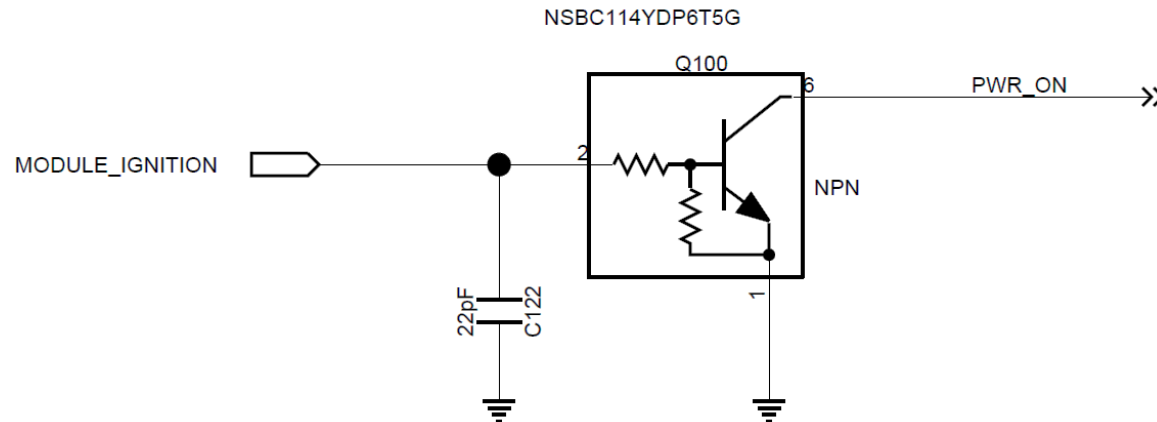
Figure 10.   PWR_ON Reference Schematic

To start the HL series embedded module, a low level pulse must be applied on the PWR_ON signal for 2000 ms.

5.3.2.   Power Off

Different AT commands are used to switch the HL modules off.

Table 19.   AT Command to Switch the HL Module Off

	HL6528x	HL6528RDx	HL7xxx	HL85xxx

AT Command	`AT*PSCPOF`
	or
	`AT+CPOF`
		`AT+EPOF`	`AT+CPWROFF`	`AT+CPOF`

Note that when the AT command to switch the module off is sent to the HL6528xx and HL85xxx:

- If a high level is applied on the PWR_ON signal, the module is turned OFF.
- If a low level is applied on the PWR_ON signal, the module is turned OFF then turned ON.

5.3.3.   Reset

The AirPrime HL series modules have an input Reset pin; this is a hardware reset and should only be used for emergency resets.

Table 20.   RESET Pin Description

Pin #	Signal Name	Description	Voltage for HL6528 and HL6528-G	Voltage for HL6528-2.8V and HL6528-G2.8V	Voltage for HL6528RDx	Voltage for HL7xxx and HL85xxx
11	RESET_IN	Input reset signal	1.8 V	2.8 V	1.8 V	1.8 V

To reset the HL series embedded module, a low level pulse must be applied on the RESET_IN pin for 38 ms. This pin cannot be directly driven by a GPIO signal; an open collector or open drain transistor must be used.

Additionally for the HL85xxx, if a power on is required after triggering the reset pin, then the PWR_ON pin must be set to logic low.
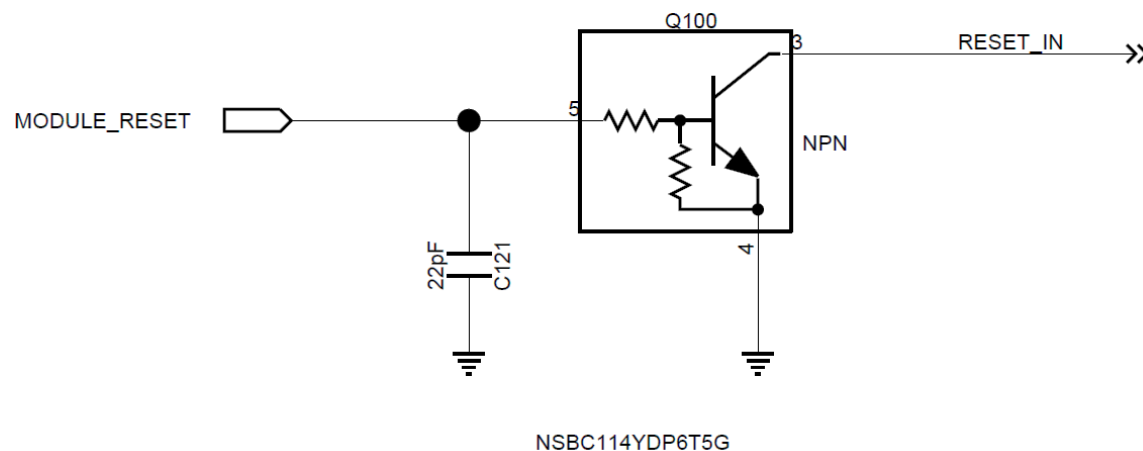
Figure 11.   RESET_IN Reference Schematic

5.4.   Interfaces

5.4.1.   UART1

The HL series modules support a full UART interface.

Table 21.   UART1 Pin Description

Pin #	Signal Name	Description	Voltage for HL6528, HL6528-G, HL6528RD, HL6528RD-G, HL7xxx and HL85xxx	Voltage for HL6528-2.8V, HL6528RD-2.8V, HL6528-G2.8V and HL6528RD-G2.8V
2	UART1_RI	UART1 Ring indicator	1.8 V	2.8 V
3	UART1_RTS	UART1 Request to send	1.8 V	2.8 V
4	UART1_CTS	UART1 Clear to send	1.8 V	2.8 V
5	UART1_TX	UART1 Transmit data	1.8 V	2.8 V

Pin #	Signal Name	Description	Voltage for HL6528, HL6528-G, HL6528RD, HL6528RD-G, HL7xxx and HL85xxx	Voltage for HL6528-2.8V, HL6528RD-2.8V, HL6528-G2.8V and HL6528RD-G2.8V
6	UART1_RX	UART1 Receive data	1.8 V	2.8 V
7	UART1_DTR	UART1 Data terminal ready	1.8 V	2.8 V
8	UART1_DCD	UART1 Data carrier detect	1.8 V	2.8 V
9	UART1_DSR	UART1 Data set ready	1.8 V	2.8 V

Note: As most microprocessor customer applications do not operate at 1.8V or 2.8V, and to ensure full scalability, customers need to use an 8-bit bi-directional voltage level translator.
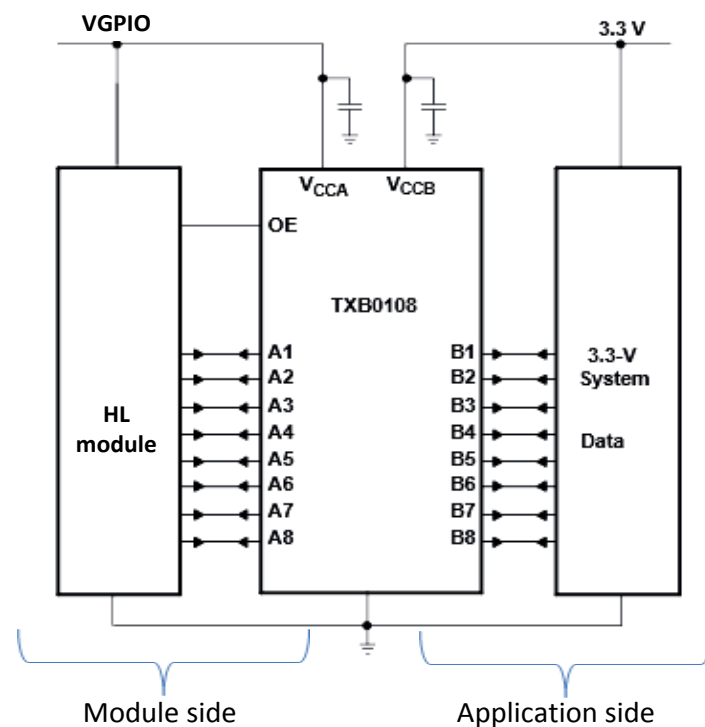
Figure 12.   Level Translator Example

5.4.2.   USB 2.0

Both HL7xxx and HL85xxx support a high-speed USB 2.0 interface, while the HL6528RDx supports a full-speed USB 2.0 interface. This USB interface can be used for AT commands, NMEA traces or software traces.

The HL6528x, on the other hand, does not support this feature; corresponding pins are not connected.

Table 22.   USB Pin Description for HL6528RDx, HL7xxx and HL854xx

Pin #	HL6528x		HL6528RDx, HL7xxx and HL85xxx		
	Signal Name	Description	Signal Name	Description	Voltage
12	NC	Not Connected	USB_D-	USB Data Negative	3.3 V
13	NC	Not Connected	USB_D+	USB Data Positive	3.3 V
16	NC	Not Connected	USB_VBUS	USB VBUS	5 V
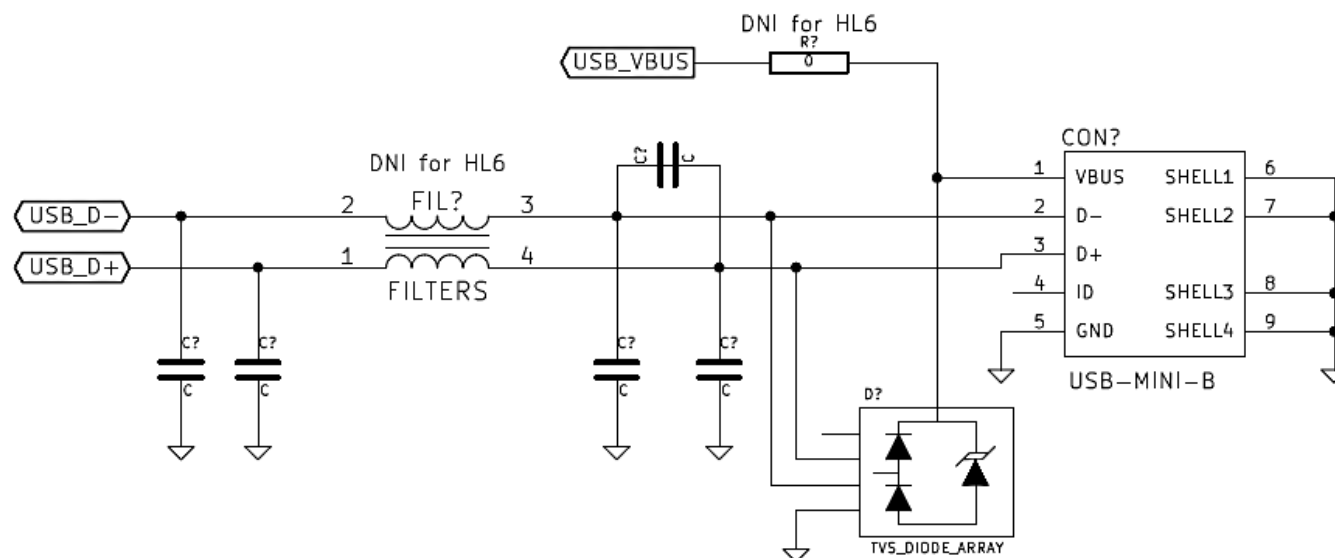
Figure 13.   USB Reference Schematic

If the 5V VUSB is not available on the customer application, VBATT can be used instead (an AT command must be used to set the level of VBUS).

Caution: *USB_VBUS is used for USB detection in the HL6528RDx and must be connected to the host's 5V VUSB.*

Note: *To ensure HL series scalability, the common mode choke coil must be dismounted for legacy HL6528x.*

5.4.3.   HSIC

Both HL75xx and HL854xx support a High Speed Inter-Chip (HSIC) interface. Note however that this interface is still under development on the HL854xx and may not be used yet.

The HL6528xx, HL7618, HL8518, HL8528 and HL8529 do not support this feature; corresponding pins are not connected.

Table 23.   HSIC Pin Description for HL75xx and HL854xx

Pin #	HL6528xx, HL7618, HL8518, HL8528 and HL8529		HL75xx and HL8548x		
	Signal Name	Description	Signal Name	Description	Voltage
14	NC	Not Connected	HSIC_DATA	High Speed Inter-Chip Data	1.2V
15	NC	Not Connected	HSIC_STRB	High Speed Inter-Chip Strobe	1.2V

Figure 14.   HSIC Reference Schematic

5.4.4. Audio

5.4.4.1. Analog Audio

The HL6528xx provides one microphone input and one speaker output, both of which supports either single ended or differential connection.

The HL7xxx and HL85xxx do not support this feature; corresponding pins are not connected.

Table 24.   Analog Audio Pin Description for HL6528xx
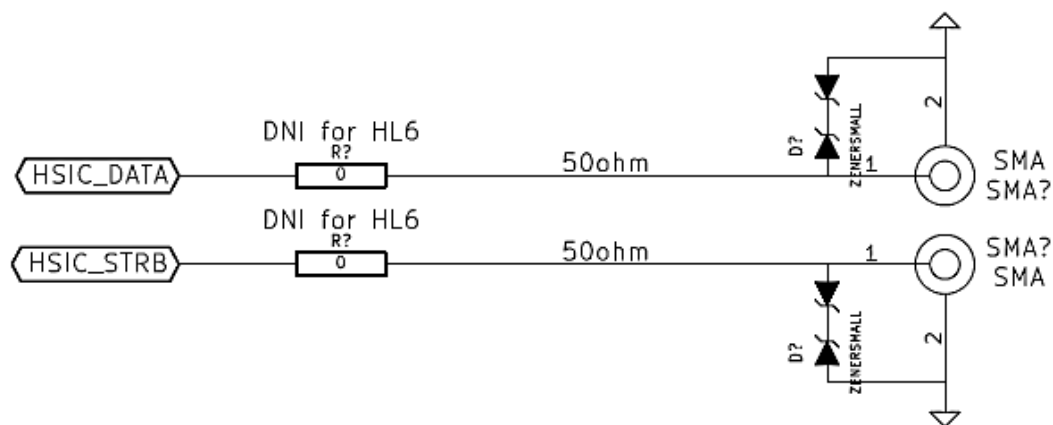
Pin #	HL6528xx			HL7xxx and HL85xxx	
	Signal Name	Description	Voltage	Signal Name	Description
17	SPKR_N	Speaker negative output	2.8 V	NC	Not Connected
18	SPKR_P	Speaker positive output	2.8 V	NC	Not Connected
19	MIC_P	Microphone positive input	2.8 V	NC	Not Connected
20	MIC_N	Microphone negative input	2.8 V	NC	Not Connected

5.4.4.2. Digital Audio (PCM)

Except for the HL7618, all other AirPrime HL modules support a digital audio (PCM) interface.

Table 25.   PCM Pin Description

Pin #	Signal Name	Description	Power Domain for HL6528xx	Power Domain for HL75xxx and HL85xxx
33	PCM_OUT	PCM data out	2.8 V	1.8 V
34	PCM_IN	PCM data in	2.8 V	1.8 V
35	PCM_SYNC	PCM sync out	2.8 V	1.8 V
36	PCM_CLK	PCM clock	2.8 V	1.8 V

Caution: *Although pins 33, 34, 35 and 36 are also marked as PCM pins in the HL7618, this interface is not supported by the module.*

Note that the power domain of the HL6528xx PCM interface is 2.8 V regardless of variant. A 4-bit level shifter is required to ensure scalability between the HL series modules.

Also, the HL series modules use different basebands which can result in varying behavior between them. The following table enumerates the PCM features of the HL series modules.

Table 26.   PCM Features

Parameters	HL6528x	HL6528RDx	HL75xx	HL85xxx	Compatible HW Audio Codec
Mode	Master and Slave	Master	Master and Slave	Master and Slave	Master and Slave
Number of bits	13 significant bits + 3 padding bits @ 0 8 bits	8 and 16 significant bits	TBC	16 significant bits	16 bits
MSB / LSB	Both	MSB only	TBC	MSB only	MSB only
Bit clock in master mode	1MHz, 500 kHz, 333 kHz, 250 kHz, 200 kHz, 166.667 kHz, 142.857 kHz, 125 kHz, 111.111 kHz, 100 kHz, 90.909 kHz, 83.333 kHz, 76.923 kHz	256 kHz, 512 kHz, 1024 kHz, 2048 kHz	TBC	256 kHz, 384 kHz, 512 kHz	Should support continuous value in slave mode
Frame clock	8 kHz	8 kHz	TBC	8 kHz	8 kHz
Rising Edge or Falling Edge	Both	Both	TBC	Both	One or the other
Long / short frame	Short frame	Both	TBC	Long frame sync	Should support both
Law	µLaw / Linear	Linear	TBC	Linear	Linear
Right / Left Alignment	Left	Left	TBC	Left	Left

The Nuvoton W681360 is a hardware voice codec that is compatible with both AirPrime HL6528x and HL85xxx; it is currently being tested for compatibility with the HL75xx.

5.4.5.   SIM

5.4.5.1.   UIM1

The AirPrime HL series modules support a SIM interface.

Table 27.   UIM1 Pin Description

Pin #	Signal Name	Description	Voltage
26	UIM1_VCC	1.8V/3V SIM1 Power supply	1.8V/3V
27	UIM1_CLK	1.8V/3V SIM1 clock	1.8V/3V
28	UIM1_DATA	1.8V/3V SIM1 Data	1.8V/3V
29	UIM1_RESET	1.8V/3V SIM1 Reset	1.8V/3V

All HL series modules support DSSS (Dual SIM Single Standby) on the UIM1 interface and require an external switch.
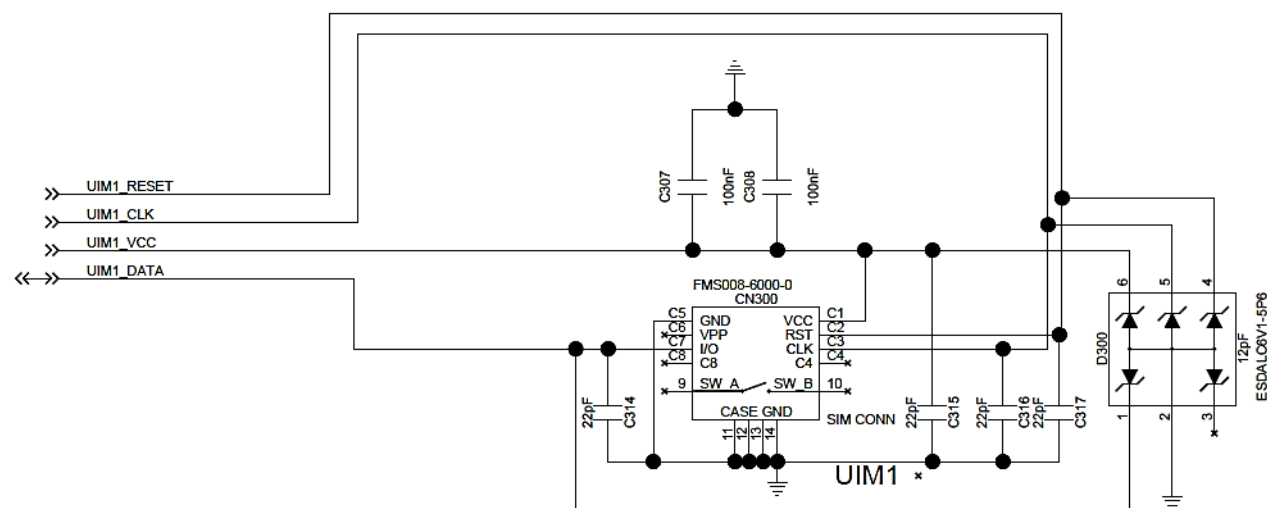

Figure 15.   UIM1 Reference Schematic

5.4.5.2. UIM2

On top of the UIM1 interface, the HL6528x also supports a second SIM interface dedicated to DSDS features (Dual SIM Dual Standby); while the HL6528RDx's second SIM interface is used for DSSS (Dual SIM Single Standby).

The HL7xxx and HL85xxx do not support this feature; corresponding pins are either not connected or used for a different interface.

Table 28. UIM2 Pin Description for HL6528xx

Pin #	HL6528x			HL6528RDx			HL7xxx		HL85xxx	
	Signal Name	Description	Voltage	Signal Name	Description	Voltage	Signal Name	Description	Signal Name	Description
55	UIM2_VCC	SIM2 power supply	2.85 V	UIM2_VCC	UIM2 Power supply	1.8 / 3 V	NC	Not connected	NC1	Reserved for future use
56	UIM2_DATA	SIM2 data	2.85 V	UIM2_DATA	UIM2 Data	1.8 / 3 V	NC	Not connected	NC2	Reserved for future use
57	UIM2_RESET / PWM1	SIM2 reset / Buzzer	2.85 V	UIM2_RESET	UIM2 Reset	1.8 / 3 V	NC	Not connected	PWM1	Pulse Width Modulation
58	UIM2_CLK / PWM2	SIM2 clock / PWM	2.85 V	UIM2_CLK	UIM2 Clock	1.8 / 3 V	NC	Not connected	PWM2 / GPIO2	Pulse Width Modulation / General purpose input/output

Note: *The legacy HL6528x UIM2 interface is 3V compatible only, but this limitation is not an issue due to there not being a 1.8V-only SIM in the field.*

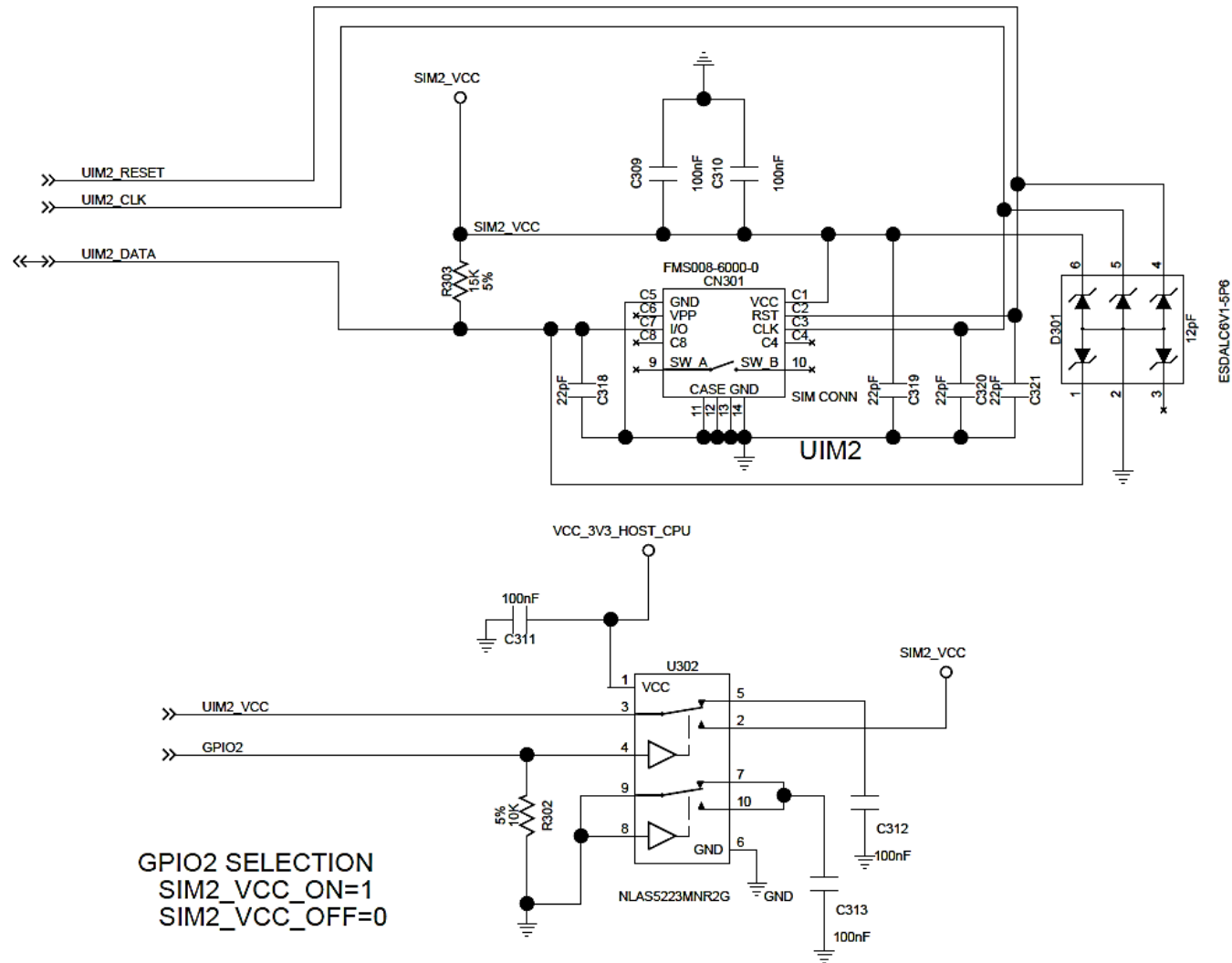*Unlike the legacy HL6528x, the HL6528RDx does not support a PWM multiplex on its UIM signals.*

Figure 16.   UIM2 Reference Schematic

5.4.5.3.   UIM1 and UIM2 Detection

The AirPrime HL series modules support UIM detection (UIM1 and UIM2 detection for the HL6528xx, and UIM1 detection for the HL7xxx and HL85xxx) through dedicated GPIOs.

Table 29.   UIM1 and UIM2 Detection Pin Description

Pin #	HL6528xx		HL7xxx		HL85xxx	
	Signal Name	**Description**	**Signal Name**	**Description**	**Signal Name**	**Description**
64	UIM1_DET/ GPIO3	UIM1 Detection / General purpose input/output	UIM1_DET	UIM1 Detection	GPIO3 / UIM1_DET	General purpose input/output / UIM1 detection
65	UIM2_DET/ GPIO4	UIM2 Detection / General purpose input/output	GPIO4	General purpose input/output	GPIO4	General purpose input/output

Caution: *The HL6528RDx needs a 4.7 kΩ pull-down resistor to properly set its logic low, which is used for both SIM detection.*

5.4.6.   ADC

Both AirPrime HL6528xx and HL85xxx have two ADC signals; the HL7xxx, on the other hand, has only one ADC signal.

Table 30.   ADC1 Pin Description

Pin #	Signal Name	Description	Voltage for HL6528x	Voltage for HL6528RDx	Voltage for HL7xxx	Voltage for HL85xxx
24	ADC1	Analog to digital converter	3 V	2.8 V	1.2 V	1.2 V

Table 31.   ADC0 Pin Description for HL6528xx and HL85xxx

Pin #	HL6528x			HL6528RDx			HL7xxx			HL85xxx		
	Signal Name	Description	Voltage	Signal Name	Description	Voltage	Signal Name	Description	Signal Name	Description	Voltage
25	ADC0	Analog to digital converter	3 V	ADC0	Analog to digital converter	2.8 V	NC	Not connected	ADC0	Analog to digital converter	1.2 V

Note: In the case of HL antenna detection, the embedded software compensates for the ADC resolution difference.

Table 32.   ADC Electrical Characteristics

Parameter		HL6528x			HL6528RDx			HL7xxx			HL85xxx			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Resolution			10			10			10			10		bits
Sampling frequency				200			100			125			125	kHz
Input signal range		0		3	0		2.8	0		1.2	0		1.2	V
Integral non-linearity (INL)		-2.5		+2.5	-1		+1	-2		+2	-2		+2	bit
Differential non-linearity (DNL)		-1		+3	-1		+1	-1		+1	-1		+1	bit
Input impedance	Input resistance	120	150				1000	1000			1000			kΩ
	Input capacitance			10		4			1				1		pF

Note: To ensure HL series scalability, a resistive level shifter must be used on the HL7xxx and HL85xxx if the signals applied are greater than 1.2 V.
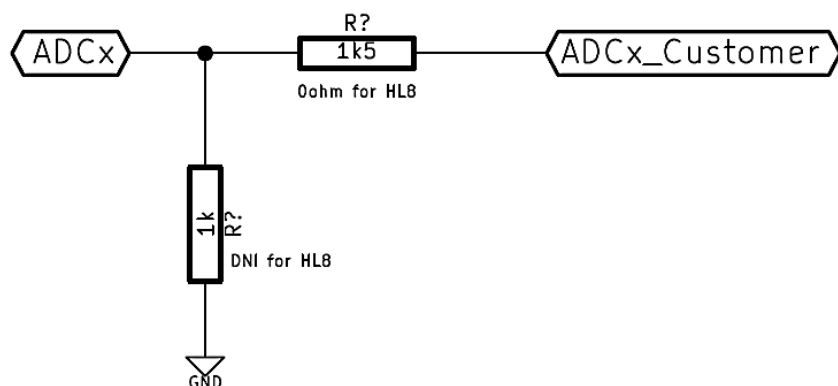
Figure 17.   Resistive Level Shifter Reference Schematic

5.4.7.   GPIO

The HL series modules share 8 common GPIOs. Some of these GPIOs are dedicated for specific purposes:

- GPIO3 / UIM1_DET (pin 64) is dedicated for UIM1 detection feature on the HL series modules
- GPIO4 is dedicated for UIM2 detection feature on the HL6528xx
- GPIO6 is dedicated to switch UIM1 for DSSS feature on the HL series modules

Table 33.   Common GPIO Pin Description

Pin #	HL6528x		HL6528RDx		HL75xx		HL76218		HL8518, HL8528, HL8529		HL85xx	
	Signal Name	Description	Signal Name	Description	Signal Name	Description	Signal Name	Description	Signal Name	Description	Signal Name	Description
1	GPIO1 / I2C1_CLK	General purpose input/output / I²C Clock	GPIO1 / I2C1_CLK	General purpose input/output / I²C serial clock line	GPIO1	General purpose input/output	GPIO1	General purpose input/output	GPIO1	General purpose input/output	GPIO1 / I2C_CLK	General purpose input/output / I²C Clock

Pin #	HL6528x		HL6528RDx		HL75xx		HL76218		HL8518, HL8528, HL8529		HL85xx	
	Signal Name	Description	Signal Name	Description	Signal Name	Description	Signal Name	Description	Signal Name	Description	Signal Name	Description
10	GPIO2	General purpose input/output	GPIO2 / UIM2_ VCC_ CTRL	General purpose input/output / UIM2 VCC Control	GPIO2	General purpose input/output	GPIO2 / TRACE _DATA2	General purpose input/output / Trace data 2	GPIO2	General purpose input/output	GPIO2	General purpose input/output
64	UIM1_ DET / GPIO3	UIM1 Detection / General purpose input/output	UIM1_ DET / GPIO3	UIM1 Detection / General purpose input/output	UIM1 DET	UIM1 Detection / General purpose input/output	UIM1_ DET	UIM1 Detection	UIM1_ DET / GPIO3	UIM1 Detection / General purpose input/output	GPIO3 / UIM1_ DET	General purpose input/output / UIM1 Detection
65	UIM2_ DET / GPIO4	UIM2 Detection / General purpose input/output	UIM2_ DET / GPIO4	UIM2 Detection / General purpose input/output	GPIO4	General purpose input/output	GPIO4	General purpose input/output	GPIO4	General purpose input/output	GPIO4	General purpose input/output
66	GPIO5 / I2C1_ DATA	General purpose input/output / I²C Data	GPIO5 / I2C1_ DATA	General purpose input/output / I²C serial data line	GPIO5	General purpose input/output	GPIO5	General purpose input/output	GPIO5	General purpose input/output	GPIO5 / I2C_ SDA	General purpose input/output / I2C Data
46	GPIO6	General purpose input/output	GPIO6	General purpose input/output	GPIO6	General purpose input/output	GPIO6	General purpose input/output	GPIO6	General purpose input/output	GPIO6	General purpose input/output
40	GPIO7	General purpose input/output	GPIO7	General purpose input/output	GPIO7	General purpose input/output	GPIO7	General purpose input/output	GPIO7	General purpose input/output	GPIO7	General purpose input/output
41	GPIO8	General purpose input/output	GPIO8	General purpose input/output	GPIO8	General purpose input/output	GPIO8 / TRACE _CLK	General purpose input/output / Trace clock	GPIO8	General purpose input/output	GPIO8	General purpose input/output

On top of these 8 GPIOs, the HL7xxx and HL85xxx have three more compatible GPIOs

Table 34.   Additional Common GPIOs on the HL7xxx and HL85xxx

Pin #	HL6528x		HL6528RDx		HL7xxx		HL85xxx	
	Signal Name	Description	Signal Name	Description	Signal Name	Description	Signal Name	Description
52	SPI_MISO	SPI Master In Slave Out	Reserved	Reserved	GPIO10	General purpose input/output	GPIO10	General purpose input/output
53	SPI_CLK	SPI Clock	Reserved	Reserved	GPIO11	General purpose input/output	GPIO11	General purpose input/output
54	SPI_MOSI	SPI Master Out Slave In	NC	Not connected	GPIO15	General purpose input/output	GPIO15	General purpose input/output

Additionally, the HL7xxx had two more GPIOs, while the HL85xxx has one extra GPIO as enumerated in the following table.

Table 35.   Additional GPIOs on the HL7xxx and HL85xxx

Pin #	HL6528x		HL6528RDx		HL7xxx		HL85xxx	
	Signal Name	Description	Signal Name	Description	Signal Name	Description	Signal Name	Description
44	SPI1_SRDY	SPI Slave Ready	GPIO13	General purpose input/output	DEBUG_TX	Debug transmit data	DEBUG_TX	Debug transmit data
51	SPI_MRDY	SPI Master Ready	GPIO14	General purpose input/output	DEBUG_RX	Debug Receive Data	DEBUG_RX	Debug receive data
58	UIM2_CLK / PWM	SIM2 Clock / PWM	NC	Not connected	UIM2_CLK	UIM2 Clock	PWM2 / GPIO12	Pulse Width Modulation / General purpose input/output

5.4.8. Internal Clock

The HL6528RDx, HL7xxx and HL85xxx support two digital clock interfaces – a 26MHz and a 32.768kHz digital clock output.

The HL6528x does not support this feature; corresponding pins are not connected or used for something else.

Table 36. Internal Clock Pin Description for HL6528RDx, HL7xxx and HL85xxx

Pin #	HL6528x		HL6528RDx, HL7xxx and HL85xxx		Voltage for HL6528RDx	Voltage for HL7xxx and HL854xx
	Signal Name	Description	Signal Name	Description		
22	TP2	Factory use only	26M_CLKOUT	26MHz system clock output	1.2 V	1.8 V
23	NC	Not Connected	32K_CLKOUT	32.768kHz system clock output	2.8 V	1.8 V

Note: *Note that the 26M_CLKOUT signal is very sensitive to loading; hence a low load on this clock is required when it's used. A 4.7pF series capacitor is recommended.*

5.4.9. TX Burst Indicator

The AirPrime HL series modules provide a signal for TX burst indication.

Table 37. TX Burst Indicator Pin Description for HL6528xx and HL85xxx

Pin #	Signal Name	Description	Power Domain for HL6528xx	Power Domain for HL85xxx
60	2G_TX_ON	2G TX burst indicator	2.8 V	1.8 V

Table 38.   TX Burst Indicator Pin Description for HL7xxx

Pin #	Signal Name	Description	Power Domain for HL7xxx
60	TX_ON	TX burst indicator	2.3 V

Note: The behavior of this signal may vary depending on the variant.

5.5.   Debug

The HL series modules provide two debug interfaces for test purposes. These interfaces are dedicated for Sierra Wireless use and do not impact scalability.

Test points on the customer application should be anticipated in the application design.

5.5.1.   SW Traces and Debug Port

The HL6528x provides a SW Trace interface accessible through the SPI interface, the HL6528RDx and HL8548x provide a 2-wire debug port interface, and the HL7xxx provides a 5-wire trace debug interface through the UART interface; these are dedicated to internal software traces.

The HL7xxx debug interface is not compatible with the HL6528xx and HL85xxx debug interface as they are on different pins.

Table 39.   SW Trace Pin Description

Pin #	HL6528x		HL6528RDx		HL7xxx		HL85xxx	
	Signal Name	Description	Signal Name	Description	Signal Name	Description	Signal Name	Description
2	UART1_RI	UART1 Ring indicator	UART1_RI	UART1 Ring indicator	UART1_RI / TRACE_DATA3	UART1 Ring indicator / Trace data 3	UART1_RI	UART1 Ring indicator
8	UART1_DCD	UART1 Data carrier detect	UART1_DCD	UART1 Data carrier detect	UART1_DCD / TRACE_DATA1	UART1 Data carrier detect / Trace data 1	UART1_DCD	UART1 Data carrier detect

Pin #	HL6528x		HL6528RDx		HL7xxx		HL85xxx	
	Signal Name	Description	Signal Name	Description	Signal Name	Description	Signal Name	Description
9	UART1_DSR	UART1 Data set ready	UART1_DSR	UART1 Data set ready	UART1_DSR / TRACE_DATA0	UART1 Data set ready / Trace data 0	UART1_DSR	UART1 Data set ready
10	GPIO2	General purpose input/output	GPIO2 / UIM2_VCC_ CTRL	General purpose input/output / UIM2 VCC Control	GPIO2 / TRACE_DATA2	General purpose input/output / Trace data 2	GPIO2	General purpose input/output
41	GPIO8	General purpose input/output	GPIO8	General purpose input/output	GPIO8 / TRACE_CLK	General purpose input/output	GPIO8	General purpose input/output
44	SPI_SRDY	SPI Slave Ready	DEBUG_TX	Debug Transmit Data	GPIO13	General purpose input/output	DEBUG_TX	Debug transmit data
51	SPI_MRDY	SPI Master Ready	DEBUG_RX	Debug Receive Data	GPIO14	General purpose input/output	DEBUG_RX	Debug receive data
52	SPI_MISO	SPI Master In Slave Out	Reserved	Reserved	GPIO10	General purpose input/output	GPIO10	General purpose input/output
53	SPI_CLK	SPI Clock	Reserved	Reserved	GPIO11	General purpose input/output	GPIO11	General purpose input/output
54	SPI_MOSI	SPI Master Out Slave In	NC	Not connected	GPIO15	General purpose input/output	GPIO15	General purpose input/output

5.5.2.   JTAG

The AirPrime HL series modules provide debug access to the module core. These JTAG signals are accessible through solder-able test points which should be accessible from the customer application.

All signals listed in the table below should be outputs on the customer board to allow JTAG debugging.

Table 40.   JTAG Pin Description

Pin #	Signal Name	Description
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

    *   This pin is NC (not connected) on the HL7618.

Note: Test points should also be reserved for pins 52 and 53 of the HL6528RDx.

6. Layout Recommendations

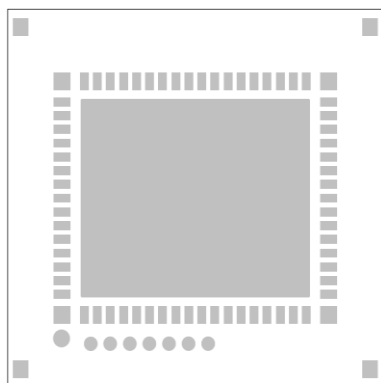The HL series modules share the same LGA pins, solder mask, and solder paste mask.
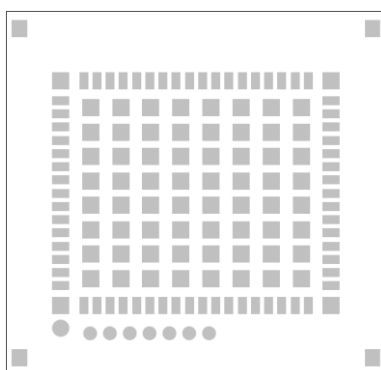

Figure 18.   AirPrime HL Series Pad Layout

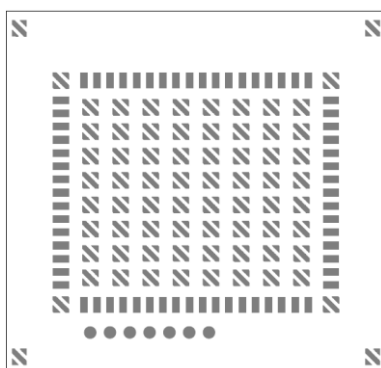*Figure 19.   AirPrime HL Series Solder Mask*

Figure 20.   AirPrime HL Series Paste Mask

To ensure HL series scalability, guidelines specified in document [8] AirPrime HL Series Customer Process Guidelines must be followed.

Also, it is recommended to leave a component-free area of 2 mm around the HL series module.

Note: The HL8549x is 2mm bigger (25mm x 24mm) but it does not impact the AirPrime HL series pad layout, solder mask and paste mask.