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AirPrime HL7800 and HL7800-M

Product Technical Specification

SIERRA WIRELESS®

41111094
1.5
July 25, 2018

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

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1.1	February 01, 2018	Added 3.3 Power Consumption States
		Updated: • Table 2 General Features • Table 5 Pin Definition • 3.2 Current Consumption • Table 11 Current Consumption Mode • 3.16 Debug Interface • 3.19.3 Rx Sensitivity
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		Updated: • GNSS to GPS • 1.7 ESD Specifications • 1.8.5 RoHS Directive Compliance • 3.2 Current Consumption • Table 21 Digital I/O Electrical Characteristics • 3.11 Power On Signal (PWR_ON_N) • 3.19 RF Interface • 5 Reliability Specification
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		Updated: • Table 9 Maximum Current Consumption • Moved Japan Approval to 6.1; updated Figure 16 Sample Japan Certification Indication

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1. Introduction

This document is the Product Technical Specification for the AirPrime HL7800 and HL7800-M Embedded Modules designed for M2M and Internet of Things (IoT) markets. It defines the high-level product features and illustrates the interfaces for these features. This document is intended to cover the hardware aspects of the product, including electrical and mechanical.

The AirPrime HL7800 and HL7800-M modules belongs to the AirPrime HL Series from Essential Connectivity Module family. These are industrial grade Embedded Wireless Modules that provides data connectivity on LTE (as listed in Table 1 Supported Bands/Connectivity).

The AirPrime HL7800 and HL7800-M modules supports a large variety of interfaces such as USB FS, UART, ADC, and GPIOs to provide customers with the highest level of flexibility in implementing high-end solutions.

Table 1. Supported Bands/Connectivity

LTE Band	Transmit Band (Tx)		Receive Band (Rx)		Cat-M1 (HL7800 and HL7800-M)	Cat-NB1 (HL7800 only)
	Minimum	Maximum	Minimum	Maximum		
B1	1920 MHz	1980 MHz	2110 MHz	2170 MHz	✓	✓
B2	1850 MHz	1910 MHz	1930 MHz	1990 MHz	✓	✓
B3	1710 MHz	1785 MHz	1805 MHz	1880 MHz	✓	✓
B4	1710 MHz	1755 MHz	2110 MHz	2155 MHz	✓	*
B5	824 MHz	849 MHz	869 MHz	894 MHz	✓	✓
B8	880 MHz	915 MHz	925 MHz	960 MHz	✓	✓
B9	1749.9 MHz	1784.9 MHz	1844.9 MHz	1879.9 MHz	*	*
B10	1710 MHz	1770 MHz	2110 MHz	2170 MHz	*	*
B12	699 MHz	716 MHz	729 MHz	746 MHz	✓	✓
B13	777 MHz	787 MHz	746 MHz	756 MHz	✓	✓
B14	788 MHz	798 MHz	758 MHz	768 MHz	✓	*
B17	704 MHz	716 MHz	734 MHz	746 MHz	*	✓
B18	815 MHz	830 MHz	860 MHz	875 MHz	✓	✓
B19	830 MHz	845 MHz	875 MHz	890 MHz	✓	✓
B20	832 MHz	862 MHz	791 MHz	821 MHz	✓	✓
B25	1850 MHz	1915 MHz	1930 MHz	1995 MHz	✓	✓
B26	814 MHz	849 MHz	859 MHz	894 MHz	✓	✓
B27	807 MHz	824 MHz	852 MHz	869 MHz	✓	*
B28	703 MHz	748 MHz	758 MHz	803 MHz	✓	✓
B66	1710 MHz	1780 MHz	2110 MHz	2200 MHz	✓	✓

* Will be supported in a future release.

Note: RF bands supported are configurable through AT command. The software-based radio allows for the ability to support extra bands for worldwide connectivity.

1.1. Common Flexible Form Factor (CF^3)

The AirPrime HL7800 and HL7800-M modules belong to the Common Flexible Form Factor (CF^3) family of modules. This family consists of a series of WWAN modules that share the same mechanical dimensions (same width and length with varying thicknesses) and footprint. The CF^3 form factor provides a unique solution to a series of problems faced commonly in the WWAN module space as it:

- Accommodates multiple radio technologies (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 as Socketability depending on customer needs.

1.2. Physical Dimensions

AirPrime HL7800 and HL7800-M modules are compact, robust, fully shielded modules with the following dimensions:

- Length: 18.0 mm
- Width: 15.0 mm
- Thickness: 2.4 mm
- Weight: 1.17 g

Note: Dimensions specified above are typical values.

1.3. General Features

The table below summarizes the AirPrime HL7800 and HL7800-M's features.

Table 2. General Features

Feature	Description
Physical	• Small form factor (86-pad solderable LGA pad) – 15.0mm x 18.0mm x 2.4mm (nominal) • Metal shield can • RF connection pads (RF main and RF GPS) • Baseband signals connection
Power supply	Single or double supply voltage (VBATT and VBATT_PA) – 3.2V – 4.35V

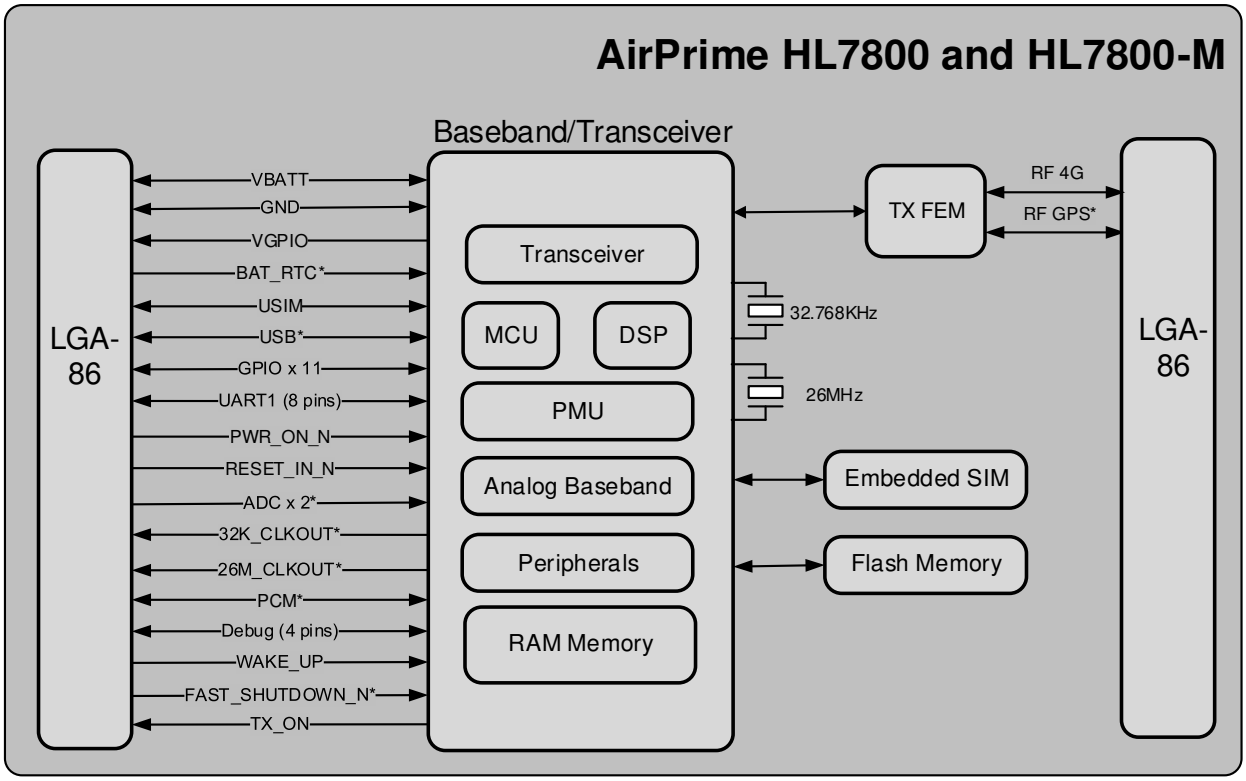
Feature	Description
RF	• Cat-M1 ▪ Power Class 3 (23dBm) ▪ Software based radio allowing support of extra bands for worldwide operation (will be supported in a future release) • Cat-NB1 (not supported on the HL7800-M) ▪ Power Class 3 (23dBm) ▪ Software based radio allowing support of extra bands for worldwide operation (will be supported in a future release) • GPS* ▪ 1575.42 MHz *Note:* *The GPS receiver shares the same RF resources as the 4G receiver. The end-device target should allow GPS positioning for asset management applications where infrequent and no real-time position updates are required.*
SIM interface	• 1.8V only support (3V SIM is not supported) • SIM extraction / hot plug detection • SIM/USIM support • Conforms with ETSI UICC Specifications. • Supports SIM application tool kit with proactive SIM commands
Application interface	• AT command interface – 3GPP 27.007 standard, plus proprietary extended AT commands • CMUX multiplexing over UART • USB FS*
Protocol stack	• Cat-M1 ▪ 3GPP Rel. 13 ▪ Half-duplex ▪ Channel bandwidth 1.4MHz ▪ LTE carrier bandwidth 1.4 / 3 / 5 / 10 / 15 / 20 MHz ▪ Up to 375kbit/s uplink, 300 kbit/s downlink ▪ Extended Coverage Mode A ▪ PSM (Power Save Mode) ▪ I-DRX ▪ C-DRX ▪ Idle mode mobility ▪ Connected mode mobility ▪ eDRX (Extended Discontinuous Reception) ▪ CiOT optimizations (U-Plane, C-Plan)* • Cat-NB1* (not supported on the HL7800-M) ▪ 3GPP Rel. 13 ▪ Half-duplex ▪ Channel bandwidth 180KHz ▪ LTE carrier bandwidth 1.4 / 3 / 5 / 10 / 15 / 20 MHz ▪ Up to 100 kbit/s in downlink ▪ Operational mode – Inband, Guard band, Standalone ▪ CioT EPS optimizations (Data over NAS) ▪ Extended coverage
Protocol stack	• Flexible selection ▪ Manual system selection across RATs ▪ Dynamic system selection across RATs (preferred RAT)*

Feature	Description
SMS	• SMS over SG • MO/MT • SMS storage to SIM card or ME storage
Connectivity	• Multiple cellular packet data profiles • Sleep mode for minimum idle power draw • Mobile-originated PDP context activation / deactivation • Static and Dynamic IP address. The network may assign a fixed IP address or dynamically assign one using DHCP (Dynamic Host Configuration Protocol). • PDP context type (IPv4, IPv6, IPv4v6). IP Packet Data Protocol context • RFC1144 TCP/IP header compression
Environmental	Operating temperature ranges (industrial grade): • Class A: -30°C to +70°C • Class B: -40°C to +85°C
RTC	Real Time Clock (RTC)

* Will be available in a future release.

1.4. Architecture

The figure below presents an overview of the AirPrime HL7800 and HL7800-M's internal architecture and external interfaces.



*** Will be available in a future release**

Figure 1. Architecture Overview

1.5. Interfaces

The AirPrime HL7800 and HL7800-M modules provide the following interfaces and peripheral connectivity:

- 1x – VGPIO (1.8V)
- 1x – BAT_RTC backup battery interface (will be available in a future release)
- 1x – 1.8V USIM
- 1x – USB FS (will be available in a future release)
- 11x – GPIOs
- 1x – 8-wire UART
- 1x – Active Low POWER ON (will be available in a future release)
- 1x – Active Low RESET
- 2x – ADC (will be available in a future release)
- 2x – System clock out (32.768 KHz and 26 MHz) (will be available in a future release)
- 1x – PCM (will be available in a future release)
- 1x – 4-wire UART for debug interface only
- 1x – Wake up signal
- 1x – Fast shutdown signal (will be available in a future release)
- 1x – Main RF Antenna
- 1x – TX indicator
- 1x – GPS Antenna (will be available in a future release)

1.6. Connection Interface

AirPrime HL7800 and HL7800-M modules are LGA form factor devices. All electrical and mechanical connections are made through the 86 Land Grid Array (LGA) pads on the bottom side of the PCB.

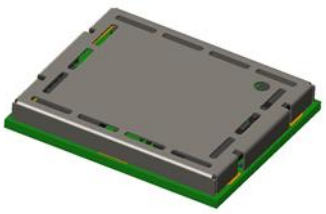


Figure 2. Mechanical Overview (Top View)

The 86 pads have the following distribution:

- 66 inner signal pads, 1x0.5mm, pitch 0.8mm
- 16 inner ground pads, 1.0x1.0mm, pitch 1.825mm/1.475mm
- 4 outer corner ground pads, 0.85x0.97mm

1.7. ESD Specifications

- IEC-61000-4-2 (test carried out on test vehicle including ESD protection)
  - Contact Voltage: ±2kV, ±4kV, ±6kV (design target)
  - Air Voltage: ±2kV, ±4kV, ±8kV (design target)
- Unless otherwise specified:
  - JESD22-A114 ± 250kV Human Body Model
  - JESD22-C101C ± 250V Charged Device Model

1.8. Environmental and Certifications

1.8.1. Environmental Specifications

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

Table 3. Environmental Specifications

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

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 an 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.

1.8.2. Frequency Drift Correction

The HL7800 and HL7800-M are environmental sensitive and able to correct temperature and aging effects automatically. Parameters to be considered when addressing the environmental effect on the HL7800 and HL7800-M are as follows:

- Maximum deviation correction: 20 ppm
- Environmental Temperature effect: 0.5 ppm
- Factory reflow effect: 1 ppm + 1 ppm / reflow
- Aging effect: 1 ppm /year of use

For example, if an HL7800 module is mounted on a single side (1 reflow) customer PCB and used for 10 years between -40 and +85°C, the frequency drift will be up to 0.5 + (1 + 1) + (1 * 10) = 12.5 ppm, which is in the limits of the 20 ppm maximum correction.

1.8.3. ATEX Compliance

The following table lists the inductor and capacitor values to be considered for ATEX certification of the system hosting the HL7800 and HL7800-M modules. All supplies in the modules are linear LDO except for one 1.3V DC/DC step-down.

Table 4. Values for ATEX Compliance

Parameter	Value	Tolerance
Total Inductance	2.21 µH	30%
Total Capacitance	43.64 µF	20 %

1.8.4. Regulatory

The AirPrime HL7800 and HL7800-M modules will be compliant with the following regulations:

- RED
- FCC
- IC
- RCM
- JRF/JPA

1.8.5. RoHS Directive Compliance

AirPrime HL7800 and HL7800-M modules are compliant with RoHS Directive 2011/65/EU, including directive 2015/863 amending annex II, which sets limits for the use of certain restricted hazardous substances. This directive states that electrical and electronic equipment put on the market does not contain lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB), polybrominated diphenyl ethers (PBDE), Bis (2-ethylhexyl) phthalate (DEHP), Butyl benzyl phthalate (BBP), Dibutyl phthalate (DBP) or Diisobutyl phthalate (DIBP) above threshold limits.

1.8.6. 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.

1.9. References

[1] AirPrime HL78xx Customer Process Guidelines
Reference Number: 41112095

[2] AirPrime HL78xx AT Commands Interface Guide
Reference Number: 41111821

[3] AirPrime HL Series Development Kit User Guide
Reference Number: 4114877

[4] AirPrime HL7800 Low Power Modes Application Note
Reference Number: 41112578

2. Pad Definition

AirPrime HL7800 and HL7800-M pins are divided into 2 functional categories.

- **Core functions and associated pins** cover all the mandatory features for M2M connectivity and will be available by default across all CF[3] family of modules. These Core functions are always available and always at the same physical pad locations. A customer platform using only these functions and associated pads are 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 pad location.

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

Table 5. Pin Definition

Pad #	Signal Name	Function	I/O	Pre and Post Reset State*	Power Supply Domain	Recommendation for Unused Pads	Type
C1	GPIO1	General purpose input/output	I/O	PU	1.8V	Left Open	Extension
C2	UART1_RI	UART1 Ring indicator	O	PU	1.8V	Connect to test point	Core
C3	UART1_RTS	UART1 Request to send	I	PU	1.8V	Connect to test point	Core
C4	UART1_CTS	UART1 Clear to send	O	PU	1.8V	Connect to test point	Core
C5	UART1_TX	UART1 Transmit data	I	PU	1.8V	Connect to test point	Core
C6	UART1_RX	UART1 Receive data	O	PU	1.8V	Connect to test point	Core
C7	UART1_DTR	UART1 Data terminal ready	I	PU	1.8V	Connect to test point	Core
C8	UART1_DCD	UART1 Data carrier detect	O	PU	1.8V	Connect to test point	Core
C9	UART1_DSR	UART1 Data set ready	O	PU	1.8V	Connect to test point	Core
C10	GPIO2	General purpose input/output	I/O	PD	1.8V	Connect to test point	Core
C11	RESET_IN_N	Input reset signal	I		1.8V	Left Open	Core
C12	USB_D-	USB Data Negative (Full Speed)	I/O		3.3V	Connect to test point	Extension
C13	USB_D+	USB Data Positive (Full Speed)	I/O		3.3V	Connect to test point	Extension

Pad #	Signal Name	Function	I/O	Pre and Post Reset State*	Power Supply Domain	Recommendation for Unused Pads	Type
C14	NC	Not Connected				Left Open	Not connected
C15	NC	Not Connected				Left Open	Not connected
C16	USB_VBUS	USB VBUS	I		5V	Connect to test point	Extension
C17	NC	Not Connected				Left Open	Not connected
C18	NC	Not Connected				Left Open	Not connected
C19	NC	Not Connected				Left Open	Not Connected
C20	NC	Not Connected				Left Open	Not Connected
C21	BAT_RTC	Power supply for RTC backup	I			Left Open	Extension
C22	26M_CLKOUT	26M System Clock Output	O	PD	1.8V	Left Open	Extension
C23	32K_CLKOUT	32.768kHz System Clock Output	O	PU	1.8V	Left Open	Extension
C24	ADC1	Analog to digital converter	I		1.2V	Left Open	Extension
C25	ADC0	Analog to digital converter	I		1.2V	Left Open	Extension
C26	UIM1_VCC	1.8V USIM1 Power supply	O		1.8V	Mandatory connection	Core
C27	UIM1_CLK	1.8V USIM1 Clock	O		1.8V	Mandatory connection	Core
C28	UIM1_DATA	1.8V USIM1 Data	I/O		1.8V	Mandatory connection	Core
C29	UIM1_RESET	1.8V USIM1 Reset	O		1.8V	Mandatory connection	Core
C30	GND	Ground	0V		0V	Mandatory connection	Extension
C31	NC	Not Connected					Not connected
C32	GND	Ground	0V		0V	Mandatory connection	Extension
C33	PCM_OUT	PCM data out	O	PU	1.8V	Left Open	Extension
C34	PCM_IN	PCM data in	I	PU	1.8V	Left Open	Extension
C35	PCM_SYNC	PCM sync out	I/O	PU	1.8V	Left Open	Extension
C36	PCM_CLK	PCM clock	I/O	PD	1.8V	Left Open	Extension
C37	GND	Ground	0V		0V	Mandatory connection	Core
C38	RF_GPS	RF_GPS				Left Open	Core
C39	GND	Ground	0V		0V	Mandatory connection	Core
C40	GPIO7	General purpose input/output	I/O	PU	1.8V	Left Open	Core

Pad #	Signal Name	Function	I/O	Pre and Post Reset State*	Power Supply Domain	Recommendation for Unused Pads	Type
C41	GPIO8	General purpose input/output	I/O	PD	1.8V	Left Open	Core
C42	NC	Not Connected					Not connected
C43	EXT_LNA_GPS_EN	External GPS LNA enable		PU		Left Open	Extension
C44	WAKE_UP	Wake up signal	I	PD	1.8V	Mandatory connection	Extension
C45	VGPIO	GPIO voltage output	O		1.8V	Left Open	Core
C46	GPIO6	General purpose input/output	I/O	PD	1.8V	Left Open	Core
C47	NC	Not Connected				Left Open	Not connected
C48	GND	Ground	0V		0V	Mandatory connection	Core
C49	RF_MAIN	RF Input/output				Mandatory connection	Core
C50	GND	Ground	0V		0V	Mandatory connection	Core
C51	GPIO14	General purpose input/output	I/O	PU	1.8V	Left Open	Extension
C52	GPIO10	General purpose input/output	I/O	PU	1.8V	Left Open	Extension
C53	GPIO11	General purpose input/output	I/O	PU	1.8V	Left Open	Extension
C54	GPIO15	General purpose input/output	I/O	PU	1.8V	Left Open	Extension
C55	UART0_RX	Debug Receive data	O	PU	1.8V	Mandatory connection	Extension
C56	UART0_TX	Debug Transmit data	I	PU	1.8V	Mandatory connection	Extension
C57	UART0_CTS	Debug Clear to Send	O	PU	1.8V	Mandatory connection	Extension
C58	UART0_RTS	Debug Request to Send	I	PD	1.8V	Mandatory connection	Extension
C59	PWR_ON_N	Active Low Power On control signal	I		1.8V	Mandatory connection	Core
C60	TX_ON	TX transmission indication	O	PU	1.8V	Left Open	Extension
C61	VBATT_PA	Power supply (refer to section 3.1 Power Supply for more information)	I		3.2V (min) 3.7V (typ) 4.35V (max)	Mandatory connection	Core
C62	VBATT_PA	Power supply (refer to section 3.1 Power Supply for more information)	I		3.2V (min) 3.7V (typ) 4.35V (max)	Mandatory connection	Core

Pad #	Signal Name	Function	I/O	Pre and Post Reset State*	Power Supply Domain	Recommendation for Unused Pads	Type
C63	VBATT	Power supply (refer to section 3.1 Power Supply for more information)	I		3.2V (min) 3.7V (typ) 4.35V (max)	Mandatory connection	Core
C64	UIM1_DET / GPIO3	USIM1 Detection / General purpose input/output	I/O	PD	1.8V	Left Open	Core
C65	FAST_SHUTDOWN_N	Fast Shutdown signal	I	PU	1.8V	Left Open	Extension
C66	GPIO5	General purpose input/output	I/O	PU	1.8V	Left Open	Extension
CG1 – CG4, G1 – G16	GND	Ground	GND		0V		Core

* This refers to the state before and after RESET_IN_N; state is Undefined during reset. Refer to section 3.12 Reset Signal (RESET_IN_N) for more details.

2.1. Pin Types

Table 6. Pin Type Codes

Type	Definition
I	Digital Input
O	Digital Output
I/O	Digital Input / Output
L	Active High
H	Active Low
T	Tristate
T/PU	Tristate with pull-up enabled
T/PD	Tristate with pull-down enabled
PU	Pull-up enabled
PD	Pull-down enabled
N/A	Not Applicable

2.2. Pad Configuration (Top View, Through Module)

Note: The following diagram shows the pad configuration from DV2 onwards.

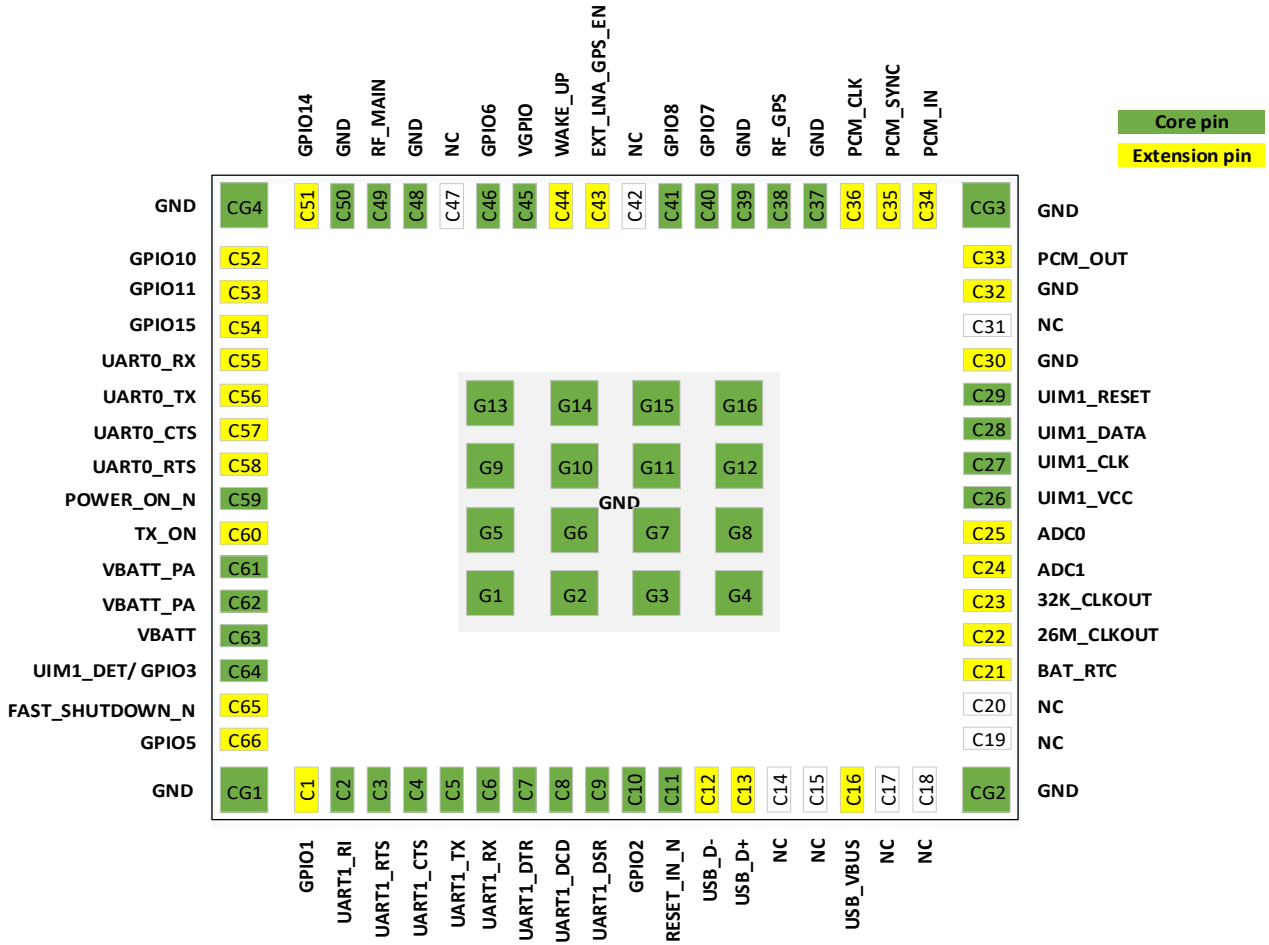


Figure 3. Pad Configuration (Top View through Module)

3. Detailed Interface Specifications

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

For standard applications, VBATT and VBATT_PA must be tied externally to the same power supply. For some specific applications, AirPrime HL7800 and HL780-M modules support separate VBATT and VBATT_PA connection if requirements below are fulfilled.

3.1. Power Supply

The AirPrime HL7800 and HL7800-M modules are supplied through the VBATT and VBATT_PA signals.

Refer to the following table for the pin description of the Power Supply interface.

Table 7. Power Supply Pin Description

Pad Number	Signal Name	I/O	Description
C63	VBATT	I	Power supply (base band)
C61, C62	VBATT_PA	I	Power supply (radio frequency)
CG1 – CG4, G1 – G16	GND		Ground

Refer to the following table for the electrical characteristics of the Power Supply interface.

Table 8. Power Supply Electrical Characteristics

Supply	Minimum	Typical	Maximum
VBATT voltage (V)	3.2	3.7	4.35
VBATT_PA voltage (V) Full Specification	3.2	3.7	4.35
VBATT_PA voltage (V) Extended Range	2.8* (TBC)	3.7	4.35

* No guarantee of 3GPP performances over extended range.

Table 9. Maximum Current Consumption

Supply	Maximum
VBATT	500mA
VBATT_PA	500mA

Note: If a single PSU is used, the recommended power supply capability is 500 mA + 500 mA = 1A.

3.2. Current Consumption

The following tables list the current consumption of the AirPrime HL7800 and HL7800-M modules at different conditions.

Note: Typical values are defined for VBATT/VBATT_PA at 3.7V and 25°C, for 50Ω impedance at all RF ports. Maximum values are provided for VSWR2.5:1 (TBC) with worst conditions among supported ranges of voltages and temperature.

Table 10. Low Current Consumption Mode

Parameter	Typical	Unit
Off mode (module switched off & VBATs Connected)	3	µA
PSM Floor in Hibernate mode	3	µA
PSM 1h in Hibernate mode	70	µA
PSM 24h in Hibernate mode	6	µA
DRX 1.28 s in Sleep mode	3.4 1.8*	mA
DRX 2.56 s in Sleep mode	3.0 1.5*	mA
eDRX 20.48 s / PTW 1 in Hibernate mode	200** <100*	µA
eDRX 81.92 s / PTW 1 in Hibernate mode	100** <50*	µA

* Enhancement will be available in a future firmware version.

** Values are PTW and DRX dependent.

Refer to section 3.3.2 Power Modes for details regarding different low power modes.

The PSM 1h and 24h in Hibernate mode assume the following conditions:

- Cat-M1
- Good channel conditions without UICC / USIM current
- Static scenario, no repetitions
- Cycle includes boot, cell acquisition, network attachment, wait for timer expiry and back to sleep

The PSM Floor in Hibernate mode assumes the following conditions:

- I/Os are not held (VGPIO is off)
- Customer application is not allowed to drive the module's I/Os
- UICC / USIM is off
- The module only wakes up by a high level on the WAKE_UP pin