User Guide

AirPrime HL7588

SIERRA WIRELESS®

TBC
1.0
July 28, 2015

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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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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
1.0	July 28, 2015	Creation

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1. Introduction

This document is the Product Technical Specification for the AirPrime HL7588 Embedded Module. 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 HL7588 belongs to the AirPrime HL Series from Essential Connectivity Module family. These are industrial grade Embedded Wireless Modules that provide data connectivity on wireless networks (as listed in Table 1 Supported Bands/Connectivity).

The HL7588 supports a large variety of interfaces such as USB 2.0, UART, GPIOs, and dual SIM to provide customers with the highest level of flexibility in implementing high-end solutions.

Table 1. Supported Bands/Connectivity

RF Band	Transmit band (Tx)	Receive band (Rx)	HL7588
LTE B2	1850 to 1910 MHz	1930 to 1990 MHz	✓
LTE B4	1710 to 1755 MHz	2110 to 2155 MHz	✓
LTE B5	824 to 849 MHz	869 to 894 MHz	✓
LTE B13	777 to 787 MHz	746 to 756 MHz	✓
LTE B17	704 to 716 MHz	734 to 746 MHz	✓
UMTS B2	1850 to 1910 MHz	1930 to 1990 MHz	✓
UMTS B5	824 to 849 MHz	869 to 894 MHz	✓

1.1. Common Flexible Form Factor (CF^3)

The AirPrime HL7588 belongs to the Common Flexible Form Factor (CF^3) family of modules. This family consists of a series of WWAN modules that share the same mechanical dimensions (same width and length with varying thicknesses) and footprint. The CF^3 form factor provides a unique solution to a series of problems faced commonly in the WWAN module space as it:

- Accommodates multiple radio technologies (from 2G to LTE advanced) and band groupings
- Supports bit-pipe (Essential Module Series) and value add (Smart Module Series) solutions
- Offers electrical and functional compatibility
- Provides Direct Mount as well as Socketability depending on customer needs

1.2. Physical Dimensions

AirPrime HL7588 module is a compact, robust, fully shielded module with the following dimensions:

- Length: 23 mm
- Width: 22 mm
- Thickness: 2.5 mm
- Weight: 3.5 g

Note: Dimensions specified above are typical values.

1.3. General Features

The table below summarizes the AirPrime HL7588 features.

Table 2. AirPrime HL7588 Features

Feature	Description
Physical	• Small form factor (146-pin solderable LGA pad) – 23mm x 22mm x 2.5mm (nominal) • Complete body shielding • RF connection pads (RF main interface) • Baseband signals connection
Electrical	Single or double supply voltage (VBATT and VBATT_PA) – 3.2V – 4.5V
RF	Penta-band LTE and dual-band UMTS: • LTE B2: 1900 PCS • LTE B4: 1700 AWS • LTE B5: 850 CLR • LTE B13: 700 • LTE B17: 700 • UMTS B2: 1900 PCS • UMTS B5: 850 CLR
SIM interface	• 1.8V/3V support • SIM extraction / hot plug detection • SIM/USIM support • Conforms with ETSI UICC Specifications • Supports SIM application tool kit with proactive SIM commands
Application interface	• NDIS NIC interface support (Windows XP, Windows 7, Windows 8, Windows CE, Linux) • Multiple non-multiplexed USB channel support • Dial-up networking • USB selective suspend to maximize power savings • CMUX multiplexing over UART (not available on the HL7588) • AT command interface – 3GPP 27.007 standard, plus proprietary extended AT commands

Feature	Description
Protocol Stack	• Single mode LTE operation: ▪ LTE FDD, bandwidth 1.4-20 MHz ▪ System Release: 3GPP Rel. 9 ▪ Category 4 (up to 150 Mbit/s in downlink, 50 Mbit/s in uplink) ▪ MIMO 2x2 ▪ Max modulation 64 QAM DL, 16 QAM UL ▪ Intra-frequency and inter-frequency mobility ▪ SMS over SGs and IMS ▪ SON ANR ▪ Public Warning System PWS • HSDPA (High Speed Downlink Packet Access)** ▪ Evolved High Speed Downlink Packet Access (HSDPA+) ▪ Compliant with 3GPP Release 9 ▪ Up to Category 24 (DC, 42.2Mbps) ▪ Continuous Packet Connectivity (CPC) ▪ Enhance fractional DPCH ▪ IPv6 support • HSUPA (High Speed Uplink Packet Access)** ▪ Compliant with 3GPP Release 9 ▪ Category 7 (11.5Mbps) ▪ Robust Header Compression (RoHC) • RXDIV Performance Enhancements ▪ Type 3i (HSDPA) • HSPA Enhancements** ▪ MAC-ehs Rel. 7 ▪ HSDPA Enhanced CELL_FACH/PCH states ▪ HSUPA Enhanced CELL_FACH states (eFACH) Rel 8 ▪ MAC-i/is Rel.8 ▪ Serving cell change enhancements Rel. 8
SMS	• SMS over SGs and IMS • SMS MO and MT • SMS saving to SIM card or ME storage • SMS reading from SIM card or ME storage • SMS sorting • SMS concatenation • SMS Status Report • SMS replacement support • SMS storing rules (support of **AT+CNMI**, **AT+CNMA**)

Feature	Description
Connectivity	• Multiple (up to 20) cellular packet data profiles • Sleep mode for minimum idle power draw • Mobile-originated PDP context activation / deactivation • Support QoS profile ▪ Release 97 – Precedence Class, Reliability Class, Delay Class, Peak Throughput, Mean Throughput ▪ Release 99 QoS negotiation – Background, Interactive, and Streaming • Static and Dynamic IP address. The network may assign a fixed IP address or dynamically assign one using DHCP (Dynamic Host Configuration Protocol). • Supports PAP and CHAP authentication protocols • PDP context type (IPv4, IPv6, IPv4v6). IP Packet Data Protocol context • RFC1144 TCP/IP header compression
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) with calendar

1.4. Architecture

The figure below presents an overview of the AirPrime HL7588's internal architecture and external interfaces.

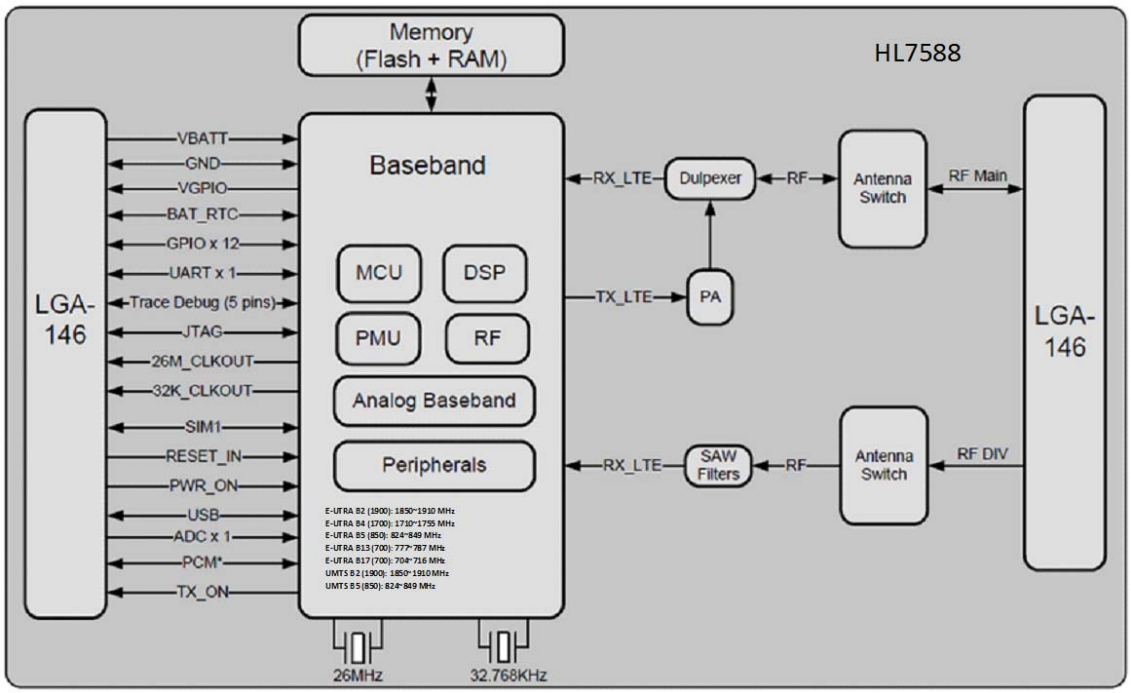


Figure 1. AirPrime HL7588 Architecture Overview

1.5. Interfaces

The AirPrime HL7588 module provides the following interfaces and peripheral connectivity:

- 1x - 4-pin UART
- 1x - Active Low RESET
- 1x - USB 2.0
- 1x - Backup Battery Interface
- 2x - System Clock Out
- 1x - Active Low POWER-ON
- 1x - 1.8V/3V SIM
- 1x - JTAG Interface
- 14x - GPIOs (5 of which have multiplexes)
- 1x - Main Antenna
- 1x - RX Diversity Antenna
- 1x – VGPIO
- 1x – TX ON
- 1x - ADC
- 1x – Debug Interface

1.6. Connection Interface

The AirPrime HL7588 module is an LGA form factor device. All electrical and mechanical connections are made through the 146 Land Grid Array (LGA) pads on the bottom side of the PCB.

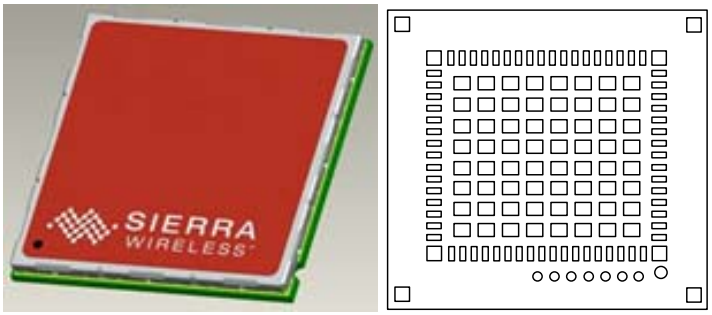


Figure 2. AirPrime HL7588 Mechanical Overview

The 146 pads have the following distribution:

- 66 inner signal pads, 1x0.5mm, pitch 0.8mm
- 1 reserved test point (do not connect), 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

1.7. ESD

Refer to the following table for ESD Specifications.

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

Table 3. ESD Specifications

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

1.8. Environmental & Certifications

1.8.1. Environmental Specifications

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

Table 4. AirPrime HL7588 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. Regulatory

The AirPrime HL7588 is compliant with FCC and IC regulations.

FCC and IC compliance will be reflected on the AirPrime HL7588 label.

Table 5. Regulation Compliance

Document	Current Version	Description	HL7588
NAPRD.03	V5.22 or later	North American Program Reference Document	✓
FCC Part 22, 24, 27	NA	Federal Communications Commission	✓

1.8.3. RoHS Directive Compliant

The AirPrime HL7588 modules are compliant with RoHS Directive 2011/65/EU which sets limits for the use of certain restricted hazardous substances. This directive states that “from 1st July 2006, new electrical and electronic equipment put on the market does not contain lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE)”.

1.8.4. 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.

1.8.5. References

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

[2] AirPrime HL7519, HL7548 and HL7588 AT Commands Interface Guide
Reference Number: TBC

2. Detailed Interface Specifications

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

For standard applications, VBATT and VBATT_PA must be tied externally to the same power supply. For some specific applications, AirPrime HL7588 modules support separate VBATT and VBATT_PA connection if requirements below are fulfilled.

2.1. Power Supply

The AirPrime HL7588 module is supplied through the VBATT signal with the following characteristics.

Table 6. Power Supply

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

1 This value has to be guaranteed during the burst.

Note: Load capacitance for VBATT is around 32µF ± 20% embedded inside the module.
Load capacitance for VBATT_PA is around 10µF ± 20% embedded inside the module.

2.2. Current Consumption

The following table lists the current consumption of the AirPrime HL7588 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 VSWR4:1 with worst conditions among supported ranges of voltages and temperature.

Table 7. Current Consumption

Parameter		Minimum	Typical	Maximum	Unit
Off mode		95.0	110	202.0	µA
Sleep mode – LTE DRX = 1.28s USB = suspended	Band 2	1.2	1.4	6.2	mA
	Band 4	1.2	1.4	6.2	mA
	Band 5	1.2	1.4	6.2	mA
	Band 13	1.2	1.4	6.2	
	Band 17	1.2	1.4	6.2	mA

Parameter		Minimum	Typical	Maximum	Unit
LTE in communication mode (TX Max)	Band 2	630	750	895	mA
	Band 4	510	610	945	mA
	Band 5	440	530	745	mA
	Band 13	460	548	720	
	Band 17	540	651	780	mA
HSPA+ (TX Max)	Band 2		TBD		mA
	Band 5		TBD		mA

2.3. VGPIO

The VGPIO output can be used to:

- Pull-up signals such as I/Os
- Supply the digital transistors driving LEDs

The VGPIO output is available when the AirPrime HL7588 module is switched ON.

Table 8. VGPIO Electrical Characteristics

Parameter	Min	Typ	Max	Remarks
Voltage level (V)	1.7	1.8	1.9	Both active mode and sleep mode
Current capability Active Mode (mA)	-	-	50	Power management support up to 50mA output in Active mode
Current capability Sleep Mode (mA)	-	-	3	Power management support up to 3mA output in Sleep mode
Rise Time(ms)	-	-	1.5	Start-Up time from 0V

3. Mechanical Drawings

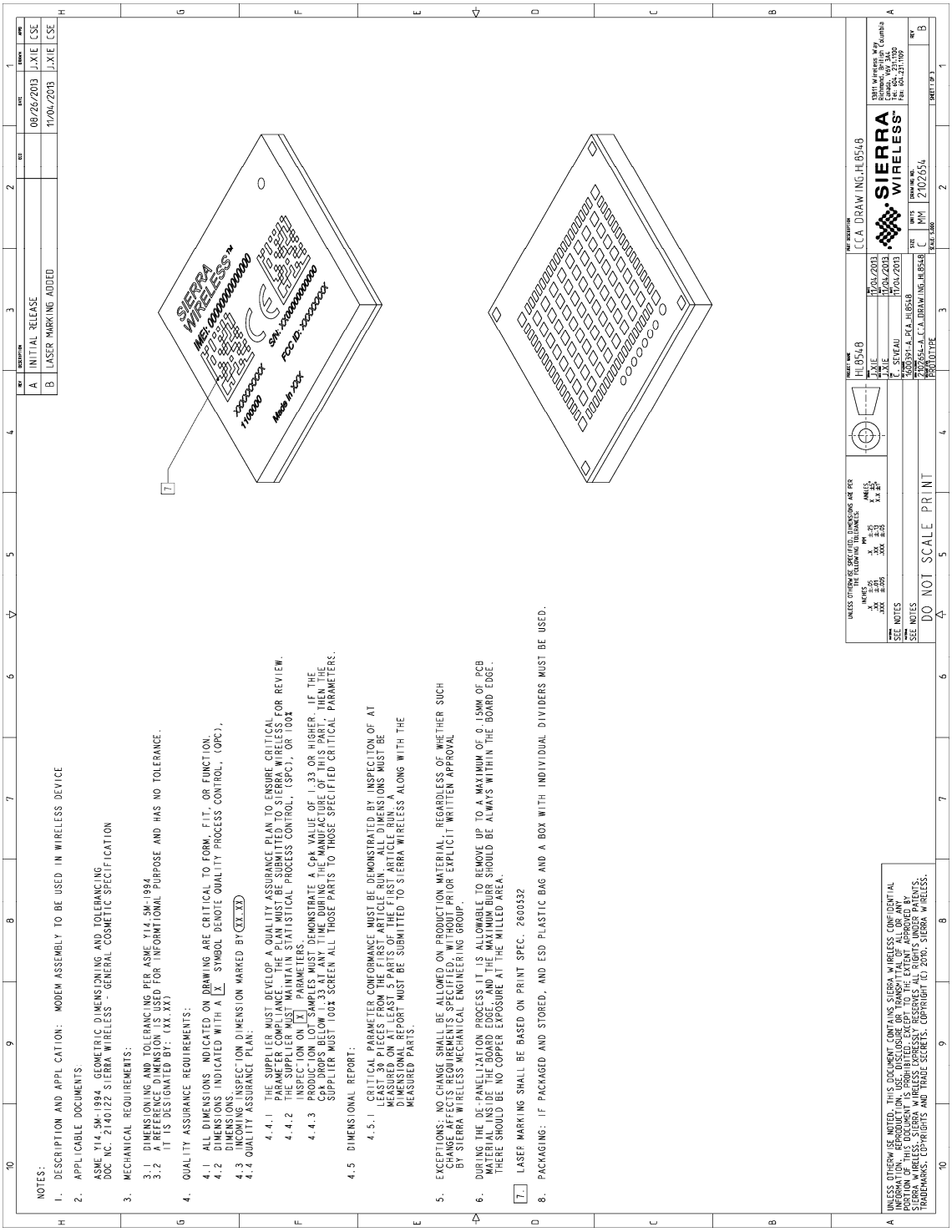


Figure 3. AirPrime HL7588 Mechanical Drawing

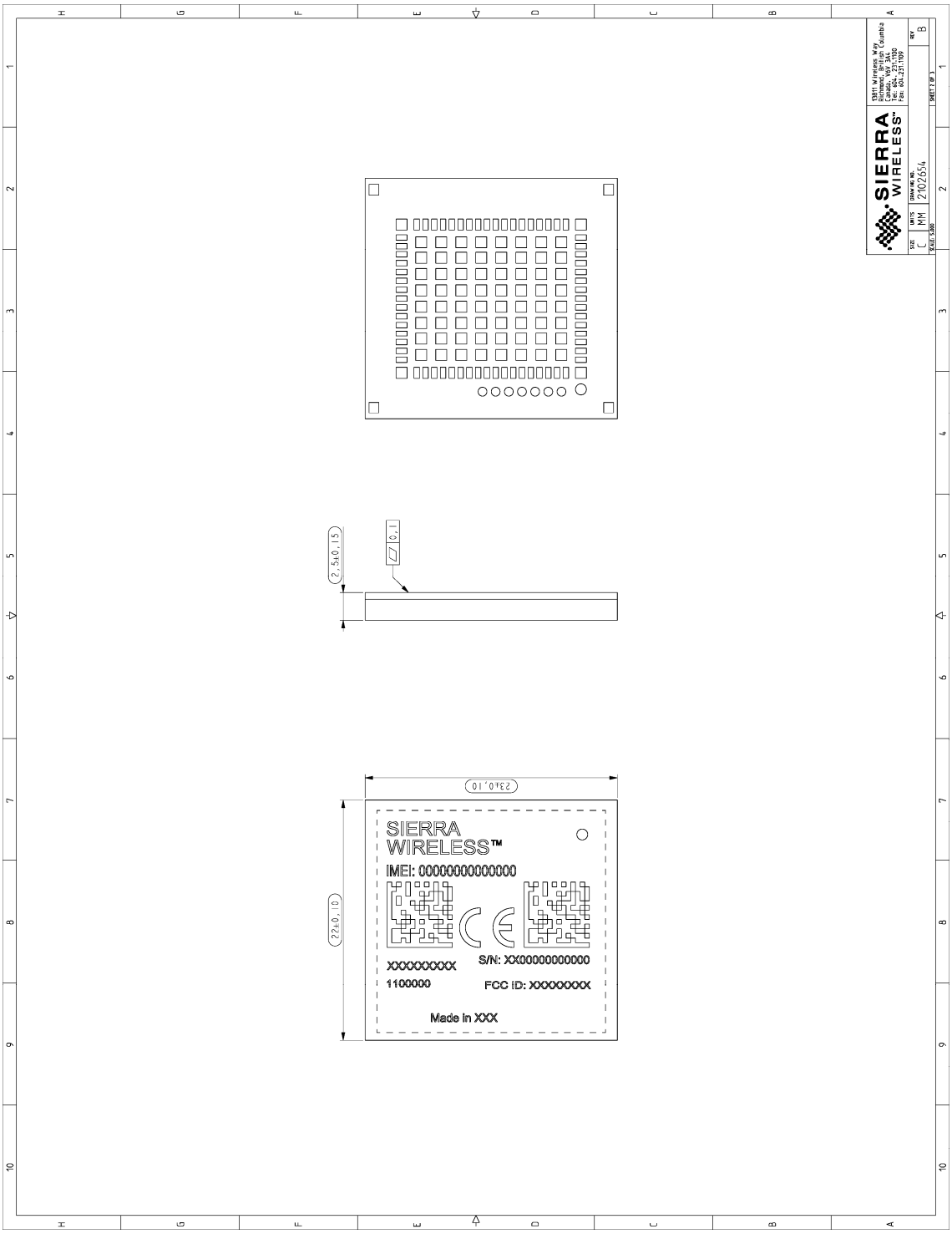


Figure 4. AirPrime HL7588 Dimensions Drawing

4. FCC Regulations

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

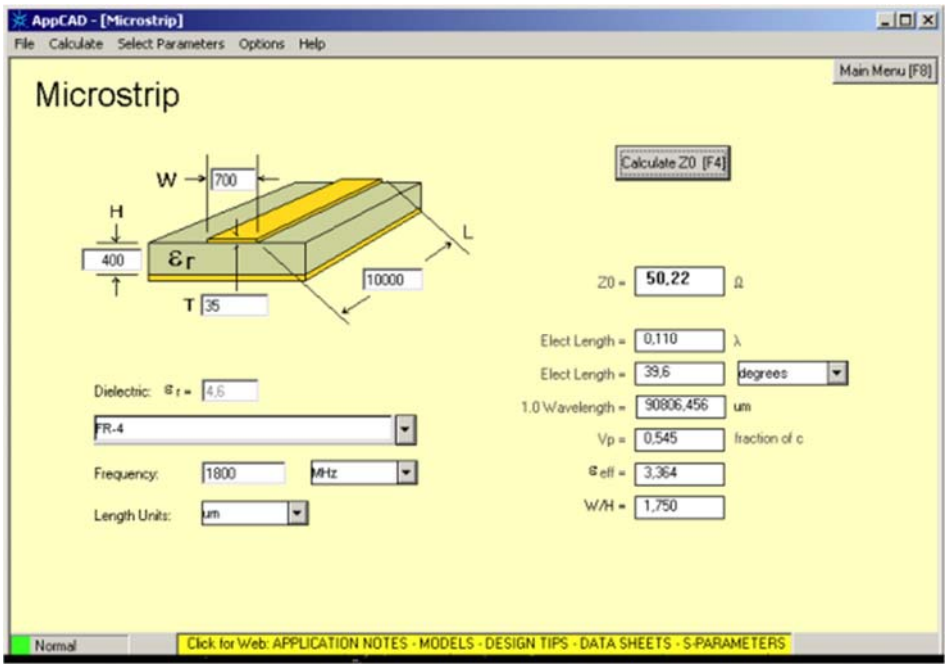
IMPORTANT NOTE – FCC Radiation Exposure Statement:

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

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

The HL7588 module has been granted modular approval for mobile applications. Integrators may use the HL7588 module in their final products without additional FCC certification if they meet the following conditions. Otherwise, additional FCC approvals must be obtained.

1. At least 20 cm separation distance between the antenna and the user's body must be maintained at all times.
2. To comply with FCC regulations limiting both maximum RF output power and human exposure to RF radiation, the maximum antenna gain including cable loss in a mobile-only exposure condition must not exceed:
    - TBD 7.51 dBi in Band 2
    - TBD 5.78 dBi in Band 4
    - TBD 9.72 dBi in Band 5
    - TBD 10.17 dBi in Band 13
    - TBD 9.74 dBi in Band 17
3. This device and its antenna(s) must not transmit be co-located or operating in conjunction with any other antenna or transmitter, except in accordance with FCC multi-transmitter RF exposure product procedures.
4. The RF signal must be routed on the application board using tracks with a 50Ω characteristic impedance. Basically, the characteristic impedance depends on the dielectric, the track width and the ground plane spacing. In order to respect this constraint, Sierra Wireless recommends using MicroStrip or StripLine structure and computing the Tracks width with a simulation tool (like AppCad shown in the figure below and that is available free of charge at http://www.agilent.com).



If a multi-layered PCB is used, the RF path on the board must not cross any signal (digital, analog or supply).

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

Stripline and Coplanar design requires having a correct ground plane at both sides. Consequently, it is necessary to add some vias along the RF path. It is recommended to use Stripline design if the RF path is fairly long (more than 3cm), since MicroStrip design is not shielded. Consequently, the RF signal (when transmitting) may interfere with neighbouring electronics (AF amplifier, etc.). In the same way, the neighbouring electronics (micro-controllers, etc.) may degrade the reception performances. The antenna connector is intended to be directly connected to a 50Ω antenna and no matching is needed.

5. A label must be affixed to the outside of the end product into which the HL7588 module is incorporated, with a statement similar to the following:

This device contains FCC ID: N7NHL7588

6. A user manual with the end product must clearly indicate the operating requirements and conditions that must be observed to ensure compliance with current FCC RF exposure guidelines.

The end product with an embedded HL7588 module may also need to pass the FCC Part 15 unintentional emission testing requirements and be properly authorized per FCC Part 15.

Note: *If this module is intended for use in a portable device, you are responsible for separate approval to satisfy the SAR requirements of FCC Part 2.1093.*

5. Terms and Abbreviations

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

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