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Modules


# Hardware Integration Guide

## HL7900

June 2024

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# Sierra Wireless

Semtech Corporation purchased Sierra Wireless in January 2023. The Sierra Wireless brand is gradually being phased out. During the phase-out period, references to both “Semtech” and “Sierra Wireless” may appear in product documentation.

# Contact Information

| | |
|---|---|
| Sales information and technical support, including warranty and returns | Web: sierrawireless.com/company/contact-us<br>Global toll-free number: 1-877-687-7795<br>6:00 am to 5:00 pm PST |
| Corporate and product information | Web: sierrawireless.com |

# Revision History

| Revision Number | Release Date | Changes |
|---|---|---|
| 1 | May 2024 | Document creation, preliminary release |
| 1.1 | June 2024 | Added:<br>▪ Japan radio and telecom approvals<br>▪ FCC/IC IDs<br>▪ Minor edits from internal reviews |

# Contents

# 1: Introduction

The HL7900 is an industrial-grade LGA 152-pad module that provides voice and data connectivity on LTE networks. The module also provides GNSS functionality as a SKU-configuration.

## 1.1 Accessories

A hardware development kit is available for Semtech series modules. The kit contains hardware components for evaluating and developing with the module, including:

- Development board
- Cables
- Antennas (additional antennas may be required to support all bands)
- Other accessories

# 2: Power

## 2.1 Power Supply

The host provides power to the HL7900 through multiple power and ground pins. The host must provide safe and continuous power at all times; the module does not have an independent power supply, or protection circuits to guard against electrical issues.

For detailed pinout and voltage/current requirements of this module, see the HL7900 Product Technical Specification.

**Table 2-1: Supported Power States**

| State | Description |
|---|---|
| Active | Module is fully powered and operating in one of the following modes:<br>▪ Full function (WWAN radio active; GNSS radio can be turned on/off)—Highest power consumption.<br>▪ Idle mode (WWAN radio on; module is registered on network, but no active connection; GNSS radio can be turned on/off)<br>▪ Airplane mode (WWAN radio off; GNSS radio can be active if allowed by PRI) |
| Sleep | ▪ Lower power consumption than Active state, but higher than PSM.<br>▪ Application Core is sleeping; modem is in DRX. The processor monitors signals (triggers) that can 'wake' the module. |
| Low Power Mode | ▪ Monitors a set number of paging opportunities in a Paging Time Window (PTW) and then enters a low power state between PTWs. This sequence (PTW followed by low power state) comprises a single eDRX cycle. The size of the PTW and the length of the eDRX cycle (TI-eDRX) are negotiated between the module (which submits desired values when enabling eDRX) and the network (which indicates the values that will actually be used). The module remains in I-eDRX until it detects a page from the network during a PO or needs to access the network (e.g. to make a data connection, send a mobility TAU or periodic TAU, etc.), at which time it returns to the connected state.<br>▪ eDRX (Extended Discontinuous Reception)—eDRX mode provides a 'flexible sleep' for the modem, which significantly reduces energy consumption. |
| OFF | ▪ Module is OFF (no power to the system).<br>▪ Apply power for system to go to Active state. |

# 3: RF Specifications

The HL7900 operates on the frequency bands listed below

## 3.1 Frequency Band Support

**Table 3-1: HL7900 Supported RF Bands/Connectivity**

| Module | RF Band | Transmit (TX) Frequency (MHz) | Receive (Rx) Frequency (MHz) | Cat-M1 | Cat-NB1/NB2 |
|---|---|---|---|---|---|
| HL7900 | LTE B1 | 1920–1980 | 2110–2170 | Y | Y |
| | LTE B2 | 1850–1910 | 1930–1990 | Y | Y[a] |
| | LTE B3 | 1710–1785 | 1805–1880 | Y | Y |
| | LTE B4 | 1710–1755 | 2110–2155 | Y | Y[a] |
| | LTE B5 | 824–849 | 869–894 | Y | Y[a] |
| | LTE B8 | 880–915 | 925–960 | Y | Y |
| | LTE B12 | 699–716 | 729–746 | Y | Y[a] |
| | LTE B13 | 777–787 | 746–756 | Y | Y[a] |
| | LTE B18 | 815–830 | 860–875 | Y | Y |
| | LTE B19 | 830–845 | 875–890 | Y | Y |
| | LTE B20 | 832–862 | 791–821 | Y | Y |
| | LTE B25 | 1850–1915 | 1930–1995 | Y | Y[a] |
| | LTE B26 | 814–849 | 859–894 | Y | Y[a] |
| | LTE B28 | 703–748 | 758–803 | Y | Y |
| | LTE B65 | 1920–2010 | 2110–2200 | | Y |
| | LTE B66 | 1710–1780 | 2110–2200 | Y | Y[a] |
| | LTE B70 | 1695–1710 | 1995–2020 | | Y |
| | LTE B85 | 698-716 | 728-746 | | Y[a] |

a. To ensure FCC compliance near NB band edges, Cat-NB2 supported TX channel ranges do not include outer channels. Supported channel ranges are:
- B2: 18602–19198
- B4: 19952–20398
- B5: 20402–20648
- B12: 23012–23178
- B13: 23182–23278
- B25: 26042–26688
- B26: 26692–27038
- B66: 131974 - 132670
- B70: 132974–133119
- B85: 134004–134179

# 3.2 Conducted Tx Max Output Power Tolerances

**Table 3-2: HL7900 Conducted Tx Max Output Power Tolerances - LTE[a]**

| LTE Bands | Min | Typ | Max | Units | Notes |
|---|---|---|---|---|---|
| All bands | 21.5[b] | 23 | 24.5 | dBm | Power class 3 |

a. Under normal operating conditions (25°C)
b. Additional power reduction is applied to the lowest and highest supported channels for each band — see Table 1-1 footnote "a" for supported Tx channel ranges. (e.g. applies to B2 channels 18602 and 19198)

# 4: Routing Constraints and Recommendations

This section describes general routing constraints and recommendations for the HL7900.

*Note: This is a non-exhaustive list of suggested design guidelines. The developer is responsible for deciding whether to implement these guidelines.*

## 4.1 General Rules and Recommendations

Clock and other high-frequency digital signals (e.g. serial buses) should be routed as far as possible from the module's analog signals.

If the application design makes it possible, all analog signals should be separated from digital signals by a ground trace on the PCB.

**Tip:** *Avoid routing any signals under the module on the application board.*

## 4.2 PCB Layout Recommendations

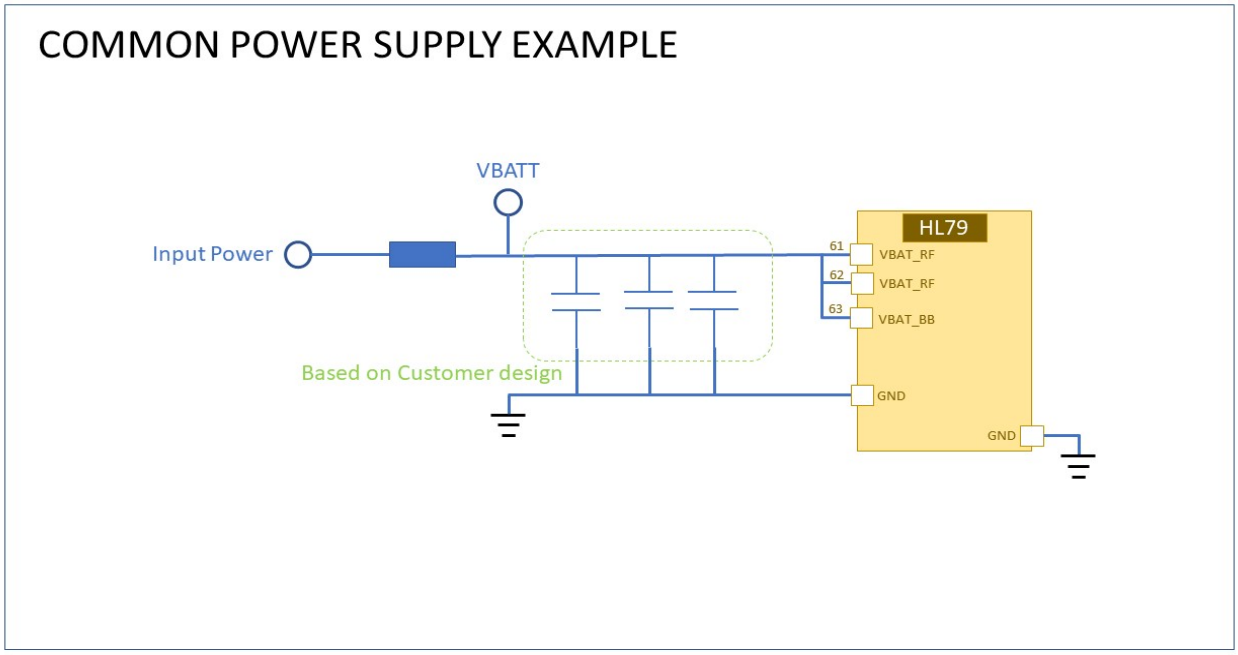
Ground pads should be re-flowed on to the host PCB with < 30% voiding to allow effective heat dissipation.

## 4.3 Power Supply

When designing the power supply, make sure that VBAT_BB/VBAT_RF meet the requirements listed in the Semtech Product Technical Specification.

Careful attention should be paid to the following:

- Power supply quality — PFM, or PSM systems should be avoided; Low ripple, linear regulation or PWM converters are preferred for low noise.
- Capacity to deliver high current peaks in a short time (for pulsed radio emission)
- VBAT_BB/VBAT_RF must support peak currents with an acceptable voltage drop that guarantees the minimum required VBAT_BB/VBAT_RF value.
- VBAT_BB/VBAT_RF signal pads must never exceed the maximum required VBAT_BB/VBAT_RF value, otherwise the module's power amplifier and GPS chipset may be severely damaged.
- A poorly-designed (not robust) power supply could affect EMC performance, the emission spectrum, and the phase error and frequency error.
- VBAT_BB and VBAT_RF full function range is 3.2~4.35V, VBAT_BB extended range is 2.2~3.2V, and VBAT_RF extended range is 2.5~3.2V. When the operation is in the voltage extended range, the VBAT_BB and VBAT_RF needs to separate.



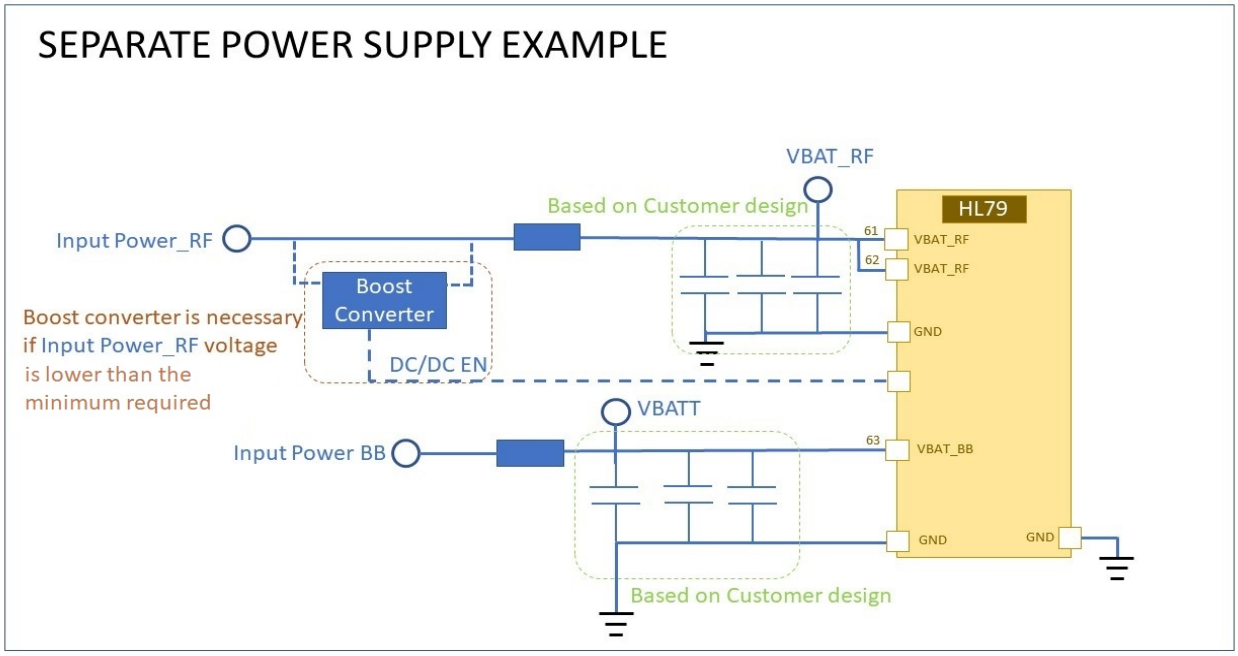




*Figure 4-1: Common Power Supply and Separate Power Supply Samples*

# 4.4 Antenna

Semtech strongly recommends working with an antenna manufacturer either to develop an antenna adapted to the application, or to adapt an existing solution to the application.

For information on routing constraints for the RF circuit, see RF Circuit.

# 4.5 PCB Specifications for the Application Board

Sensitive signals (such as audio, UIM, and clocks) should be protected by ground planes/fills. Routing sensitive signals close to noisy signals could result in noise being coupled.

# 4.6 Recommended PCB Land Pattern

Refer to HL Series Customer Process Guidelines, available at http://source.sierrawireless.com.

# 4.7 Routing Constraints

## 4.7.1 Power Supply

If the following design recommendations are not followed, phase error (peak) and power loss could occur.

- Since the maximum peak current can reach 0.9 A, Sierra Wireless strongly recommends having a large width for the layout of the power supply signal (to avoid voltage loss between the external power supply and VBAT_BB/VBAT_RF.

*Note: Figure ▪ shows separate traces for VBAT_BB and VBAT_RF. If VBAT_BB and VBAT_RF share a single power supply, these traces should be connected.*

*Note: For optimal decoupling, place the capacitors on the underside of the board, directly under the pins.*

- Filtering capacitors (100 nF to 1500 µF) are recommended near the module's power supply.
- Attention should be paid to the ground trace or the ground plane on the application board for the power supply that supplies the module. The ground trace or ground plane, as well as the VBAT trace, must be able to support current peaks.
- If the ground trace between the module and the power supply is a copper plane, make sure it is a solid plane.
- Design routing to make sure total line impedance does not exceed 10 mΩ @ 217 Hz.

### 4.7.1.1 Ground Plane Connection

The HL7900 requires a solid, central ground plane (with solder mask defined pads) located directly under the module. This will:

- Ensure high current signal returns
- Provide heat dissipation under higher operating temperatures

The ground plane should be connected (with vias) to the reference ground layer of the application board.

## 4.7.2 UIM Interface

- The length of the tracks between the HL7900 and the UIM socket should be as short as possible. Maximum recommended length is 10cm.
- ESD protection is mandatory on the UIM lines unless there is no physical access to the UIM.
- The decoupling capacitor(s) should be placed as close as possible to the UIM card connector for the UIM_VCC signal.

## 4.7.3 RF Circuit

The RF signal must be routed on the application board using tracks with a 50Ω characteristic impedance.

The characteristic impedance depends on the dielectric, the track width and the ground plane spacing.

It is recommended to use stripline design if the RF path is fairly long (more than 3 cm), since microstrip design is not shielded. Consequently, the RF (transmit) signal may interfere with neighboring electronic circuits. In the same way, the neighboring electronics (micro-controllers, etc.) may interfere with the RF (receive) signal and degrade the reception performance.

The RF trace on the development board is routed from the module antenna port to the RF connector (SMA). The RF trace is designed as a 50Ω coplanar stripline and its length is 24.17 mm.

The following drawings show the location of the HL7900 on the development board, the routing cross section and the top view of the RF trace on the development board.

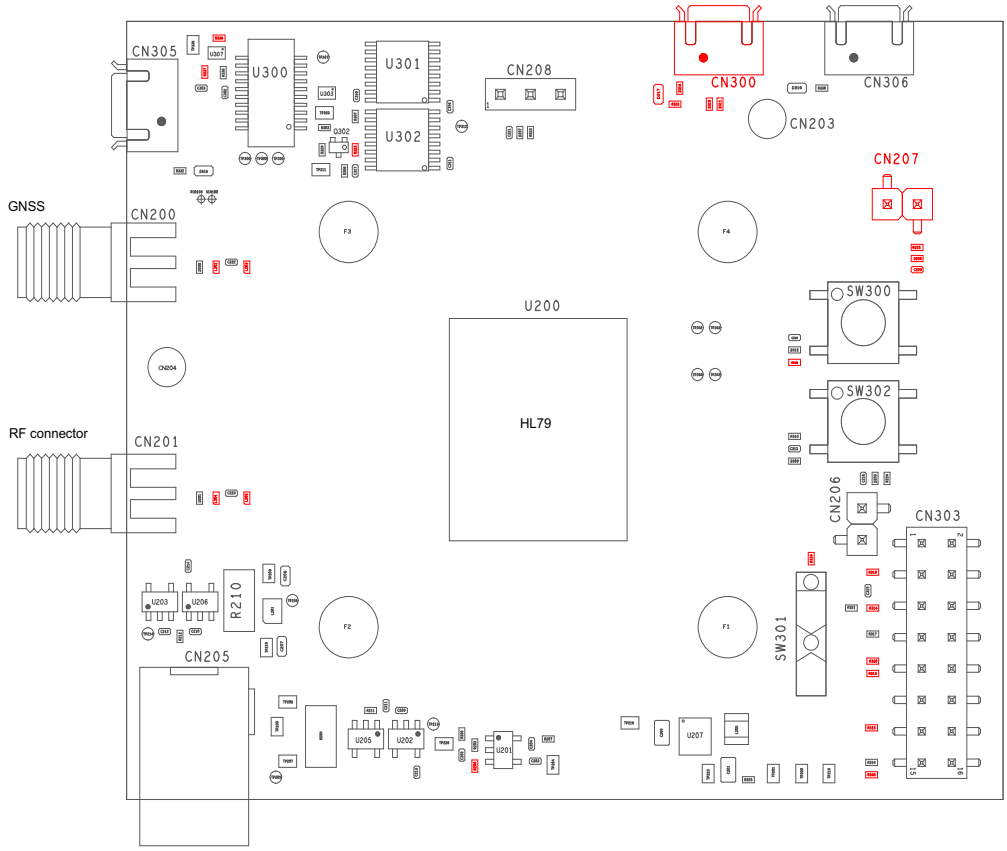



*Figure 4-2: Module Location on the Development Board*

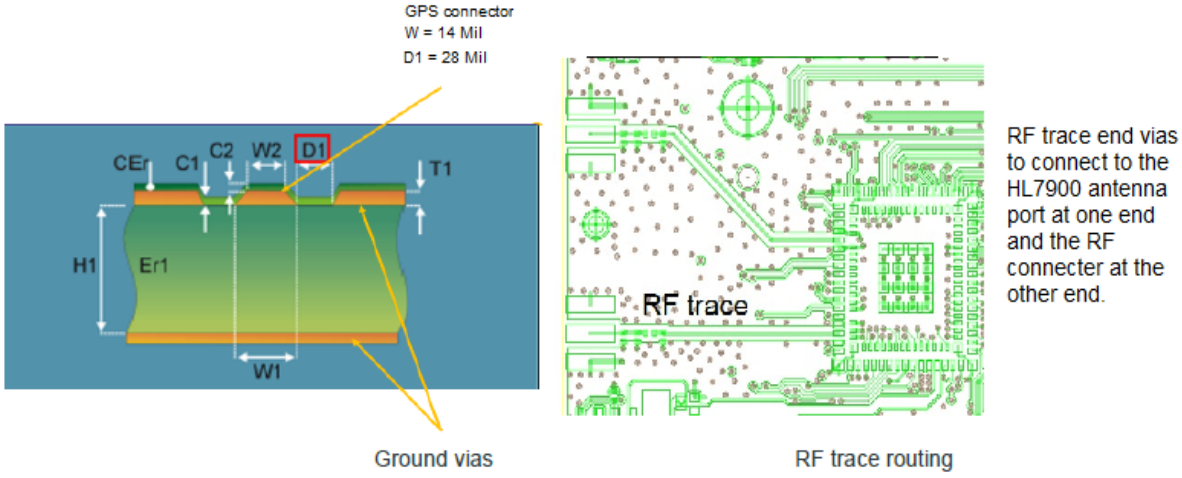



*Figure 4-3: Development Board RF Trace Design*

## 4.8 Thermal Considerations

When transmitting, the HL7900 can generate significant amounts of heat (due to the internal Power Amplifier) that must be dissipated in the host device for safety and performance reasons.

The amount of thermal dissipation required depends on the following factors:
- Supply voltage — Maximum power dissipation for these modules can be up to 1.2 W at voltage supply limits.
- Usage — Typical power dissipation values depend on the location within the host, amount of data transferred, etc.

To enhance heat dissipation:
- Maximize airflow over / around the module
- Locate the module away from other components that generate heat
- Ensure the module is connected to a solid ground plane

## 4.9 EMC and ESD Recommendations

EMC tests must be performed on the application as soon as possible to detect any potential problems.

When designing, special attention should be paid to:
- Possible spurious emissions radiated by the application to the RF receiver in the receiver band
- ESD protection — Typically, ESD protection is mandatory for externally accessible signals, including:
  - VBAT_RF/VBAT_BB
  - UIM (if accessible from outside)
  - Serial link
  - USB
  - Antennas
- Length of the UIM interface lines (preferably <10 cm)
- EMC protection on audio input/output (filters against 900 MHz emissions)
- Ground plane: Semtech recommends a common ground plane for analog/digital/RF grounds

*Note: The HL7900 does not include any protection against over-voltage.*

The host device must provide adequate ESD protection on digital circuits and antenna ports as detailed in the following table.

*Note: The level of protection required depends on your application.*

**Table 4-1: ESD Specifications [a,b]**

| Category | Connection | Recommendation |
|---|---|---|
| Operational | RF ports<br>UIM connector<br>USB connector<br>UART connector | IEC-61000-4-2 - Level (Electrostatic Discharge Immunity Test)<br>▪ ± 6kV Contact<br>▪ ± 8kV Air |
| Non-operational | Host connector interface | Unless otherwise specified:<br>▪ JESD22-A114 ± 1kV Human Body Model<br>▪ JESD22-A115 ± 100V Machine Model<br>▪ JESD22-C101C ± 500V Charged Device Model |

a. ESD specifications are preliminary, subject to change.
b. ESD protection is highly recommended at the point where the UIM contacts are exposed, and for any other signals that would be subjected to ESD by the user.

# 4.10 Mechanical Integration

Attention should be paid to:
- Antenna cable integration (bending, length, position, etc)
- Pads of the HL7900 to be soldered to the ground plane
- Ensuring proper board layout
- Providing sufficient space around the module for heat dissipation

# 4.11 Signal Reference Schematics

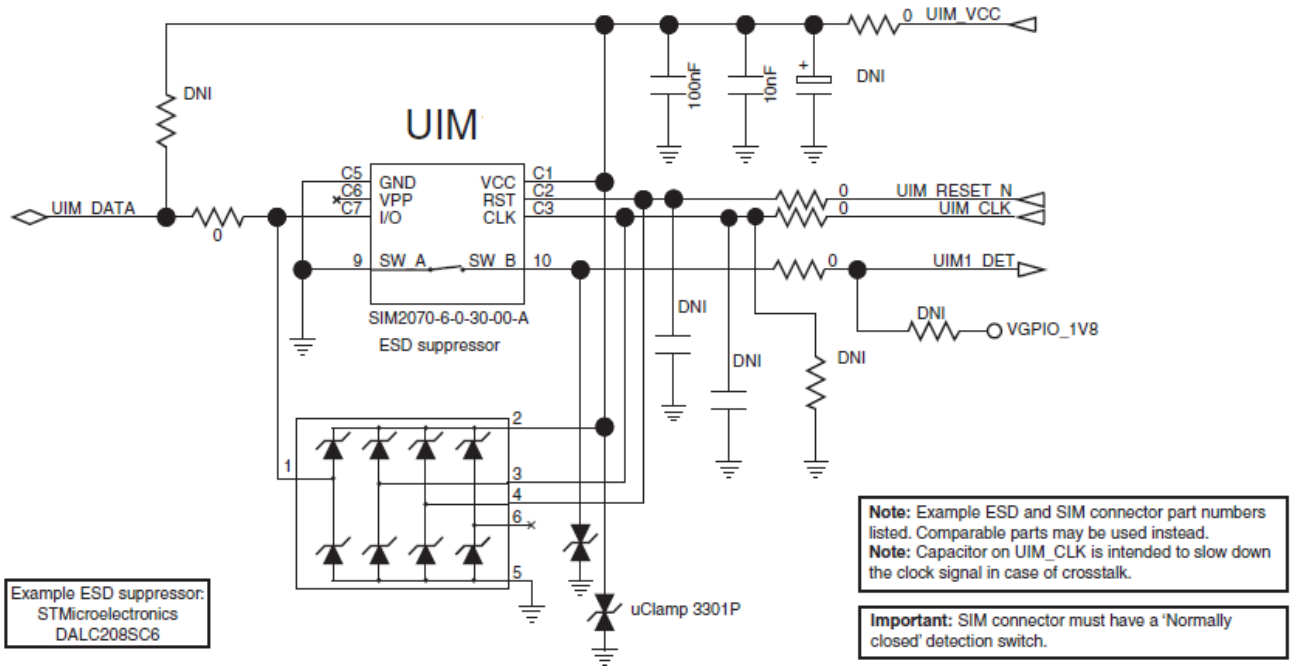



*Figure 4-4: UIM Interface*

# 5: Regulatory Compliance and Industry Certifications

This chapter describes the current certification status of the HL7900. Certifications in other countries may be attained upon customer request—contact your Semtech account representative for details.

Additional testing and certification may be required for the host product with an embedded HL7900 module and are the responsibility of the OEM. Semtech offers professional services-based assistance to OEMs with the testing and certification process, if required.

## 5.1 Compliance Acceptance and Certification

The HL7900 is designed to be compliant with the 3GPP Release 14 E-UTRA Specification for Mobile Terminated Equipment.

Final regulatory and operator certification requires regulatory agency testing and approval with the fully integrated UE host device incorporating the HL7900.

The OEM host device and, in particular, the OEM antenna design and implementation will affect the final product functionality, RF performance, and certification test results.

*Note: Tests that require features not supported by the HL7900 (as defined by this document) are not supported.*

## 5.2 Regulatory Compliance

The HL7900 module is designed to meet, and upon commercial release, will meet the requirements of the following regulatory bodies and regulations, where applicable:

- Federal Communications Commission (FCC) of the United States
- Innovation, Science and Economic Development Canada (ISED)
- Radio Equipment Directive (RED)
- The National Communications Commission (NCC) of Taiwan, Republic of China
- Japan Ministry of Internal Affairs and Communications (MIC)

## 5.2.1 Important Compliance Information for Canada and the United States

The HL7900 module upon commercial release, will have been granted modular approval for mobile applications under:

- FCC ID: N7NHL79
- IC: 2417C-HL79

Integrators may use the HL7900 module in their host products without additional FCC/ISED certification if they meet the following conditions. Otherwise, additional FCC/ISED approvals must be obtained.

1. The host product must use the RF trace design approved for the HL7900 module. The Gerber file of the trace can be obtained from Semtech upon request.
2. At least 20 cm separation distance between the antenna and the user's body must be maintained at all times.
3. To comply with FCC/ISED 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 the limits stipulated in Table 5-1.
4. The HL7900 may transmit simultaneously with other collocated radio transmitters within a host product, provided the following conditions are met:
   - Each collocated radio transmitter has been certified by FCC/ISED for mobile application.
   - At least 20 cm separation distance between the antennas of the collocated transmitters and the user's body must be maintained at all times.
   - The radiated power of a collocated transmitter must not exceed the EIRP limit stipulated in Table 5-2.

**Table 5-1: Product Name Antenna Gain Specifications**

| Device | Technology | Band | Frequency (MHz) | Maximum antenna gain (dBi) | |
|---|---|---|---|---|---|
| | | | | Standalone | Collocated |
| HL7900 | LTE[a] | B2 | 1850–1910 | 6 | 6 |
| | | B4 | 1710–1755 | 5.5 | 5.5 |
| | | B5 | 824-829 | 6 | 4 |
| | | B8 | 897.5-900.5 | 6 | 4 |
| | | B12 | 699-716 | 6 | 4 |
| | | B13[b] | 777-787 | 6 | 4 |
| | | B25 | 1850-1915 | 6 | 6 |
| | | B26 | 814-849 | 6 | 4 |
| | | B66 | 1710-1780 | 5.5 | 5.5 |
| | | B70 | 1695-1710 | 5.5 | 5.5 |
| | | B85 | 698-716 | 6 | 4 |

a. The isolation between LTE and GNSS antenna is at least 15dB.
b. The antenna gain at 1560MHz suggests less than 3dBi for FCC radiation spurious.

**Table 5-2: HL7900 Collocated Radio Transmitter Specifications**

| Device | Technology | Frequency (MHz) | EIRP Limit (dBm) |
|---|---|---|---|
| Collocated transmitters[a] | WLAN 2.4 GHz | 2400–2500 | 30 |
| | WLAN 5 GHz | 5150–5850 | 30 |
| | BT | 2400–2500 | 16 |

a. Valid collocated transmitter combinations: WLAN+BT; WiGig+BT. (WLAN+WiGig+BT is not permitted.)

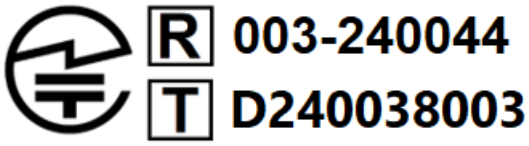
5. A label must be affixed to the outside of the end product into which the HL7900 is incorporated, with a statement similar to the following:
   - **(HL7900)— This device contains FCC ID: N7NHL79/ IC: 2417C-HL79**
6. A user manual with the host product must clearly indicate the operating requirements and conditions that must be observed to ensure compliance with current FCC/ISED RF exposure guidelines.

*Note: Host product manufacturers are responsible for the overall compliance of the host products including, where applicable, all additional equipment authorization and testing not covered by the modular approval (e.g., unintentional radiator FCC Part 15 Subpart B requirements, ISED's Interference-Causing Equipment Standards, and RF exposure requirements for host products intended for use within 20 cm of the user's body.)*

## 5.2.2 Japan Radio and Telecom Approval

The HL7900 module upon commercial release, will have been granted Japan radio and telecom approvals with the approval numbers shown below:

- HL7900:



## 5.3 Industry Certifications

The HL7900 module complies with the mandatory requirements described in the following standards. The exact set of requirements supported is network operator-dependent.

**Table 5-3: Standards Compliance**

| Technology | Standards |
|---|---|
| **5G NR** | 3GPP Release 17 |
| **LTE** | 3GPP Release 14 |
| **WCDMA** | 3GPP Release 99 |

Upon commercial release, the following industry certifications will have been obtained, where applicable:

- GCF
- PTCRB

## 5.4 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 environmentally friendly manner.