Skywire® HSPA+ HE910 Embedded Cellular Modem Datasheet

NimbeLink Corp.

Updated: January 2019

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1. Introduction

1.1 Orderable Part Numbers

Orderable Device	Telit Chipset	Operating Temperature	Bands	Fallback?	Network Type	GPS
NL-SW-HSPA	HE910-DG	-40 to +85˚C	B1, B2, B4, B5, B6, B8	Yes	GSM	Yes
NL-SW-HSPA-B	HE910-DG	-40 to +85˚C	B1, B2, B4, B5, B6, B8	Yes	GSM	Yes

1.2 Additional Resources

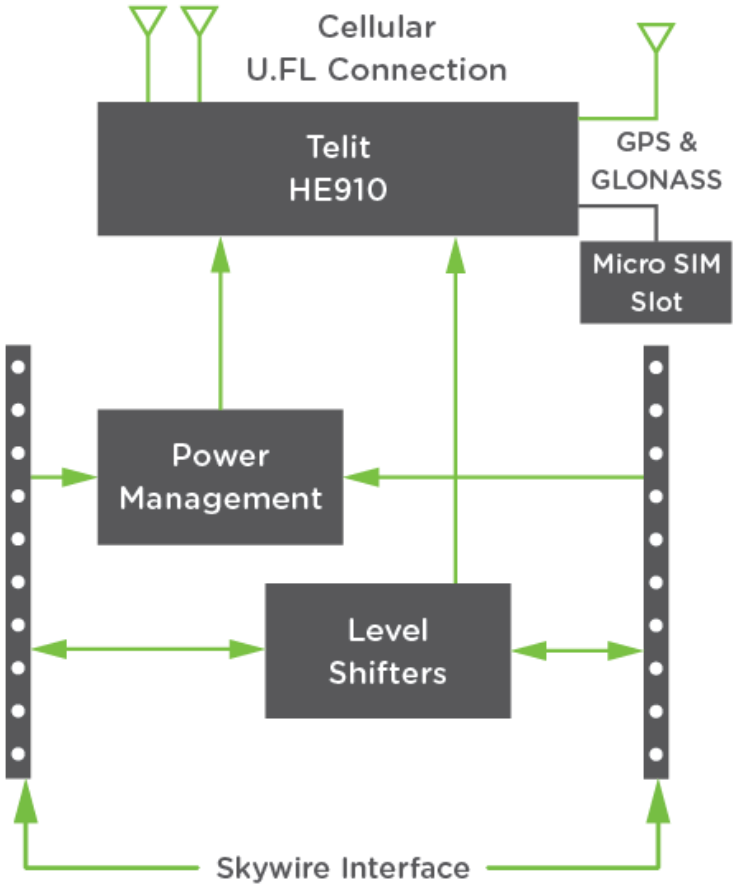
The following documents or documentation resources are referenced within this document.

- NL-SW-HSPA Product Page
- GPS & Assisted GPS App Note
- Sending and Receiving data with Socket Dials
- Prototyping considerations App Note

1.3 Product Overview

Add robust cellular connectivity to your M2M devices with scalable radio technology with Skywire line of modems including HE910 based HSPA+ solutions. Extensive experience in designing and building embedded product solutions makes the NimbeLink Skywire® embedded cellular modem the smallest on the market. It uses the popular Skywire interface and supports multiple GSM bands and fallback capability minimizing costs of hardware and network access. The module is designed for volume production and is intended for OEMs to embed into end equipment designs.

1.4 Block Diagram



2. Technical Specifications

2.1 Electrical Specifications

2.1.1 Absolute Maximum Ratings

Parameter	Signal	Maximum Rating
Main Power Supply	VCC	4.3V
I/O Voltage Reference	VREF	5.0V

2.1.2 Recommended Ratings & Module Pin out

2.1.2.1 Connectors J1 and J2

Pin	Name	Direction	Description	Min	Typical	Max	If not used
1	VCC	Input	Main Power supply	3.5V	3.9V	4.3V	Must be implemented
2	DOUT	Output	UART data out, I/O level tied to VREF	VOL: GND to 0.55V		VOH: VREF x 0.67 to VREF	Must be implemented if USB not used, No connection
3	DIN	Input	UART data in, I/O level tied to VREF	VIL: GND to 0.15V		VIH: VREF-0.4 V to VREF	Must be implemented if USB not used, No connection
4	GND	Input	Ground Pin		0		Must be implemented
5	RESET_nIN	Input	Controls HW_SHUTDOWN input on Telit HE910, tie low for 200mS and released to activate. Internally pulled up to 1.8V. Drive with open collector output. Assert only in an emergency as the module will not gracefully exit the cellular network when asserted.	0V		1.8V	No connection
6	VUSB	Input	Supply for USB interface	4.4V	5V	5V	No connection
7	USB_D+	I/O	USB differential Data + signal				No connection
8	USB_D-	I/O	USB differential Data - signal				No connection
9	DTR	Input	Modem Data Terminal Ready input	VIL: GND to 0.15V		VIH: VREF-0.4 V to VREF	Tie to GND
10	GND	Input	Ground Pin		0		Must be implemented
11	GND	Input	Ground Pin		0		Must be implemented
12	CTS	Output	Modem Clear to Send hardware flow control output	VOL: GND to 0.55V		VOH: VREF x 0.67 to VREF	No connection

Pin	Name	Direction	Description	Min	Typical	Max	If not used
13	ON/nSLEEP	Output	Signal drives the onboard LED indicating network status. See section 3.5 for details.	0		1.8V	No connection
14	VREF	Input	Voltage reference for offboard I/O signals. This signal drives the input voltage side of an onboard buffer which converts all external I/O voltage from VREF range to 1.8V range to drive the onboard Telit HE910 modem module.	1.65V	1.8V or 3.3V	5.0V	Must be implemented
15	GND	Input	Ground Pin		0		Must be implemented
16	RTS	Input	Modem Request to Send hardware flow control input	VIL: GND to 0.15V		VIH: VREF-0.4 V to VREF	Tie to GND
17	DIO3	I/O	Programmable GPIO_03 on Telit HE910 module	0		1.8V	No connection
18	DIO2	I/O	Programmable GPIO_02 on Telit HE910 module	0		1.8V	No connection
19	ADC1	Input	ADC_IN1 input on Telit HE910 module (8bit resolution, <6.6mV)	0		1.3V	No connection
20	ON_OFF	Input	Modem On/Off signal. Assert low for at least 5 seconds and then release to activate start sequence. Drive with open collector output. Internally pulled up to internal 1.8V rail with pull up. Do not use any external pull ups. **Note:** If you want modem to turn on automatically when power is applied, permanently tie this signal to GND.	0		1.8V	Must be implemented.

2.1.2.2 Connectors J3, X1, X2, X3

Connector Designator	Description	Connector Location
J3	Micro SIM Connector	Bottom Side of Module
X1	Primary Antenna Connection	Topside of Module
X2	Diversity Antenna Connection	Topside of Module
X3	GPS/GNSS Satellite Receiver	Bottom Side of Module

2.1.3 Typical Power Consumption

Measurement	Attenuation (dB)	AT+CSQ	Average Current (mA)	Peak Current (mA)	Average Charge (µAh)	Notes
Socket Dial	0	18	106.391	228.14	386.07	Tested at 3.8V Time elapsed: 12.565s Test: Opening socket, making HTTP POST, reading HTTP response, closing socket, powering off Skywire.
Socket Dial	20	10	116.74	246.35	390.753	Tested at 3.8V Time elapsed: 12.322s Test: Opening socket, making HTTP POST, reading HTTP response, closing socket, powering off Skywire.
Socket Dial	40	1	152.03	622.075	594.341	Tested at 3.8V Time elapsed: 12.507s Test: Opening socket, making HTTP POST, reading HTTP response, closing socket, powering off Skywire.
Off	0	-	2.64	3.01	660.68	Tested at 3.8V Connected to power, not turned on. 15 minute sample.
Idle - Low Power	0	-	7.91	85.795	1990.34	Tested at 3.8V 15 minute sample period. AT+CFUN=5, DTR held HIGH.
Idle	0	-	19.3	114.60	4820.16	Tested at 3.8V Registered on network, 15 minute sample period.

2.2 Mechanical Specifications

2.2.1 Mechanical Characteristics

Parameter	Typical	Unit
Dimensions (excluding pin height, for solder to board applications)	29.0 x 33.60 x 6.63	mm
Dimensions (including pin height, for board to board connector applications)	29.0 x 33.60 x 10.73	mm
Weight	x	Grams
Connector Insertion/Removal	hundreds	Cycles

2.2.2 Mating Connectors

Connector Designator	Manufacture	Populated on Module	Recommended Mate	Mate Manufacture
J1, J2	3M	951110-2530-AR-PR	950510-6102-AR	3M
			Acceptable alternate: NPPN101BFCN-RC	Sullins Connector Solutions
J3	Molex	786463001	Micro SIM Card	Micro SIM Card
X1, X2, X3	Hirose	U.FL-R-SMT(10)	CAB.011	Taoglas

2.2.3 Device Placement

⚠ **Make sure the Skywire is installed in the correct orientation; failure to do so will damage the device and void the warranty.**

2.3 Environmental Specifications

Parameter	Min	Typical	Max	Unit	Note
Operating Temperature	-40	25	+85	˚C	
Storage Temperature	-40	25	+85	˚C	
Operating Humidity	20		90	%	Non-condensing

3. Important Design Considerations

3.1 ON_OFF Signal

The ON_OFF signal on pin 20 is used to trigger the modem to turn on and to turn the modem off.

To conserve power, the onboard cellular module does not automatically startup when power is applied. The baseboard design must supply a means to assert the ON_OFF signal low for at least 5 seconds, then released to start up the modem. The ON_OFF signal should be driven with an open collector output or with an open collector transistor. The signal is internally pulled up and should not be driven high, as doing so may prevent the modem from booting.

The modem can be configured to automatically start when power is applied. This can be done by tying the ON_OFF signal to GND (either directly or through a pulldown resistor). However, doing so does run the risk of the modem attempting to boot before the input voltage to the modem is >3.20V, which could cause the modem to lock up. If lock up occurs, the nRESET pin should be asserted to force the modem to initiate a restart.

For optimal control of the cellular modem, it is recommended that the system designer control the ON_OFF signal from their host platform using an open collector output or external discrete open collector transistor.

The modem will be ready to accept AT commands 2 seconds (average) after the 5 second ON_OFF signal toggle has been released. Users may also use one of the modems GPIO pins as a power monitoring pin as described in section 4.1. The modem will be ready to accept AT commands 1 second after the power monitoring pin as gone high.

To turn the modem off via the ON_OFF signal drive the ON_OFF Signal low for at least 3 seconds when the modem is on.

3.2 Power Monitoring

Applications can monitor if the modem has powered up by configuring one of the modem's GPIO pins as an output, set to a high logic state. This output will output a 1.8V signal when the modem's internal power rail has powered up and go to 0V when the modem shuts down. To configure the modem to use one of its GPIO's as a power monitor, issue the following command:

Issue the following AT command to configure pin 17 (GPIO 3) to output a high logic signal and save the setting across reboots:

```
AT#GPIO=3,1,1,1
```

Issue the following AT command to configure pin 18 (GPIO 2) to output a high logic signal and save the setting across reboots:

```
AT#GPIO=2,1,1,1
```

3.3 Power Supply Requirements

The equipment must be supplied by an external limited power source in compliance with the clause 2.5 of the standard IEC-60950-1.

The module will regularly consume high amounts of current on the Main Power Supply (VCC), up to 2A during active transmits and receives. The baseboard power supply should be designed to support peak currents up to 2 Amps @3.80V. A 100uF capacitor should be placed near the VCC pin on the module to ensure ample energy is available, with a low inductance path to the VCC pin. For example power supply designs, there are multiple references available. See the NimbeLink Skywire Development Kit schematic for a switching regulator example.

3.4 Serial Communications

The HE910 can communicate over UART and/or USB. Design should implement one or both serial interfaces to be able to send commands to the modem.

3.5 Network Connection Status LED

The ON/nSLEEP signal on pin 13 drives the on-board LED indicating network status. By default, the 3G HSPA module has this setting disabled. Use the following commands to enable and save this feature.

First, configure the GPIO for alternate function:

```
AT#GPIO = 1,0,2
```

The modem should respond with:

```
OK
```

Next, set the desired LED behavior with this command:

```
AT#SLED=2,10,10
```

The modem should respond with:

```
OK
```

Finally, commit the changes to non-volatile memory so the setting will persist across power down/power up:

```
AT#SLEDSAV
```

The modem should respond with:

```
OK
```

See the table below for a description of the various LED behavior.

LED Status	Network Status Indication
Permanently OFF	Device OFF or setting disabled (see above)
Permanently ON	Searching for Network & Not Registered
Slow Blinking	Registered with full service
Permanently ON	Call is active (Modem has been registered)

3.6 FOTA

Cellular networks are constantly being updated, improved, and enhanced with new features. As a result, carriers are making frequent network changes. Most will not negatively affect devices connected to those networks, but occasionally an update will prevent an unprepared device from re-connecting to the network permanently.

To account for these future changes, FOTA (Firmware over the Air) capability is being added to all cellular modules by each module manufacturer, and NimbeLink supports this functionality in the Skywire family of embedded modems. However, there is often a requirement to implement support for this FOTA functionality in your device firmware.

As a developer using the Skywire modem, it is required that your device firmware plan to accommodate FOTA updates after deployment. Failure to do so may result in interruption of your device's cellular connectivity if the carriers implement a network change. If the device can no longer access the network, FOTA cannot be used to resolve the situation after the fact. The only way to restore connectivity will be physical access to the device to perform the updates directly on the device.

FOTA Instructions are available by contacting Nimbelink's product support team at the following email address: product.support@nimbelink.com

4. Mounting Guidelines

Skywire embedded cellular modems support multiple connection methods. The two primary methods are board-to-board connectors and soldering directly to the baseboard.

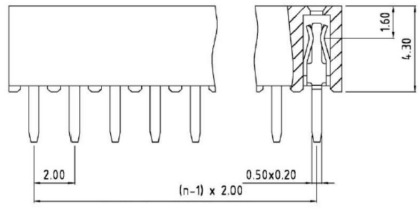
4.1 Board to Board connectors approach

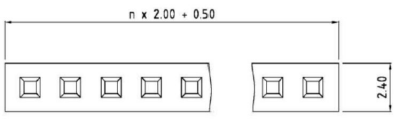
The Skywire interface calls for two 10-pin, 2mm pitch, female receptacles spaced 22 mm apart. There are many connector manufacturers that can be used. Below is one readily available product:

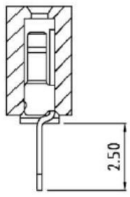
Manufacturer: Sullins Connector Solutions

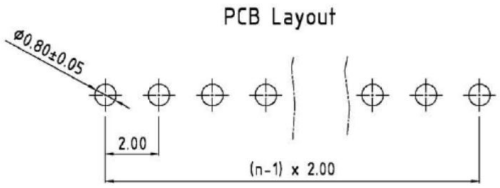
Part Number: NPPN101BFCN-RC

Typical part drawing and footprint information for the NPPN101BFCN-RC connector:



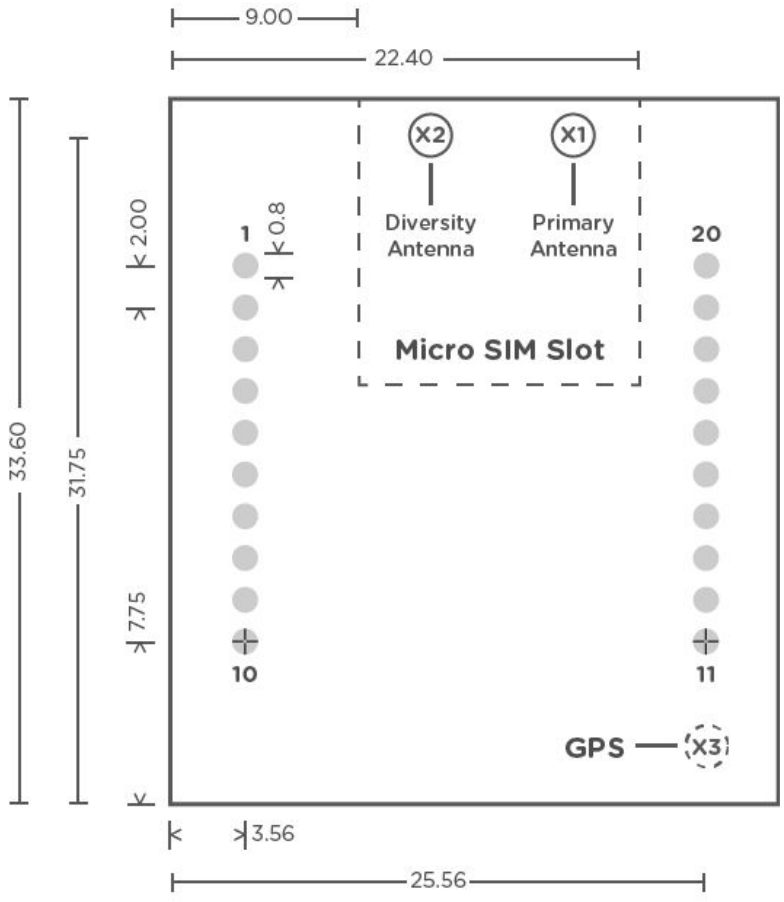






4.2 Solder to Board connection approach

Alternatively, Skywires can be soldered directly to a PCB. The PCB should be designed with two rows of ten 0.8mm plated through holes spaced 2mm apart. The two rows should be 22mm apart. See the figure below for the recommended footprint. All measurements are in millimeters. U.FL locations are marked with circles, X1 is on the top of the board, X3 is on the bottom of the board. J3 is the Micro SIM card slot on bottom side of board.



5. Antenna Considerations

5.1 Primary Antenna Requirements

These tables are copied from Telit HE910 Hardware User Guide. Designers should review latest HE910 Hardware User Guide to ensure the information is up to date.

ANTENNA REQUIREMENTS	
Frequency range	Depending by frequency band(s) provided by the network operator, the customer shall use the most suitable antenna for that/those band(s)
Bandwidth (GSM/EDGE)	70 MHz in GSM850, 80 MHz in GSM900, 170 MHz in DCS & 140 MHz PCS band
Bandwidth (WCDMA)	70 MHz in WCDMA Band V 80 MHz in WCDMA Band VIII 460 MHz in WCDMA Band IV 140 MHz in WCDMA Band II 250 MHz in WCDMA Band I
Impedance	50 ohm
Input power	> 33dBm(2 W) peak power in GSM > 24dBm Average power in WCDMA
VSWR absolute max	≤ 10:1 (limit to avoid permanent damage)
VSWR recommended	≤ 2:1 (limit to fulfil all regulatory requirements)

5.2 Diversity Antenna Requirements

These tables are copied from Telit HE910 Hardware User Guide. Designers should review latest HE910 Hardware User Guide to ensure the information is up to date.

ANTENNA REQUIREMENTS	
Frequency range	Depending by frequency band(s) provided by the network operator, the customer shall use the most suitable antenna for that/those band(s)
Bandwidth (GSM/EDGE)	70 MHz in GSM850, 80 MHz in GSM900 & 140 MHz PCS band
Bandwidth (WCDMA)	70 MHz in WCDMA Band V 80 MHz in WCDMA Band VIII 140 MHz in WCDMA Band II 250 MHz in WCDMA Band I
Impedance	50 ohm

5.3 GPS Antenna Requirements

NimbeLink recommends using active GPS antennas. The Skywire forwards the voltage supplied by the VREF pin to the GPS coax connection X3. This is to provide power to active GNSS antennas.

When using a passive antenna installed on the baseboard, users must ensure that the coax cable connection is kept as short as possible between the Skywire and the mating PCB. Excess loss in long cables will significantly reduce GPS performance. Users must also ensure that the passive antenna does not behave like a DC short to ground since the Skywire provides voltage on the coax. When using such an antenna you must

use a DC blocking capacitor. NimbeLink recommends a Samsung 56pF 0402 CL05C560FB5NNNC.

For GPS/GNSS, circularly polarized antennas are desired over linear and patch topologies because they typically have 3dB improved sensitivity.

The cellular module on the NL-SW-HSPA has an internal, built-in LNA. Because of the internal LNA, the overall gain (including signal losses past the external LNA and cable losses between the external LNA and the modem) should not exceed 14 dB. Levels higher than 14 dB will affect the ability of the modems GPS to operate. If a higher gain LNA is used, either a resistive Pi or T attenuator can be inserted after the LNA to bring the gain down to 14 dB.

GNSS Antenna Requirements	
Active GNSS Antenna Max Gain	14 dB
Antenna LNA Noise Figure	>1 dB
Impedance	50 ohms

5.4 Recommended Antennas

Type	Manufacturer	Part Number
Primary & Diversity	Taoglas[1]	TG.30.8113

Note 1: U.FL to SMA adapter required.

For applications not using the recommended antennas, developers must ensure that the selected antenna(s) meet certain requirements. In order to maintain FCC and carrier specific certifications the antennas cannot exceed the maximum gain levels listed here:

Frequency	Max Gain (dBi)
850 MHz Band	5.22 dBi
1700 MHz Band	6.45 dBi
1900 MHz Band	3.31 dBi

6. Certifications

6.1 Carrier Specific

NL-SW-HSPA: PTCRB, AT&T Rogers

Each carrier has different requirements for activating the HE910 modem on their networks. Many accept the Telit PTCRB & GCF certification to allow device on the network, however, recent carrier preferences may require the end product to go through PTCRB & GCF certification in the final enclosure, antenna, and software configuration.

6.2 Geography Specific

Federal Communications Commission (FCC47) part 22, 24

Complies with FCC47 Part 15 Class B Radiated and Conducted Emissions

7. Federal Regulatory Licensing

7.1 Export Control Classification Number (ECCN)

ECCNs are five character alpha-numeric designations used on the Commerce Control List (CCL) to identify dual-use items for export control purposes. An ECCN categorizes items based on the nature of the product, i.e. type of commodity, software, or technology and its respective technical parameters.

All Skywire Modems: 5A992.c

7.2 Harmonized Tariff Schedule Code

HTS Code: 8517.62.0010

8. End Product Labeling Requirements

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interferences, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Device Uses Approved Radio: NL-SW-HSPA
Contains FCC ID: RI7HE910 and IC ID: 5131A-HE910