Skywire 4G LTE Cat 4 EU Embedded Cellular Modem Datasheet

NimbeLink Corp

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1. Introduction

1.1 Scope

This document serves as the hardware datasheet for the NL-SW-LTE-TC4EU 4G LTE CAT4 EU Skywire® modem.

1.2 Contact Information

NimbeLink's goal is to make integrating Skywire modems into end-user applications as easy as possible. Please send any feedback, documentation requests, or technical support questions to NimbeLink's product support team at:

product.support@nimbelink.com

For purchasing information, please visit the "Part Ordering Information" section on the modem's product page. Any additional sales questions or requests for quotation can be directed to NimbeLink's sales team at:

sales@nimbelink.com

1.3 Orderable Part Numbers

Orderable Device	Operating Temperature	4G LTE Bands	Fallback
NL-SW-LTE-TC4EU	-40 to +85˚C	**LTE-FDD**: B1, B3, B7, B8, B20	**3G:** B1, B8 **2G:** GSM 900, DCS 1800

1.4 Additional Resources

- Skywire® 4G LTE Cat 4 EU Embedded Modem Product Page
- Skywire® 4G LTE Cat 4 EU AT Command Manual
- Skywire® 4G LTE Cat 4 EU Application Notes
- Skywire® 4G LTE Cat 4 EU 3D Model (STEP)
- NL-SWDK User Manual
- Skywire Hardware Design Developers Guide
- Skywire Hardware Design Checklist
- Skywire Software Developers Guide

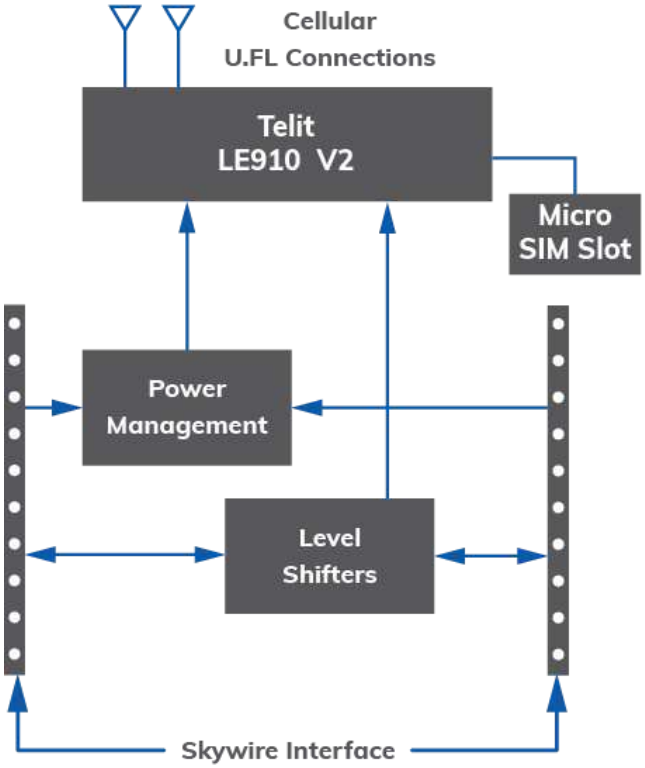
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1.5 Product Overview

If you're searching for the fastest and most reliable way to bring cellular connectivity to your IoT product in Europe, the Skywire 4G LTE CAT 4 EU modem is your best choice. The CAT 4 EU modem delivers exceptional download and upload speeds and is ideal for high-bandwidth applications. And, like all Skywire modems, the CAT 4 EU is smart, simple, and future-proof, enabling you to dramatically reduce your cellular development time and quickly realize the full value of your IoT product.

All Skywire modems are based on the same small form factor and are pin-compatible, enabling you to design your board once and deploy it globally on virtually any network type or carrier by simply swapping out the modem with the appropriate version for the desired network. So whether you want to future-proof your design, or build in carrier flexibility around the world, Skywire is a great choice. In addition, the Skywire 4G LTE CAT 4 EU modem is compatible with many NimbeLink development kits, capes, and adapters, allowing for faster development

1.6 Block Diagram



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2. Technical Specifications

2.1 Electrical Specifications

2.1.1 Absolute Maximum Ratings

Parameter	Signal	Maximum Rating
Main Power Supply	VCC	4.5V
I/O Voltage Reference	VREF	5.5V

2.1.2 Module Pinout for Connectors J1 and J2

The following table details the pinout of the NL-SW-LTE-TC4EU family of Skywire modems, and recommended ratings for the Skywire interface on connectors J1 and J2. More details and design requirements for these pins are documented in Section 3.

Pin	Name	Direction	Description		Min	Typ.	Max
1 (J1-1)	VCC	Input	Main Power supply		3.4V	3.8V	4.2V
2 (J1-2)	DOUT	Output	UART data out, I/O level tied to VREF		0V		VREF
3 (J1-3)	DIN	Input	UART data in, I/O level tied to VREF	VREF Range	VIL (max)		VIH (min)
				1.65V to 1.95V	VREF x 0.35V		VREF x 0.65
				2.3V to 2.7V	0.7V		1.7V
				3.0V to 3.6V	0.8V		2V
				4.5V to 5.5V	VREF x 0.3V		VREF x 0.7
4 (J1-4)	GND	Input	Ground Pin			0V	
5 (J1-5)	nRESET	Input	Reset signal for the LE910-V2 module		VIL: 0V to 0.35V		VIH: 1.5V to 1.9V
6 (J1-6)	VUSB	Input	USB connection detection		4.4V	5.0V	5.25V
7 (J1-7)	USB_P	I/O	USB differential data bus (+) Requires differential impedance of 90Ω.		Compliant with USB 2.0 standard specification.		

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Pin	Name	Direction	Description		Min	Typ.	Max
8 (J1-8)	USB_N	I/O	USB differential data bus (-) Requires differential impedance of 90Ω.		Compliant with USB 2.0 standard specification.		
9 (J1-9)	DTR	Input	Data terminal ready (sleep mode control), tied to internal reference voltage of 1.8V		VIL (max)		VIH (min)
					0.45V		1.35V
10 (J1-10)	GND	Input	Ground Pin			0V	
11 (J2-1)	GND	Input	Ground Pin			0V	
12 (J2-2)	CTS	Output	Modem "Clear to Send" hardware flow control input	VREF Range	VIL (max)		VIH (min)
				1.65V to 1.95V	VREF x 0.35V		VREF x 0.65
				2.3V to 2.7V	0.7V		1.7V
				3.0V to 3.6V	0.8V		2V
				4.5V to 5.5V	VREF x 0.3V		VREF x 0.7
13 (J2-3)	ON/nSLEEP	Output	Modem status pin. See Section 3.6 for further information.		0V		1.8V
14 (J2-4)	VREF	Input	Voltage reference for offboard I/O signals.		1.65V	1.8V or 3.3V	5.5V
15 (J2-5)	GND	Input	Ground Pin			0V	
16 (J2-6)	RTS	Input	Modem "Request to Send" hardware flow control input	VREF Range	VIL (max)		VIH (min)
				1.65V to 1.95V	VREF x 0.35V		VREF x 0.65
				2.3V to 2.7V	0.7V		1.7V
				3.0V to 3.6V	0.8V		2V
				4.5V to 5.5V	VREF x 0.3V		VREF x 0.7
17 (J2-7)	GPIO_3	I/O	Modem GPIO pin. 1 mA drive strength.		Pulled up to 1.8V internally		
18 (J2-8)	GPIO_2	I/O	Modem GPIO pin. 1 mA drive strength.		Pulled up to 1.8V internally		

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Pin	Name	Direction	Description	Min	Typ.	Max
19 (J2-9)	RING	Output	Modem Ring indicator pin. Open drain output, pulled up to VREF using 1M resistor on the Skywire. Pulled low when a new modem URC is available.	0V		VREF
20 (J2-10)	ON_OFF	Input	Modem On/Off signal. See Section 3.5 for additional requirements.	VIL: 0V to 0.35V		VIH: 1.5V to 1.9V

Additional information on the Skywires pinout is available in Section 3.

2.1.3 Module Pinout for Connectors J3, X1, X3

Connector Designator	Description	Connector Location
J3	Micro SIM Connector	Bottom Side of Modem
X1	Primary Cellular Antenna Connection	Top side of Modem
X2	Diversity Cellular Antenna Connection	Top side of Modem

2.1.4 Typical Power Consumption

Mode	Signal Attenuation (dB)	RSRQ (dBm)	RSRQ (dBm)	Peak Current (mA)	Average Current (mA)	Charge Consumed (mAh)	Measurement Notes
Active Socket Dial	0	-51	-8	224.276	135.278	82.794 (µAh)	**Tested at:** 3.8V **Time elapsed:** 2.202 s **Test:** Open socket, HTTP POST, read HTTP response, close socket
	20	-59	-8	233.347	135.165	83.434 (µAh)	**Tested at:** 3.8V **Time elapsed:** 2.221 s **Test:** Open socket, HTTP POST, read HTTP response, close socket
	40	-63	-8	239.473	135.891	87.122 (µAh)	**Tested at:** 3.8V **Time elapsed:** 2.305 s **Test:** Open socket, HTTP POST, read HTTP response, close socket
Idle, With an open socket	0	-51	-4	227.232	50.354	4.219	**Tested at:** 3.8V **Time elapsed:** 300 s **Test:** 300 second measurement with an open socket connection, socket is idle during the entire test.

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Mode	Signal Attenuation (dB)	RSRQ (dBm)	RSRQ (dBm)	Peak Current (mA)	Average Current (mA)	Charge Consumed (mAh)	Measurement Notes
Idle, Registered on network	0	-51	-4	146.578	39.878	3.342	**Tested at:** 3.8V **Time elapsed:** 300 s **Test:** 300 seconds idle while modem is registered on network.
Idle, Not registered on network	0	N/A	N/A	59.480	35.862	2.990	**Tested at:** 3.8V **Time elapsed:** 300 s **Test:** 300 second idle with ATκCFUN1ģ, and modem unregistered.
Off	0	N/A	N/A	218.889 (µA)	88.493 (µA)	7.373 (µAh)	**Tested at:** 3.8V **Time elapsed:** 300 s **Test:** Modem powered off with ATfiSHDN.

2.2 RF Specifications

2.2.1 TX Power

Available Cellular Technologies and Output Power	
4G LTE Technology	4G LTE CAT 4
4G LTE TX Output Power	0.2 W (Class 3)
3G Technology	WCDMA
3G TX Output Power (all bands)	0.25 W (Class 3)
2G Technology	GSM, DCS
2G GSM TX Output Power	2 W (Class 4)

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2.2.2 RX Sensitivity

Available Cellular Technologies and RX Sensitivity		
4G	LTE FDD B1	-103.0 dBm
	LTE FDD B3	-101.5 dBm
	LTE FDD B7	-101.5 dBm
	LTE FDD B8	-102.5 dBm
	LTE FDD B20	-101.5 dBm
3G	WCDMA FDD B1	-113.0 dBm
	WCDMA FDD B8	-113.0 dBm
2G	GSM 900	-112.5 dBm
	DCS1800	-111.5 dBm

2.2.3 4G LTE Uplink and Downlink Speeds

4G LTE Peak Uplink and Downlink Speeds	
Uplink	50 Mbps
Downlink	150 Mbps

2.3 Mechanical Characteristics

2.3.1 Mechanical Specifications

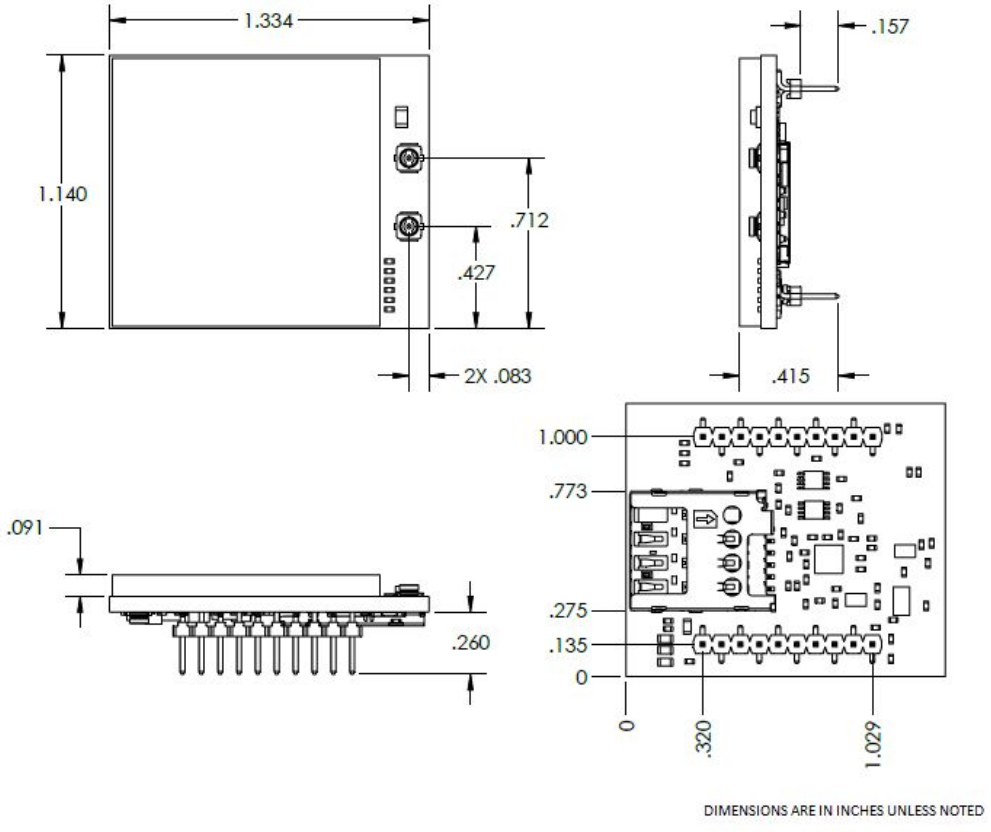
Parameter	Typical	Unit
Dimensions	29.0 x 33.8 x 10.7	mm
Weight	8	Grams
Connector Insertion/Removal	hundreds	Cycles

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2.3.2 Mating Connectors

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

2.3.3 Mechanical Drawing



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2.3.4 Device Placement

⚠ **Make sure the Skywire is installed in the correct orientation in your host board. Failure to do so will damage the device and void the warranty.**

2.3.5 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. Design Considerations

The following sections detail various design considerations that system designers should follow when designing the Skywire modem into their system. NimbeLink offers free schematic and layout design reviews for customers integrating a Skywire modem into their design. For more details please reach out to NimbeLink product support team at product.support@nimbelink.com.

3.1 Power Supply Requirements

NL-SW-LTE-TC4EU modems will regularly consume high amounts of current on their Main Power Supply input (Pin 1, VCC). For LTE and WCDMA transmits and receives, this current consumption can be up to 0.8 A. Furthermore, 2G and 3G connections will repeatedly hit 2A during transmissions.

In order to maintain compatibility with other 4G Skywire modems, the baseboard power supply should be designed to support peak currents of at least 2 Amps. A 0.1 µF and 100 µF low ESR ceramic capacitor should be placed near the VCC pin of the Skywire to ensure that a local energy supply is available, with a low inductance path to the VCC pin.

Parameter	Value
Nominal Supply Voltage	3.8V
Operating Voltage Range	3.40V to 4.20V
Extended Operating Voltage Range	3.10V to 4.50V

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NL-SW-LTE-TC4EU modems have a normal operating voltage range of 3.40V to 4.30V, with a recommended input voltage of 3.80V. The modems also support an extended operating voltage range of 3.10V to 4.50V.

However, extreme care must be taken when operating the modem outside of the standard operating voltage range. If there is a voltage drop or overshoot that exceeds the limits of the extended operating voltage range, it may cause damage to the modem and void the modem's warranty.

The extended operating voltage range should only be used with thoroughly tested power supply systems that are capable of meeting the rigorous current demands of an LTE modem without falling out of the extended operating voltage range.

3.1.1 Power Supply Design Guidelines

When designing the power supply for a Skywire modem it is recommended to adhere to the following design guidelines:

- For most applications, a switching power supply is recommended to supply power to the Skywire modem. This is because switching power supplies are able to rapidly respond to the sudden current demands of an LTE modem. To ensure compatibility with other Skywire modems, it is recommended to use a switching regulator capable of supporting up to 2A. Example designs using a switching DC/DC regulator can be found in the reference schematics below.

- To reduce EMI from the switching regulator, it is important to follow the design guidelines from the device manufacturer.

- Bypass ceramic capacitors (low ESR) with adequate capacity must be placed near the input to pin 1 (VCC) of the Skywire modem. It is recommended that the capacitor have a rated voltage of at least 2x the input voltage to the Skywire. A minimum of a 100 µF and 0.1 µF capacitor is recommended for all Skywire modems. The 0.1 µF capacitor should be placed as close as possible to pin 1 of the Skywire modem, followed by the 100 µF capacitor.

- The PCB traces from the power regulator and the bypass capacitors must be at least 80 mils to ensure that there is a low impedance power delivery circuit available to the modem. This ensures that no significant voltage drops occur. Try to keep the trace as short as possible.

- A dedicated ground plane is recommended.

- Power supply input cables should be kept away from noise sensitive lines, such antennas.

NimbeLink offers multiple reference designs in order to assist customers with their designs at no charge. Two of the designs are linked to below:

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NL-AB-BBCL Reference Schematic:
https://nimbelink.com/Documentation/Development_Kits/NL-AB-BBCL/20057s_NL-AB-BBCL_SCH.PDF

NL-SWDK Reference Schematic:

https://nimbelink.com/Documentation/Development_Kits/NL-SWDK/20002_NL-SWDK_Schematic.pdf

While prototyping with the modem, it is recommended to use a Skywire development kit, as opposed to a breadboard. Please refer to the following application note on why breadboards might cause problems and how to fix them:

Prototyping with Cellular Modems and Modules:

https://nimbelink.com/Documentation/Skywire/1001619_Breadboard_WhitePaper.pdf

3.2 Serial Communications

NL-SW-LTE-TC4EU modems have two communication paths: serial (UART) and USB. The serial UART interface is targeted for applications using lower speed 8/16/32 bit microcontrollers that do not have a USB interface or easily-available USB interface drivers. The USB interface for the modem is meant for use by higher-end systems with a native USB interface controller or operating system, like single-board computers running Linux or Windows.

For designs that are only using the serial UART interface, NimbeLink recommends that designers include test points or a non-populated USB connector footprint in their designs. This allows access to the modem's USB interface to enable easy debugging and firmware updates.

3.2.1 Serial UART Interface

All Skywire modems support a serial UART interface with transmit and receive on pins 2 (DOUT) and 3 (DIN). On NL-SW-LTE-TC4EU modems, the baud rate defaults to 115200 Baud 8N1. If a different baud rate is required, it can be changed with the **ATκIPR** command as defined in the AT command manual. The modem also supports hardware flow control (RTS/CTS) on pins 12 (CTS) and 16 (RTS).

By default, the modem does have flow control enabled. To modify the flow control setting, please see the **ATκIFC** command in the AT command manual. It is recommended that any designs using the serial UART interface connect the RTS/CTS flow control lines to the host microcontroller and enable them in their application.

3.2.2 USB Interface

NL-SW-LTE-TC4EU modems supports a USB 2.0 interface on pins 6 (VUSB), 7 (USB_P), and 8 (USB_N). Systems connecting to the modem's USB interface must observe proper design practices for connecting to a high speed USB device including, but not limited to, the following:

- The USB D± traces should be routed as a 90 ohm impedance differential pair.

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- The USB D± traces should length matched.
- USB trace lengths should be minimized.
- USB differential pairs should be carefully routed to ensure they have a continuous return path beneath the traces. Do not route differential pairs over splits in ground or power planes.
- If the USB signals will be used off-board, ESD protection should be implemented near the off-board connector.

Pin 6 (VUSB) is the pin that the modem uses to detect if a USB host controller has been connected to the modem. This pin has an internal pulldown and must have a voltage between 4.4V and 5.25V applied to it in order to activate the USB interface. The VUSB pin will draw less than 5mA when connected. VUSB must be disconnected or asserted to ground before activating Power Saving Mode.

3.3 VREF

The VREF signal (pin J2-4) drives the input voltage side of an onboard buffer which converts external I/O voltage from the VREF range to the 1.8V range in order to drive the onboard Telit LE910-V2 module. System designers should connect the reference voltage of their system to this pin. The VREF signal will draw less than 5mA when the modem is powered.

If the host system powers down the modem the system should also remove the VREF input.

3.4 nRESET Signal

In the event that the modem becomes unresponsive, pin 5 (nRESET) can be grounded to unconditionally shut down the modem. When pin 5 is grounded, the modem will cease all ongoing operations and reset itself.

Network providers request that a device gracefully detach from the network before shutting down. However, using the nRESET signal to unconditionally shutdown the modem violates this request. As such, this functionality should only be used as an emergency reset when the modem is not responding to commands.

To unconditionally shut down the modem with the nRESET signal, tie the pin low for at least 200 ms, and then release. The signal is internally pulled up to the modem's internal 1.8V rail.

If the signal is unused, it can be left floating, but it is highly recommended that the signal be connected to the host system. If the signal is used, it should be driven with an open collector output from the host system or a discrete open collector transistor.

In high noise (high EMI) environments, NimbeLink recommends that designers place a 0.01 µF - 0.1 µF capacitor on the nRESET line near the J1 connector.

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3.5 Power Control

3.5.1 ON_OFF Signal

The ON_OFF signal on pin 20 is used to trigger the modem to turn on and off. Do not power this pin nor apply a pullup resistor, as doing so may prevent the modem from booting, or may cause damage to the modem.

To conserve power, the onboard cellular module does not automatically startup when power is applied. Therefore, the baseboard design must supply a means to assert a logic-low level on the ON_OFF pin. To initiate the startup procedure, tie ON_OFF to ground for at least 5 seconds.

The ON_OFF pin can also be used to power off the modem. To power down the modem, tie the ON_OFF pin to low for at least 3 seconds.

Do not permanently tie the ON_OFF signal to ground. Doing so will cause the modem to continually power on and power off, which will render the modem inoperable, and may cause permanent damage.

For optimal control of the cellular modem, it is recommended that the host platform use an open collector output or external discrete open collector transistor to drive the ON_OFF signal of the Skywire.

3.5.2 Shutdown

The modem should be shut down in a controlled manner, so as to gracefully disconnect it from the network. Failure to do so violates carrier requirements. In rare events, failure to properly shut down the modem could render the modem inoperable due to firmware corruption.

In order to gracefully shut down the modem, there are two preferred methods. The first is to tie the ON_OFF signal low for 3 seconds, as mentioned in Section 3.5.1.

The other option power down the modem is to issue the **`AT+SHDN`** command to modem using the modem's AT interface. When shutting down the modem via AT command the ON_OFF signal must not be grounded.

Both of these options will force the modem to issue a detach request to the network, which informs the network that the device will be unreachable for an indefinite time. After issuing this request, the modem will power down.

For an ideal shutdown, it is also recommended to the remove VCC from the Skywire after it has powered down. This can be accomplished by disconnecting the power supply from the VCC pin, for instance. It is also recommended to remove the VREF signal from the Skywire when disconnecting VCC. Finally, ensure that the modem is not being back-powered by any of its I/O lines.

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3.6 Network Status Monitoring

NL-SW-LTE-TC4EU Skywires feature an optional status LED that is connected to the ON/nSLEEP signal (pin J2-3). This signal is used to drive a status LED, and is enabled by default. However if the status LED is off, issue these commands to turn it on:

```
ATfiGPIOł0dfldg0
ATfiSLEDł1
```

These AT commands will enable the ON/nSLEEP signal to drive the status LED with the behavior listed in the table below:

Device Status	LED Behavior
Device Off	Permanently Off
Idle, Not Registered	Permanently On
Registered in Idle, with Power Saving	Fast Blinking (blinking period depends on network status)
Registered in Idle with Full Network Service	Slow Blinking (3 second period, T_{ON} = 1s)

After the status LED has been enabled, it can be shut off if desired. To do so, issue the following command:

```
ATfiGPIOł0d0d0
```

Note: The blinking pattern of the status LED can be changed using the **ATfiSLED** command (see the AT command manual for details). To save a modified LED behavior state, issue the following command:

```
ATfiSLEDSAV
```

3.7 Firmware Updates Over the Air (FOTA)

LTE 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 reconnecting to the network permanently.

To account for these future changes, FOTA (Firmware over the Air) capability is being added to cellular modules by each manufacturer. Accordingly, NimbeLink supports this functionality in the entire Skywire family of embedded modems. As such, it is highly recommended that designers implement provisions to accommodate for FOTA processes.

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Failure to accommodate FOTA processes may result in interruptions in cellular connectivity in the event of network changes. If a device can no longer access the network, FOTA cannot be used to remedy the problem. The only way to recover functionality is to physically update the device firmware.

FOTA instructions are available by contacting NimbeLink's product support team at product.support@nimbelink.com.

3.8 Cellular Antenna Requirements

The NL-SW-LTE-TC4EU Skywire modem supports a primary cellular antenna connection, and a diversity antenna connection. These connectors are U.FL connectors, and are labeled as X1 and X2, respectively.

The modem's primary antenna interface, X1, supports both TX and RX communication. The diversity antenna interface is an input for a second Rx antenna to improve radio sensitivity. According to carrier requirements, both the primary and the diversity antenna must be implemented.

Note: Many antennas require the use of a U.FL to SMA cable, such as the Taoglas CAB.011.

3.8.1 Primary Antenna Output Power

Primary Antenna Output Power	
Band	**Power Class**
LTE All Bands	Class 3 (0.2W)
WCDMA All Bands	Class 3 (0.25W)
GSM 900	Class 4 (2W)
DCS	Class 1 (1W)

3.8.2 Primary Antenna Requirements

Depending on the frequency band(s) provided by the network operator, the customer shall use the most suitable antenna for that/those band(s):

Available Cellular Technologies and Required Primary Antenna Bandwidth		
4G	LTE FDD B1	250 MHz
	LTE FDD B3	170 MHz
	LTE FDD B7	190 MHz
	LTE FDD B8	80 MHz
	LTE FDD B20	71 MHz
3G	WCDMA FDD B1	250 MHz

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	WCDMA FDD B8	80 MHz
2G	GSM 900	80 MHz
	DCS 1800	170 MHz

Note: Any antennas used with the modem will need to comply with the Wireless Notice detailed in Section 5.7.

In addition to the bandwidth requirements above, the chosen antenna must conform to the specifications below:

Relevant Primary Antenna Specifications	
Impedance	50 Ω
Input Power	≥ 24 dBm Average Power
VSWR Absolute Max[1]	≤ 10:1(limit to avoid permanent damage)
VSWR Recommended[2]	≤ 2:1(limit to fulfill all regulatory requirements)

1. Limit to avoid permanent damage
2. Limit to fulfill all regulatory requirements

3.8.3 Diversity Antenna Requirements

Depending on the frequency band(s) provided by the network operator, the customer shall use the most suitable antenna for that/those band(s):

Available Cellular Technologies and Required Diversity Antenna Bandwidth		
4G	LTE FDD B1	60 MHz
	LTE FDD B3	75 MHz
	LTE FDD B7	70 MHz
	LTE FDD B8	35 MHz
	LTE FDD B20	30 MHz
3G	WCDMA FDD B1	60 MHz
	WCDMA FDD B8	35 MHz
2G	GSM 900	35 MHz
	DCS 1800	75 MHz

Note: Any antennas used with the modem will need to comply with the Wireless Notice detailed in Section 5.7.

In addition to the bandwidth requirements above, the chosen antenna must conform to the specifications below:

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Relevant Diversity Antenna Specifications	
Impedance	50 Ω
VSWR Recommended[1]	≤ 2:1

1. Limit to obtain maximum sensitivity

3.8.4 Antenna Placement

The modem's cellular antenna placement will directly affect the modem's performance. It is vital that system designers carefully consider the placement of the antenna and follow all of the guidelines and specifications set by the antenna manufacturer. The following guidelines are general recommendations for antenna installation:

- The antenna must have an impedance of 50 ohms.
- Keep the antenna cable as short as possible.
- The antenna must not be installed inside a metal enclosure, nor near metal objects unless specified by the antenna manufacturer.
- The antenna must be installed according to the manufacturer's instructions.
- Antenna gain must not exceed the values indicated in the regulatory requirements in Section 5.7.
- Antenna integration should optimize antenna efficiency. Antennas are recommended to have >50% efficiency on all frequency bands.
- Antenna should not be mounted near noisy EM devices.

3.8.5 Recommended Antennas

Type	Manufacturer	Part Number
Internal Cellular Antenna	Taoglas	FXUB65.07.0180C
External Cellular Antenna [1]	Taoglas	TG.30.8113

Note 1: U.FL to SMA adapter required.

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3.9 Skywire Reference Design

NimbeLink offers free reference schematic and layout files as examples of how to integrate Skywire modems into various systems. Schematics, design files, gerber files, and tutorials for a variety of different systems can be found on the Skywire Development Kits webpage: https://nimbelink.com/development-kits/

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.

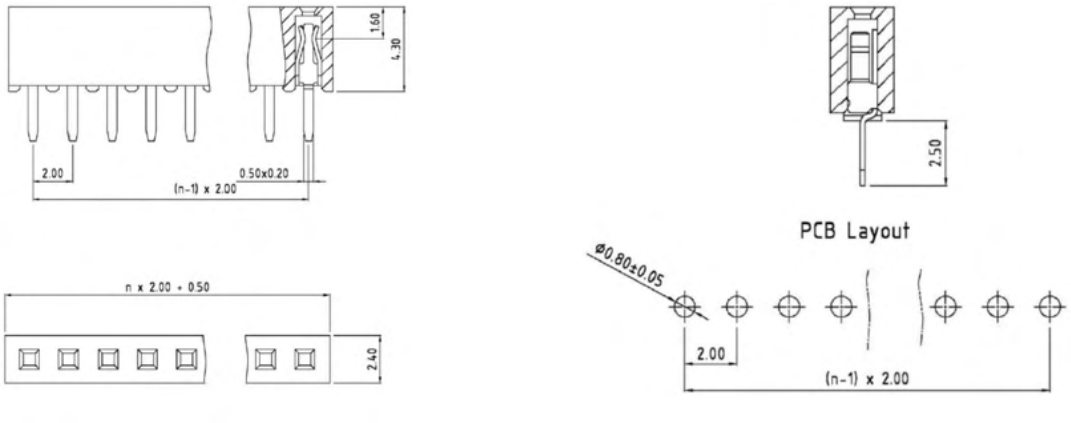
4.1 Board-to-Board Connectors Approach

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:



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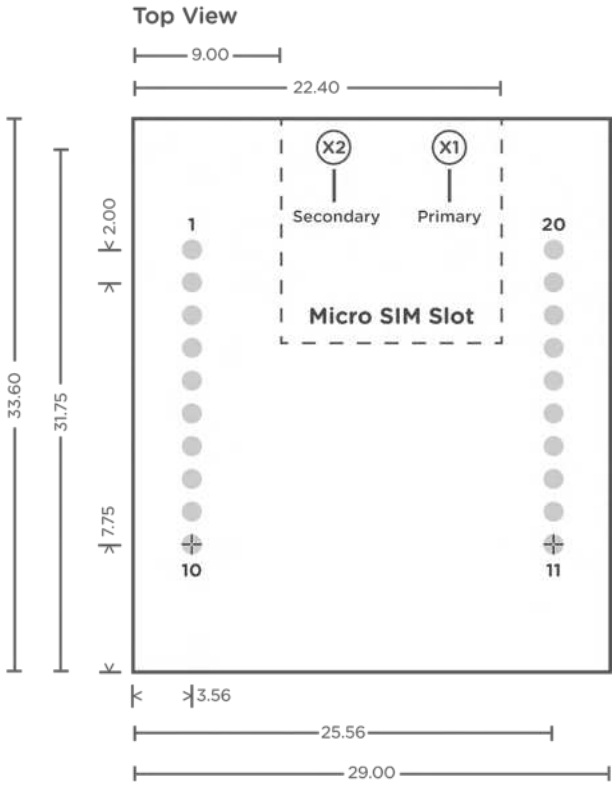
4.1.1 Mechanical Retention

Certain applications where the modem is mounted on the host board using the connector approach detailed in Section 4.1 may need to mechanically secure the Skywire modem and its SIM card in order to prevent the modem from vibrating out of the mating connectors. Skywire modems do not have any dedicated attachment points for securing to the host board, however it can easily be secured by one of the following methods:

- Zip ties
- Foam tape mounted on the Skywire to press against the enclosure
- Mechanical retention of the modem and SIM by the enclosure (example below)
    - https://nimbelink.com/Documentation/Skywire/1001460_Mechanical_Retention_Enclosure.pdf
- Solder the Skywire to the host board (as described in Section 4.2)

4.2 Solder to Board Connection

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 and X2 are on the top of the board. J3 is the Micro SIM card slot on bottom side of board.



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5. Regulatory Information

5.1 Carrier Specific Certifications

NL-SW-LTE-TC4EU: GCF, RED

5.2 Export Control Classification Number (ECCN)

ECCNs are five character alphanumeric 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.

ECCN for All Skywire Modems: 5A992.c

5.3 Harmonized Tariff Schedule Code

HTS Code: 8517.62.0010

5.4 RoHS Compliance

NL-SW-LTE-TC4EU modems comply with the RoHS (Restriction of Hazardous Substances) directive of the European Union, EU Directive 2011/65/EU.

5.5 CE Compliance

NL-SW-LTE-TC4EU Skywire modems have been tested and proved to be in compliance with all applicable Radio Equipment Directive (RED) requirements, including:

- EN301511
- EN301908-1, EN301908-13
- EN301489-1, EN301489-52
- EN55032
- EN55035
- EN62311
- EN62368-1

The modems EU Declaration of Conformity can be found here: https://nimbelink.com/Documentation/Skywire/4G_LTE_Cat_4_Telit/1002072_Rev_A_CE-RED_DoC_NL-SW-LTE-TC4EU.pdf

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5.6 Wireless Notice

5.6.1 NL-SW-LTE-TC4EU Skywire Modems

In order to maintain CE radiation exposure limits set forth for an uncontrolled environment alongside carrier specific certifications, associated antennas cannot exceed the maximum output power levels listed in the table below:

Network Type and Frequency Bands	Maximum Allowable Output Power
4G LTE FDD 1 / 3 / 7 / 8 / 20	24 dBm
3G WCDMA FDD 1 / 8	24.5 dBm
2G GSM 900	33.5 dBm
2G DCS 1800	30.5 dBm

5.7 Modification Statement

NimbeLink has not approved any changes or modifications to this device by the user. Any changes or modifications could void the user's authorization to operate the equipment.

5.8 End Product Labeling Requirements

5.8.1 Products Containing NL-SW-LTE-TC4EU Skywire Modems

All end products containing NL-SW-LTE-TC4EU Skywire modems must be labeled with the CE logo in order to be sold in European markets. For more information, please refer to the link below:

https://ec.europa.eu/growth/single-market/ce-marking_en

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