

Skywire[®] Nano Development Kit

User Manual

NimbeLink Corp

Updated: December 2020



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1. Introduction

1.1 Scope

This document serves as the user manual for the Skywire Nano Development Kit.

1.2 Orderable Devices

Orderable Device	Description	Carrier
NL-SWNDK	Skywire Nano Development Kit	Any
NL-SWN-LTE-NRF9160	Skywire Nano, Global, CAT M1, NBloT, GPS	Any

1.3 Product Overview

The NL-SWNDK is a development kit made for use specifically with the Skywire Nano embedded cellular modem that enables easy development and integration of the Skywire® Nano into a custom design.

The NL-SWNDK offers the following critical features and functionality:

- One micro-USB connector, J2, that provides 5V, 500mA power to the board, and enables easy communication between the host PC and the modem.
- Two SMA to U.FL connectors for cellular and GPS antennas
- Two 20-pin headers for connection to modem's GPIO pins, and other signals.
- 3FF SIM slot that adds support for various other SIM cards and cellular carriers.

For more information regarding the development kit, please refer to the NL-SWNDK datasheet and design files:

Datasheet: *Coming Soon*

Design Files:

https://nimbelink.com/Documentation/Development_Kits/NL-SWNDK/1002333_REVB_NL-SWNDK_Design_Files.zip

1.4 Important Note on the included SIM cards



The NL-SWNDK development kit includes two SIM card identities, a physical AT&T 3FF SIM card, and Verizon MFF2 SIM chip which is soldered on the modem assembly.

The NL-SWN-LTE-NRF9160 modem is certified for use on Verizon network and carriers that honor PTCRB certifications.

If you wish to use the Verizon cellular network, the soldered SIM chip can be activated. If you wish to use a different carrier network, a physical SIM card can be inserted into the

3FF SIM card connector slot on the development kit baseboard.

At this time, the AT&T SIM card provided in the kit should not be used. The Nordic Semiconductor nRF9160 cellular module SiP (System in Package) has not completed AT&T's network certification. When the SiP and modem complete the AT&T certification, this document will be updated to include additional instructions for how to use the provided AT&T SIM card.

All questions can be sent to: product.support@nimbelink.com

2. Connect to the Development Kit

2.1 Unpack the Kit

The Skywire® Nano Development Kit includes an NL-SWN-LTE-NRF9160 Skywire Nano modem with soldered-down Verizon LTE-M SIM, mounting screws and tool, NL-SWNDK Development Kit baseboard, micro-USB cable, cellular antenna, and an AT&T SIM card.

The picture below shows the contents of the development kit when unboxed:



2.2 Connecting the Modem to the Development Kit

For convenience, the NL-SWNDK ships pre-assembled with the modem already mated to the baseboard, and with the U.FL antenna connectors attached to the modem.

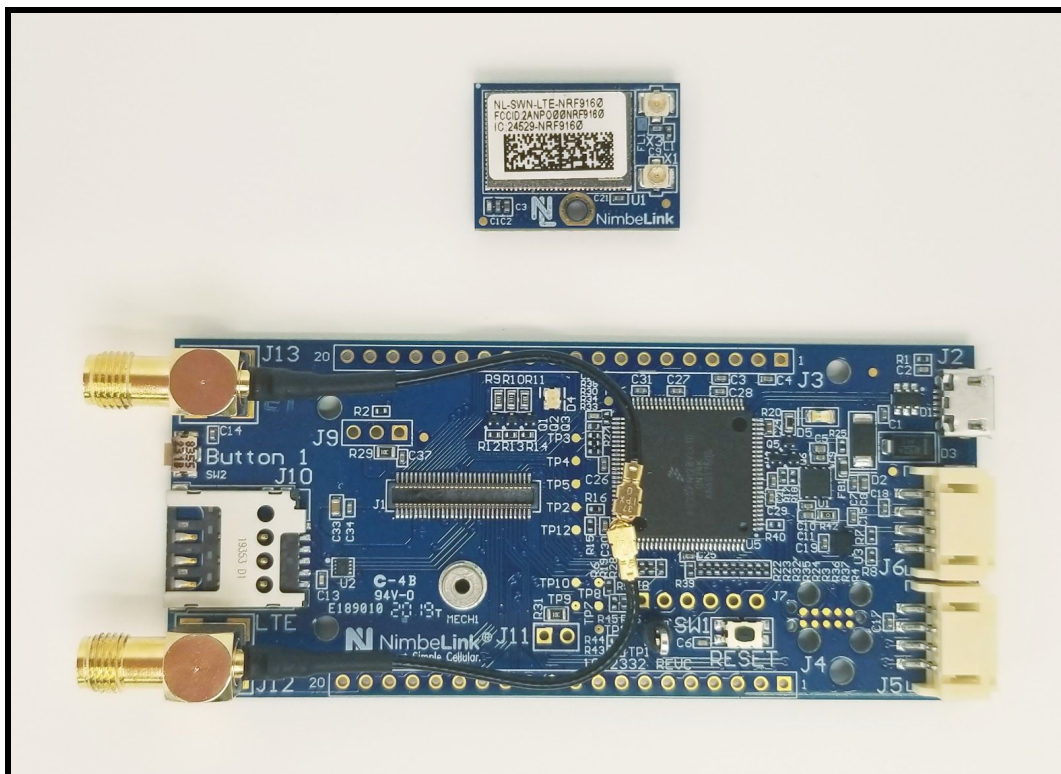
However, the instructions below explain how to install the modem into the baseboard:

1. Gather the following material that come with the kit:
 - a. Skywire Nano Development Kit PCB
 - b. Skywire Nano Cellular Modem
 - c. Mounting Screw(s)
 - d. Hex Key Tool

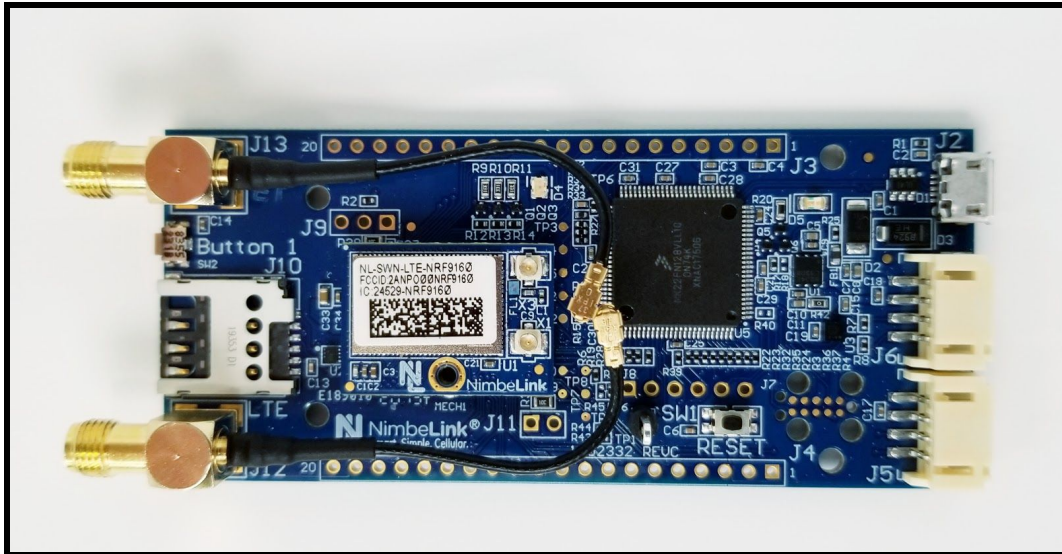
It is also strongly recommended to use a U.FL removal tool in order to prevent damage to the modem's U.FL connectors when unmating the connectors. The following part is a suitable tool for this purpose:

Hirose P/N: [U.FL-LP\(V\)-N-2](#)

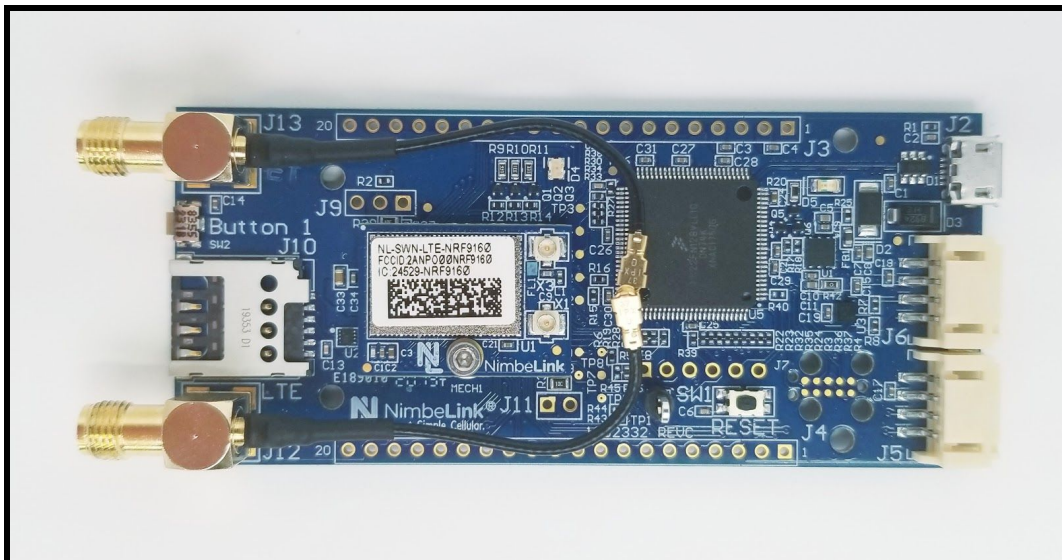
2. Before connecting, ensure that the Skywire Nano is properly oriented with respect to the baseboard. See the image below for reference:



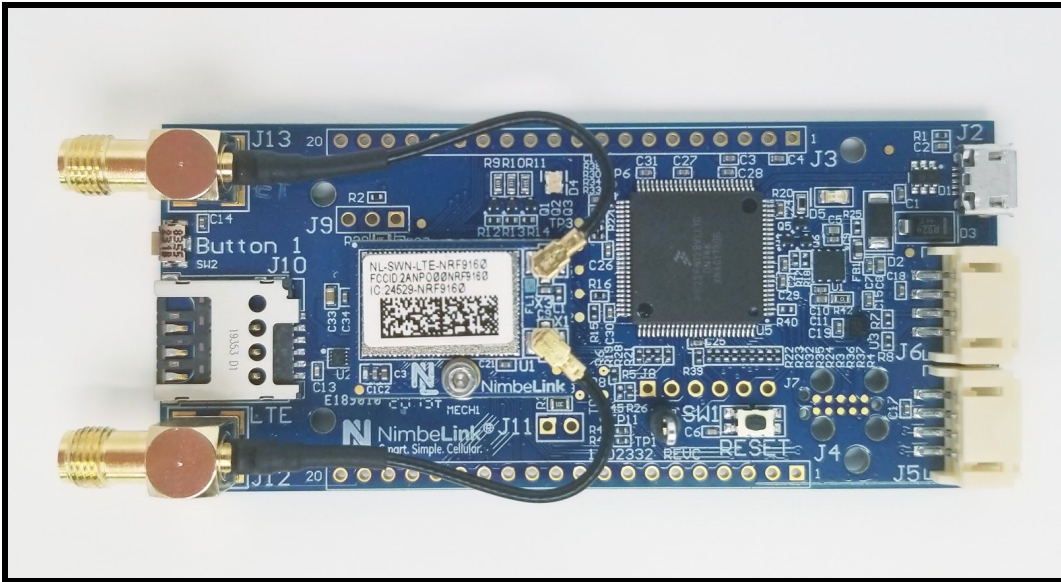
3. Install the Skywire Nano onto the Skywire Nano interface.
 - a. Ensure that the modem is properly lined up with the 60-pin connector and the steel spacer on the baseboard before applying any force.
 - b. Once the modem is oriented properly, press down gently on the top of the modem, perpendicular to the surface of the modem.



4. Using the provided hex key tool, insert a mounting screw into the screw hole on the modem and baseboard. Gently tighten the screw until it meets resistance.



5. Attach the female U.FL connectors on the baseboard to the male U.FL connectors on the modem.
 - a. Connector J12 on the baseboard should be mated with the LTE antenna connector, X1, on the modem.
 - b. Connector J13 on the baseboard should be mated with the GPS antenna connector, X3, on the modem.



6. Attach the provided LTE Antenna to connector J12 on the development kit.
 - a. The antenna should be positioned such that it is sticking straight up, perpendicular to the development kit in order to ensure the best possible signal quality.



7. If desired, attach a compatible GPS antenna to connector J13 on the development kit.

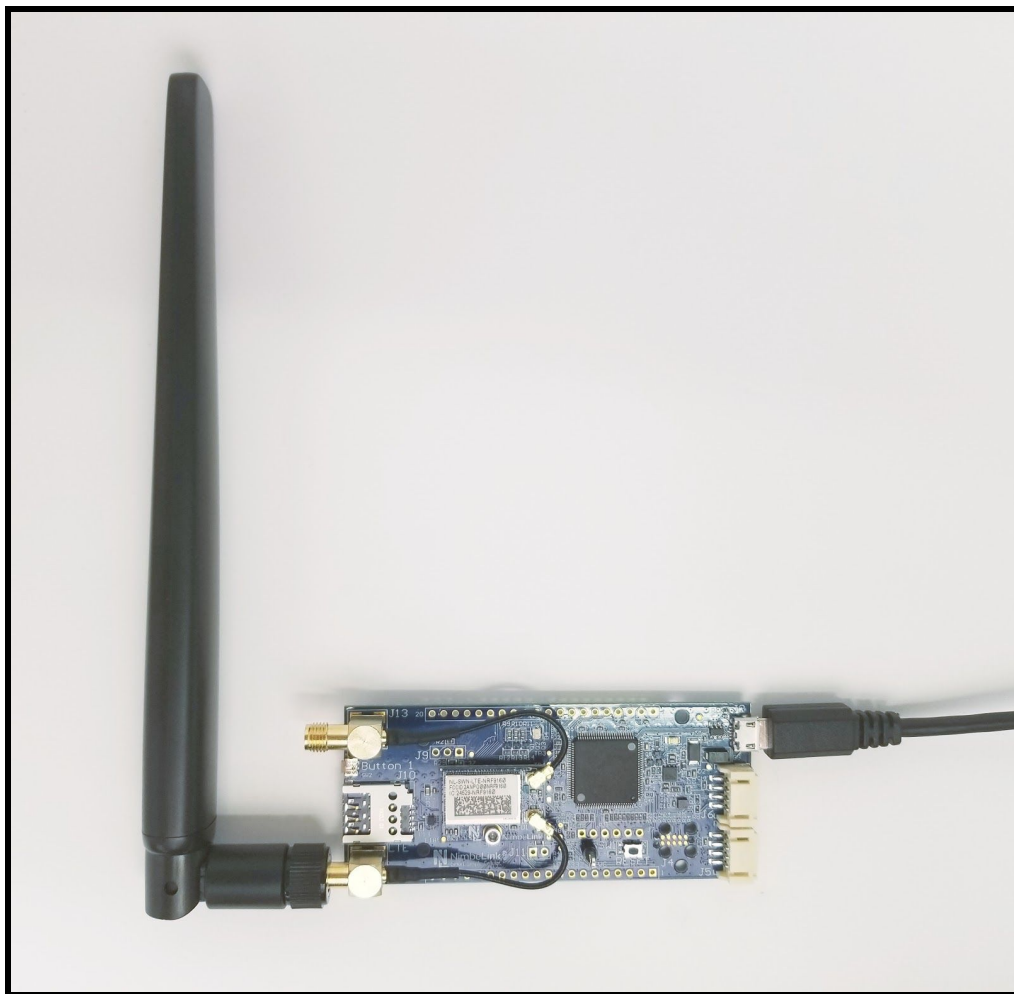


Do not attach a passive antenna (such as a cellular antenna) to the modem's GPS connector X3. Doing so may cause irreparable damage to the modem's GPS interface.

The Skywire Nano datasheet has a list of recommended active GPS antennas that are compatible with the modem. See Section 4.13.4 at the link below for more details:

https://nimbelink.com/Documentation/Skywire/Nano/4G_LTE_Cat_M1_Nordic/1002347_NL-SWN-LTE-NRF9160_Datasheet.pdf

8. Attach the provided USB cable to connector J2 on the development kit, and the other end to the host PC. This will cause the modem to power on and enumerate on the host PC.



3. Communicating with the Skywire Nano

3.1 Install a Terminal Emulator Program

In order to communicate with the modem, a terminal emulator program such as Tera Term, PuTTY, or an equivalent must be used.

If the user does not have a preferred terminal emulator program, please refer to the following recommendations:

Windows Users:

- Download Tera Term at the following link:
 - <https://ttssh2.osdn.jp/index.html.en>

Linux Users:

- Download PuTTY with the following terminal command:
 - **[sudo] apt install putty**

3.2 Default Serial Port Settings

The Skywire Nano requires the following default serial port settings:

Parameter	Value
Default Baud Rate	115200 bps
Data Bits	8
Parity Bit	N
Stop Bit(s)	1

When setting up the connection to the modem in the chosen terminal emulator program, make sure that everything is configured to match the default settings.

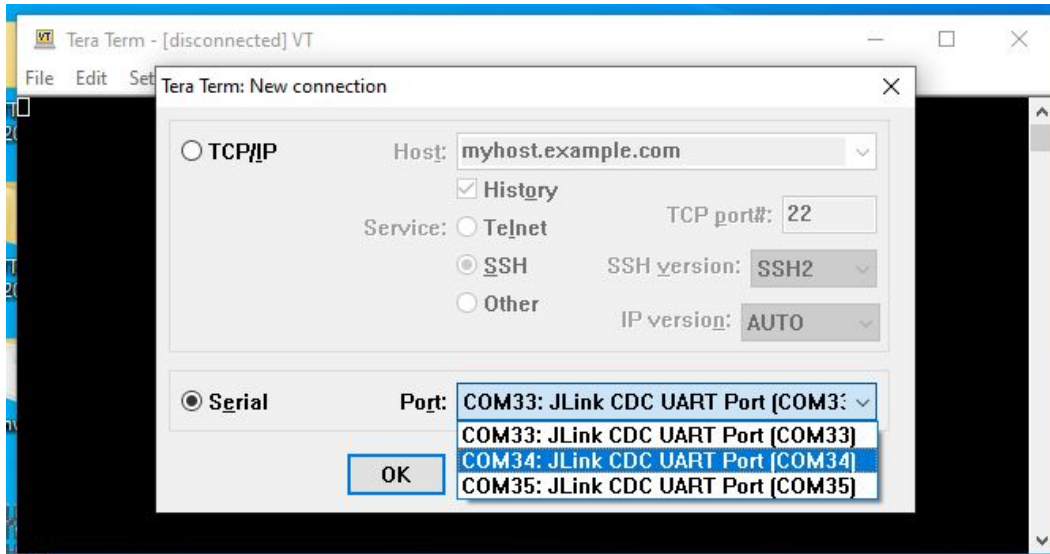
3.3 Modem Enumeration on the Host PC

When the NL-SWNDK is connected via the USB cable, it will enumerate differently depending on the OS of the host PC. Instructions for Linux and Windows users are found on the next two pages.

Windows Users:

The NL-SWNDK will enumerate on a Windows host PC as three COM ports. These COM ports will be named something like "JLink CDC UART Port".

The image below depicts the enumeration for the NL-SWNDK on a Windows 10 PC, as seen in the Tera Term "New Connection" menu:



The Segger J-Link drivers for the development kit should automatically install when the development kit is plugged into the test PC.

If this is not the case, please refer to the following link. Download and install the J-Link Software and Documentation Pack:

<https://www.segger.com/downloads/jlink/#J-LinkSoftwareAndDocumentationPack>

The COM port that is connected to the modem's AT command parser serial port (UART1) may vary from PC to PC. Using Tera Term, test out each COM port until the AT interface is found.

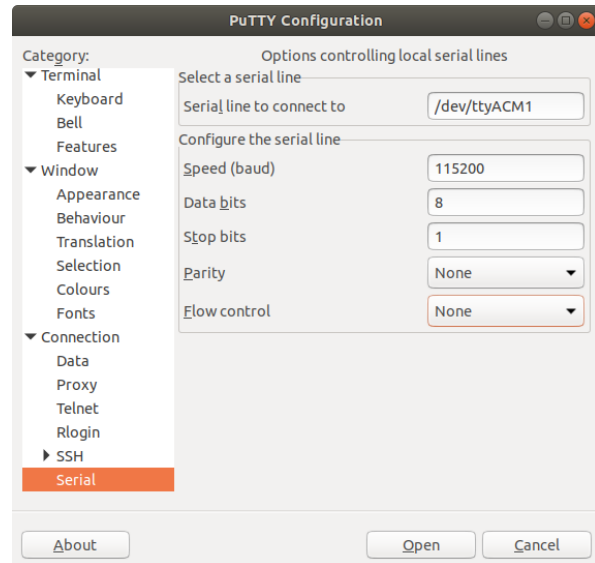
Linux Users:

The NL-SWNDK will enumerate on a Linux PC as three ACM devices. The AT parser for the modem should be connected to `/dev/ttyACM1`, but this may vary from system to system.

The serial port settings in PuTTY may need to be adjusted before connecting the modem. These can be accessed in Tera Term by going to *Setup -> Serial Port*. The settings can be updated in Putty by navigating to *Connection -> Serial*.

The serial settings should be as follows:

Baud Rate:	115200 bps
Data:	8bit
Parity:	none
Stop:	1bit
Flow Control:	none



3.4 Test Serial Communication

In the terminal program, type the command:

AT

followed by the Enter key, and the terminal should respond with:

OK

Note: The modem will output "**ERROR**" when a command is entered incorrectly. To enable verbose error mode to see what error is occurring issue **AT+CMEE=2** to the modem.

3.5 Disable Cellular Functionality



As soon as power is applied to the NL-SWNDK, the Skywire Nano will boot up, and attempt to connect to the cellular network using the on-board soldered-down SIM by default.

Since the soldered-down SIM is not currently activated, the modem should be unable to connect to the network. This will trigger the automatic backoff sequence on the modem, which delays the next network connection for a certain amount of time as per GSMA standards.

After the backoff timer expires, the modem will attempt to connect to the network once more. If the connection fails again, the timer is reset for a longer period of time, and the process continues.

To prevent subsequent failed connections while the modem's soldered-down SIM is inactive, the modem's cellular functionality should be disabled temporarily. Type the following command:

AT+CFUN=4

followed by the Enter key, and the modem should respond with:

OK

3.6 Set the Desired SIM Interface

By default, the modem uses the soldered-down SIM card. However, users can swap between the soldered-down SIM card, and the external SIM interface on the NL-SWNDK using the AT#SIMSELECT command.

Note: The #SIMSELECT setting is saved by the modem, and will persist across reboots.

To use the external SIM card connector with a compatible SIM card of your choice, type the command:

AT#SIMSELECT=1

followed by the Enter key, and the terminal should respond with:

OK

To use the onboard solder-down SIM chip, type the command:

AT#SIMSELECT=0

followed by the Enter key, and the terminal should respond with:

OK

To query which SIM interface is being used, issue the command:

AT#SIMSELECT?

followed by the Enter key, and the terminal should respond with:

#SIMSELECT: x

OK

where **x** is either **0** or **1**. **0** means the onboard soldered-down SIM is selected, and **1** means the external SIM connector is selected.

3.7 Activate Modem (One-Time Step)



If you are using a new Skywire Nano cellular modem, it does not have an active cellular plan.

To activate the modem's soldered-down Verizon SIM, visit <https://go.nimbelink.com>, create an account, and activate the SIM with a cellular data plan.

Alternatively, a SIM from a cellular carrier that honors PTCRB certifications can also be used.

The AT&T SIM card that is included with the development kit must not be used, as per the guidance in [Section 1.4](#).

To activate a new plan for the modem's soldered-down SIM, the International Mobile Equipment Identity (IMEI) of the modem and the Integrated Circuit Card Identifier (ICCID) of the SIM must be recorded.

First, select the soldered-down SIM interface as outlined in [Section 3.6](#). Enable cellular functionality by issuing:

AT+CFUN=1

followed by the Enter key, and the modem will reply with:

OK

Query the ICCID of this SIM with the following command:

AT#ICCID?

followed by the Enter key, and the modem will reply with:

#ICCID: <ICCID>

OK

where **<ICCID>** is the ICCID of the soldered-down SIM.

Next, query the IMEI of the modem with the following command:

AT+CGSN

followed by the Enter key, and the modem will reply with:

<IMEI>

OK

where **<IMEI>** is the IMEI of the modem.

Use these two values to activate the Skywire Nano on <https://go.nimbelink.com> or directly with your desired cellular carrier partner.

Once you have the IMEI and ICCID, turn off cellular functionality to continue setting up the modem by issuing:

AT+CFUN=4

followed by the Enter key, and the modem will reply with:

OK

3.8 Configure the PDP Context

Before the modem can successfully register on the cellular network, a Packet Data Protocol (PDP) context may need to be configured on the modem.

The PDP context is used to set up the connection between the modem and the network, including specifying the Access Point Name (APN) that the modem should use for the connection.

Verizon Users:

Mobile equipment using Verizon's LTE network will have their APN's automatically pushed to them during the network registration process. Therefore, setting up a PDP context is not usually required.

Verizon users should skip the setting of the PDP context, and attempt to connect without setting one. If for some reason the modem cannot connect with the automatic APN push, refer to the AT+CGDCONT command below for PDP context configuration.

Non-Verizon Users:

Networks other than Verizon typically require that a PDP context be configured before attempting to register on the network.

In the terminal program, type the command:

```
AT+CGDCONT=0,"IPV4V6","APN"
```

where **APN** is the individual APN for the chosen network. To find the network's APN please see [Section 4.2](#).

Press the Enter key, and the terminal program should respond with:

```
OK
```

To verify that the APN was set correctly, in the terminal program type the command:

```
AT+CGDCONT?
```

followed by the Enter key, and the terminal should respond with:

```
+CGDCONT: 0,"IPV4V6","APN"
```

```
OK
```

[Section 5.1](#) contains further information regarding APN's, and some common APN's that users may encounter.

3.9 Enable Cellular Functionality

After the chosen SIM card has been activated, and the PDP context is configured (if applicable) the modem is ready to connect to the network.

To instruct the modem to enable its cellular radio and attempt to connect to the network, send the following command:

```
AT+CFUN=1
```

followed by the Enter key, and the modem should respond with:

```
OK
```

3.10 Verify the Network Registration Status

To test whether the modem has registered on the network, the AT+CEREG command can be used. To query the current registration status, send the following command:

```
AT+CEREG?
```

followed by the Enter key, and the modem should respond with:

+CEREG: 0,<n>

OK

Where <n> is replaced with the current network registration status.

If the modem is registered on the network, the response to the AT+CEREG? command should be:

+CEREG: 0,1

OK

If the modem is still searching for the network, the response to the AT+CEREG? command should be:

+CEREG: 0,2

OK

If the modem's registration was denied, the response to the AT+CEREG? command should be:

+CEREG: 0,3

OK

A "registration denied" status is a good indication that the PDP context was set incorrectly, or that the SIM is not active. Verify that the APN was set correctly (if applicable), and that the SIM is indeed activated with your cellular carrier.

If the modem's registration status is unknown or indeterminable, the response to the AT+CEREG? command should be:

+CEREG: 0,4

OK

This status is a good indication that the signal quality conditions are too low, and the modem is unable to connect.

Verify that the J12 antenna connector is properly seated in the modem's X1 connector, and ensure that the testing area has acceptable signal quality. Moving closer to a window, or outdoors can help to improve LTE signal quality.

[Section 3.11](#) also has information on the signal quality AT command that can help to identify low signal quality problems.

If the modem is registered and roaming, the response to the AT+CEREG? command should be:

+CEREG: 0,5

OK

Please refer to the Skywire Nano AT Command Manual for more information regarding the AT+CEREG command and all others:

https://nimbelink.com/Documentation/Skywire/Nano/4G_LTE_Cat_M1_Nordic/1002399_NL-SWN-LTE-NRF9160_AT-Command-Manual.pdf

3.11 Test Signal Strength

To check the signal strength on any LTE modem the user should refer to the RSRP (Reference Signal Received Power) & RSRQ (Reference Signal Received Quality) values reported by the modem.

These signal measurements will accurately reflect the quality of the cellular link for LTE modems. Typical values are as follows:

Values of <rsrq>	RSRQ (Reference Signal Received Quality)
0	RSRQ < -19.5 dB
1	-19.5 dB ≤ RSRQ < -19 dB
2	-19 dB ≤ RSRQ < -18.5 dB
...	...
32	-4 dB ≤ RSRQ < -3.5 dB
33	-3.5 dB ≤ RSRQ < -3 dB
34	-3 dB ≤ RSRQ
255	Not known or detectable

Values of <rsrp>	RSRP (Reference Signal Received Power)
0	RSRP < -140 dBm
1	-140 dBm ≤ RSRP < -139 dBm
2	-139 dBm ≤ RSRP < -138 dBm
...	

95	$-46 \text{ dBm} \leq \text{RSRP} < -45 \text{ dBm}$
96	$-45 \text{ dBm} \leq \text{RSRP} < -44$
97	$-44 \text{ dBm} \leq \text{RSRP}$
255	Not known or not detectable

The table below contains estimated signal qualities base on the values in the previous tables:

<rsrq>	RSRQ	<rsrp>	RSRP	Quality
0	RSRQ < -19.5 dB	0 - 40	RSRP < -100 dBm	Marginal
1 - 9	-19.5 dB ≤ RSRQ < -15 dB	41 - 50	-100 dBm ≤ RSRP < -90 dBm	Fair
10 - 19	-15 dB ≤ RSRQ < -10 dB	51 - 59	-90 dBm ≤ RSRP < -80 dBm	Good
20 - 34	≥ -10 dB	60 - 97	≥ -80 dBm	Excellent

To query the current signal strength seen by the modem, type this command:

AT+CESQ

followed by the Enter key, and the terminal should respond with:

+CESQ: <rxlev>,<ber>,<rscp>,<ecno>,<rsrq>,<rsrp>

Where **<rsrq>,<rsrp>** are the RSRP/RSRQ values as defined by the modems AT command manual.

4. Common Next Steps

Once the network setup and testing is complete, the Skywire Nano is ready for development. Common application examples include sending and receiving TCP/UDP packets, SMS messages, and using the modem with an external microcontroller.

NL-SWNDK Product Page:

- <https://nimbelink.com/products/skywire-nano-dev-kit-swndk/>

NL-SWN-NRF9160 Product Page:

- <https://nimbelink.com/products/4g-lte-m-global-nano/>

Skywire Nano Application Notes:

- Sending and Receiving data with Socket Dials:
 - Learn how to use TCP/IP sockets to send and receive data.
 - https://nimbelink.com/Documentation/Skywire/Nano/4G_LTE_Cat_M1_Nordic/1002400_NL-SW-LTE-NRF9160_SocketDialAppNote.pdf
- Firmware Over The Air (FOTA) Update Procedure
 - Learn how to perform a Firmware Over the Air update on the modem.
 - https://nimbelink.com/Documentation/Skywire/Nano/4G_LTE_Cat_M1_Nordic/1002401_NL-SW-LTE-NRF9160_FOTA-Guide.pdf
- NL-SWN-LTE-NRF9160 AT Command Manual
 - Learn about all the available AT commands.
 - https://nimbelink.com/Documentation/Skywire/Nano/4G_LTE_Cat_M1_Nordic/1002399_NL-SWN-LTE-NRF9160_AT-Command-Manual.pdf
- Learn about the interfaces available on the modem.
 - Section 4.6: Proper Technique for Turning Off The Modem
 - Section 4.9: GPIO pins
 - Section 4.13.2 GPS interface
 - https://nimbelink.com/Documentation/Skywire/Nano/4G_LTE_Cat_M1_Nordic/1002347_NL-SWN-LTE-NRF9160_Datasheet.pdf

5. Appendix

5.1 APN Configuration

5.1.1 Overview

APNs are used by devices and cellular networks to initialize and properly set up a cellular connection. In order to connect to a cellular network, it is crucial to ensure that the proper APN is set on the device.

If the Skywire Nano was activated on <https://go.nimbelink.com>, use the proper APN from the table below. For data plans not activated through NimbeLink please reach out to your carrier for correct APN configuration details.

5.1.2 Common APN's and Their Respective Carriers

The table below contains a list of common APNs and their respective carriers.

It is important to use the APN that corresponds to the proper carrier and the specific IP address configuration. Failure to do so will result in failed cellular network connections.

Cellular Carrier	Common APNs	Description
Verizon	NIMBLINK.GW12.VZWENTP	APN for Verizon devices activated through go.nimbelink.com
	MW01.VZWSTATIC	APN for devices upgraded to a Public Static IP address
AT&T	iot0718.com.attz	AT&T Direct APN
Global	n12.nimbelink	APN for NimbeLink 10 year bundled data plans