

Troubleshooting Guide for Skywire[®] Modems

NimbeLink Corp

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1. Introduction

This guide provides Troubleshooting recommendations to help users explore Skywire® modems and how to interact with them to quickly move through evaluation and development phases of product design.

2. Determining if the modem is ON

When power is applied to the modem, the modem stays off by default. To turn the modem on, you must either drive the ON_OFF signal low using an open-drain output for the required turn-on-time OR you can tie ON_OFF low permanently.

Each modem exhibits slightly different turn on behavior, this list should help you determine if your modem is ON or OFF.

2.1 NL-SW-GPRS

LED behavior: blinks once when the modem turns on, then stays off.

UART: Once the ON_OFF signal has been low for 5 seconds, it will echo back AT commands after roughly 1 second.

USB: This modem does not have a USB interface.

2.2 NL-SW-1XRTT-V

LED behavior: blink once when the modem turns on, then stays off.

UART: Echos back AT commands after roughly 3 seconds

USB: Windows PC recognizes USB COM ports after 3 seconds
COM port 1: Telit diagnostic interface (firmware updates)
COM port 2: AT command interpreter

2.3 NL-SW-EVDO-V

LED behavior: LED turns on and fades off two times, then stays off.

UART: Echos back AT commands after roughly 4-5 seconds

USB: Windows PC recognizes USB COM ports after 4-5 seconds
COM port 1: Primary AT command interpreter
COM port 2: NMEA GPS output
COM port 3: Telit diagnostic interface (firmware updates)
COM port 4: Auxiliary AT command interpreter

2.4 NL-SW-HSPAxx

LED behavior: LED turns on and stays on.

UART: Echos back AT commands after roughly 1-2 seconds

USB: Windows PC recognizes USB COM ports after 1-2 seconds
COM port 1: Primary AT command interpreter
COM port 2: Telit diagnostic interface (firmware updates)

COM port 3: not used by default
COM port 4: Auxiliary AT command interpreter
COM port 5: not used by default

2.5 NL-SW-LTE-Txxx

LED behavior: LED stays off.

UART: Echos back AT commands after roughly 7-8 seconds.

USB: Windows PC recognizes USB COM ports after 15-16 seconds.

COM port 1: Telit diagnostic interface (firmware updates)

COM port 2: NMEA GPS output

COM port 3: Primary AT command Interpreter

COM port 4: Auxiliary AT command interpreter

COM port 5: Telit SAP port

2.6 NL-SW-LTE-GELS3

LED behavior: LED stays off.

UART: Echo is off by default, responds to AT commands after roughly 17-18 seconds, need to send command ATE1<CR> in order to turn on echo.

USB: Windows PC recognizes USB COM ports after 22-23 seconds

COM port 1: Primary AT command interpreter (Gemalto CDC/ACM)

COM port 2: CDC_ECM

Unique: PIN13, VPGIO will raise to 1.8V when the modem is ON

2.7 NL-SW-LTE-S7588-x

LED behavior: LED stays off.

UART: Echos back AT commands after roughly 5-8 seconds

USB: Windows PC recognizes USB COM ports after 4-5 seconds

COM port 1: Primary AT command interpreter (SierraWireless CDC/ACM)

COM port 2: CDC_NCM

3. Connectivity Troubleshooting

3.1 AT commands

To query cellular tower reception, issue AT command:

AT+CSQ

Response:

+CSQ: xx,yy

The **yy** parameter is the bit error rate. The bit error rate will typically show 99 until a valid IP connection is made and some data traffic has passed. You can ignore this for now.

The important parameter is **xx** which is the receive signal strength(RSSI) of the antenna system. This ranges from 0-32 and also can be 99.

- 99 indicates no signal or not enough signal to calculate a valid RSSI, this is common immediately after power on and the modem has not had enough time to capture enough samples to calculate an RSSI average.
- 10-32 indicates a good signal strong enough for data connections
- 0-9 indicates valid signal, but very poor signal quality.

3.2 Important items to review

3.2.1 Antenna Ports

Every modem has a primary antenna connection point, and some also have diversity antenna connection points. The modem has text labels next to each antenna port written in the PCB silkscreen. The connector marked X1 is the primary antenna port and MUST have an antenna connected. X2 is the diversity antenna port and does not affect RSSI!



3.2.2 RF Connectors

The antenna connection ports are Hirose U.FL connectors. These connectors are designed for single insertion attachment of the mating connectors. During product development, it's common to plug and unplug U.FL connectors multiple times, but with each removal, the quality of the connection is diminished. So, if you are having poor reception, try replacing the mating U.FL cable, or in some cases, just remove and reattach the cable. We recommend using a U.FL removal tool to connect and disconnect the U.FL connector.

3.2.3 Antenna Selection

There are good and bad antennas out there. Each modem has a different set of frequency bands used to communicate with different cellular technologies and geographical requirements. When selecting an antenna for your product, you should look at the antenna specifications specifically efficiency at the frequencies used by the modem. The antenna needs to have an efficiency of 40% or higher at the modems operating bands. If the antenna does not specify efficiency look at both the Return Loss and Gain parameters to determine how the antenna will function. A point of caution, many antenna datasheets will report the efficiency, return loss, and gain for very specific test setups with large ground planes. These results will not be the same for your custom device. If you need help with your antenna, please contact the antenna manufacture or Nimbelink.

4. Registration Troubleshooting

4.1 AT commands

The AT+CREG? and AT+CGREG? commands are used to determine network registration status:

4.2 CDMA Modems

For CDMA devices (NL-SW-1XRTT, NL-SW-EVDO) use AT+CREG?:

AT+CREG?

Response:

+CREG: x,y

Possible responses are:

0,0	Not registered, Searching for operator to register
0,1	Registered on home network
0,2	Not registered, searching for operator
0,3	Registration denied
0,4	Unknown
0,5	Registered, Roaming(non-home network)

If you get 0,1 the device is registered and things are good! If you get any other result, continue reading.

4.2.1 Cellular Reception

Network Registration and Authentication will fail if cellular reception is too low or non-existent. Test cellular reception first using information from Section 3. Connectivity Troubleshooting.

4.2.2 Provision the modem

CDMA devices must be provisioned on the cellular network. Try provisioning the modem by issuing the ATD*22899; command:

ATD*22899;

Good Response:

OK

#OTASP: 0

#OTASP: 1

#OTASP: 2

NO CARRIER

Failed Response:

OK

#OTASP: 0

NO CARRIER

If the provisioning failed, keep reading:

4.2.2.1 Home Network?

2G/3G devices can only provision while on a Verizon Home network, not while roaming. Try moving the modem to a known Home network location and try provisioning commands again.

4.2.2.2 Data Plan Issue?

If the cellular signal is good, and you are in a home network, then the cellular data plan should be reviewed to ensure it is active and properly configured. Provide the MEID of your device to your Verizon sales rep or MVNO provider and they can look up to see if there is an active cellular data plan. If you have purchased cellular service from NimbeLink, contact product.support@nimbelink.com with your MEID and describe the problem you are experiencing, specifically provisioning failing and NimbeLink team members will look into the line of service using our tools.

4.3 LTE and GSM Modems

For LTE and GSM devices (NL-SW-GPRS, NL-SW-HSPA*, NL-SW-LTE-*) the CGDCONT must be set AND the network registration command is used to test network registration.

For NL-SW-LTE-GELS3-*:

AT+CEREG?

For all others:

AT+CGREG?

Response:

+CREG: x,y

Possible responses are:

0,0	Not registered, not currently searching for operator to register
0,1	Registered on home network
0,2	Not registered, searching for operator
0,3	Registration denied
0,4	Unknown
0,5	Registered, Roaming(non-home network)

If you get 0,1 the device is registered and things are good! If you get any other result, continue reading.

4.3.1 Cellular Reception

Network Registration and Authentication will fail if cellular reception is too low or non-existent. Test cellular reception first using information from Section 3. Connectivity Troubleshooting.

4.3.2 SIM card present?

Confirm there is a SIM card present in the modem. The modem requires a Micro-SIM size 3FF.

4.3.3 PDP Context Set?

Review the PDP context your modem is trying to use by issuing command:
AT+CGDCONT?

Typical Response for NL-SW-LTE-TSVG:

```
+CGDCONT: 1,"IPV4V6","vzwims", "",0,0
+CGDCONT: 2,"IPV4V6","vzwadmin", "",0,0
+CGDCONT: 3,"IPV4V6","vzwinternet", "",0,0
+CGDCONT: 4,"IPV4V6","vzwapp", "",0,0
+CGDCONT: 5,"IPV4V6", "", "",0,0
```

OK

In order for SMS messages to properly work on the Verizon network, AT+CGDCONT=1 must be set to "vzwims"

In order for Data connections to properly work on the Verizon network, AT+CGDCONT=3 must be set to the correct APN provided by your Verizon sales rep, MVNO, or NimbeLink.

4.3.3.1 Known APN values

If you are having trouble locating the proper APN, here are some tips to potentially determine your proper APN based on your IP service type.

4.3.3.2 Go.NimbeLink.Com Activations

Use: "NIMBLINK.GW12.VZWENTP" if you activated your Verizon SIM card on go.nimbelink.com.

Use: "C1.KOREM2M.COM" if you activated your NimbeLink NL-SIM-TMO T-Mobile service SIM card at go.nimbelink.com.

Use: "10569.MCS" if you activated your NimbeLink NL-SIM-ATT AT&T service SIM card at go.nimbelink.com.

4.3.3.3 **Public Dynamic**

Use: "VZWINTERNET" If your type of IP service was unspecified at time of order, or you specifically requested a public dynamic IP address.

4.3.3.4 **Public Static**

Use: "MW01.VZWSTATIC" If you requested a Public Static IP address from NimbeLink or a Verizon Rep in the MidWest region.

Use: "NE01.VZWSTATIC" If you requested a Public Static IP address from Verizon rep in the North East region.

Use: "SO01.VZWSTATIC" If you requested a Public Static IP address from a Verizon rep in the South Region.

Use: "WE01.VZWSTATIC" If you requested a Public Static IP address from a Verizon rep in the West Region.

4.3.3.5 **Private Dynamic/Static**

If your company has a Verizon Virtual Private Network, sometimes referred to as Customer Private Network (CPN), then your APN will be of the form "COMPANYNAME.GW12.VZWENTP", so you'll need to contact your Verizon Solution Architect in order to get the correct APN setting.

4.3.4 Data Plan Issue?

If the cellular signal is good, and you are in a home network, then the cellular data plan should be reviewed to ensure it is active and properly configured. Provide the IMEI and SIM ID of your device and SIM card to your Verizon sales rep or MVNO provider and they can look up to see if there is an active cellular data plan. If you have purchased cellular service from NimbeLink, contact product.support@nimbelink.com with your IMEI and SIM ID and describe the problem you are experiencing, specifically AT+CGREG? failing and NimbeLink team members will look into the line of service using our tools.

5. USB Connectivity Troubleshooting

This section is intended to help diagnose any hardware or software issues that prevent the USB interface from being discovered by the USB Host.

5.1 VBUS Pin

The Skywire interface pin 6 is the USB VBUS input. This input must have a valid high level for the modem to detect that a USB Host is present. Unfortunately, the module chip designers have not been consistent on their VBUS minimum thresholds. Below is the list of acceptable input voltage ranges for each product:

NL-SW-1XRTT	4.4V-5.0V
NL-SW-EVDO	5.0V
NL-SW-HSPA	4.4V-5.25V
NL-SW-LTE-TSVG	2.0V-5.25V
NL-SW-LTE-GELS3	3.0V-5.25V
NL-SW-LTE-S7588	4.4V-5.0V

5.2 Host Software

USB connectivity requires the host platform to recognize the USB ID of the modem. Each operating system needs the USB ID added to its environment in order to recognize the modem.

5.2.1 Windows Environments

Windows platforms should install the Windows USB drivers in order to recognize the modem. We have found this to work well under Windows 7 and Windows 8 environments. We know it does not work in Windows 10 implementations.

USB device driver files and further instructions are accessible here:

Telit based modems:

http://nimbelink.com/wp-content/uploads/2014/08/Telit_USB_Driver_Win_Desktop_UF.00.01.zip

5.2.2 Linux Environments

Linux and Mac environments may need to be modified in order to provide access to the USB and/or UART connections from the modems.

6. UART Connectivity Troubleshooting

The modem UART requires a TTL level signals in order to communicate with an MCU, typically using 115200 8N1.

6.1 UART Signal Overview

- 1) Connect ground (GND) between MCU platform and modem development kit.
- 2) Connect modem Data Input (DIN) signal to MCU UART TX signal so the MCU can transmit data to the modem DIN signal.
- 3) Connect modem Data Output (DOUT) signal to MCU UART RX signal so the MCU can receive data from the modem DOUT signal.
- 4) The modem DTR signal must be grounded (tied to GND) in order to ensure the modem does not go into low-power modes while transmitting data to the MCU.
- 5) The modem RTS signal must be grounded (tied to GND) in order to ensure the modem does not halt UART communications waiting for the MCU to lower the RTS signal to receive data, this most commonly causes issues when using PPP or socket dial commands and the MCU cannot receive data as fast as the modem can feed it to the MCU.

6.2 BAUD Rate

Each modem is capable of supporting many different baud rate frequencies, however, some modems support auto-bauding, or the auto-detection of the baud rate, and others do not support auto-bauding and must be manually set to the desired setting using the AT+IPR.

To change the baud rate, put the modem into a development kit and issue the AT command below substituting your desired baud rate, for example, to set to 230,400bps, the command is:

```
AT+IPR=230400
```

```
OK
```

Then you need to save the new baud rate setting to non-volatile memory so the change persists across modem reset and power down. To do this, you need to change serial port setting on the terminal emulator to 230400 and issue the command:

```
AT&W
```

```
OK
```

The AT&W command will save the baud rate setting in non-volatile memory, so you can then take the modem and put back into your hardware.

6.3 DTR and RTS Signals

Use a voltmeter to measure the actual voltage on these signals on the modem connector. Resistor pull-downs may not be sufficient. Some NimbeLink reference designs that are targeted for 2G/3G Modems use 10K pulldowns on these signals to terminate them, however, newer LTE modems require stronger pulldowns to ensure the DTR and RTS signals are at valid low levels.

7. PPP Link Troubleshooting

This section is intended to help diagnose any hardware or software issues that prevent PPP connections from working on UART or USB interfaces.

7.1 Scripts Failing

The default ppp chat scripts may need to be modified for the following reasons:

- 1) To use the correct USB or Serial port.
- 2) Change to correct APN

7.1.1 Use Picocom

One debug step is to manually send the PPP script commands individually to the modem to see which command is failing. Picocom is a simple terminal emulator that can be used to send AT commands to the modem's serial port. You'll need to define the correct USB or UART serial port and baud rate in the command.

For example:

```
picocom /dev/ttyUSB0 -b 115200 -l
```

Starts picocom on ttyUSB0 with baud rate of 115,200bps

Then issue commands to troubleshoot the failure using commands and tips from other chapters in this document:

```
AT+CSQ
```

```
AT+CREG? or AT+CGREG?
```

Test to see if you can get a valid IP address:

```
AT+SGACT=1,1 or AT+SGACT=3,1 or AT+CGACT=1,3
```

If you get a valid IP address, restart the system and then test all the PPP chat script commands to see which (if any) fail.

7.1.2 Cellular Reception

Poor cellular reception can cause the PPP link to fail. Here is one customer's example of a failed connection due to poor cellular connection:

```
Serial connection established.  
using channel 1  
Using interface ppp0  
Connect: ppp0 <--> /dev/ttyUSB3  
rcvd [LCP ConfReq id=0x1 <asynctest 0x0> <auth pap> <magic 0xa1d5378d> <pcomp> <accomp>]  
sent [LCP ConfReq id=0x1 <asynctest 0x0> <magic 0xf558d6b4> <pcomp> <accomp>]  
sent [LCP ConfAck id=0x1 <asynctest 0x0> <auth pap> <magic 0xa1d5378d> <pcomp> <accomp>]  
rcvd [LCP ConfAck id=0x1 <asynctest 0x0> <magic 0xf558d6b4> <pcomp> <accomp>]  
sent [LCP EchoReq id=0x0 magic=0xf558d6b4]  
sent [PAP AuthReq id=0x1 user="beaglebone" password=<hidden>]  
rcvd [LCP DiscReq id=0x2 magic=0xa1d5378d]
```

```

rcvd [LCP EchoRep id=0x0 magic=0xa1d5378d f5 58 d6 b4]
rcvd [PAP AuthAck id=0x1 ""]
PAP authentication succeeded
sent [CCP ConfReq id=0x1 <deflate 15> <deflate(old#) 15> <bsd v1 15>]
sent [IPCP ConfReq id=0x1 <compress VJ 0f 01> <addr 0.0.0.0> <ms-dns1 0.0.0.0> <ms-dns2 0.0.0.0>]
rcvd [LCP ProtRej id=0x3 80 fd 01 01 00 0f 1a 04 78 00 18 04 78 00 15 03 2f]
Protocol-Reject for 'Compression Control Protocol' (0x80fd) received
sent [IPCP ConfReq id=0x1 <compress VJ 0f 01> <addr 0.0.0.0> <ms-dns1 0.0.0.0> <ms-dns2 0.0.0.0>]
sent [IPCP ConfReq id=0x1 <compress VJ 0f 01> <addr 0.0.0.0> <ms-dns1 0.0.0.0> <ms-dns2 0.0.0.0>]
sent [IPCP ConfReq id=0x1 <compress VJ 0f 01> <addr 0.0.0.0> <ms-dns1 0.0.0.0> <ms-dns2 0.0.0.0>]
sent [IPCP ConfReq id=0x1 <compress VJ 0f 01> <addr 0.0.0.0> <ms-dns1 0.0.0.0> <ms-dns2 0.0.0.0>]
sent [IPCP ConfReq id=0x1 <compress VJ 0f 01> <addr 0.0.0.0> <ms-dns1 0.0.0.0> <ms-dns2 0.0.0.0>]
sent [IPCP ConfReq id=0x1 <compress VJ 0f 01> <addr 0.0.0.0> <ms-dns1 0.0.0.0> <ms-dns2 0.0.0.0>]
sent [IPCP ConfReq id=0x1 <compress VJ 0f 01> <addr 0.0.0.0> <ms-dns1 0.0.0.0> <ms-dns2 0.0.0.0>]
sent [IPCP ConfReq id=0x1 <compress VJ 0f 01> <addr 0.0.0.0> <ms-dns1 0.0.0.0> <ms-dns2 0.0.0.0>]
sent [LCP EchoReq id=0x1 magic=0xf558d6b4]
IPCP: timeout sending Config-Requests
sent [LCP TermReq id=0x2 "No network protocols running"]
sent [LCP TermReq id=0x3 "No network protocols running"]
Connection terminated.
Modem hangup

```

7.2 DTR and RTS

Use a voltmeter to measure the actual voltage on these signals on the modem connector. Resistor pull-downs may not be sufficient. Some NimbeLink reference designs that are targeted for 2G/3G Modems use 10K pulldowns on these signals to terminate them, however, newer LTE modems require stronger pulldowns to ensure the DTR and RTS signals are at valid low levels. The PPP connection process on USB and/or UART can be stalled if the DTR and RTS lines are not sufficiently driven low.

Here is an example of a ppp script failing due to the DTR and RTS lines being high

```

id=0x1 <asynctmap 0x0> <magic 0xa148261> <pcomp> <accomp>]
sent [LCP EchoReq id=0x0 magic=0xa148261]
sent [PAP AuthR-bash: root@beaglebone:/etc/ppp/peers#: No such file or directory
eq id=0x1 user="beaglebone" password=<hidden>]
rcvd [LCP DiscReq id=0x2a magic=0x44223dcc]
rcvd [LCP EchoRep id=0x0 magic=0x44223dcc 0a 14 82 61]
rcvd [PAP AuthAck id=0x1 ""]
PAP authentication succeeded
sent [CCP ConfReq id=0x1 <deflate 15> <deflate(old#) 15> <bsd v1 15>]
sent [IPCP ConfReq id=0x1 <compress VJ 0f 01> <addr 0.0.0.0> <ms-dns1 0.0.0.0> <ms-dns2 0.0.0.0>]
rcvd [LCP ProtRej id=0x2b 80 fd 01 01 00 0f 1a 04 78 00 18 04 78 00 15 03 2f]
Protocol-Reject for 'Compression Control Protocol' (0x80fd) received
rcvd [IPCP ConfNak id=0x1 <ms-dns1 10.11.12.13> <ms-dns2 10.11.12.14> <ms-wins 10.11.12.13> <ms-wins 10.11.12.14>]
sent [IPCP ConfReq id=0x2 <compress VJ 0f 01> <addr 0.0.0.0> <ms-dns1 10.11.12.13> <ms-dns2 10.11.12.14> <ms-wins
10.11.12.13> <ms-wins 10.11.12.14>]
rcvd [IPCP ConfNak id=0x2 <ms-dns1 10.11.12.13> <ms-dns2 10.11.12.14> <ms-wins 10.11.12.13> <ms-wins 10.11.12.14>]

```

sent [IPCP ConfReq id=0x3 <compress VJ 0f 01> <addr 0.0.0.0> <ms-dns1 10.11.12.13> <ms-dns2 10.11.12.14> <ms-wins 10.11.12.13> <ms-wins 10.11.12.14>]
rcvd [IPCP ConfNak id=0x3 <ms-dns1 10.11.12.13> <ms-dns2 10.11.12.14> <ms-wins 10.11.12.13> <ms-wins 10.11.12.14>]
sent [IPCP ConfReq id=0x4 <compress VJ 0f 01> <addr 0.0.0.0> <ms-dns1 10.11.12.13> <ms-dns2 10.11.12.14> <ms-wins 10.11.12.13> <ms-wins 10.11.12.14>]
rcvd [IPCP ConfNak id=0x4 <ms-dns1 10.11.12.13> <ms-dns2 10.11.12.14> <ms-wins 10.11.12.13> <ms-wins 10.11.12.14>]
sent [IPCP ConfReq id=0x5 <compress VJ 0f 01> <addr 0.0.0.0> <ms-dns1 10.11.12.13> <ms-dns2 10.11.12.14> <ms-wins 10.11.12.13> <ms-wins 10.11.12.14>]
sent [IPCP ConfReq id=0x5 <compress VJ 0f 01> <addr 0.0.0.0> <ms-dns1 10.11.12.13> <ms-dns2 10.11.12.14> <ms-wins 10.11.12.13> <ms-wins 10.11.12.14>]
sent [IPCP ConfReq id=0x5 <compress VJ 0f 01> <addr 0.0.0.0> <ms-dns1 10.11.12.13> <ms-dns2 10.11.12.14> <ms-wins 10.11.12.13> <ms-wins 10.11.12.14>]
sent [IPCP ConfReq id=0x5 <compress VJ 0f 01> <addr 0.0.0.0> <ms-dns1 10.11.12.13> <ms-dns2 10.11.12.14> <ms-wins 10.11.12.13> <ms-wins 10.11.12.14>]
sent [IPCP ConfReq id=0x5 <compress VJ 0f 01> <addr 0.0.0.0> <ms-dns1 10.11.12.13> <ms-dns2 10.11.12.14> <ms-wins 10.11.12.13> <ms-wins 10.11.12.14>]
sent [IPCP ConfReq id=0x5 <compress VJ 0f 01> <addr 0.0.0.0> <ms-dns1 10.11.12.13> <ms-dns2 10.11.12.14> <ms-wins 10.11.12.13> <ms-wins 10.11.12.14>]
sent [IPCP ConfReq id=0x5 <compress VJ 0f 01> <addr 0.0.0.0> <ms-dns1 10.11.12.13> <ms-dns2 10.11.12.14> <ms-wins 10.11.12.13> <ms-wins 10.11.12.14>]
sent [LCP EchoReq id=0x1 magic=0xa148261]
sent [IPCP ConfReq id=0x5 <compress VJ 0f 01> <addr 0.0.0.0> <ms-dns1 10.11.12.13> <ms-dns2 10.11.12.14> <ms-wins 10.11.12.13> <ms-wins 10.11.12.14>]
IPCP: timeout sending Config-Requests
sent [LCP TermReq id=0x2 "No network protocols running"]
sent [LCP TermReq id=0x3 "No network protocols running"]
Connection terminated.
Modem hangup