Skywire® M1 Development Kit User Manual

NimbeLink Corp

Updated: October 2017

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1. Introduction

1.1 Overview

This document is the User Manual for the NL-M1DK-ES, NL-SW-LTE-SVZM20-ES, and NL-SW-LTE-SVZM20 family of Skywire® modems. The procedure outlined in this guide walks through installing the Skywire modem, setting up your workstation, issuing basic commands, and registering on the Verizon network.

1.2 Orderable Parts

Table 1.1 Orderable Parts

Number	Description	Manufacturer	Carrier
NL-M1DK-ES	Skywire 4G LTE CAT M1 Development Kit	NimbeLink	Verizon
NL-SW-LTE-SVZM20-ES	Skywire 4G LTE CAT M1 Cellular Modem	NimbeLink	Verizon
NL-SW-LTE-SVZM20	Skywire 4G LTE CAT M1 Cellular Modem	NimbeLink	Verizon
NL-SIM-VER-M1	3FF Verizon LTE CAT M1 Sim Card	NimbeLink	Verizon
TG.30.8113	Dipole Cellular Antenna	Taoglas	
TG.08.0113	Monopole Cellular Antenna	Taoglas	

1.3 Firmware Changes

The chipset manufacturer has released a new version of firmware - firmware version 32902 - that makes available some features and fixes many issues. Here is a brief description of the firmware changes:

- More AT command are enabled and functioning. We have an AT command manual available on our website:

  http://nimbelink.com/Documentation/Skywire/4G_LTE_Cat_M1/1001534_NL-SW-LTE-SVZM_AT_COMMAND_MANUAL.pdf

- Low power modes are enabled, and will soon be documented in the datasheet:

  http://nimbelink.com/Documentation/Skywire/4G_LTE_Cat_M1/30163_NL-SW-LTE-SVZM_Datasheet.pdf

- SMS messages are enabled. At this time, the Verizon network only supports CAT M1 device to other CAT M1 device messages only. An application note with examples will be posted soon.
- Baud rate changes now persist across reboots.

There are still outstanding notes from Section 1.4 to keep in mind:

- CATM1 still only uses Band 13
- CATM1 devices still require a CAT-M1 SIM card.

1.4 Archive of Critical Engineering Sample Notes

1.4.1 Engineering Sample

The NL-M1DK-ES are Engineering Sample products. This means that there is some functionality not enabled yet, and there will be numerous software and firmware changed and updates in the near future as these features mature.

1.4.2 Modem Firmware

The firmware in the modem may have some limited functionality, but you will need to update the firmware as part of the out-of-the-box experience.

1.4.3 AT Commands - Addressed in firmware 32902

Not all AT commands listed in the AT Commands Manual are enabled. The associated Application Notes will reference commands and sequences that are available at the time of writing and known to be working. If you receive an ERROR response when trying to use one of the commands not listed in an Application Note, you can expect that the implementation is not complete for that feature.

1.4.4 Lower Power Modes - Available in firmware 32902

We do not advise performing any advanced power testing at this time. Low power modes (and power-save modes) are not available in current firmware so results are not representative of the product's true capabilities yet.

1.4.5 SMS Messaging - Available in firmware 32902

SMS messages are not available at this time.

1.4.6 Supported LTE Bands

LTE Band 13 is the only cellular band supported by Verizon at this time.

LTE Band 4 is a future network enhancement. Expect a firmware update when Band 4 is made available.

1.4.7 "Assertion failed" Errors - Fixed in firmware 32902

During development and testing, you may receive error messages that start with the following:

^EXIT: Assertion failed

This error will cause the Skywire to restart. This is a known issue that is being investigated and will be addressed in a future firmware release. This error most often occurs while the Skywire is registering on the network.

1.4.8 Real-Time Clock Error - Fixed in firmware 32902

The real-time clock (RTC) may report the time incorrectly. It may be an hour off, report in Coordinated Universal Time (UTC), or something else. There are two ways around this:

- You can manually set the RTC using the AT+CCLK command
- You can issue:

  AT+CGATT=0

  to disconnect from the network. Then, reset the RTC with:

  AT+CCLK="00/01/01,00:00:00+0"

  and reconnect to the network with:

  AT+CGATT=1

  Your RTC should now be set to the correct time.

This is a known issue that is being investigated, and will be addressed in a future firmware release.

1.4.9 Command Mode Socket Dials - Hex - Fixed in firmware 32902

If you are using Command Mode to send socket dials, and are sending hex characters instead of ASCII characters, you cannot send hex values larger than "7F". This is a known issue that will be addressed in a future firmware release.

1.4.10 AT Interface Lockup Issues - Fixed in firmware 32902

There may be times when the Skywire interface will lock up, and you are no longer able to issue AT commands when the Skywire is idle. This is a known issue that is being investigated, and will be address in a future firmware release.

1.4.11 Network Registration Issues - Fixed in firmware 32902

There may be times when the Skywire will not register on the network, or will take a long time to register, despite having an active and known-working SIM. This is a known issue that is being investigated, and will be addressed in a future firmware release.

1.4.12 SIM Cards

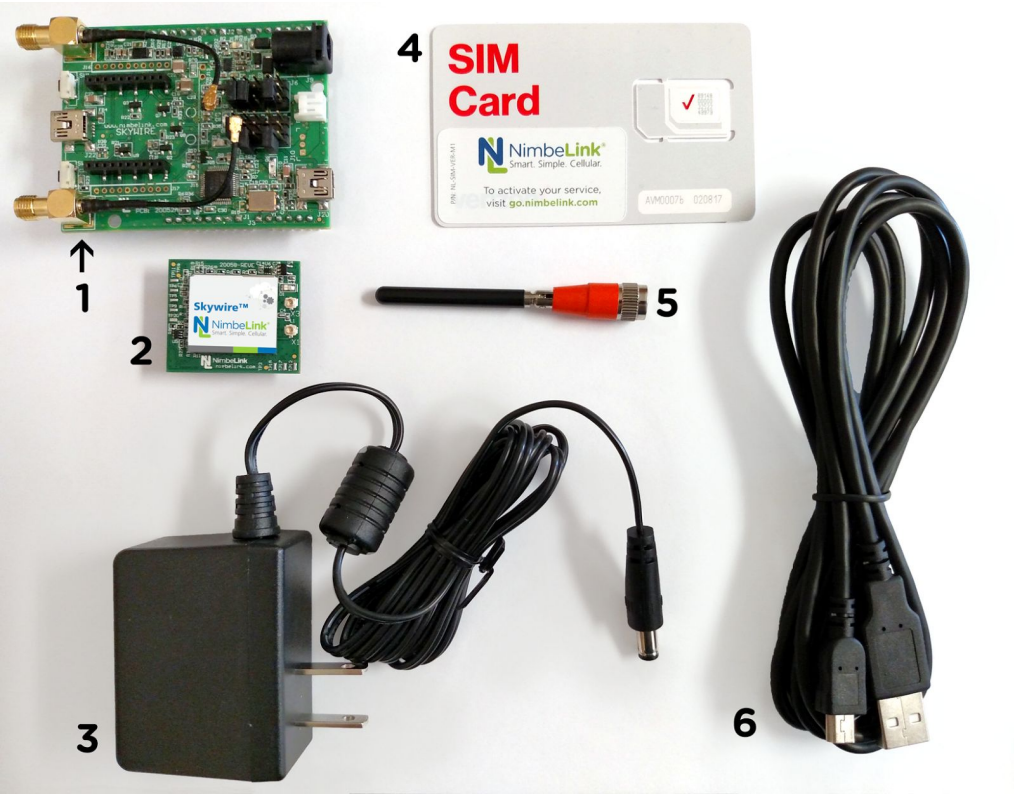
The LTE CAT M1 network requires the use of a special SIM card. Other Verizon LTE SIM cards, including the SIM cards used in other Skywire models, will not work on the LTE CAT M1 network.

Please follow the procedure outlined in Section 3 for activating the included LTE CAT M1 SIM card on the Verizon network.

2. Getting Started

2.1 Kit Contents

The NL-M1DK-ES kit includes the following hardware:



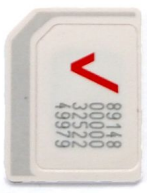
1. NL-M1DK-ES - Skywire 4G LTE CAT M1 Cellular Modem Development Kit with jumpers installed
2. NL-SW-LTE-SVZM20-ES - Skywire 4G LTE CAT M1 Cellular Modem
3. CUI 5V Power Supply
4. NL-SIM-VER-M1 - Skywire 3FF 4G LTE CAT M1 SIM Card
5. Taoglas Antenna
6. USB to mini-USB Cable

2.2 Hardware Setup

2.2.1 SIM Card Installation

The SIM card included in your kit includes a tri-cut carrier and adapter for different sizes. The Skywire family of modems use the Micro-SIM (3FF size form factor), which is the SIM card size outlined in red in the below picture:

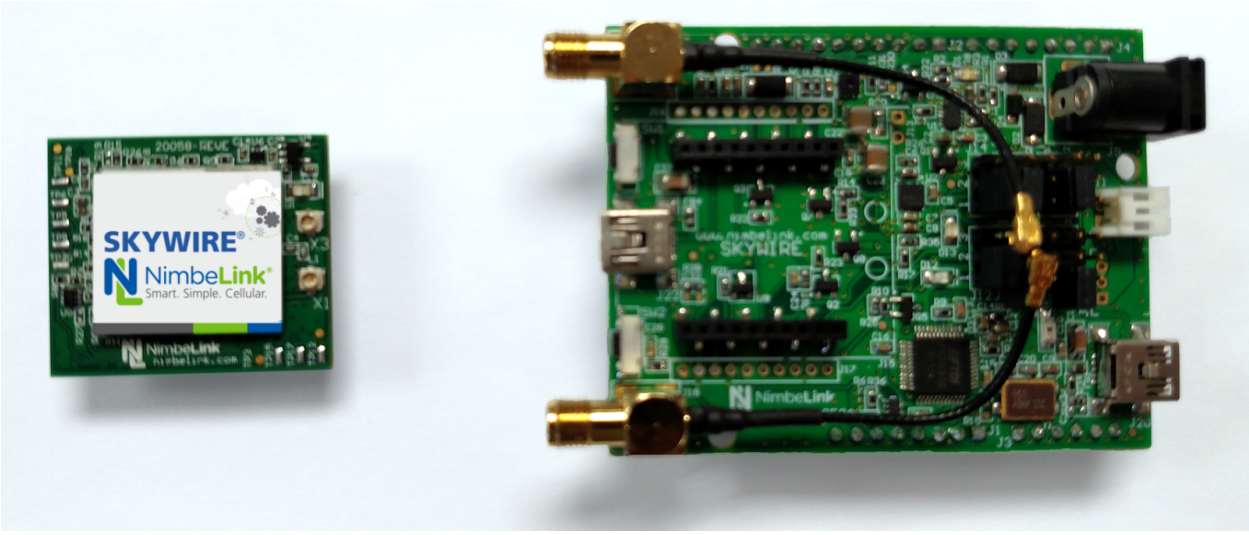
Carefully snap out the 3FF SIM card size from the SIM card carrier, and insert it into your Skywire modem. The pads on the SIM card should face the pins on the SIM cage, and the keyed corner will go in as shown below:



Insert the SIM card into the Skywire:

2.2.2 Skywire Installation

Install the Skywire as shown below. The small circles on the NL-M1DK-ES shows the proper orientation of the U.FL connectors on the Skywire:



Please verify that the installation of the Skywire is correct. If it is installed 180 degrees from the proper orientation, or if the Skywire is installed one pin off, it will damage the Skywire modem when power is applied. This voids the warranty of the Skywire and the NL-M1DK-ES.

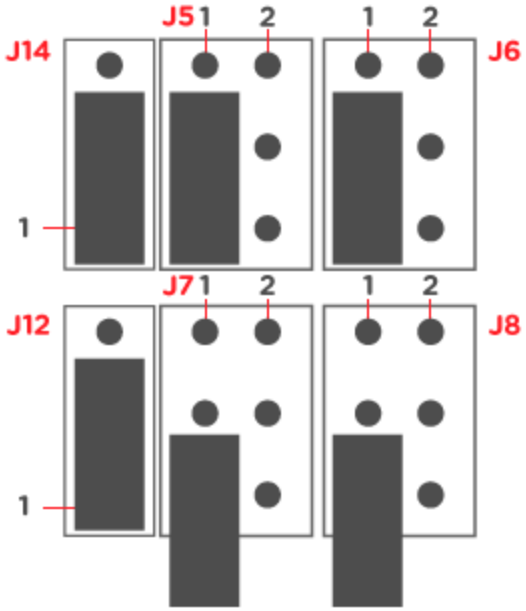
Attach the antenna cables to the Skywire.

Note: when removing antenna cables from the Skywire, use a U.FL removal tool.

Here is a picture of the fully-installed Skywire:

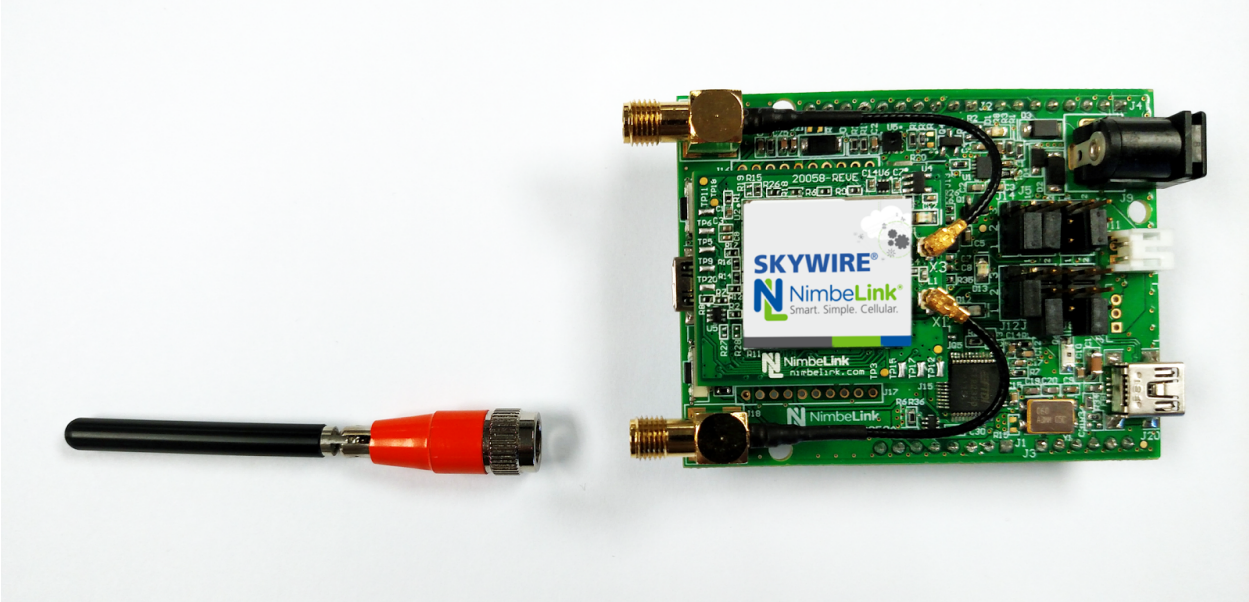
2.2.3 Jumper Installation

The NL-M1DK-ES has the capability to connect to your workstation via a USB-Serial connection, or to different microcontroller platforms. Your NL-M1DK-ES is setup from the factory for the USB-Serial connection. However, if a jumper was knocked off during shipment, here is a diagram for the proper jumper settings:

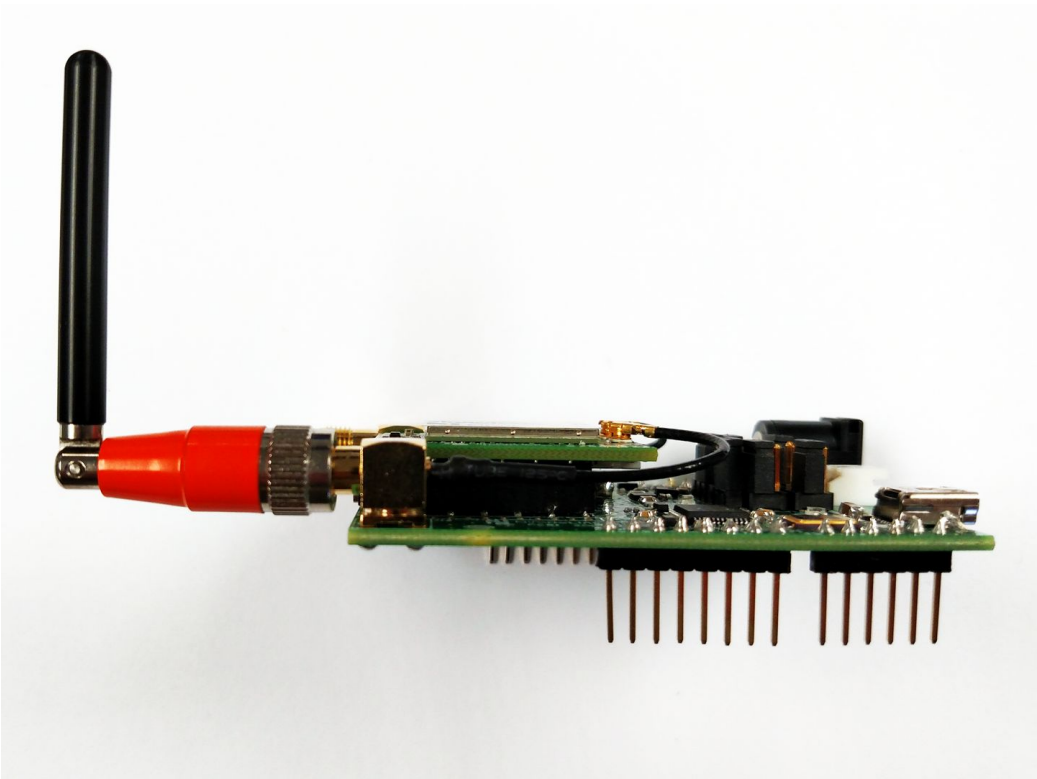


2.2.4 Antenna Installation

Install the antenna to SMA connector J18 by screwing on the antenna. Make note not to cross-thread the antenna:



Bend the antenna connector so it is pointing vertically. Below is a side view of the installed antenna.



2.3 Software Setup

2.3.1 Terminal Program

You will need a Terminal program to communicate with the Skywire. For Windows, we recommend TeraTerm or PuTTY:

TeraTerm - https://ttssh2.osdn.jp/index.html.en

PuTTY - http://www.putty.org/

For Unix-based systems (macOS, Linux), we recommend picocom or minicom.

Note: Additional setup may be necessary for macOS. Please consult Section 6.3 before continuing.

2.3.2 Baudrate

The default baudrate of the NL-SW-LTE-SVZM20-ES is **921600**. Please make sure to change the settings of your terminal program to reflect this.

3. Activate LTE CAT M1 SIM Data plan

To activate Skywire modem and SIM card, visit:

go.nimbelink.com

Create an account. Follow the instructions to activate the SIM card. The IMEI is the fifteen-digit number listed on top of the Skywire, and the ICCID is the twenty-digit number on the SIM card holder.

4. Hardware Verification

4.1 Introduction

Now that the Skywire is installed in the NL-M1DK-ES, it is time to verify that the Skywire can connect to the network. This example uses TeraTerm on Windows 7, however the process is similar for your platform. Generally,

- Setup your terminal program to use **baudrate 921600** and connect to your Skywire port
- Issue the listed AT commands to verify communications and network connectivity

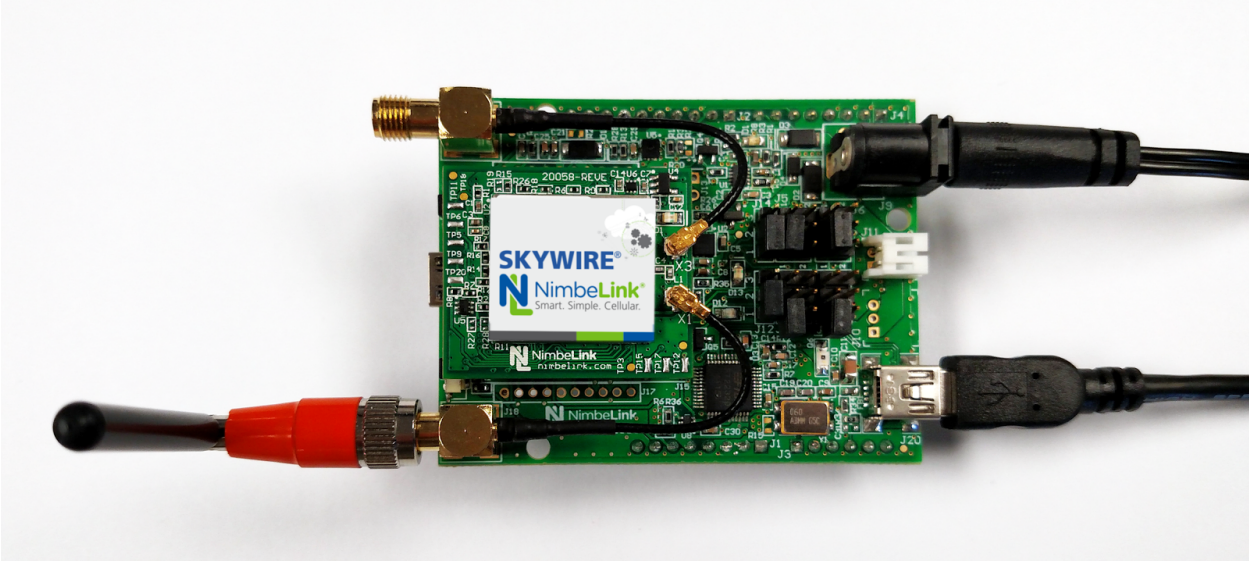
4.2 Insert USB Cable

Insert the USB cable to port J20 on the NL-M1DK-ES:

Insert the other end of the USB cable to your workstation.

4.3 Apply Power

Insert the included 5V power adapter into the NL-M1DK-ES:



Plug the power supply into a power outlet.

4.4 Verify COM Port Enumeration

Open Windows Device Manager, and verify that the FTDI drivers installed properly. There will be two new COM ports on your PC. You will use the first COM port for AT commands. The second COM port is used for GPS data when that functionality is available. Note the first COM port number. For this guide, the ports enumerate as COM44 and COM45:

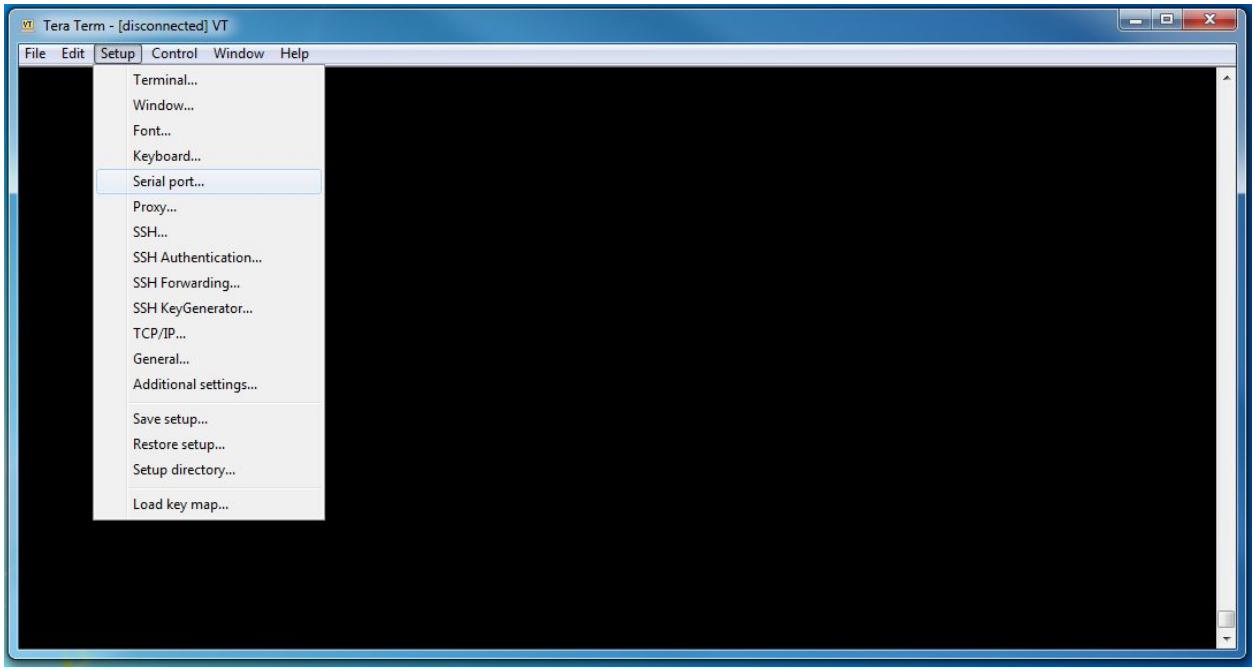
If your devices do not install, you may need to download drivers from FTDI. Please find them here:

http://www.ftdichip.com/Drivers/VCP.htm

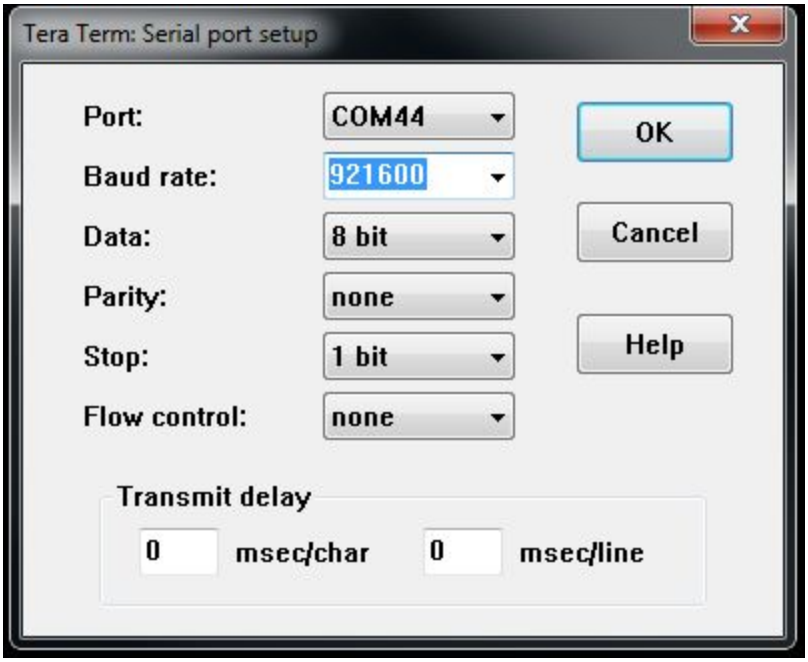
4.5 Connect to the Skywire

Open TeraTerm, and close the initial connection window that appears: this window doesn't allow us to change the baud rate. Go to:

Setup > Serial Port



and in the Baud Rate field either type in 921600 or use the dropdown to select 921600. All other settings should remain at their defaults. For the Port, use the dropdown to select your COM port if it isn't selected already. COM44 has been selected for this example, corresponding to the port listed in Section 4.4:



Once you have the correct settings, click "OK" to establish the connection to your Skywire.

4.6 AT Commands

The Skywire family of embedded modems communicates using AT commands. AT commands are issued by typing the command, pressing the Enter key on your keyboard, and observing the response.

4.7 Verify AT Command Communications

Type the following command:

```
AT
```

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

```
OK
```

Please note: the default behavior of the NL-SW-LTE-SVZM20-ES is to not echo the command back, so you will not see AT as you type it, only the 'OK' response if Enter key is pressed.

4.8 Enable Command Echo

To enable the command echo, type the following command:

```
ATE1
```

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

```
OK
```


You will now see the commands as they are typed. This functionality will default back to off with a power cycle. You can also disable the command echo by typing the following command:

```
ATE0
```

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

```
OK
```

4.9 Check Firmware Version

It is beneficial to make sure that you always have the latest firmware to ensure stability and feature set. To check your firmware, type the following command:

```
ATI1
```

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

```
UE5.0.0.0

LR5.0.0.0-30193


OK
```

`30193` is the firmware version number to look for. Please compare that firmware version with the version available at the NL-SW-LTE-SVZM20 webpage:

http://nimbelink.com/skywire-4g-lte-cat-m1/#docs

If your version is older than the latest one available, please update the firmware using the below guide:

http://www.nimbelink.com/Skywire/4G_LTE_Cat_M1/1001541_NL-SW-LTE-SVZM20_Firmware-Upgrade

4.10 Set Your APN

When you activate cellular service, an APN is assigned and must be used by the modem to properly route traffic when using the network. Testing has been performed with Verizon Dynamic APNs and Private Network APNs. Accounts activated through NimbeLink(go.nimbelink.com) will be setup with the APN:

```
NIMBLINK.GW12.VZWENTP
```

To set this APN in the modem, type the following command:

```
AT+CGDCONT=3,"IPV4V6","NIMBLINK.GW12.VZWENTP"
```

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

```
OK
```


4.11 Enable Cellular Functionality

To conserve power, by default cellular functionality is disabled. To enable cellular functionality, type the following command:

```
AT+CFUN=1
```

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

```
OK
```

This functionality will reset when rebooted. Therefore, this command will need to be sent at each power-on.

4.12 Verify Auto-Attach

Depending on your settings, the Skywire may not automatically try to register on the network. To enable this functionality, type the following command:

```
AT^AUTOATT=1
```

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

OK

This command is saved in non-volatile memory (NVM), and therefore only needs to be issued once. However, if you would like to verify that this command is set, you can type the following command:

```
AT^AUTOATT?
```

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

```
^AUTOATT: x


OK
```

where x is either 0 for disabled or 1 for enabled.

4.13 Verify Cellular Signal Strength

To verify the signal strength, type the following command:

```
AT+CSQ
```

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

```
+CSQ: xx,yy


OK
```

where xx and yy will be numbers corresponding to the signal strength and error rate, respectively. Please see the below table to convert these numbers to real-world values:

[table from AT commands manual]

Note: AT+CSQ may respond with:

```
+CSQ: 99,99
```

as the Skywire is registering on the network. Poll the command until it returns a valid number, indicating that the Skywire is receiving a valid cellular signal.

4.14 Verify Network Registration

Once you have a cellular signal, you can verify that you are registered on the network. Type the following command:

```
AT+CEREG?
```

followed by the Enter Key, and the terminal will respond with:

```
+CEREG: 2,x,y,z


OK
```

where `x` is your registration status, and `y` and `z` are further network details. Poll this command until it returns:

```
+CEREG: 2,1,y,z
```

A value of 1 means that your Skywire is registered on the network.

5. Next Steps

Now that you have verified that you can communicate with the Skywire modem, and that it's registered on the network, you are ready to start building your cellular-connected device. Most users will be using the PPP functionality, or perform raw socket dials. Here are application notes to get you started:

CAT M1 PPP on BeagleBone Black - http://www.nimbelink.com/Documentation/Skywire/4G_LTE_Cat_M1/30272_NL-SW-LTE-SVZM21_PPP-on-CATM1_BBB.pdf

CAT M1 PPP on Raspberry Pi - http://www.nimbelink.com/Documentation/Skywire/4G_LTE_Cat_M1/30273_NL-SW-LTE-SVZM21_PPP-on-CATM1_RPi.pdf

CAT M1 Socket Dials -

http://www.nimbelink.com/Documentation/Skywire/4G_LTE_Cat_M1/1001412_NL-SW-LTE-SVZM_SocketDialAppNote.pdf

CAT M1 SMS Messages Application note - (Coming soon)

Be sure to keep an eye on the NimbeLink website for the NL-SW-LTE-SVZM20 family of Skywire modems, as well as the website for the NL-M1DK-x Development Kit for updates and examples.

6. Additional Resources

Technical Resources

All documentation for the Skywire M1 modem and development kit: http://nimbelink.com/skywire-4g-lte-cat-m1/#docs

General Information

NL-SW-LTE-SVZM20 Website - http://nimbelink.com/skywire-4g-lte-cat-m1/

NL-M1DK-x Website - http://nimbelink.com/skywire-m1dk/

7. Troubleshooting

7.1 Introduction

This section covers troubleshooting steps if the above procedures do not work for you.

7.2 Communications with the Skywire

If you are unable to communicate with your Skywire Modem, make sure that you have the jumpers setup correctly for your application according to Section 2.2.3, and the baudrate set to 921600 according to Sections 2.3.2 and 4.5. In addition, make sure you are communicating with the correct COM port according to Section 4.5.

7.3 Serial Communications on macOS

If you are using macOS and are unable to communicate with the Skywire Modem, you may need to manually change the baud rate. By default, macOS does not support baud rates higher than 230400. There are two ways around this:

1. Using your favorite terminal program, open the serial port at a lower baudrate. For example, using `picocom`:

   ```
   $ picocom -b 115200 [your device name]
   ```

   In another terminal window, change the baudrate on that serial port:

   ```
   $ stty -f [your device name] 921600
   ```

   Go back to your first terminal window and you can use the device now. Note: you may need to use `sudo` for the `stty` command.

2. Check if your favorite terminal program has implemented this change. For example, compiling `picocom` from source would implement this fix:

   https://github.com/npat-efault/picocom/commit/74e0245fb001889e168755dabf6badac0b6967d3

Additionally, you may get different listings or multiple listing for serial devices. For example, you may get listings for:

```
$ /dev/cu.[your device name]A
$ /dev/cu.[your device name]B
$ /dev/tty.[your device name]A
$ /dev/tty.[your device name]B
```


We have found that using the `/dev/cu.[your device name]` works, and have verified Step 1 working on the `/dev/cu.[your device name]` device. You may get an error trying to use `/dev/tty[your device name]`.

Using higher baud rates in Windows and Linux does not appear to be an issue as of the publication of this document.

7.4 Network Registration

If your Skywire is not registering on the network, ensure that you have the antenna connected to the correct port on your Skywire and M1DK according to Section 2.2.4. In addition, please make sure that you are setup to automatically register on the network by checking the auto-attach settings in Section 4.12. Make sure you are getting an acceptable signal strength according to Section 4.13. Finally, make sure that you typed the APN correctly according to Section 4.10.

If the Skywire does not automatically register on the network after about thirty (30) seconds, check the status of the attachment by typing the following command:

```
AT+CGATT?
```

followed by the Enter Key, and you should see:

```
+CGATT: x

OK
```

where `x` is either `0` (not attached) or `1` (attached). If the result is `0`, type the command:

```
AT+CGATT=1
```

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

```
OK
```

Return to Section 4.14 and continue from there.

8. Technical Support

Technical support is available at:

support.nimbelink.com

or by sending an email to:

product.support@nimbelink.com

If you have an issue with the procedure outlined in this user guide, please first consult Section 7: Troubleshooting before contacting Technical Support. Responses generally occur within one business day.

9. Appendix

9.1 Microcontroller Programming

The NL-M1DK-ES can interface with a variety of microcontroller platforms, including select ST Nucleo, NXP K64F, and Arduino platforms. Please see page 2 of the schematic for more information on setting up this capability:

http://nimbelink.com/Documentation/Development_Kits/NL-M1DK/20052_NL-M1DK_Schematic.PDF

9.2 NL-M1DK-ES Block Diagram