STEVENS
MEASUREMENTS TO MIND

Cellular Data Modem

Model:
STEVENS CELL-NET

- Product Manual -

Stevens Water Monitoring Systems, Inc.
www.stevenswater.com

Contents

1. Product Overview

The Stevens Cell-Net is a cellular data modem that operates over cellular data networks, allowing the transmission of data from any field location that is within the cellular service area. The Stevens Cell-Net modem includes features for low power operations and data redundancy. Communication can be made via ether HTTP or FTP protocols as well as IP:Port, allowing data to be uploaded directly to a web service such as "Stevens Connect" for display, or sent to a server with FTP access for storage and future analysis, or for direct M2M data connections. The Stevens Cell-Net modem has advanced buffering capabilities allowing for datapackets to be queued ensuring reliability during periods of high cellular data traffic over network towers.Advanced low-power modes allow Stevens Cell-Net to idle for use with low-power solar systems. Transmissions can be scheduled to occur at set intervals or be event driven, allowing the modem to remain in a low- power state longer to maximize battery life. Stevens Cell-Net features a user-selectable header, which can include RSSI (receive signal strength Indicator), battery voltage, time, date, latitude, and longitude information with every data transmission.

Applications include;

- •Water resource management
- • Soil monitoring
- • Golf course / sports turf
- • Aquaculture/Agriculture
- • Mining

- • Tanks
- • Bioremediation
- • Tidal and port systems
- • Environmental and climate monitoring
- • Any RS232 to Cellular M2M communication

For additional information about the Stevens Cell-Net, please visit the www.stevenswater.com or call Stevens at (800) 452-5272.

2. Technical Specifications

2.1 Features

RF Module
TELIT LE910-NA1
FCC ID: Rl7LE910NAV2
TAC: 35605210

Frequency Band
TX: 824-849MHz; 1850-1910MHz; 1710-1780MHz
RX: 869-894MHz; 1930-1990MHz; 2110-2180MHz

Transmission Power
0.229W max. (850MHz)
0.232W max. (1900MHz)
0.205W max (1700MHz)

Power Input Voltage
10 to 18 Volts DC
Current Consumption
TX: 300 mA
RX: 150 mA
Idle: <2 mA

LED Indicators
(See appendix for LED behavior definition)
Power: indicates power to the unit
GPS: indicates a GPS location fix
Cell: indicates state of its connection to the tower.
BIST: Built-In Self-Test

Ports
RS-232 for M2M communication
USB A for connection to computer for configuration
SMA connection for cellular antenna
SMA connection for GPS antenna

Unit Weight (without antenna)
10.78 ounces
305.6 g

Dimensions (H x L x W)
1 3/8 x 5 1/8 x 3 ¾ inches
3.5 x 13 x 9.7 cm

Each Stevens Cell-Net includes power cable with flying leads, dipole dual band cellular 800/1900 MHz antenna,and a USB cable for configuration.
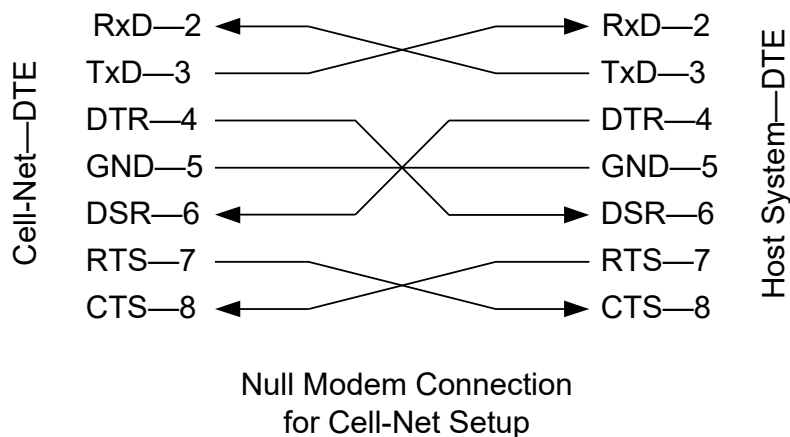
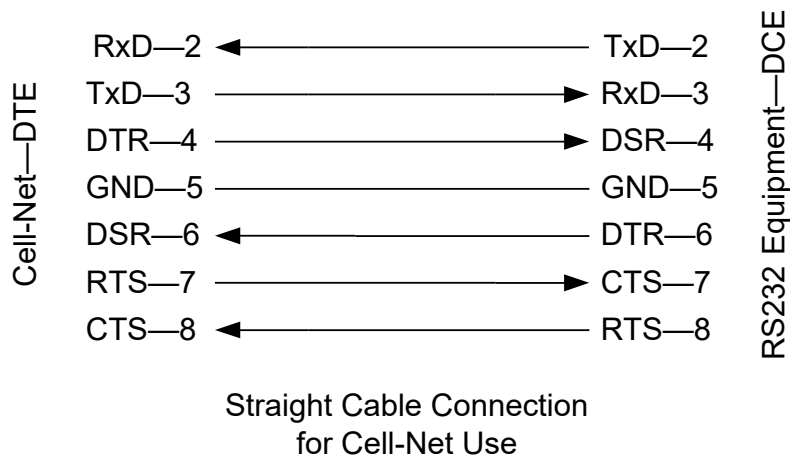| Items sold separately	
Part Number	Item
93688	Cable, Comms, Universal DB9 Female
93942-009	SMA to SMA Bulkhead connector for GPS antenna.
93744	Cable, RS232, black, 3 ft.
93777	Antenna, ruggedized, 900Mhz, 3DB, whip with N Female
92824-002	Cable Assy, cell modem to bulkhead, N to SMA, 2 ft.
51108	GPS Antenna, with 5 meters cable SMA connector.
92845-010	LMR400, N-to-N, Antenna Cable length per 10 feet
93772	Antenna, 900 Mhz, 9DB, Yagi with N Connector
93950-108	Antenna, Wide-Band Yagi, 9dB, with N Connector

2.2 LED Indicators

The power LED blinks continuously if the modem is powered. The GPS LED stays on while it is getting a GPS fix goes off once it gets its fix. The Cell LED will flash red while it is in contact with the tower. The BIST (Built-In Self-Test) LED indicates if there is a problem after a power-on self-test sequence. Please refer to appendix A for a detailed explanation of LED behavior.

2.3 Comm Port Pin-out

```
Cell-Net—DTE                                          Host System—DTE

        RxD—2  ◄──────────╲  ╱──────────►  RxD—2
        TxD—3  ───────────╳───────────  TxD—3
        DTR—4  ───────────╲             DTR—4
        GND—5  ────────────╳───────────  GND—5
        DSR—6  ◄───────────╱──────────►  DSR—6
        RTS—7  ───────────╲  ╱──────────  RTS—7
        CTS—8  ◄──────────╱  ╲─────────►  CTS—8
```

Null Modem Connection
for Cell-Net Setup

Stevens Cell-Net is a DTE, Use this pinout configuration when connecting the serial comm port to another DTE such as a computer. Note that you will need a null modem cable or a null modem with a straight through cable to connect to a computer through the serial port.

```
Cell-Net—DTE                                     RS232 Equipment—DCE

        RxD—2  ◄─────────────────────  TxD—2
        TxD—3  ─────────────────────►  RxD—3
        DTR—4  ─────────────────────►  DSR—4
        GND—5  ─────────────────────  GND—5
        DSR—6  ◄─────────────────────  DTR—6
        RTS—7  ─────────────────────►  CTS—7
        CTS—8  ◄─────────────────────  RTS—8
```

Straight Cable Connection
for Cell-Net Use

Stevens Cell-Net can be connected to a DCE such as a data logger or any other RS232 device using a straightthrough cable.

3.0 Cell-Net-Set Software

The Stevens Cell-Net can be configured with Cell-Net-Set software. Cell-Net-Set Software can be loaded from the CDthat accompanied the shipment of this product.

3.1 Cell-Net Setup

Once Cell-Net-Set Software is installed on the computer, and the Stevens Cell-Net modem is properly poweredwith a 12 volt DC source, connect a USB cable between the modem and the computer.

3.2 Connecting to the modem
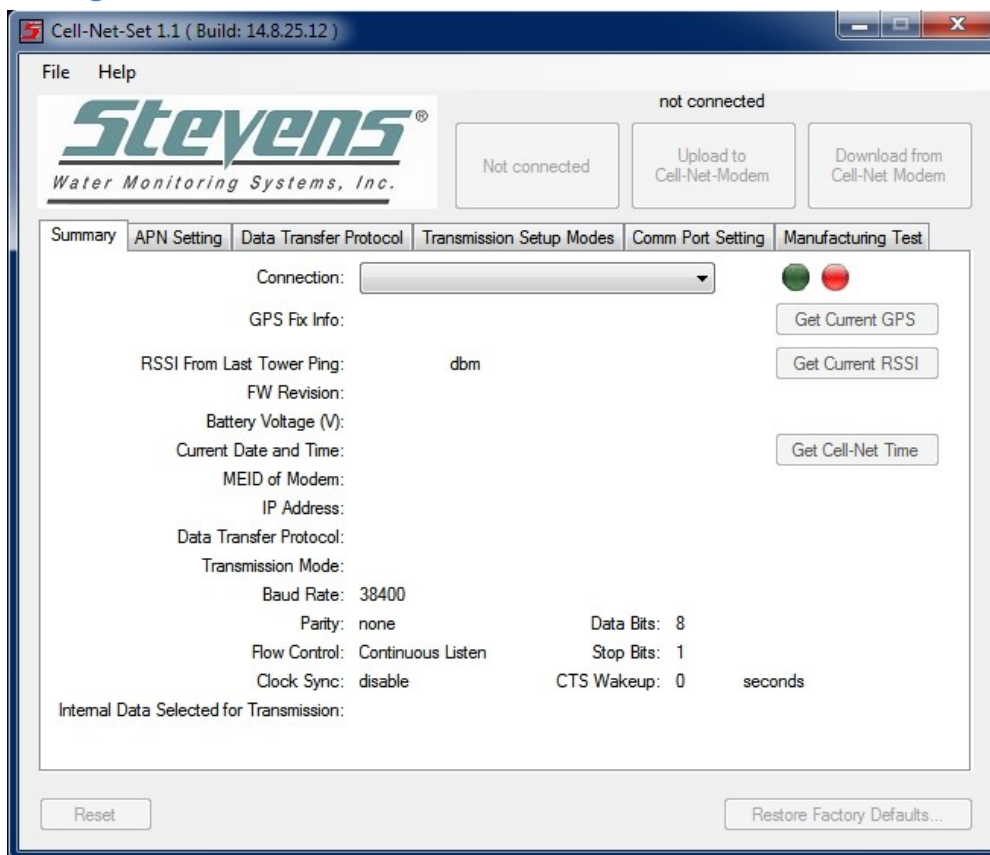
When the software is first opened, the "Go Online/Go Offline" Button (see section 4) will say that it is not connected near the top. In the summery tab, click the down arrow in the connection box. If the modem is connected through the USB, the MEID or IMEI of the connected modem will appear. In this example, the IMEI number is 354660047225845, but will be different for every modem.

Note: The Connection field will be "greyed out" until USB enumeration has taken place. After which, the pull-down menu will be available. **This can take up to 1 minute after power up**.

3.3 Summery Tab while configuring the modem
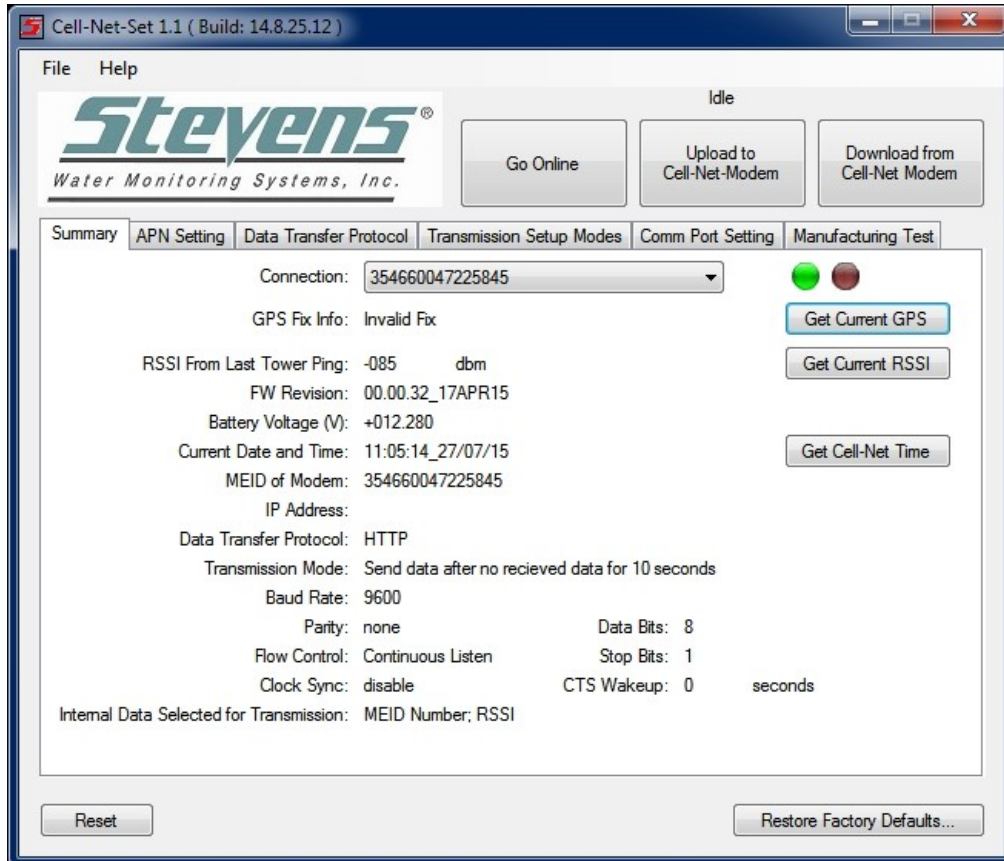
By clicking on the MEID or IMEI number in the connection box, the modem is connected. The term "Idle" will appear at the top of the window.

The file menu in the top left hand Conner of the window will allow the user to save a configuration. The user may also load a configuration that is saved to the hard drive location on the local machine. This will allow users to conveniently put the same configuration on multiple modems. The Help menu in the software contains a subset of the information that is in this manual.

"GPS Fix Info:"

If there is no GPS Fix, then this field will say "Invalid Fix". If the modem has a GPS Fix, the longitude and latitude in WGS84 decimal degrees is displayed. The modem will not get a GPS fix if it does not have a GPS antenna. However, the modem will still function normally without the GPS clock and position fixes. The Cell-Net time will default to cellular network time.

"Get Current GPS" Button

Pressing the GPS Button will update the GPS Fix Info field, as long as a GPS antenna is connected and

sufficient time is given to get a GPS fix. 90 seconds is a typical time for this if there is a clear view of the sky.

<u>"RSSI From the last tower ping"</u>
The RSSI is the received signal strength index between the modem and the cell tower. It is the log of the received power in Watts. The measurement unit for RSSI is dbm. The RSSI can range from -51 to -113 dBm.

GSM		
RSSI dBm	Units	Quality
-51	dBm or more	Excellent
-53	dBm	Excellent
-55	dBm	Excellent
-57	dBm	Excellent
-59	dBm	Excellent
-61	dBm	Excellent
-63	dBm	Excellent
-65	dBm	Good
-67	dBm	Good
-69	dBm	Good
-71	dBm	Good
-73	dBm	Good
-75	dBm	Good
-77	dBm	OK
-79	dBm	OK
-81	dBm	OK
-83	dBm	OK
-85	dBm	Marginal
-87	dBm	Marginal
-89	dBm	Marginal
-91	dBm	Marginal
-93	dBm	Marginal
-95	dBm	Marginal
-97	dBm	BAD
-99	dBm	BAD
-101	dBm	BAD
-103	dBm	BAD
-105	dBm	BAD
-107	dBm	BAD
-109	dBm	BAD
-111	dBm	BAD
-113	dBm	BAD
???	not detected	very BAD

The chart above can be used to interpret the RSSI for trouble shooting purposes.

If the RSSI becomes marginal or bad in the chart, it may indicate a problem with the antenna. If the RSSI is marginal or bad, check to see if the antenna screw connection is tight. A low RSSI can also indicate a bad location for the Stevens Cell-Net in relation to the nearest cellular tower. An antenna with higher gain mightbe necessary. See the table in section 2.1 for higher gain antenna options.

"Get Current RSSI" Button
This button updates the RSSI information. It is useful for trouble shooting poor cell coverage areas or antenna issues.

"FW Revision"
This field displays the revision number of the firmware programmed into Stevens Cell-Net.

 "Battery Voltage (V)"
This field displays the level of the power source the modem is connected to in volts. 12 volts is typical.

"Current and Date and Time"
This field displays the current date and time on the modem.

"Get Cell-Net Time" Button
This button will update the date and time field above.

"IP Address"
This field shows the IP address of the modem. It may be dynamic or static depending on the data plan.

"Data Transfer Protocol:"
This field describes the protocol Cell-Net is programmed to use. It will say HTTP, FTP or Both. Use the Data Transfer protocol tab to change this as described in section 3.5.

"Transmission Mode"
This field will state the relevant transmission mode conditions of the Data Transfer Protocol programmed into Stevens Cell-Net. To edit these modes, use the Transmission Setup Modes tab as described insection 3.6.

The Serial Port Properties; Baud Rate, Party, Flow Control, Data Bits, Stop Bits, are displayed. The serial port settings are setup using the Comm Port Setting tab and described in section 3.6.

"Clock Sync"

This field shows whether the feature Clock Sync is disabled or enabled for use. It is described in section 3.7 for the Comm Port Setting tab.

"CTS Wakeup"

This field shows if the modem is using CTS to wake up a logger or device through its RS232 port. It is described in section 3.7 for the Comm Port Setting tab.

"Internal Data Selected for Transmission:"

This field shows the header information the modem is programmed to send, See Transmission Setup Modes tab in section 3.6.

"Reset" Button

The reset button recycles power on the modem and will perform its BIST (Built-In Self-Test) and enumerate the USB again just like when the device is first powered.

"Restore to Factory Defaults" Button

This button returns the modem to its factory defaults. The cellular data plan is associated with the MEID or IMEI number which cannot be changed; therefore hitting the reset button will have no effect on the cellular data plan.

3.4 APN Setting – Using GSM Model
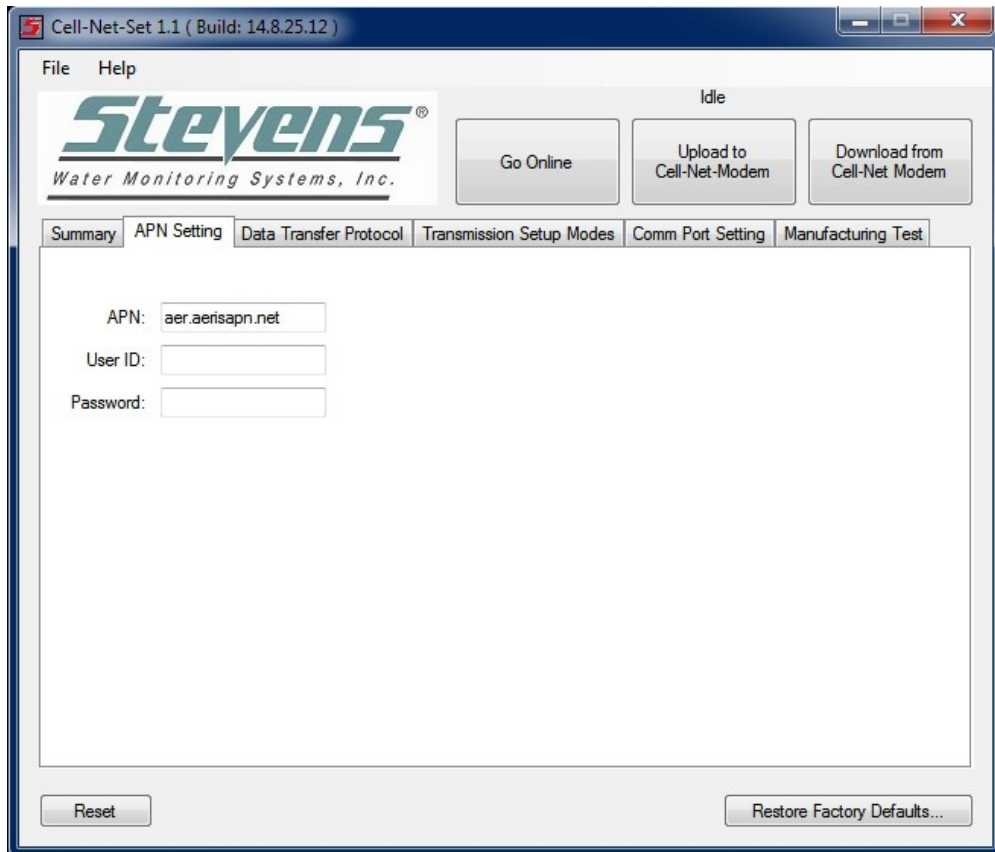
In this tab, you can set the APN (Access Point Name) User ID, and Password for the Cellular network associated with the installed SIM (subscriber identity module) card. Many times a User ID and Password is not needed. In this case, leave these fields blank.

Hit "Upload to Cell-Net-Modem" to apply these changes.

3.5 Data Transfer Protocol Tab

In the data transfer protocol tab, the destination to either an FTP, HTTP or Both HTTP & FTP can be configured.

"Data Transfer Protocol"

In this field, select the type of destination, FTP, HTTP or Both HTTP & FTP.

This page has two sections. On the right, the FTP protocols are entered, and on the left, the HTTP protocols are entered. If FTP only is selected with the drop-down menu, the HTTP section will be grayed out and likewise if the HTTP only is selected. If Both HTTP & FTP are selected, the user can enter both the FTP and the HTTP protocols in the proper fields.

3.5.1 HTTP Setup

"Target Domain OR IP Address. Folder/File name, and Port" for HTTP

Enter the target domain in the field. The target domain can be a .com web address (for example; www.yourdomain.com) or an IP address (for example 012.345.678.910).

The "Test HTTP Message" Button, if pressed will send a test message to the destination written in these fields and uploaded to Stevens Cell-Net modem. The test message is an information string. An example of the test message is:

A10000,32B89CE4_____1403180213251700_132517.000,,,,,0,,,,180314,_0_____

The "A10000,32B89CE4" is the unique MEID number for the modem. The "1403180213251700" string is the time and date of the test message, which in this example is March 18th 2014 at 1:25:17 pm. The other digits and characters are parameters of the GPS satellite fix.

3.5.2 FTP Setup

"Target Domain OR IP Address. Folder/File name, and Port" for FTP

Enter the target domain in the field. The target domain can be a .com web address (for example; www.yourdomain.com) or an IP address (for example 012.345.678.910).
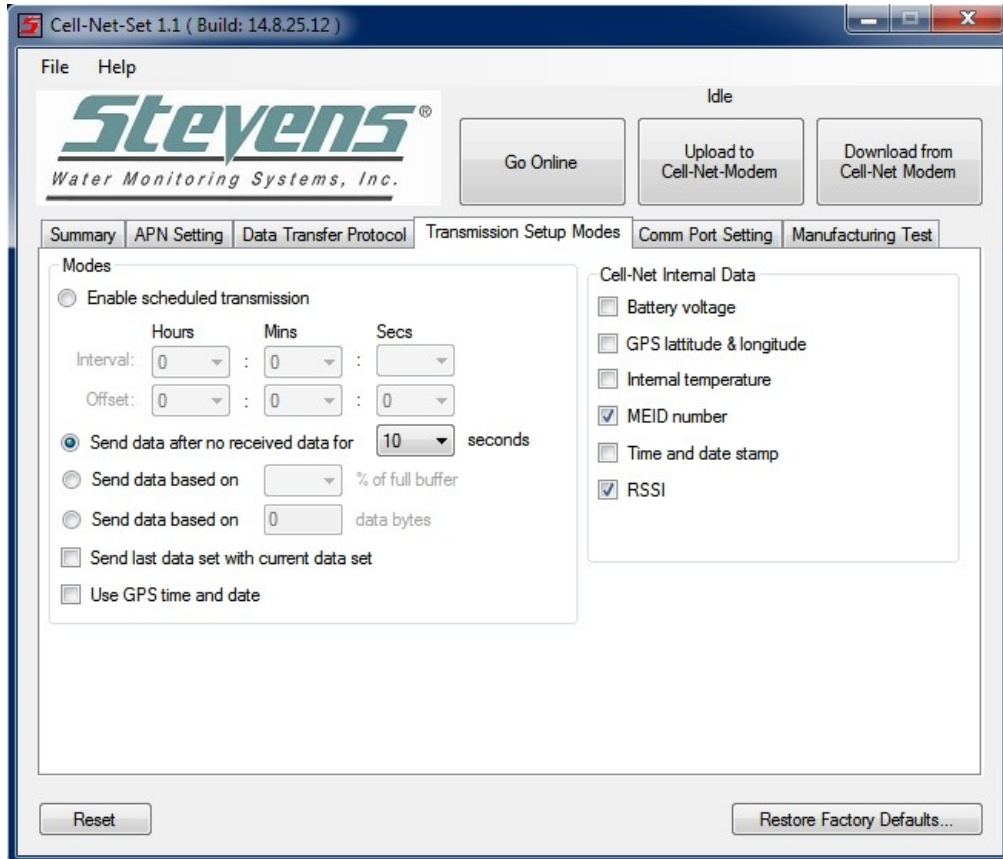
Enter the user name and password associated with the FTP site in the proper field.

The "Test FTP Message" Button, if pressed will send a test message to the destination uploaded from these fields. The test message is an information string. An example of the test message is:

A10000,32B89CE4   1403180213251700 132517.000,,,,,0,,,,180314, 0

The "A10000,32B89CE4" is the unique MEID number for the modem. The "1403180213251700" string is the time and date of the test message, which in this example is March 18th 2014 at 1:25:17 pm. The other digits and characters are parameters of the GPS satellite fix.

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3.6 Transmission Setup Modes Tab

In the Transmission Setup Modes Tab, the user can select and control the data transmission criteria.

There are 4 modes that are selectable on the left side of the window. These modes will help the user conserve power consumption as well as control the amount of data sent over the cellular channel, which in turn helps keep the data plan cost from getting out of control.

"Enable Scheduled Transmission"
Select this option if you need the modem to automatically send the information in its data buffer on a regular time interval. For example, if this is enabled with an interval of 1 hour and an offset of 15 minutes, the modem will send all data in its buffer 15 minutes after every hour. Any data the modem receives during this reporting interval will be stored in a buffer that holds up to 8k bytes.

"Send data after no received data for   Seconds"
Select this option if you need the external device to be in control of when the data gets transmitted. If this transmission mode option is selected, the modem will send the data when it receives it after a selectable time delay. This allows users to continue to fill the buffer even if there are gaps in time for

data sets. Just set the delay time for something greater than the largest gap in the data set. The buffer will hold 8k bytes.

<u>"Send data based on % of full buffer"</u>
In this field, the user can select the % of full buffer before the modem transmits the data in its buffer. Since the buffer holds 8k bytes, if 1% is selected, the modem will transmit the data once 82 bytes are received.

<u>"Send data based on ___ data bytes"</u>
In this field, the user can select the exact amount of data in bytes before the modem transmits the data in its buffer. Since the buffer holds no more than 8k bytes, the user must be sure to not overrun this as well as be absolutely sure of the amount of data being sent from the externally connected device to appropriately use this transmission mode.

<u>"Send last data set with current data set"</u>
This option enables data redundancy. If selected the previous data string will be included in the current data string. This is used to insure that the data makes it to its destination if a data drop out occurs.

<u>"Use GPS Time and Date"</u>
If this is selected, the modem will update its clock with the time it gets from the GPS satellite given in UTC time.

<u>"Cell-Net Internal Data"</u>
The modems internal data can be set to prepend the data every time there is a transmission. The user can select all of the parameters of interest or have none selected. The user has a choice of Battery Voltage, GPS latitude and longitude, internal temperature, MEID, date and time stamp, and RSSI. For example, if all of the parameters are checked and the data is "My_Data123456" the data string will look like this:

MEID=A10000,32B89CE4,
 TIME=23:07:26,
 DATE=18/03/14,
 RSSI=-081,
 BATT= 011.845,
 TEMP= 027.683,
 LATT=4534.1007N,
 LONG=12232.1531W,
 My_Data123456

3.7 Comm Port Setup

The user can set up the RS232 comm port on the modem with the baud rate, data bits, parity, stop bits, and flow control. It is very important to note that the modem's comm port needs to have the same setup as the connected device's comm port. Flow control can be set to continuous listen or CTS Trigger mode. If the modem is in continuous listen mode, the logger or device can send the data to the modem any time and the modem will hold the data in the buffer until it transmits the message. In CTS Trigger mode, the CTS (Clear to Send) pin on the DB9 connector will assert high for a selectable number of seconds (CTS Wakeup) to wake up and ask the logger or device for its data.

The Clock Sync can be enabled or disabled. If enabled, the logger or connected device can send the command "A6" (in HEX) to the modem. The modem will report back the time and date to the logger in BCD (binary coded decimal) format.

3.8 Manufacturing Test Tab.

This tab is used for testing and configuration by the factory. It is password protected.

3.9 Go Online/ Go Offline Button

At the top of the software page located above the tabs, the first button is the "Go Online/Go Offline" Button. When the software is first opened, the button will say "Not Connected" and the text "Not Connected" will appear on the very top of the main window. Once the modem is connected, the "Go Online/Go Offline" button will say either "Go Online" or "Go Offline". If the modem is offline, the user can click the button to go online and vice-versa if the modem is offline. If the Modem is online, it will transmit data to the cell tower in accordance to how it was configured in the transmission setup modes tab described in section 3.6. Navigation to the other tabs is suspended while the modem in online. If the user wants to make changes to the modem's configuration, the modem will have to be taken offline. Note that in order for the modem to receive a new configuration, the "Upload to Cell-Net Modem" button needs to be clicked to apply changes made in each tab (See Section 5.2).

4.0 Configuration File Management.
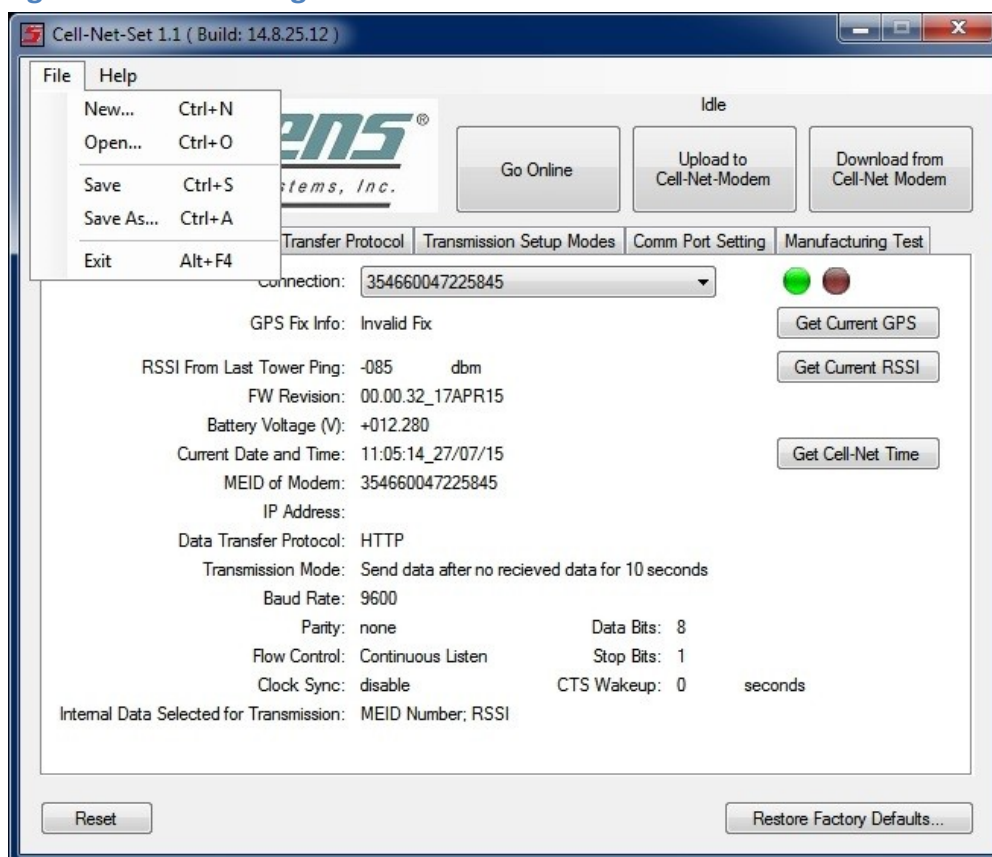
4.1 File Menu

The File menu allows the user to save and open configurations. This feature is useful if a large number of modems need to be setup with the same configuration, or if the user wants to keep a record of the configurations on individual modems. Note that in order for the modem to receive a new configuration, the "Upload to Cell-Net Modem" button needs to be clicked to apply changes made in each tab (See Section 4.2).

4.2 Uploading Configuration to Cell-Net Modem

After changes to the modem's configuration have been made in the software (see section 3) the new configuration needs to be uploaded to the modem so that the modem can be deployed with the new settings. This is done by pressing the "Upload to Cell-Net Modem" button located near the top of the window. The modem does not need to be reset or repowered to receive or use a new configuration.

4.3 Downloading from Cell Modem

If the user wants to download the configuration that currently resides on the modem, the "Download from Cell-Net Modem" button needs to be clicked. This button is located near the top of the window. By clicking this button, the modem's configuration populates the software fields.

5.0 Trouble Shooting

5.1 How do I know if the data is getting to the modem from the device?

-Double check the comm port settings. The comm port Settings of the modem need to match that of the device.

-Make sure the pin outs match. The Stevens Cell-Net comm port is a male DTE nine pin RS232 DB9. That means you would need a null modem between the computer RS232 port and the modem. You may not need anull modem if it is connected to a logger or device that is a DCE.

-One way to test the communication would be to open a terminal session such as Hyper-Terminal, type out a text message and send it to the modem. This can mimic a logger. The user can also use the send test message feature in the data transfer tab (see section3.4)

5.2 What if the modem works during the day but not at night?

-If it is operating on a solar powered system, check the battery or the power system. There might be a blown fuse in the power system. Use a hand held volt meter to check the voltage going to the modem. It should be 12 volts. The battery voltage can also be put into the header of the transmission.

5.3 What if the software freezes up?

Reboot the computer, and restart the software. Recycle power on the modem.

5.4 What do I do if there is poor coverage from the cell tower?

The RSSI will indicate the quality of the coverage. It is on the main page in the software and can be put in the header. See section 3.3. The Modem has an SMA connector. A higher gain antenna can be used. You may need an SMA to Type N Bulk head connector (Part Number 92824-002) an N to N cable (92845-010) and a higher gain antenna. See table in section 2.1.
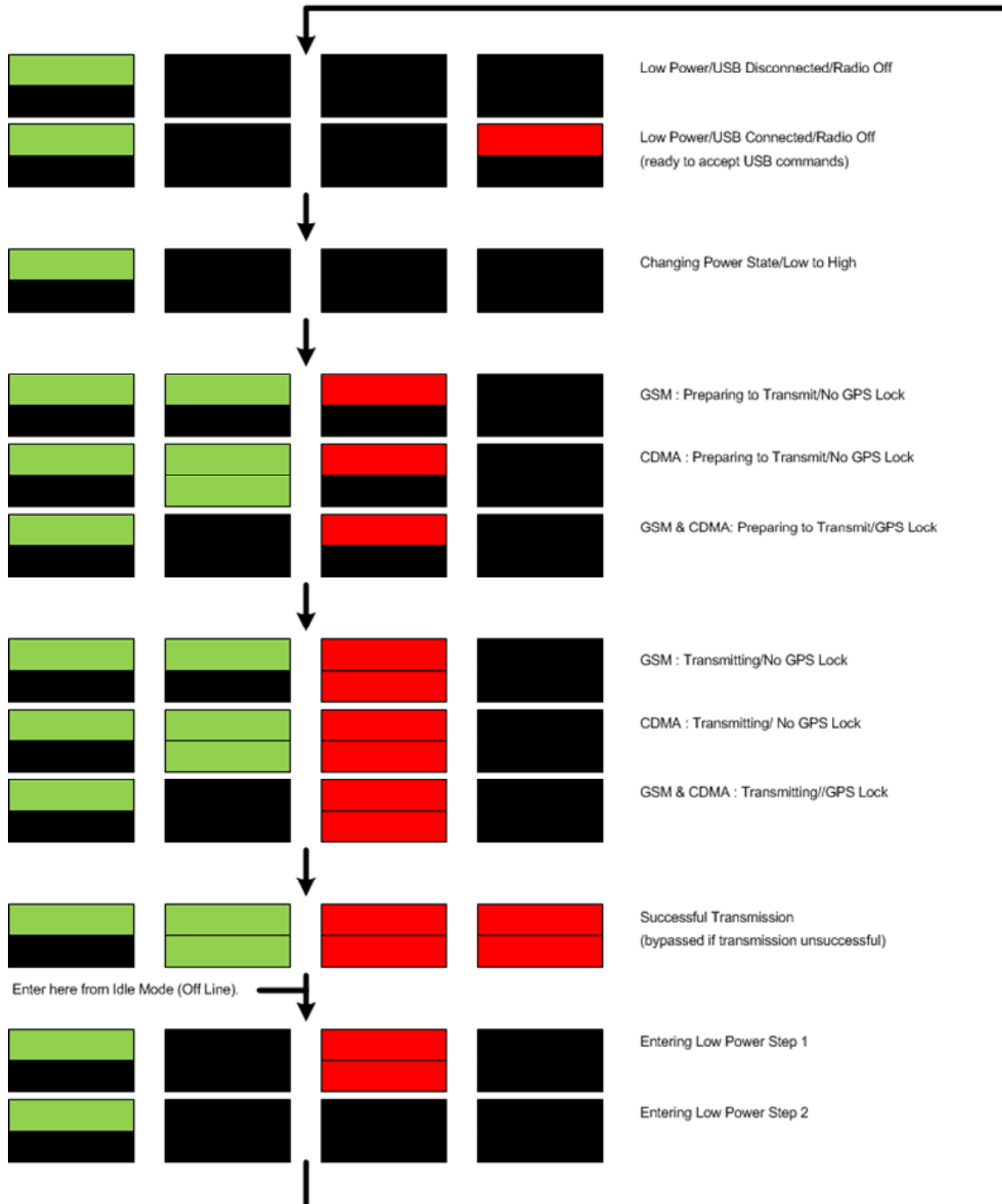
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6.0 Appendix I – LED Behavior Described

LED INDICATIONS: DEPLOYED MODE

Low Power/USB Disconnected/Radio Off

Low Power/USB Connected/Radio Off
(ready to accept USB commands)

Changing Power State/Low to High

GSM : Preparing to Transmit/No GPS Lock

CDMA : Preparing to Transmit/No GPS Lock

GSM & CDMA: Preparing to Transmit/GPS Lock

GSM : Transmitting/No GPS Lock

CDMA : Transmitting/ No GPS Lock

GSM & CDMA : Transmitting//GPS Lock

Successful Transmission
(bypassed if transmission unsuccessful)

Enter here from Idle Mode (Off Line).

Entering Low Power Step 1

Entering Low Power Step 2

CELLNET either remains in Deployed Mode (On Line). CELLNET changes to Idle Mode (Off Line) upon receiving GUI command.