

Solar-Current.com

Furl-Kit WT2012 v2

with the
Solar-Array Supervisor for Windows 7
Product Manual v1.2

John Rucker

Furl-Kit Overview

Solar-Current.com's Furl-Kit adds intelligent self-preservation and remote management to residential two axis sun tracking solar arrays. The Furl-Kit is designed to be easy to install and provide comprehensive management of your Solar-Array.

Once a Solar-Array has been retrofitted with the Furl-Kit Array CPU it will have the intelligence to automatically place itself into a self-preservation mode (Furled Mode or Wind Park Mode) during high wind conditions. Once a Solar-Array has entered Furled Mode it will remain there until the Array mounted CPU detects the winds have diminished and it is safe to return to normal operation. With multiple Solar-Arrays (Solar-Array Farm) each array in the farm is fitted with a Furl-Kit providing independent intelligence to monitor the environment and Furl as required.

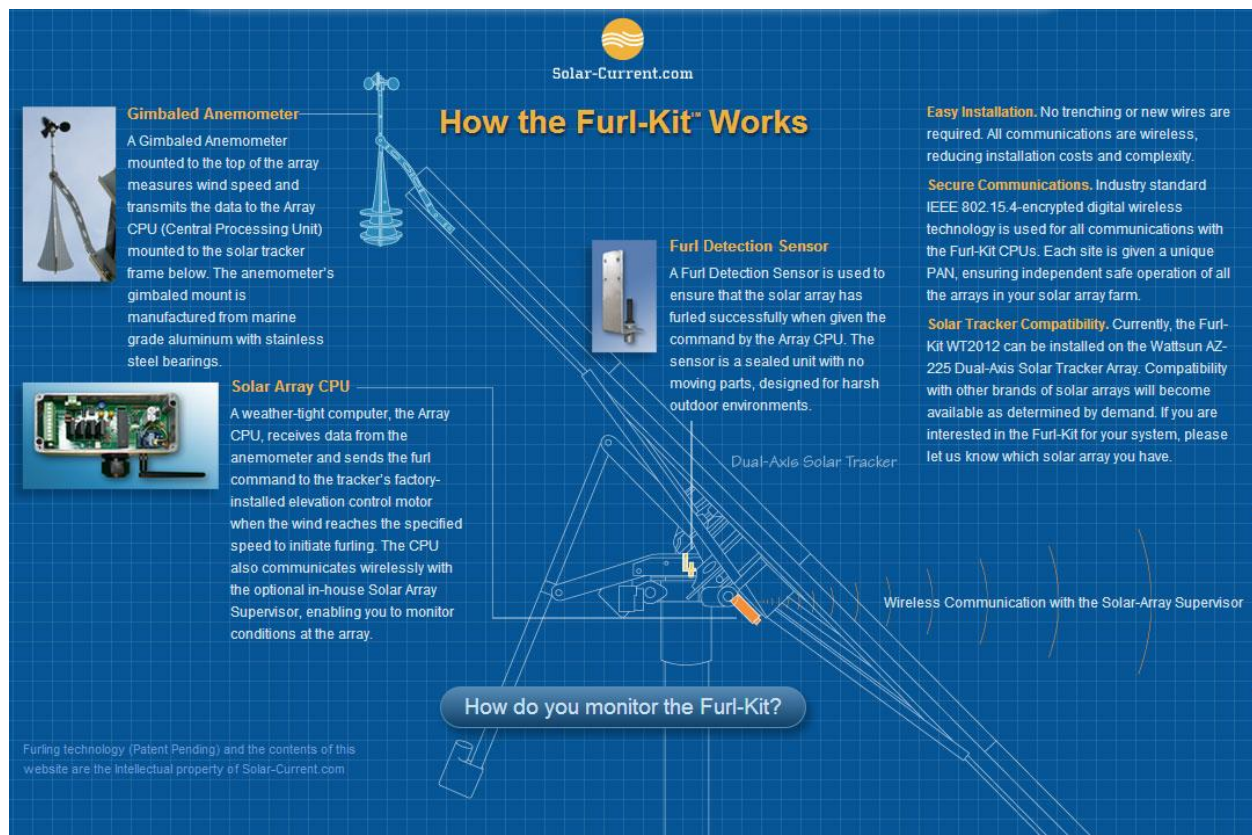


Figure 1 How the Furl-Kit Works

Contents:

| | |
|---|----|
| System Components | 4 |
| Furl-Kit Array CPU | 4 |
| Solar-Array Supervisor for Windows 7 | 5 |
| Solar-Array Supervisor for Windows 7 in Detail | 6 |
| Solar-Array Supervisor for Windows Data Grid | 7 |
| Solar-Array Supervisor for Windows 7 Menu Commands | 10 |
| Session Communication Setup | 10 |
| Session Open & Session Close | 10 |
| Session Logging | 11 |
| Session Chart | 11 |
| Furl-Kit Administration Select Furl-Kit S/N to Administrate | 12 |
| Furl-Kit Administration Reset Daily High at Midnight | 13 |
| Furl-Kit Administration Furl all Arrays if one or more detect high wind | 13 |
| Furl-Kit Administration Save Solar Array Table | 13 |
| Furl-Kit Command Confirmation Window | 14 |
| View Command Status Window | 14 |
| Session Log and Command Buttons | 16 |
| Command Buttons | 16 |
| Charting | 18 |
| Installation and Setup | 21 |
| Solar-Array Supervisor for Windows 7 Installation | 22 |
| Site Preparation | 22 |
| Solar-Array Supervisor for Windows 7 Step by Step | 22 |
| Furl Kit CPU Installation | 25 |
| Site Preparation | 25 |
| Setup Discussion | 26 |
| Furl-Kit CPU Step by Step | 28 |
| Troubleshooting | 34 |
| Limited Warranty | 35 |

Table of Figures:

| | |
|--|----|
| Figure 1 How the Furl-Kit Works | 1 |
| Figure 2 Furl-Kit Array CPU | 4 |
| Figure 3 Gimbaled Anemometer | 4 |
| Figure 4 Solar-Array Supervisor for Windows 7 | 5 |
| Figure 5 Supervisor Main Windows | 6 |
| Figure 6 Data Grid | 7 |
| Figure 7 Communication Setup Menu | 10 |
| Figure 8 Delay Packet Multiplier Menu Setting | 11 |
| Figure 9 Chart Time in Hours Menu Setting | 12 |
| Figure 10 Select Furl-Kit S/N to Administrate Menu | 12 |
| Figure 11 Furl-Kit Command Confirmation Window | 14 |
| Figure 12 Session Log | 16 |
| Figure 13 Wind Speed in Real Time Chart | 18 |
| Figure 14 Wind Speed Over 24Hrs. Chart | 19 |
| Figure 15 Signal Strength Over 24Hrs. Chart | 20 |
| Figure 16 Multi Array Installation | 21 |
| Figure 17 Solar-Array Supervisor for Windows 7 Laptop | 21 |
| Figure 18 USB RF Modem | 22 |
| Figure 19 Data Grid with Current status = 1 Hr. Furl | 24 |
| Figure 20 Wiring diagram before Furl-Kit install | 26 |
| Figure 21 Wiring diagram after Furl-Kit install | 27 |
| Figure 22 Furl-Kit CPU mounting holes | 28 |
| Figure 23 Furl Sensor bracket for Hall Effect Sensor and Magnet Location | 29 |
| Figure 24 Anemometer | 30 |
| Figure 25 Elevation Actuator | 31 |
| Figure 26 Furl-Kit CPU inside lid markings | 32 |

System Components

A Complete Furl-Kit solution consists of two major components: the Solar-Array Supervisor and a Furl-Kit Array CPU mounted to each Solar Array in the farm. The Solar-Array Supervisor is optional and not required for the Furl-Kit Array mounted CPU to function.

Furl-Kit Array CPU

The Furl-Kit Array CPU consists of three basic components:

1. Array CPU
 - a. Weather tight computer mounted outside on each Solar-Array in the farm.
 - b. Monitors the array mounted anemometer to observe wind speed at each array.
 - c. Connects to the Solar-Array's factory installed elevation control motor leads.
 - d. Monitors the furl detection switch to insure array is properly functioning.
 - e. Wirelessly communicates with the optional in-house Solar-Array Supervisor.
2. Gimbaled Anemometer
 - a. Mounted to the top of the array and connects to the Array CPU.
 - b. The gimbaled mount for the anemometer is manufactured from marine grade aluminum with stainless steel bearings.
 - c. The anemometer is placed at the highest point on the array providing the best access for detecting damaging wind.
3. Furl Detection Sensor
 - a. The Furl Detection Sensor is used to insure the Solar-Array has successfully furled when instructed to by the Array CPU.
 - b. The Furl Detection sensor is a sealed unit with no moving parts designed for harsh outdoor environments.



Figure 2 Furl-Kit Array CPU

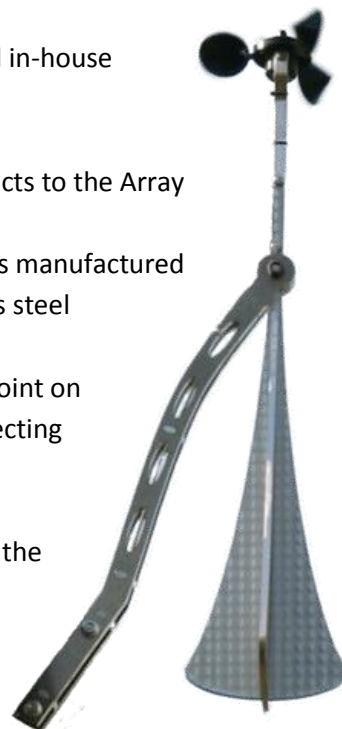


Figure 3 Gimbaled Anemometer

Furl-Kit Array CPU

The Furl-Kit Array CPU can be purchased as a stand-alone unit (no wireless communications) or part of a complete solution with wireless control from the in-house Solar-Array Supervisor. Regardless of the configuration, the Furl-Kit Array CPU does not have user configurable switches or jumpers. Once installed, the CPU continually samples the wind and will automatically furl the array during high-wind. The Furl Wind speed is set to 30mph at the factory. The CPU also conducts a weekly self-test of the furling circuit and elevation motor to insure proper operating conditions.

Solar-Array Supervisor for Windows 7

The Solar-Array Supervisor for Windows 7 is an optional application that monitors and controls each Furl-Kit in the Solar-Array farm. The Solar-Array Supervisor for Windows 7 requires an USB RF modem to wirelessly communicate with each Furl-kit mounted CPU over an encrypted IEEE 802.15.4 digital network.



Solar-Array Supervisor for Windows 7 Key Features:

1. The Solar-Array Supervisor for Windows 7 is easy to setup and use. The Supervisor will allow you to initiate a one hour furl or a one hour snow dump with the push of a button.
2. The Solar-Array Supervisor wirelessly communicates with each Solar-Array CPU to securely send and receive telemetry over an encrypted 802.15.4 network. The wireless modules operate within the ISM 2.4 GHz frequency band and do not require a special FCC License. The modules have a range of 300' in a congested setting, to 1 mile with clear line of sight. Each installation is setup on a unique PAN (Personal Area Network) to insure no interference from other nearby Furl-Kit installations.
3. The Solar-Array Supervisor for Windows 7 monitors your array's data stream to insure your Furl-Kit is operating within specs. If an error is observed, an audible beep is played and a time stamped log entry is shown in the Session Log. Wind data is graphed in real time from each of your arrays.

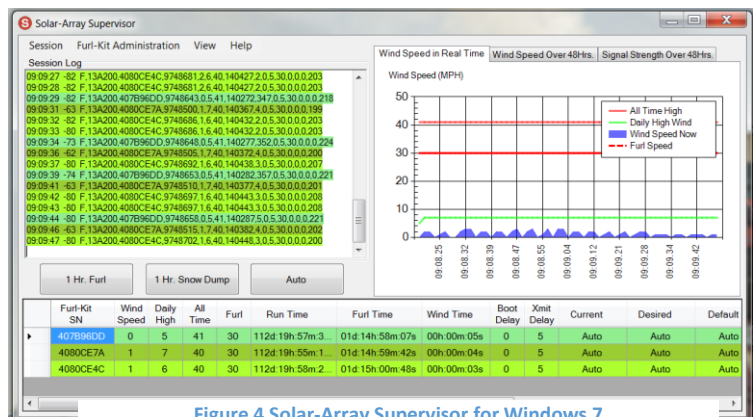


Figure 4 Solar-Array Supervisor for Windows 7

Solar-Array Supervisor for Windows 7 in Detail

The Solar-Array Supervisor's screen will display the operating status of all the Solar-Arrays in the farm, as well as, the current wind speed. If an error is detected with the system, an error message will be displayed.

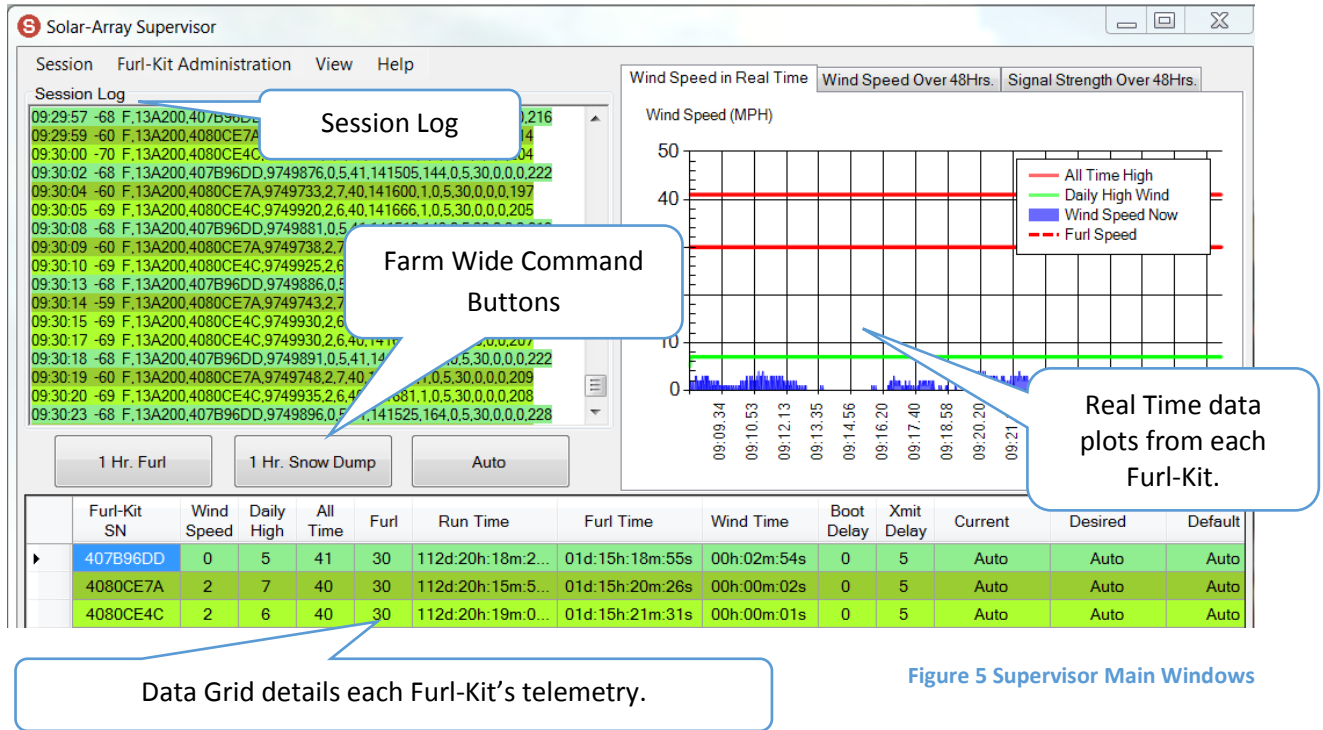


Figure 5 Supervisor Main Windows

Solar-Array Supervisor for Windows Data Grid

The data grid at the bottom of the screen contains details from each Furl-Kit in the PAN. The data grid information will continually update as new data is received from each Furl-Kit. Each line in the data grid will be color coordinated to match the data packet displayed in the Session Log (Robust Logging must be enabled).

Figure 6 Data Grid

| Furl-Kit SN | Wind Speed | Daily High | All Time | Furl | Run Time | Furl Time | Wind Time | Boot Delay | Xmit Delay | Current | Desired | Default | Packets | Low | RSSI | High | Last Packet |
|-------------|------------|------------|----------|------|-------------------|-----------------|-------------|------------|------------|---------|---------|---------|---------|-----|------|------|--------------------|
| 407B86DD | 4 | 6 | 41 | 30 | 112d 23h 06m 5... | 01d 18h 07m 28s | 00h 00m 03s | 0 | 5 | Auto | Auto | Auto | 2590 | -88 | -85 | -59 | 9/25/2013 12:19 PM |
| 4080CE7A | 6 | 8 | 40 | 30 | 112d 23h 04m 3... | 01d 18h 09m 03s | 00h 00m 01s | 0 | 5 | Auto | Auto | Auto | 2491 | -67 | -54 | -50 | 9/25/2013 12:19 PM |
| 4080CE4C | 4 | 7 | 40 | 30 | 112d 23h 07m 3... | 01d 18h 10m 03s | 00h 00m 04s | 0 | 5 | Auto | Auto | Auto | 2432 | -88 | -60 | -56 | 9/25/2013 12:19 PM |

Table 1 Supervisor for Windows Data Grid Column headings in detail

| Data Grid Column | Description |
|------------------|--|
| Furl-Kit SN | This is the Serial number printed on the Furl-Kit CPU lid. It is used to identify the array and is also part of the 802.15.4 address. |
| Wind Speed | Current wind speed from the array in Miles Per Hour. |
| Daily High | The highest wind speed detected over the last 24 hours. This can be reset at Midnight by checking "Reset Daily High at Midnight" under the Furl-Kit Administration dropdown menu. |
| All Time | All time high wind detected by the Furl-Kit CPU. This number is retained through a power cycle or reboot. |
| Furl | This is the wind speed in MPH that the Furl-Kit will furl (go into wind park mode). |
| Run Time | The amount of time since the Furl-Kit CPU has been reset or power cycled. |
| Furl Time | Last time a successful furl was detected. Should always be less than 7 days since each furl-kit does a weekly test. If it is set to all zeros then a furl test has not been run since the last power cycle. |
| Wind Time | Time of last wind reading from the Solar-Array. |
| Boot Delay | Factory set to 0 (random time). This is the time the array will wait after a reset or reboot to start sending its data stream. Each Furl-Kit has a unique delay to prevent them from all broadcasting at the same time after a reboot. |
| Xmit Delay | This is the time in seconds between each data packet broadcast. For small installations (5 furl-kits or less) it is recommended to have this value set to 5. For larger installations it may be necessary to increase the delay to 10 or 30 seconds. This setting can be changed under the Furl-Kit Administration dropdown menu |

| | item. | | | | | | | | | | | | | | | | | | | | | | | | | | |
|----------------------|---|--------|-------------|------|--------------------------------|-----------|--|-----------|---|----------------|---|-----------|--|----------------|--|-----------|--|------------------|--|----------------------|--|---------|---|----------|---|-----------|---|
| Current | <p>This is the current status of each Furl-Kit. The following table details possible status messages.</p> <table> <tr> <th>Status</th><th>Description</th></tr> <tr> <td>Auto</td><td>Normal Full Sun Tracking mode.</td></tr> <tr> <td>Dump Lock</td><td>The Array is in Snow Dump mode (Winter Mode)</td></tr> <tr> <td>Furl Lock</td><td>The Array is in Furl Lock mode (Wind Park Mode)</td></tr> <tr> <td>High Wind Furl</td><td>The Array has successfully furled after high wind was detected at the array</td></tr> <tr> <td>Furl Test</td><td>Successful Furl Test for the array was completed</td></tr> <tr> <td>1 Hr Snow Dump</td><td>The Array has entered a temporary one hour snow dump. This is initiated by pushing the "1 Hr. Snow Dump" button.</td></tr> <tr> <td>1 Hr Furl</td><td>The Array has successfully entered the temporary furl state for 1 hour. This is initiated by pushing the "1 Hr. Furl".</td></tr> <tr> <td>Anemometer Fault</td><td>An error has been detected with the Gimbaled Anemometer on the Solar-Array. This condition must be addressed. Please consult the troubleshooting section of this guide on page 34.</td></tr> <tr> <td>Returning to Default</td><td>The Solar Array has timed out of the temporary one hour snow dump or furl and is returning to the default state.</td></tr> <tr> <td>Furling</td><td>The Solar Array is moving to the furled position.</td></tr> <tr> <td>TestFail</td><td>The furl self-test has failed. Initiate another test and check the array for movement. If not successful, see the troubleshooting section on page 34 of this guide.</td></tr> <tr> <td>FurlError</td><td>A furl error has occurred. Initiate a 1 Hr. furl and check the array for movement. If not successful, see the troubleshooting section on page 34 of this guide.</td></tr> </table> | Status | Description | Auto | Normal Full Sun Tracking mode. | Dump Lock | The Array is in Snow Dump mode (Winter Mode) | Furl Lock | The Array is in Furl Lock mode (Wind Park Mode) | High Wind Furl | The Array has successfully furled after high wind was detected at the array | Furl Test | Successful Furl Test for the array was completed | 1 Hr Snow Dump | The Array has entered a temporary one hour snow dump. This is initiated by pushing the "1 Hr. Snow Dump" button. | 1 Hr Furl | The Array has successfully entered the temporary furl state for 1 hour. This is initiated by pushing the "1 Hr. Furl". | Anemometer Fault | An error has been detected with the Gimbaled Anemometer on the Solar-Array. This condition must be addressed. Please consult the troubleshooting section of this guide on page 34. | Returning to Default | The Solar Array has timed out of the temporary one hour snow dump or furl and is returning to the default state. | Furling | The Solar Array is moving to the furled position. | TestFail | The furl self-test has failed. Initiate another test and check the array for movement. If not successful, see the troubleshooting section on page 34 of this guide. | FurlError | A furl error has occurred. Initiate a 1 Hr. furl and check the array for movement. If not successful, see the troubleshooting section on page 34 of this guide. |
| Status | Description | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Auto | Normal Full Sun Tracking mode. | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Dump Lock | The Array is in Snow Dump mode (Winter Mode) | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Furl Lock | The Array is in Furl Lock mode (Wind Park Mode) | | | | | | | | | | | | | | | | | | | | | | | | | | |
| High Wind Furl | The Array has successfully furled after high wind was detected at the array | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Furl Test | Successful Furl Test for the array was completed | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 Hr Snow Dump | The Array has entered a temporary one hour snow dump. This is initiated by pushing the "1 Hr. Snow Dump" button. | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 Hr Furl | The Array has successfully entered the temporary furl state for 1 hour. This is initiated by pushing the "1 Hr. Furl". | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Anemometer Fault | An error has been detected with the Gimbaled Anemometer on the Solar-Array. This condition must be addressed. Please consult the troubleshooting section of this guide on page 34. | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Returning to Default | The Solar Array has timed out of the temporary one hour snow dump or furl and is returning to the default state. | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Furling | The Solar Array is moving to the furled position. | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TestFail | The furl self-test has failed. Initiate another test and check the array for movement. If not successful, see the troubleshooting section on page 34 of this guide. | | | | | | | | | | | | | | | | | | | | | | | | | | |
| FurlError | A furl error has occurred. Initiate a 1 Hr. furl and check the array for movement. If not successful, see the troubleshooting section on page 34 of this guide. | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Desired | <p>This is the desired state of the array. This can change based on user action. For example if a user pushes the 1 Hr. Furl button the desired status will change to 1 Hr. Furl. The action will be complete when the current state equals the desired state.</p> | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Default | <p>This is the default state the Furl-Kit will return to when the Auto button is pushed, or after a power cycle, or after a command times out like a 1 Hr. Furl.</p> <p>The default state can be set to Auto (Sun Tracking enabled), Furl (Wind Park</p> | | | | | | | | | | | | | | | | | | | | | | | | | | |

| | |
|-------------|---|
| | Position), or Snow Dump (Winter Mode) under the Furl-Kit Administration dropdown menu. |
| Packets | This is a count of the number of valid data packets received from each Furl-Kit. A packet should be received according to the value set in the Xmit Delay. If the value is set to 5 then a packet will be received every 5 seconds causing this counter to increment. |
| Low | This is the lowest signal strength detected by the Furl-Kits RF transmitter since the Solar-Array Supervisor for Windows app was loaded. |
| RSSI | This is the Received Signal Strength Indicator in dBmv. This value is also graphed in the Signal Strength chart. It is common to see the signal strength vary as the arrays follow the sun throughout the day. |
| High | This is the highest signal strength detected by the Furl-Kits RF transmitter since the Solar-Array Supervisor for Windows app was loaded. |
| Last Packet | This is a time stamp of the last good data packet received from a Furl-Kit. This time stamp is used to monitor each Furl-Kit to insure they are on-line and sending good data. |

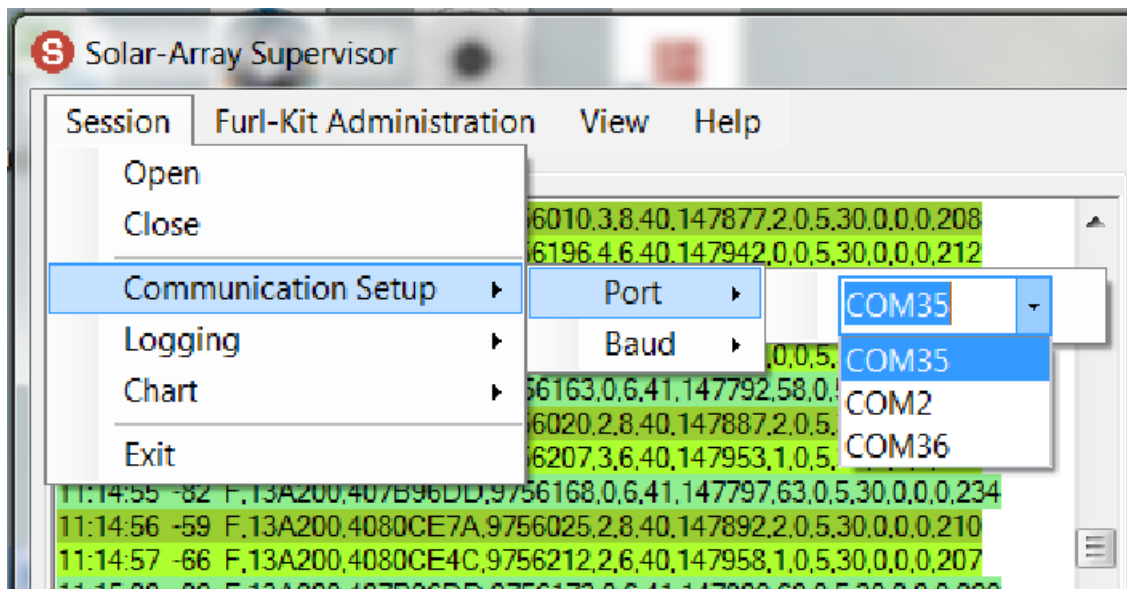
Solar-Array Supervisor for Windows 7 Menu Commands

The dropdown menu bar at the top of the screen presents options for setup and configuration of the Solar-Array Supervisor for Windows application as well as the configuration settings for each of the Furl-Kits.

Session | Communication Setup

The *Session* menu items control and setup communications with the Furl-Kits. The Solar-Array Supervisor for Windows will listen to all Furl-Kits broadcasting on the RF Modem's Personal Area Network (PAN). The RF Modem is connected to the Windows 7 workstation through a USB port and appears as a standard Communications port listed as a COMxx port. In the example shown here the USB RF modem is connected to a USB port showing up as COM35 with a Baud rate of 115,200 bits per second.

Figure 7 Communication Setup Menu



The first step in setting up your Solar-Array Supervisor for Windows 7 is to open the Session menu, click on “Communication Setup” and set the port and baud rate for your RF modem. You should only need to do this once as the settings are saved if you successfully connect to the RF Modem.

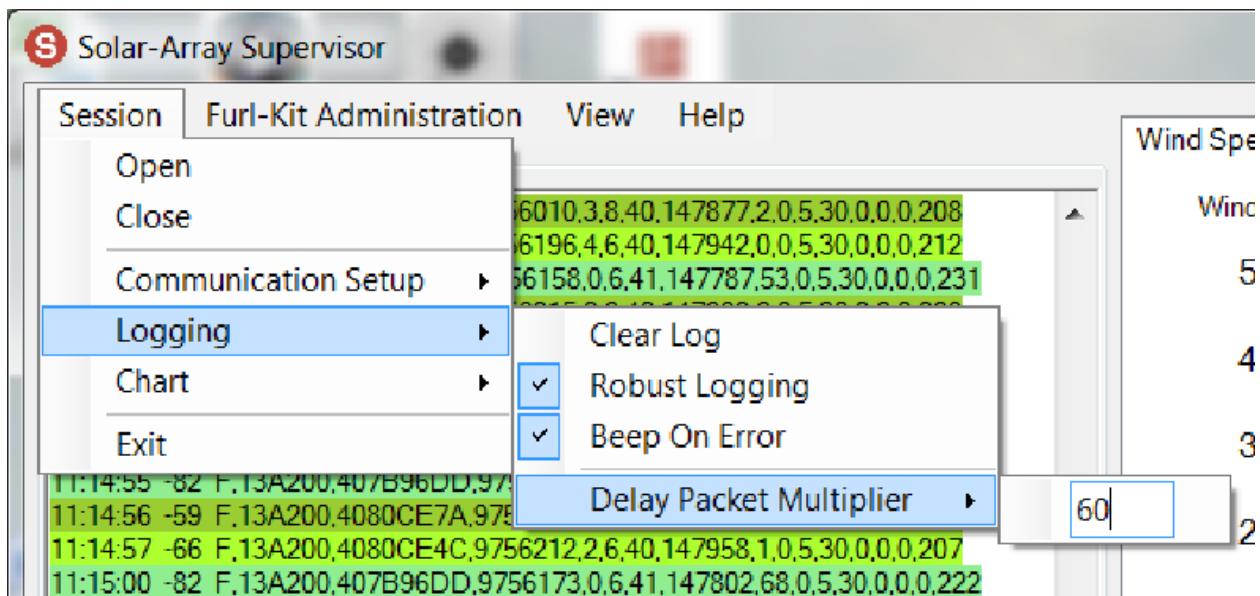
Session | Open & Session | Close

Once you have the Communication Setup you can click on “Open” and if your PC is in range of your Furl-Kits, data will start filling the data grid, Wind Speed Real Time chart, and the session log. The next time you load the Solar-Array Supervisor for Windows you will need to click on *Open* to open communications with the arrays. Please Note: The com port and baud rate will be saved from the previous configuration.

Session | Logging

Under the logging section you will find commands to control the system logging. The first option “Clear Log” Clears the Session log and makes a note in the log of the date and time it was cleared. Next you will find the “Robust Logging” option. When robust logging is checked, all packets are shown in the session log color coordinated to the Furl-Kit that sent them. This color coordination occurs after a rigorous scrubbing process on each data packet. The scrubbing process de-encrypts the packet, verifies the RF Chksum and the Furl-Kit packet Chksum, and then parses the packet for data. If the packet does not pass the above verification process it is shown in the session log as an error (No color).

Figure 8 Delay Packet Multiplier Menu Setting



The “Beep On Error” checkmark will force the PC to beep if an error is detected with one of the Furl-Kits. This is a handy way of calling your attention to the application allowing you to view the details of the error in the session log.

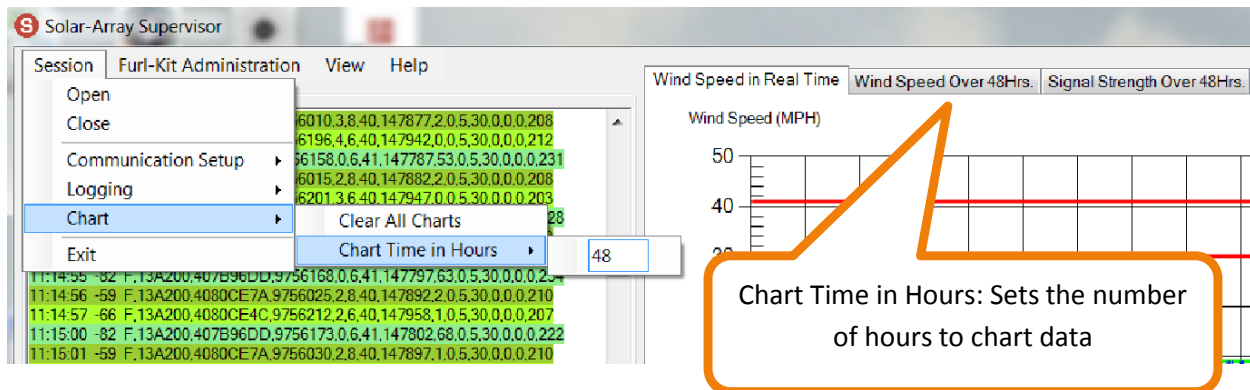
The “Delay Packet Multiplier” is used to determine when a Furl-Kit packet transmission is tardy. The value in this example is set to 60. That number is multiplied by the value of xMit Delay in the data grid at the bottom of the screen. By default Furl-Kits leave the factory set with a xMit Delay of 5 seconds so multiplying that by 60 gets you 300 seconds or 5 minutes. Therefore, a Furl-Kit will be considered tardy and in an error state if there is a delay of 5 minutes or more between RF data packets. This error condition will be noted in the session log and in the data grid by turning the line red. It is not uncommon to get a few of these errors a day and sometimes several an hour. If the laptop with the RF Modem connected to it is too far away from the solar-arrays you will see an excessive amount of these errors and it should be moved closer to resolve the errors.

Session | Chart

The “Clear All Charts” option clears the data in the Wind Speed and Signal Strength charts and makes a log entry of the date and time they were cleared. The “Chart Time in Hours” sets the amount of time a

chart will collect data before the old data scrolls off to the left of the chart. In this example it is set to 48 hours and as you can see both the Wind Speed Over 48Hrs and Signal Strength Over 48Hrs are set to 48.

Figure 9 Chart Time in Hours Menu Setting



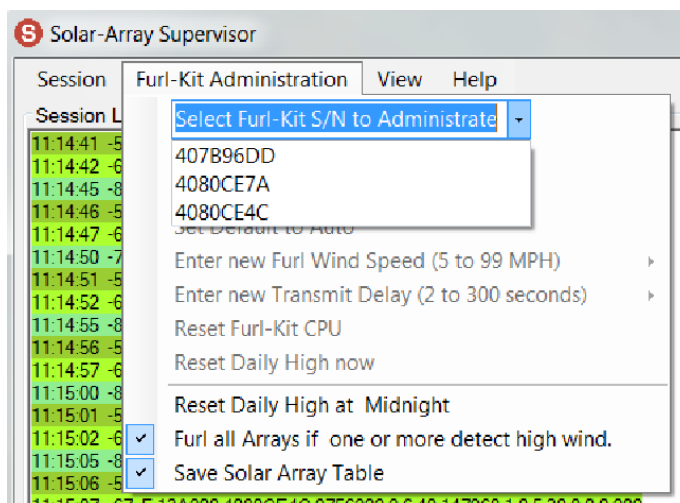
Furl-Kit Administration | Select Furl-Kit S/N to Administrate

By clicking on the “Select Furl-Kit S/N to Administrate” dropdown you will be presented with a list of Furl-Kit serial numbers to choose. Once you select one, the following 7 menu items are enabled allowing you to make changes to the selected Furl-Kit.

Warning!

The changes made in this section are stored in each Furl-Kit’s non-volatile memory and will be retained even if the power is lost and restored to the Furl-Kit. Use caution when making changes in this section.

Figure 10 Select Furl-Kit S/N to Administrate Menu



As noted above, the following commands are made to only the Furl-Kit selected. If you wish all the Furl-Kits to have the same setting you will have to repeat each step after selecting the Furl-Kit from the “Select Furl-Kit S/N to Administrate” dropdown.

The “[Set Default to Furl](#)”, “[Set Default to Dump](#)”, and “[Set Default to Auto](#)” all change the default state of the selected Furl-Kit. For example in northern climates during the winter months you may want to change your arrays default state to Dump. This will keep the array at a steep angle all winter (unless high wind is detected) allowing snow to slide off.

The “[Enter new Furl Wind Speed \(5 to 99 MPH\)](#)” allows you to set the wind speed that will cause the array to Furl. The factory setting is 30 MPH. On older arrays that have been beat-up by the elements it may be beneficial to reduce this threshold subjecting them to less stress from high wind.

The “[Enter new Transmit Delay \(2 to 300 seconds\)](#)” sets the time between packet broadcast. The factory default is 5 seconds. The Furl-Kits use this setting to determine when to broadcast their status packet. If you have more than five Furl-Kits and are seeing command transmission failures you may want to increase this delay to 10 to 30 seconds.

Pressing the “[Reset Furl-Kit CPU](#)” will cause the Furl-Kit to reboot and reload its settings. This can be done as a troubleshooting step to try and recover a non-responsive Furl-Kit.

The “[Reset Daily High now](#)” will instruct the selected Furl-Kit to reset its daily high wind to zero. From this moment on the Furl-Kit will reset its daily high wind every 24 hours from now. For example: If you prefer the daily high wind to be reset to zero every morning at 8am then issue this command at 8am. From this point on the Furl-Kit will reset its daily high wind at 8am.

[Furl-Kit Administration | Reset Daily High at Midnight](#)

By checking the “[Reset Daily High at Midnight](#)” option the Solar-Array Supervisor for Windows 7 application will send a reset command to each of the Furl-Kits in the data grid at midnight. Please Note: The CPU running the Solar-Array Supervisor for Windows 7 application must remain on and the program loaded in order for the command to be sent at midnight.

[Furl-Kit Administration | Furl all Arrays if one or more detect high wind](#)

By checking the “[Furl all Arrays if one of more detect high wind](#)” will cause the Solar-Array Supervisor for Windows 7 to automatically send a furl command to all arrays in the data grid if any one of them furl. Please Note: The CPU running the Solar-Array Supervisor for Windows 7 application must remain on and the program loaded in order for the command to be sent.

[Furl-Kit Administration | Save Solar Array Table](#)

Checking the “[Save Solar Array Table](#)” will cause the data grid to be saved at the time it was checked. It will also cause the table to be reloaded next time the Solar-Array Supervisor for Windows 7 is loaded. This should be done during initial setup and every time a Furl-Kit has been added to the farm.

Tip: To remove an old Furl-Kit from the data grid, follow these steps:

1. Un-check “[Save Solar Array Table](#)” and close the program
2. Re-load the Solar-Array Supervisor for Windows 7 program and notice the data grid is blank.
3. Open a session and wait for the Solar-Arrays to register in the data grid.
4. Check “[Save Solar Array Table](#)” to save the list once all the Furl-Kits have appeared in the grid.

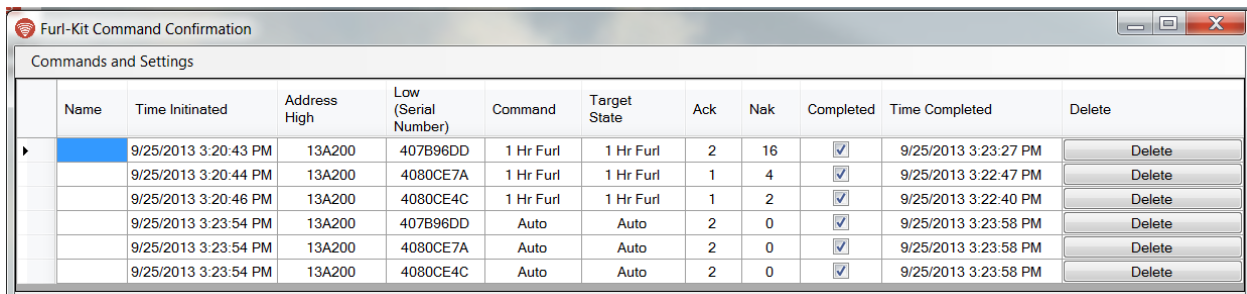
Furl-Kit Command Confirmation Window

The Solar-Array Supervisor for Windows 7 employs a “state machine” that controls the transmitting of command packets to each Furl-Kit. Unlike previous solutions that simply broadcast command packets to all Furl-Kits on the PAN the state machine addresses packets to each Furl-Kit’s network address and verifies delivery. In addition to the verification of packet delivery the Furl-Kit’s target state and current state are compared to determine if a command request was successful and will retransmit the command if necessary. The Furl-Kit Command Confirmation Window allows control and monitoring of the “state machine”. You can use it to see the status of your command request and cancel a command request if necessary.

View | Command Status Window

By clicking on the “Command Status Window” under the “View” dropdown menu you will load the Furl-Kit Command Confirmation window. This window contains a data grid showing the status of the commands sent to the Furl-Kits. Here you can use the Commands and Settings Dropdown menu to cancel commands, clear the grid, and set the Max retries a command will attempt before giving up on that command request.

Figure 11 Furl-Kit Command Confirmation Window



| Furl-Kit Command Confirmation | | | | | | | | | | | |
|-------------------------------|------|----------------------|--------------|---------------------|-----------|--------------|-----|-----|-------------------------------------|----------------------|--------|
| Commands and Settings | | | | | | | | | | | |
| | Name | Time Initiated | Address High | Low (Serial Number) | Command | Target State | Ack | Nak | Completed | Time Completed | Delete |
| ▶ | | 9/25/2013 3:20:43 PM | 13A200 | 407B96DD | 1 Hr Furl | 1 Hr Furl | 2 | 16 | <input checked="" type="checkbox"/> | 9/25/2013 3:23:27 PM | Delete |
| | | 9/25/2013 3:20:44 PM | 13A200 | 4080CE7A | 1 Hr Furl | 1 Hr Furl | 1 | 4 | <input checked="" type="checkbox"/> | 9/25/2013 3:22:47 PM | Delete |
| | | 9/25/2013 3:20:46 PM | 13A200 | 4080CE4C | 1 Hr Furl | 1 Hr Furl | 1 | 2 | <input checked="" type="checkbox"/> | 9/25/2013 3:22:40 PM | Delete |
| | | 9/25/2013 3:23:54 PM | 13A200 | 407B96DD | Auto | Auto | 2 | 0 | <input checked="" type="checkbox"/> | 9/25/2013 3:23:58 PM | Delete |
| | | 9/25/2013 3:23:54 PM | 13A200 | 4080CE7A | Auto | Auto | 2 | 0 | <input checked="" type="checkbox"/> | 9/25/2013 3:23:58 PM | Delete |
| | | 9/25/2013 3:23:54 PM | 13A200 | 4080CE4C | Auto | Auto | 2 | 0 | <input checked="" type="checkbox"/> | 9/25/2013 3:23:58 PM | Delete |

Table 2 Furl-Kit Command Confirmation Data Grid details

| Data Grid Column | Description |
|---------------------|--|
| Name | This column is for future use. |
| Time Initiated | This is the time the command was first sent to the Furl-Kit. |
| Address High | This is the upper 32 bit Mac address the 802.15.4 RF modem in the Furl-kit. |
| Low (Serial Number) | This is the lower 32 bit address of the 802.15.4 Mac address as well as the Furl-Kit’s serial number printed on the lid of the Furl-Kit. Together with the High 32 bit address these two values make up the target address of the furl-kit this command is intended for. |
| Command | Command sent to the Furl-Kit (1Hr Furl, Auto, FurlSpeed, etc..). |

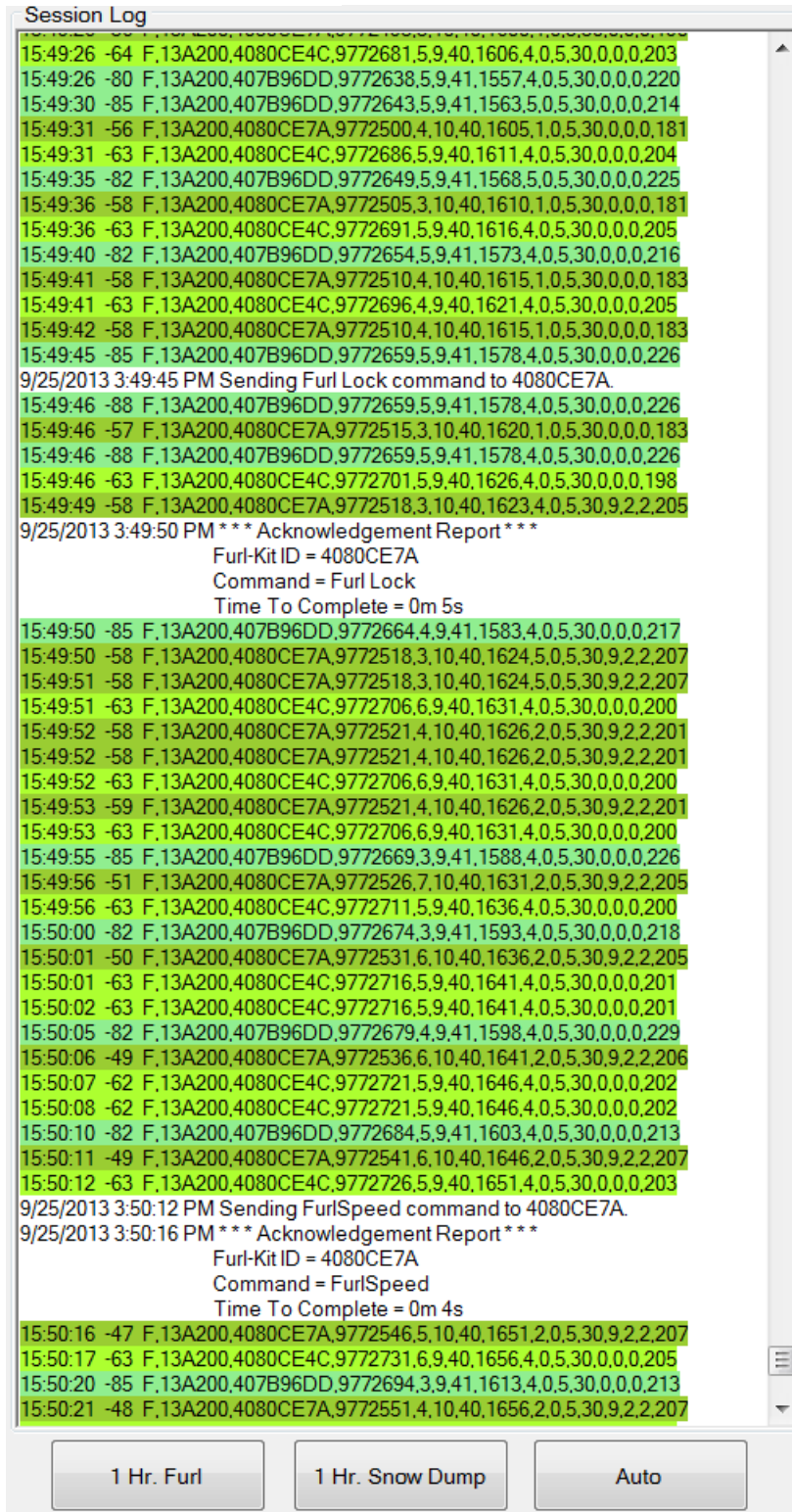
| | |
|----------------|---|
| Target State | This is the target state the Furl-Kit is expected to achieve. The Furl-Kit's target state on the main form is monitored to determine if the Furl-Kit actually carried out its command. For example, if you issue a 1 Hr. Furl you will see the target state set to 1 Hr. Furl. However, back on the main form the current state will say Furling. The command will be marked as complete when the Furl-Kit actually reaches its 1Hr. Furl status. |
| Ack | This is a count of the number of packets that have been sent and acknowledged as received by the target Furl-Kit. This number together with the Nak number will equal the total number of retries for this command. |
| Nak | This is a count of the packets sent to the target Furl-Kit but not acknowledged. If the USB RF Modem is not close enough to the target Furl-Kit you will see a high amount of Naks. Once the Nak count plus the Ack count equal the setting under Commands and Settings Set Max Retries the command will be disabled. |
| Completed | This box will be checked once the command has been verified complete. A command is verified when its Target State on this data grid matches the "Current" column back on the main forms data grid. |
| Time Completed | When a command is completed this column will contain the date and time the command was verified complete. If a command is canceled by selecting the Commands and Settings Disable All Active Commands drop down menu, or the max retries is exceeded this column will note the command was canceled and why. |
| Delete Button | The Delete Button can be used to delete that row of data. |

Session Log and Command Buttons

The session log is located on the left side of the main window. It is a rich text log that provides a running

Figure 12 Session Log

status log of the communications to and from the Furl-Kits. When robust



Session Log

```

15:49:26 -64 F,13A200,4080CE4C,9772681,5,9,40,1606,4,0,5,30,0,0,0,203
15:49:26 -80 F,13A200,407B96DD,9772638,5,9,41,1557,4,0,5,30,0,0,0,220
15:49:30 -85 F,13A200,407B96DD,9772643,5,9,41,1563,5,0,5,30,0,0,0,214
15:49:31 -56 F,13A200,4080CE7A,9772500,4,10,40,1605,1,0,5,30,0,0,0,181
15:49:31 -63 F,13A200,4080CE4C,9772686,5,9,40,1611,4,0,5,30,0,0,0,204
15:49:35 -82 F,13A200,407B96DD,9772649,5,9,41,1568,5,0,5,30,0,0,0,225
15:49:36 -58 F,13A200,4080CE7A,9772505,3,10,40,1610,1,0,5,30,0,0,0,181
15:49:36 -63 F,13A200,4080CE4C,9772691,5,9,40,1616,4,0,5,30,0,0,0,205
15:49:40 -82 F,13A200,407B96DD,9772654,5,9,41,1573,4,0,5,30,0,0,0,216
15:49:41 -58 F,13A200,4080CE7A,9772510,4,10,40,1615,1,0,5,30,0,0,0,183
15:49:41 -63 F,13A200,4080CE4C,9772696,4,9,40,1621,4,0,5,30,0,0,0,205
15:49:42 -58 F,13A200,4080CE7A,9772510,4,10,40,1615,1,0,5,30,0,0,0,183
15:49:45 -85 F,13A200,407B96DD,9772659,5,9,41,1578,4,0,5,30,0,0,0,226
9/25/2013 3:49:45 PM Sending Furl Lock command to 4080CE7A.
15:49:46 -88 F,13A200,407B96DD,9772659,5,9,41,1578,4,0,5,30,0,0,0,226
15:49:46 -57 F,13A200,4080CE7A,9772515,3,10,40,1620,1,0,5,30,0,0,0,183
15:49:46 -88 F,13A200,407B96DD,9772659,5,9,41,1578,4,0,5,30,0,0,0,226
15:49:46 -63 F,13A200,4080CE4C,9772701,5,9,40,1626,4,0,5,30,0,0,0,198
15:49:49 -58 F,13A200,4080CE7A,9772518,3,10,40,1623,4,0,5,30,9,2,2,205
9/25/2013 3:49:50 PM *** Acknowledgement Report ***
Furl-Kit ID = 4080CE7A
Command = Furl Lock
Time To Complete = 0m 5s
15:49:50 -85 F,13A200,407B96DD,9772664,4,9,41,1583,4,0,5,30,0,0,0,217
15:49:50 -58 F,13A200,4080CE7A,9772518,3,10,40,1624,5,0,5,30,9,2,2,207
15:49:51 -58 F,13A200,4080CE7A,9772518,3,10,40,1624,5,0,5,30,9,2,2,207
15:49:51 -63 F,13A200,4080CE4C,9772706,6,9,40,1631,4,0,5,30,0,0,0,200
15:49:52 -58 F,13A200,4080CE7A,9772521,4,10,40,1626,2,0,5,30,9,2,2,201
15:49:52 -58 F,13A200,4080CE7A,9772521,4,10,40,1626,2,0,5,30,9,2,2,201
15:49:52 -63 F,13A200,4080CE4C,9772706,6,9,40,1631,4,0,5,30,0,0,0,200
15:49:53 -59 F,13A200,4080CE7A,9772521,4,10,40,1626,2,0,5,30,9,2,2,201
15:49:53 -63 F,13A200,4080CE4C,9772706,6,9,40,1631,4,0,5,30,0,0,0,200
15:49:55 -85 F,13A200,407B96DD,9772669,3,9,41,1588,4,0,5,30,0,0,0,226
15:49:56 -51 F,13A200,4080CE7A,9772526,7,10,40,1631,2,0,5,30,9,2,2,205
15:49:56 -63 F,13A200,4080CE4C,9772711,5,9,40,1636,4,0,5,30,0,0,0,200
15:50:00 -82 F,13A200,407B96DD,9772674,3,9,41,1593,4,0,5,30,0,0,0,218
15:50:01 -50 F,13A200,4080CE7A,9772531,6,10,40,1636,2,0,5,30,9,2,2,205
15:50:01 -63 F,13A200,4080CE4C,9772716,5,9,40,1641,4,0,5,30,0,0,0,201
15:50:02 -63 F,13A200,4080CE4C,9772716,5,9,40,1641,4,0,5,30,0,0,0,201
15:50:05 -82 F,13A200,407B96DD,9772679,4,9,41,1598,4,0,5,30,0,0,0,229
15:50:06 -49 F,13A200,4080CE7A,9772536,6,10,40,1641,2,0,5,30,9,2,2,206
15:50:07 -62 F,13A200,4080CE4C,9772721,5,9,40,1646,4,0,5,30,0,0,0,202
15:50:08 -62 F,13A200,4080CE4C,9772721,5,9,40,1646,4,0,5,30,0,0,0,202
15:50:10 -82 F,13A200,407B96DD,9772684,5,9,41,1603,4,0,5,30,0,0,0,213
15:50:11 -49 F,13A200,4080CE7A,9772541,6,10,40,1646,2,0,5,30,9,2,2,207
15:50:12 -63 F,13A200,4080CE4C,9772726,5,9,40,1651,4,0,5,30,0,0,0,203
9/25/2013 3:50:12 PM Sending FurlSpeed command to 4080CE7A.
9/25/2013 3:50:16 PM *** Acknowledgement Report ***
Furl-Kit ID = 4080CE7A
Command = FurlSpeed
Time To Complete = 0m 4s
15:50:16 -47 F,13A200,4080CE7A,9772546,5,10,40,1651,2,0,5,30,9,2,2,207
15:50:17 -63 F,13A200,4080CE4C,9772731,6,9,40,1656,4,0,5,30,0,0,0,205
15:50:20 -85 F,13A200,407B96DD,9772694,3,9,41,1613,4,0,5,30,0,0,0,213
15:50:21 -48 F,13A200,4080CE7A,9772551,4,10,40,1656,2,0,5,30,9,2,2,207
  
```

1 Hr. Furl 1 Hr. Snow Dump Auto

logging is enabled data packets from each furl-kit are displayed as they are received in a unique color. This color will match that Furl-Kits information in the data grid at the bottom of the screen. Alerts will appear in Red and warnings in yellow. Black and White text will be general status messages.

In the sample to the left, the state machine has posted an Acknowledgement Report of a Furl Lock command and noted how long it took to complete.

Command Buttons

Just below the Session Log are the three Farm Wind command buttons. When pressed these buttons will send commands to every Furl-Kit in the Solar-Array Farm

Auto button

Clicking the Auto button will set all the arrays in the farm to their default state. The factory default state is "Auto Sun Tracking" but this can be changed by selecting a new default under the Furl-Kit Administration dropdown menu.

1 Hr. Furl button

The Furl Array's button sends a 1 hour furl command to all arrays in the farm. After 1 hour the arrays will return to their default state.

Once the arrays have completely furled the Auto Mode button can be used to cancel this selection before the 1 hour cycle is complete if desired. Once the arrays have furled this will count as a successful Furl Test and the last successful furl test counter will be reset to 0 seconds.

Some common uses of this button are to furl (lay the array's flat) for mowing under them, temporarily reducing wind resistance during the bad part of a storm, or it can simply be used as a quick test before an approaching storm. Please note with a heavy overcast sky the arrays may not move after the 1 hour furl is over since the sun is hidden by the clouds.

1Hr. Snow Dump button

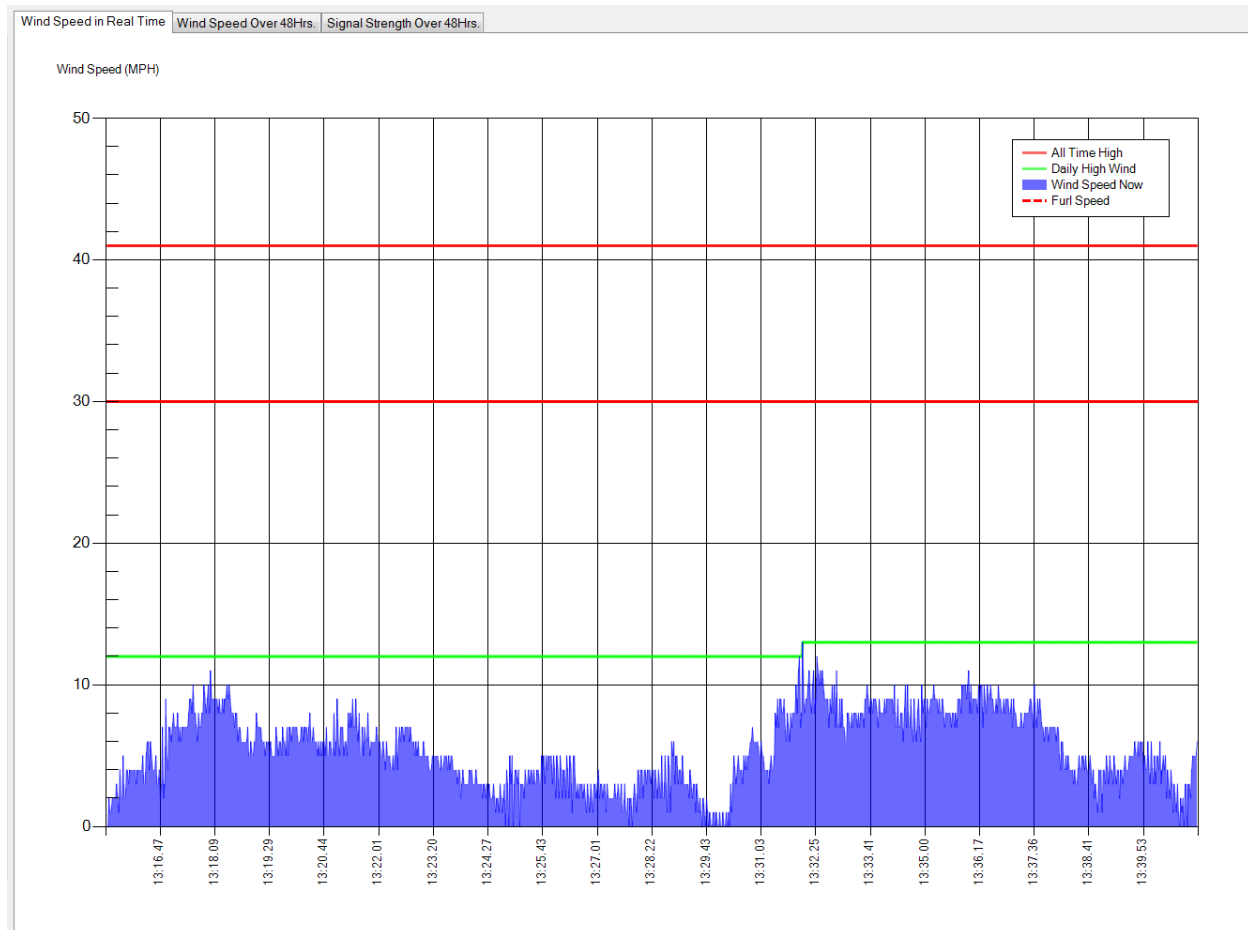
The Snow Dump button sends a 1 hour snow dump command to all arrays in the farm. After 1 hour the arrays will return to their default state. Please note: if a high wind above the furl speed setting is detected during this 1 hour dump the Furl-Kit Array CPU will cancel the snow dump and the array will furl entering survival mode. Clicking the Auto Mode will cancel the 1 hour dump and return the arrays to their default state. Please note: with a heavy overcast sky the arrays may not move after the 1 hour snow dump is over since the sun is hidden by the clouds.

The most common use of this button is to dump the snow off the arrays. It is convenient since you can click it and walk away knowing the arrays will return to tracking the sun after an hour.

Charting

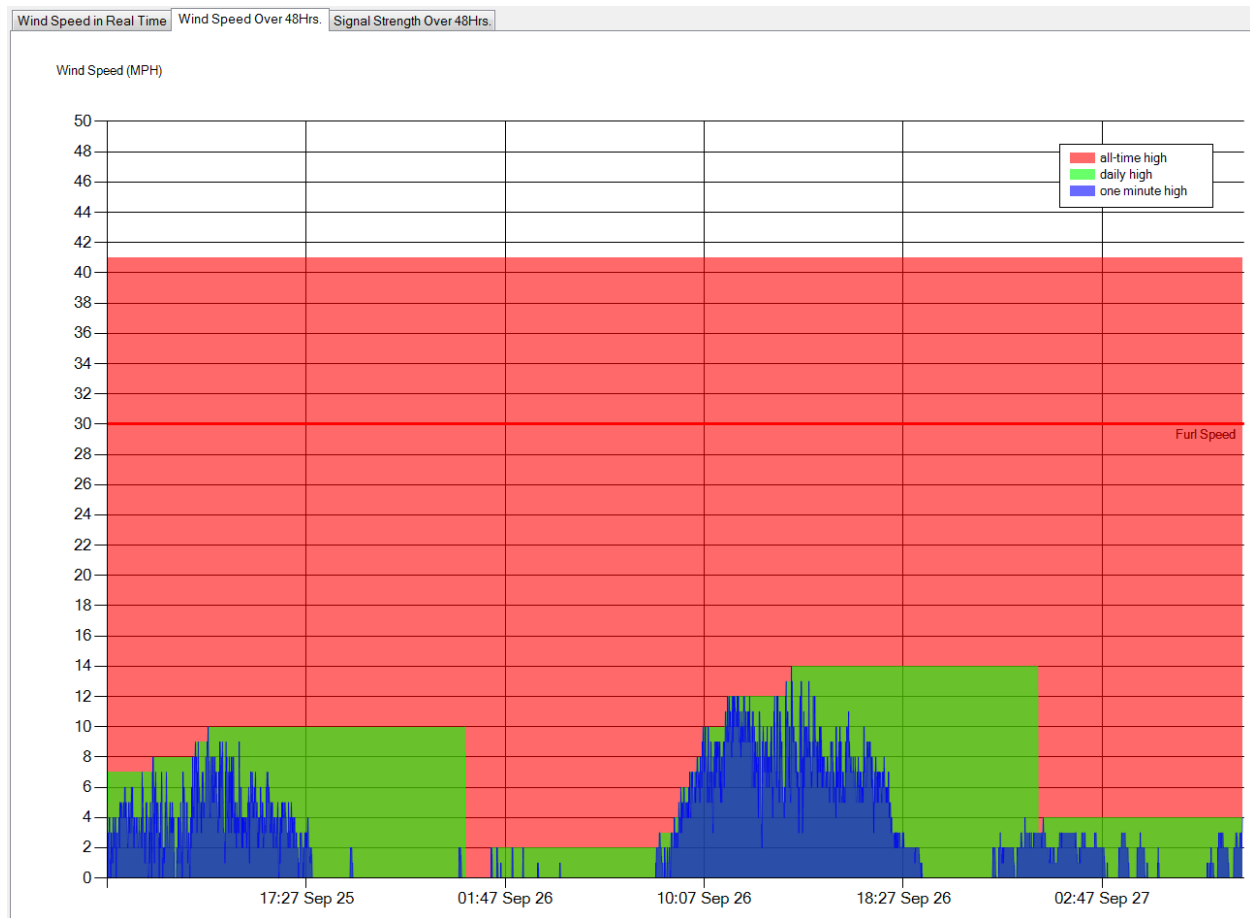
By clicking on one of the three charting tabs at the top of the main window you can access graphical view of the Furl-Kits in your Solar-Array Farm.

Figure 13 Wind Speed in Real Time Chart



The wind speed in Real Time chart will update every time a valid packet is received from a Furl-Kit. The horizontal axis across the bottom is time and the vertical axis is the wind speed in miles per hour. By observing the Chart's key you can see the colors of the lines representing the All Time High wind speed, Daily High Wind Speed, Current wind speed, and the Furl wind speed setting. Once the data fills the chart old data will scroll off the left as new data appears on the right.

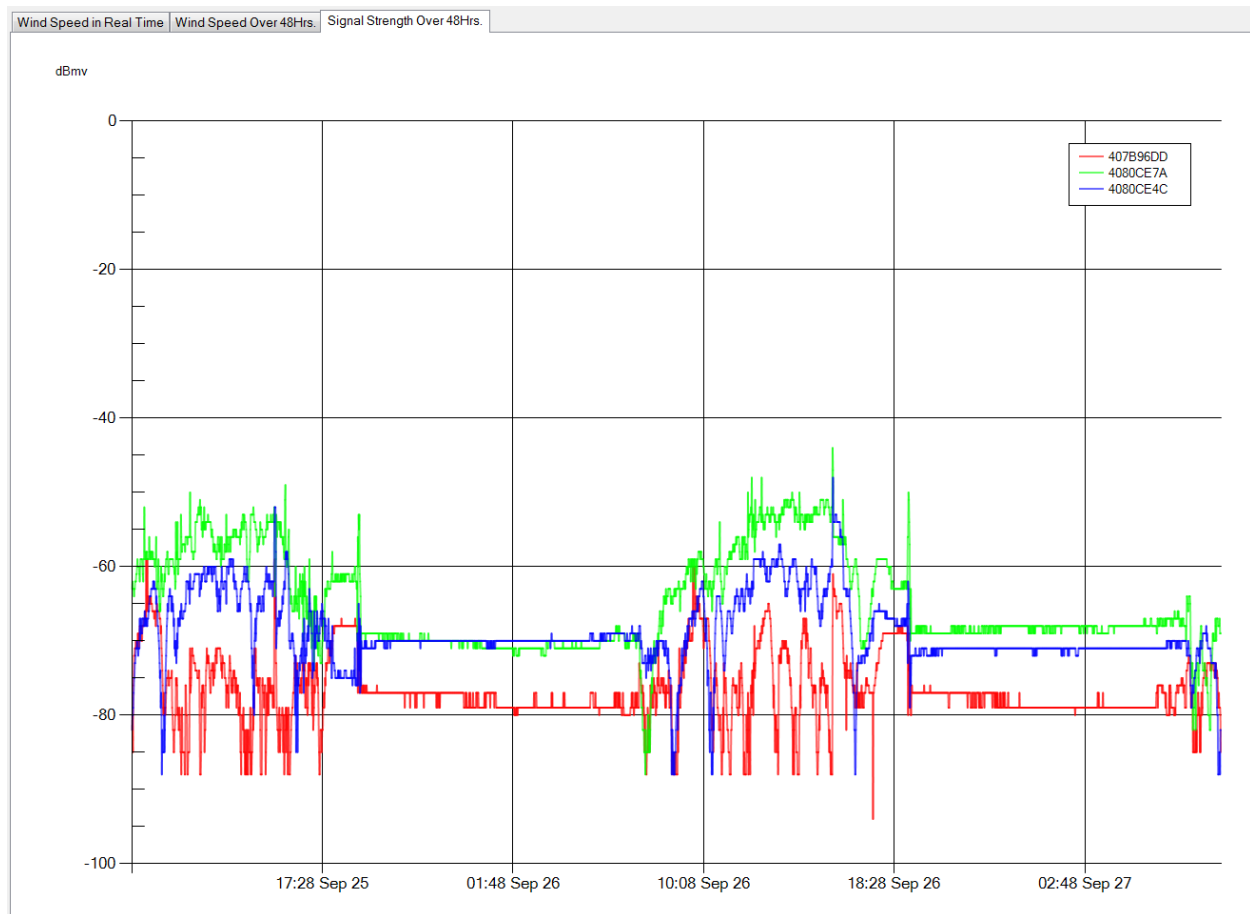
Figure 14 Wind Speed Over 24Hrs. Chart



The wind speed over 24Hrs. chart is a historical view of the wind speed over the last 24 hours. The default time for this chart can be changed with the [Session | Chart Time in Hours](#) dropdown menu command. In our example above the time frame is set for 48 hours giving us a view of the wind data collected over the last 48 hours. The chart's key in the upper right hand corner shows the color for the All-Time High wind, Daily High wind, and One Minute High wind. This chart is updated every minute with the highest wind value received over all Furl-Kits in the farm. After 48 hours the old data will scroll off to the left as new data appears on the right.

Tip: You can hover your mouse over the chart to see the detail for that point in time.

Figure 15 Signal Strength Over 24Hrs. Chart



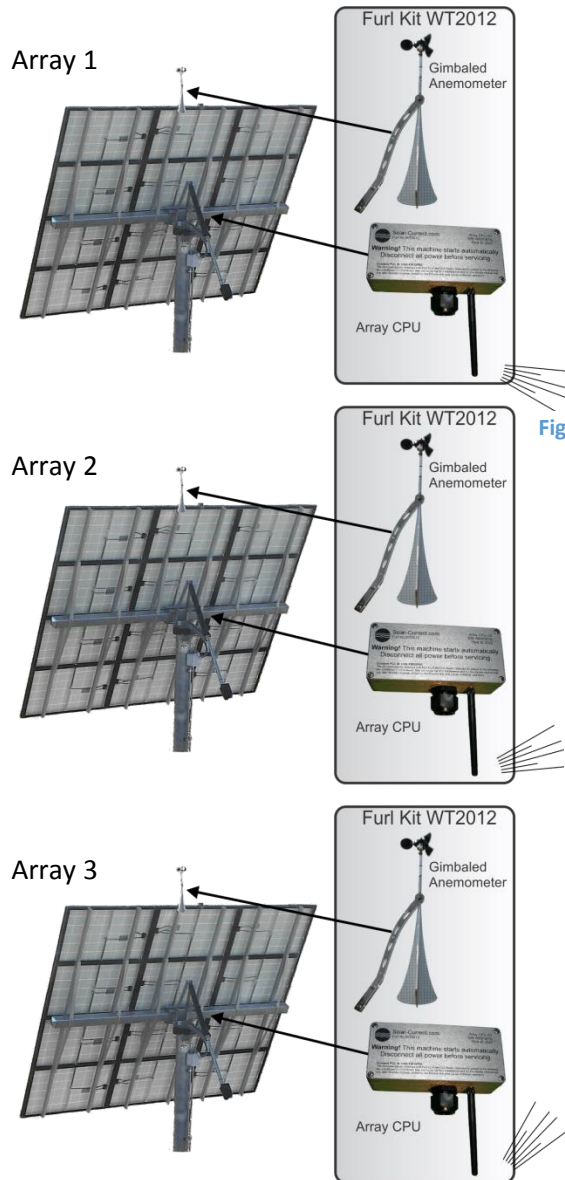
The Signal Strength Over 24Hrs. chart is a historical view of the RF signal strength observed from each Furl-Kit over the last 24 hours. The default time for this chart can be changed with the [Session | Chart Time in Hours](#) dropdown menu command. In our example above the time frame is set for 48 hours giving us a view of signal strength over the last 48 hours. The chart's key in the upper right hand corner shows the color corresponding to each Furl-Kits Serial number. This chart is updated every minute and after 48 hours the old data will scroll off to the left as new data appears on the right.

Tip: You can hover your mouse over the chart to see the detail for that point in time.

Installation and Setup

In Figure 16 we show the components for a 3 solar array system with the Furl Kit installed on each array. For an overview of the Furl-Kit's components see the *Furl-Kit Overview* on page 1 of this document.

Figure 16 Multi Array Installation



In a multi-array installation each solar array will have a Furl Kit Array CPU and Gimbaled Anemometer installed. This insures accurate independent wind measurements at each array and provides a baseline of wind data used by the Solar-Array Supervisor to detect system problems. The Furl Kit Array CPU is designed to run off the same 5 amp 24 volt dc power source used by the Array's tracker controller, No new wires are required to the array.

Figure 17 Solar-Array Supervisor for Windows 7 Laptop



The Solar-Array Supervisor for Windows 7 communicates with the Array mounted Furl Kits wirelessly; no new trenching or conduit is required for communication or power wiring.

Multiple Solar-Array Supervisors may be installed if desired. This will allow control of the arrays from multiple rooms.

The Furl Kit CPU and Solar-Array Supervisor should be installed by a qualified dealer / technician. There are dangerous voltages and moving parts on the Solar-Array and great care must be taken during installation. The Furl-Kit WT2012 is designed to work on the Wattsun Tracker AZ-225 Dual-Axis Solar tracker.

Solar-Array Supervisor for Windows 7 Installation

The Solar-Array Supervisor for Windows 7 is installed onto a user supplied Windows 7 PC inside the user's home. The user can have multiple Solar-Array Supervisors installed in the house if desired. If multiple Solar-Array Supervisors are to be installed, make sure the xBee RF Modems are ordered with the same PAN as the Furl Kit CPU. Install one, at first, adding the other supervisors later after the Furl Kit CPU's have been installed.

Site Preparation

- Physical location of the Solar-Array Supervisor PC
 - Select a location inside the house close to the Solar-Arrays to be monitored.
- Home Network
 - The Solar-Array Supervisor for Windows 7 requires a connection to the Internet to install the USB RF Modem drivers from Digi.Com. After the drivers are installed an Internet connection is not required.

Solar-Array Supervisor for Windows 7 Step by Step

Step 1) Unpack and Inspect

Unpack the Solar-Array Supervisor for Windows 7 USB RF Modem and make sure you have the following items:

- Windows 7 Workstation or Laptop
- USB RF Modem from Solar-Current.com
- Access to the Internet to install the USB RF Modem drivers and the Solar-Array Supervisor for Windows 7 software

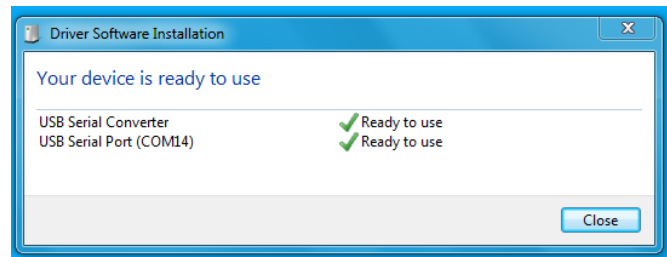
It is important to purchase the USB RF Modem from Solar-Current.com or a dealer as it has to be pre-configured with the correct PAN and encryption key. If you purchase one directly from Digi.com it will not work with your system.

Figure 18 USB RF Modem



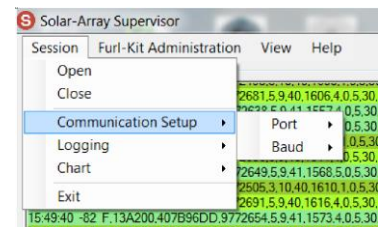
Step 2) Install USB Modem

With your computer **powered on and connected to the Internet** plug in the Digi USB RF Modem to an available USB Port on the PC. Windows will detect it and connect to Digi to download the drivers. Once the driver is installed the USB RF modem will be available as a com port on your system. In this example the driver was installed on Com14



Step 3) Install Solar-Array Supervisor for Windows 7

1. Install the latest Solar-Array Supervisor for Windows 7 from <http://Solar-Current.com>.
2. Once the Solar-Array Supervisor for Windows 7 is installed, load the program. You can find it in your start menu under Solar-Array Supervisor folder.
3. Once the program is loaded configure the Com port and baud rate under the Session | Communication Setup dropdown menu. See Session | Communication Setup on page 10 for more information. In our example here the Port will be Com14 and the Baud will be 115200. Your Com number may be different but your baud rate should be the same.
4. After you have selected the com port and baud rate click on Session | Open to open communications with the Furl-Kits. Once your Furl-Kits are on-line they will automatically register and start reporting their data.



Step 4) Install Furl-Kits

If you haven't installed the Furl-Kit CPU on the array(s) you will not see any arrays listed. It is now a good time to stop and Install the Furl-Kit CPUs (See Furl Kit CPU Installation on page 25) and return to this page and continue with Step 5) when they are all installed.

Step 5) Configure the Furl-Kit CPUs

After all the Furl-Kit CPU's have been installed, you should see a line in the data grid at the bottom of the screen for each array in your farm as discussed in the Solar-Array Supervisor for Windows Data Grid on page 7 of this document. If the Furl-Kits do not appear in the view check all power connections and make sure the PC with the USB RF Modem is close enough to receive the RF data packets.

Step 6) Test and Check Results

After step 5 is complete, each Furl-Kit CPU is configured and ready for final testing. The first thing to check is the wind speed column of the data grid. Each array should have a value for the daily high wind (unless no wind has been blowing since the install). If you don't see wind speed values above 0, check the connection of the anemometer for that array to insure it is properly connected to the Furl-Kit CPU. You may need to spin it with your finger for a few seconds to generate wind data.

Next, click on the "1 Hr. Furl" button. After a few moments you will notice all the arrays in the farm starting to lay flat. Once they completely lay flat for one full minute, they will report that they have

successfully furling to the Supervisor and the Session Log ([See Session Log and Command Buttons on page 16](#)) will have an Acknowledgement Report for each Array. Also note that the Furl Time Column will start to increment and the Current column will say “1 Hr Furl” as shown below.

Figure 19 Data Grid with Current status = 1 Hr. Furl

| Furl-Kit SN | Wind Speed | Daily High | All Time | Furl | Run Time | Furl Time | Wind Time | Boot Delay | Xmit Delay | Current | Desired | Default |
|-------------|------------|------------|----------|------|-------------------|-----------------|-------------|------------|------------|-----------|-----------|---------|
| 407B96DD | 5 | 14 | 41 | 30 | 114d:02h:59m:0... | 00d:00h:23m:43s | 00h:00m:00s | 0 | 5 | 1 Hr Furl | 1 Hr Furl | Auto |
| 4080CE7A | 8 | 14 | 40 | 30 | 114d:02h:56m:3... | 00d:00h:23m:41s | 00h:00m:00s | 0 | 5 | 1 Hr Furl | 1 Hr Furl | Auto |
| 4080CE4C | 7 | 14 | 40 | 30 | 114d:02h:59m:4... | 00d:00h:23m:39s | 00h:00m:04s | 0 | 5 | 1 Hr Furl | 1 Hr Furl | Auto |

If any of the arrays fail to furl (The “Current” column doesn’t say 1Hr Furl) check that array’s installation to insure the furl sensor is adjusted close enough to the magnet that triggers the sensor. Once all the arrays have passed their furl test and are reporting wind data the system is ready for operation.

Please note once a week each Furl-Kit will perform a self-test by furling for one minute and returning back to normal operation. You should never see the “Furl Time” column greater than 7 days.

Step 7) Save the configuration

Once all the arrays have appeared in the Solar-Array Supervisors for Windows 7 data grid save the list by checking Save Solar Array Table under the Furl-Kit Administration dropdown. See Furl-Kit Administration | Save Solar Array Table on page 13 for more information.

Step 8) Review with users

As a final step, review the Solar-Array Supervisor’s interface and explain the three Farm Wide command buttons ([see Command Buttons on page 16](#)) with any users of the system. It is okay to close or power off the Solar-Array Supervisor for Windows 7 machine anytime. The Furl-Kits do not rely on it to operate. At this point each Furl-Kit can operate as a standalone unit and will work fine with or without the Solar-Array Supervisor for Windows 7 running.

Furl Kit CPU Installation

Each Solar Array to be managed by the Solar-Array Supervisor must have a Furl Kit CPU installed. This requires the installation of 3 key components:

1. Furl Kit CPU
2. Furl Sensor
3. Gimbaled Anemometer

The Wattsun Tracker should be installed and verified to be in proper working order before the installation. The Furl Kit CPU does not replace the Wattsun Tracker Controller; it simply connects between the Controller and the Solar Array's elevation motor.

Site Preparation

- Verify that the existing Wattsun Tracker is in full operating condition and able to accurately follow the sun with both axes.
- Verify that the array's elevation motor can freely travel from one extreme to the other without hitting any obstacles and that the limit switches are set correctly stopping the motor before it reaches its mechanical stall position.
- The array must have a permanent grid-tied or regulated battery bank providing 24 Volt 5 Amp DC power. Running the Furl Kit Array CPU directly from the solar panels is not supported. The Furl Kit can share the power source in use by the AZ 225 tracker if it meets these requirements.
- Review the proper Shutdown procedures of the customer's Solar-Arrays. All Solar-Arrays should be completely shut down before installing the Furl-Kit.
- Special tools required
 - #8 – 32 Tap
 - Number 29 Drill Bit
 - Portable electric drill
 - Soldering iron to tin leads

Setup Discussion

The following two diagrams, Figure 20 and Figure 21, depict a before and after view of the Furl Kit WT2012 installation.

Figure 20 Wiring diagram before Furl-Kit install



Figure 21 Wiring diagram after Furl-Kit install

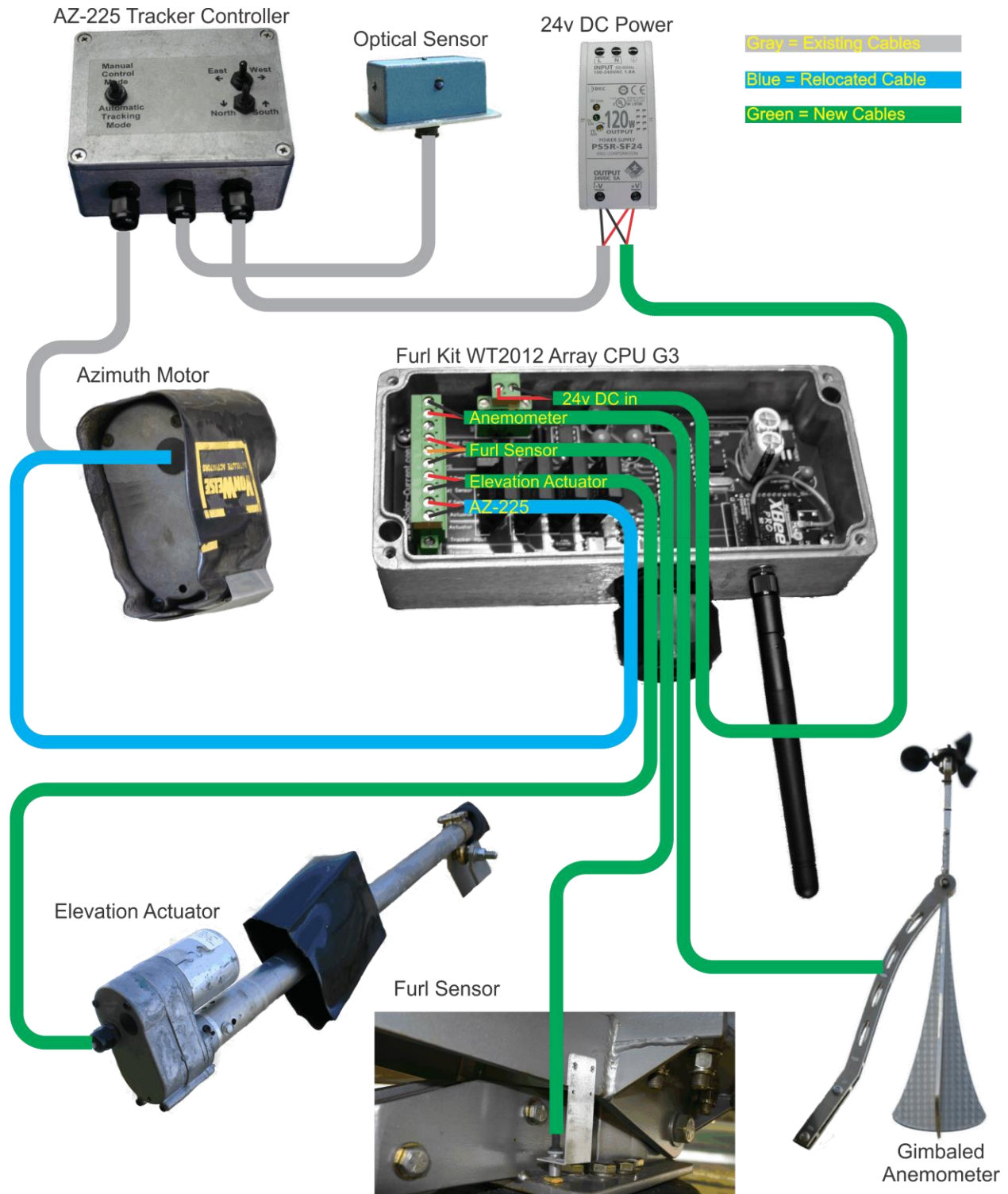


Figure 20 above shows a typical Wattsun Solar Tracker installation. Notice that the Elevation Motor control cable (blue cable) runs from the AZ-225 controller through the Azimuth Motor housing to get to the Elevation Actuator. In Figure 21 you will see that the blue cable has been disconnected from the

Elevation Actuator and moved to the two terminals marked “Tracker Input” on the Furl Kit CPU. This cable is the only direct connection between the AZ-225 Controller and The Furl Kit CPU.

To complete the installation four new (green) cables will be required connecting the Furl Kit CPU to Power, the Anemometer, the Furl Sensor and the Elevation Actuator.

Furl-Kit CPU Step by Step

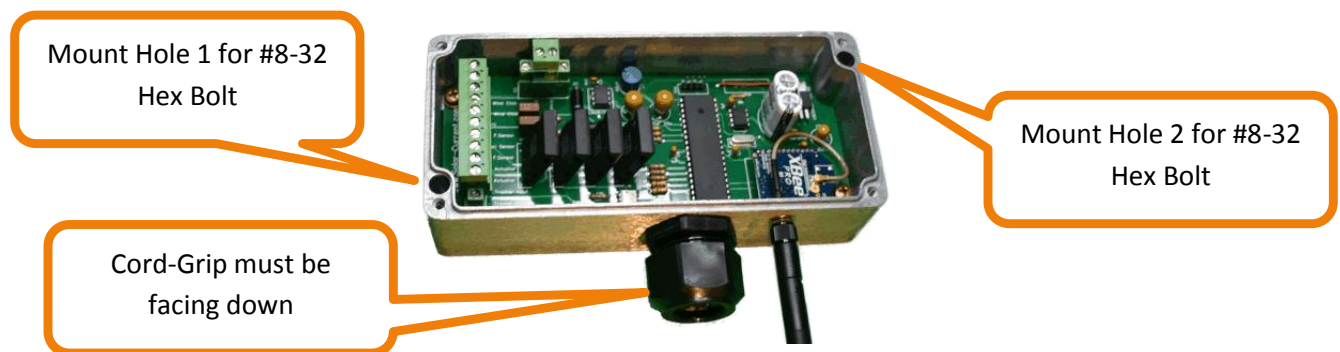
Step 1) Power Shutdown

Using the manual controls, lay the array flat all the way back. Once the Array is flat disconnect or switch off the power to the Wattsun Tracker. Switch off the solar-array according to array’s shutdown procedures. If this array is part of an array farm connected to a combiner box, insure it is isolated from the other arrays by switching off the master disconnect and removing its fuse according to the site’s shutdown procedure. **Make sure all power is disconnected before installing the Furl-Kit!**

Step 2) Mount the Furl-Kit Array CPU

Select a location for the Furl-Kit Array CPU’s water tight enclosure on the Torque Tube next to the AZ-225 Saddle Clamp Assembly. Make sure the cord-grip is on the bottom and accessible for routing cables as shown in Figure 22. Using the enclosure, mark the location for the two mount holes and drill and tap using number 29 bit and #8–32 tap.

Figure 22 Furl-Kit CPU mounting holes

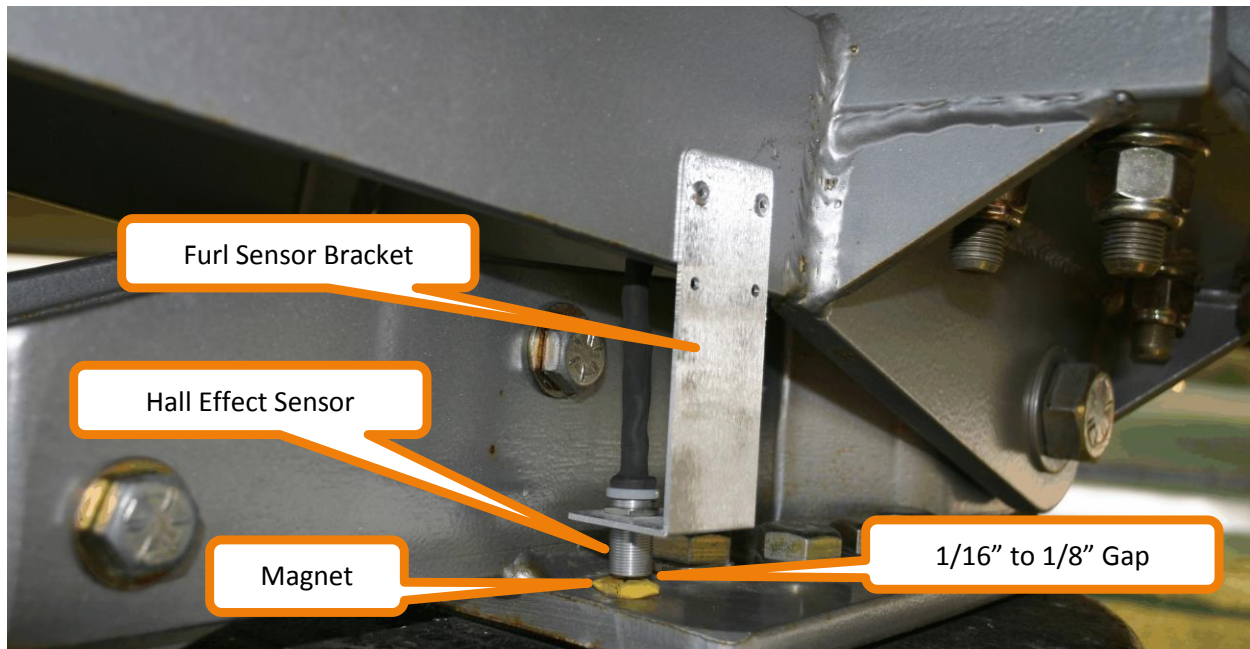


After the Torque Tube has been tapped, mount the enclosure to the Torque Tube and replace the lid to keep foreign materials out during the remaining installation steps.

Step 2) Mount the Furl Sensor

The Furl sensor is a Hall Effect sensor that senses the array has furled by proximity to a magnet on the array.

Figure 23 Furl Sensor bracket for Hall Effect Sensor and Magnet Location

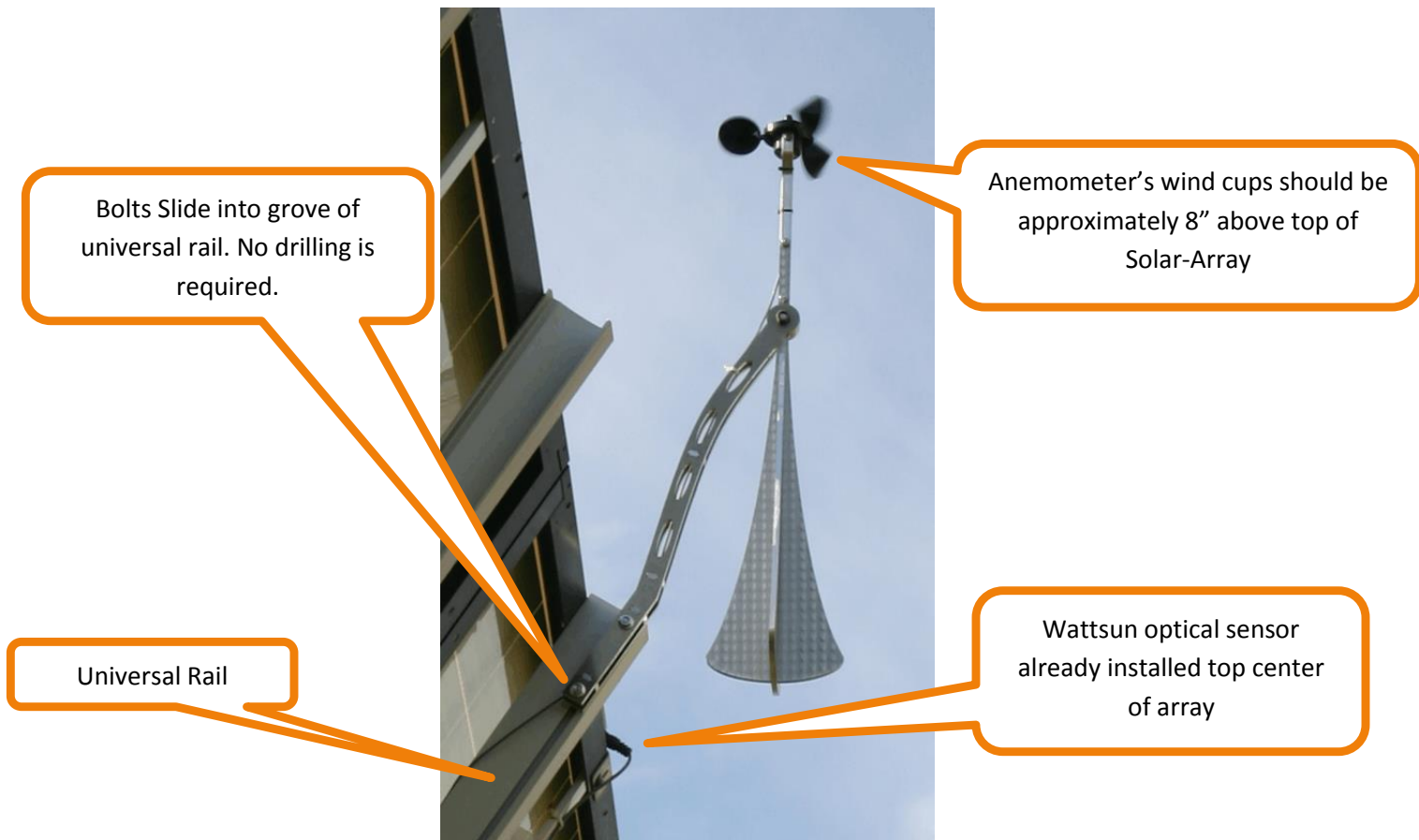


Mount the Furl Sensor bracket to the right side of the bottom half of the saddle clamp as shown in Figure 23. Place the supplied magnet on the steel frame of the tracker just under the location of the Hall Effect Sensor. Hold the bracket so there is approximately 1/8 to 1/16 of an inch clearance between the Hall Effect Sensor and Magnet, then mark two mounting holes. Drill and tap the two marked holes with a number 29 bit and #8–32 tap. Attach the sensor bracket and realign magnet and sensor. Route the attached cable to the Furl-Kit CPU making sure it has freedom to move and is clear of pinch points as the array's elevation changes. Push the cable up through one of the 5 holes in the cord grip and cut to size. Strip the insulation off each of the wires, tin and connect as shown in Figure 21. The red wire will connect to the screw terminal marked "+ F.Sensor", the bare wire to the terminal marked "- F.Sensor", and the black wire to the "Furl Sensor".

Step 3) Mount the Gimbaled Anemometer

The Gimbaled Anemometer is bolted to the top of one of the center two Universal Rails. The supplied bolts will slide into the groove as shown in Figure 24 and are tightened with a ½" wrench.

Figure 24 Anemometer

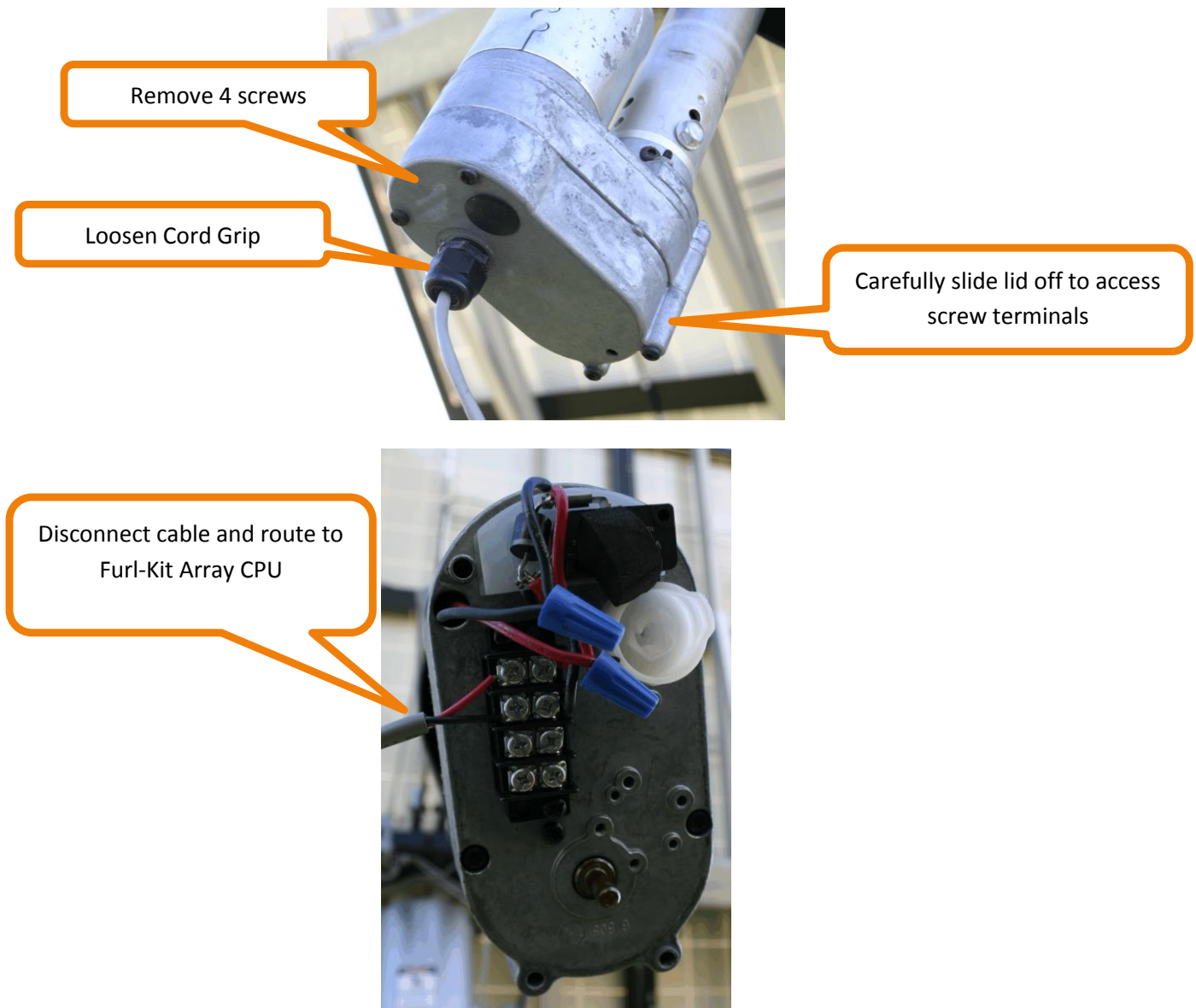


Route the anemometer's attached cable to the Furl-Kit CPU making sure it has freedom to move and is clear of pinch points as the array's elevation changes. Push the cable up through one of the 5 holes in the cord grip and cut to size. Strip the insulation off each of the two wires, tin and connect as shown in Figure 21. The red wire will connect to the screw terminal marked "+ Wind Click" and the black wire to the "- Wind Click".

Step 4) Connect the Wattsun Tracker to Furl-Kit

The Wattsun Tracker's elevation actuator cable is directly connected to the Furl-Kit CPU as shown in Figure 21. If the Furl-Kit CPU was mounted close to the center of the Torque Tube, there is a very good chance the existing cable connecting the elevation actuator can be moved and reconnected to the Furl-Kit CPU.

Figure 25 Elevation Actuator



Disconnect the existing cable from the Elevation Actuator and reroute to the Furl-Kit CPU making sure it has freedom to move and is clear of pinch points as the array's elevation and azimuth changes. Push the cable up through one of the 5 open holes in the cord grip and cut to size. Strip the insulation off each of the two wires, tin and connect as shown in Figure 21. The red wire will connect to the screw terminal marked "+ Tracker Input" and the black wire to the "- Tracker Input".

Step 5) Connect the Elevation Motor

Connect a new cable to the elevation terminals in Figure 25 above making sure the red wire is across from the red wire and the black wire is across from the black wire on the adjacent side of the screw terminal. Route through the elevation actuator cord grip and replace the lid on the actuator. Continue routing the new cable to the Furl-Kit CPU making sure it has freedom to move and is clear of pinch points as the array's elevation changes. Push the cable up through one of the open holes in the cord grip and cut to size. Strip the insulation off each of the two wires, tin and connect as shown in Figure 21. The red wire will connect to the screw terminal marked "+ Actuator" and the black wire to the "- Actuator".

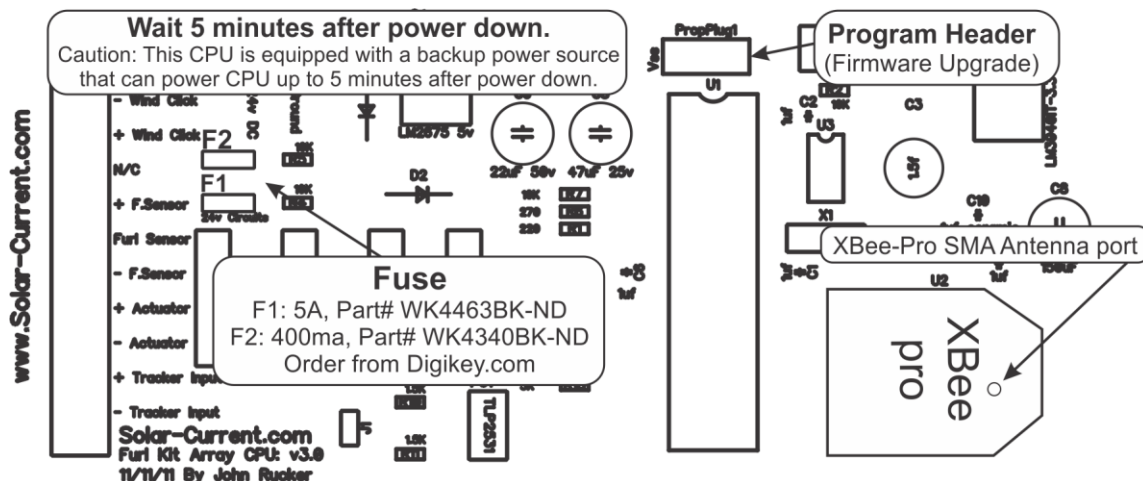
Step 6) Connect DC Power to Furl-Kit CPU

The Furl-Kit CPU requires very little power and can easily run off the same 24VDC 5A power supply feeding the Wattsun Tracker. Route a new cable from the array's 24VDC 5A Power supply to the Furl-Kit CPU making sure it has freedom to move and is clear of pinch points as the array's elevation and azimuth changes. Push the cable up through the last open hole in the cord grip and cut to size. Strip the insulation off each of the two wires, tin and connect as shown in Figure 21. The red wire (+24vdc) will connect to the screw terminal marked "24v DC" and the black wire will connect to the "Ground".

Step 7)

Please note on the backside of the Furl-Kit CPU's lid, there is a laser etched schematic that shows the placement and part numbers of the two fuses on the CPU circuit board as well as various other components.

Figure 26 Furl-Kit CPU inside lid markings



Make sure the small antenna cable inside the enclosure is still connected to the xBee RF modem (See Figure 26). Adjust the wires so they won't be pinched and place the lid on the Furl-Kit CPU making sure the rubber gasket is sitting in its channel. Tighten the four screws on the lid and tighten the cord grip.

Double check all cables are neat and secure, free of pinch points and obstacles. Restore power to array and wait a few minutes for the Furl-Kit CPU to boot up and come on-line. Using the Wattsun Tracker's

elevation switch, move the arrays elevation from one extreme to the other making sure the cables are free from pinch points and secure. Place the Wattsun Tracker into “Auto” and continue on with the installation of the Solar-Array Supervisor.

Troubleshooting

The following table contains possible error conditions and remedies. For a more complete list refer to the troubleshooting section of <http://Solar-Current.com>

| Error or Problem | Description |
|--|--|
| Array will not pass Furl Test | If the array moves and lays flat but the Solar-Array Supervisor doesn't show a successful furl has occurred there may be a problem with the Furl Sensor. Check that the sensor is 1/8" to 1/16" from the magnet and that the magnet is directly under the sensor with the "UP" letters or color dot facing up. Refer to Figure 23 on page 29 for proper alignment. |
| The Solar-Array used to work fine but now it is stuck in Furl position | <p>Every 7 days each Furl-Kit will perform a furl test. If the furl test is not completed successfully the array will remain in the furled position until either the power is cycled or the problem is addressed. To verify this use the Solar-Array Supervisor to perform a 1Hr. Furl and if the Furl is successful the Furl-Kits current stat should say 1 Hr. Furl.</p> <p>To remedy the problem:</p> <p>Check the Hall Effect sensor and make sure the magnet is still close enough for it to sense it when the array is furled. The Hall Effect sensor has three wires connecting it to the Furl-Kit CPU, check to make sure these wires have not been pinched.</p> |

Limited Warranty

Solar-Current.com Inc. warrants the Furl-Kit WT2012 including (the Solar-Array Supervisor, Gimbaled Anemometer, and Furl-Kit Array CPU) to the original consumer purchaser that it will repair, or replace at Solar-Current.com's option, any Furl-Kit WT2012 component that is determined to be defective in material or workmanship for the following terms:

One year from date of purchase on all components including the Gimbaled Anemometer, Furl-Kit Array CPU, and Furl Sensor.

To be eligible for repair or replacement under this warranty, the part in question must be sent to Solar-Current.com within the warranty period and the original consumer purchaser must comply with the following conditions:

- Furl-Kit component must not have been modified or altered in any way by an unauthorized source.
- Furl-Kit component must have been installed in accordance with the installation instructions including DC power supply requirements and polarity.

This limited warranty does not cover:

- Damage due to improper installation;
- Accidental or intentional damage;
- Misuse, abuse, corrosion or neglect;
- Damage due to improper packaging or return shipment;
- Products impaired by severe conditions, such as excessive wind, lightning, or other natural occurrences;
- Damage from use on a non Wattsun AZ-225 tracker.

Any and all labor charges for troubleshooting, removal or replacement of Furl-Kit WT2012 components are not covered by this warranty and will not be honored by Solar-Current.com Inc.

Return shipping is to be paid by the original consumer purchaser. Solar-Current.com Inc. will pay the standard return ground UPS shipping charges within the continental US only.

THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES OF ANY KIND, EXPRESSED OR IMPLIED, INCLUDING (WITHOUT LIMITATION) ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, AND OF ANY NONCONTRACTUAL LIABILITIES BASED UPON NEGLIGENCE OR STRICT LIABILITY. IN NO EVENT SHALL SOLAR-CURRENT.COM, INC. BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING (WITHOUT LIMITATIONS) ANY DAMAGE FOR PERSONAL INJURY OR PROPERTY DAMAGE OR OTHER PRODUCT LIABILITIES BASED UPON ALLEGED NEGLIGENCE OR BREACH OF EXPRESS OR IMPLIED WARRANTIES OR STRICT LIABILITY. SOLAR-CURRENT.COM, INC. NEITHER ASSUMES NOR AUTHORIZES ANY OTHER PERSON TO ASSUME FOR IT ANY OTHER OBLIGATION IN CONNECTION WITH THE SALE OF ITS FURL-KIT WT2012.

THIS WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS, AND YOU ALSO MAY HAVE OTHER RIGHTS THAT MAY VARY FROM STATE TO STATE. SOME STATES DO NOT ALLOW LIMITATIONS ON HOW LONG AN IMPLIED WARRANTY WILL LAST OR THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THE ABOVE LIMITATIONS OR EXCLUSIONS MAY NOT APPLY TO YOU.