PrecisionSolar
TECHNOLOGIES

November 20, 2016

Tap

The

Sun

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The Prospector Mule™

Setup and Operation Guide

Note: The scope of this manual is sufficient to instruct a trained meteorological science or solar tracking installation technician to assemble and commission the Prospector Mule™. Experience with electromechanical device installation, interaction with electronic control systems and computer software installation and usage is necessary. Knowledge of solar tracking equipment priorities and the language of trigonometry will help also.

Previous experience and practiced finesse in the operation of making the mechanical adjustments required for the final calibration of the tracker will result in lower frustration levels of the installer and higher performance of the Prospector.

Improper interpretation of the instructions or skipping steps can result in poor performance or even damage to the equipment or humans involved. Every step presented should be considered and checked off as if it were a pilot's preflight check list.

Reading through these instructions once fully prior to beginning the installation will provide overall equipment context and useful information for organizing your task on site.

Table of Contents

Assembling the SolarTrak Prospector Mule™

===== Note: This task requires two technicians for safety =====

(It will also go more than twice as fast)

Requirements

Location:

- **Line of sight:** Your location should have an unobstructed view of the track of the sun during all seasons.
- **Access to the site:** At least weekly after installation to clean the instrument lenses.

Position:

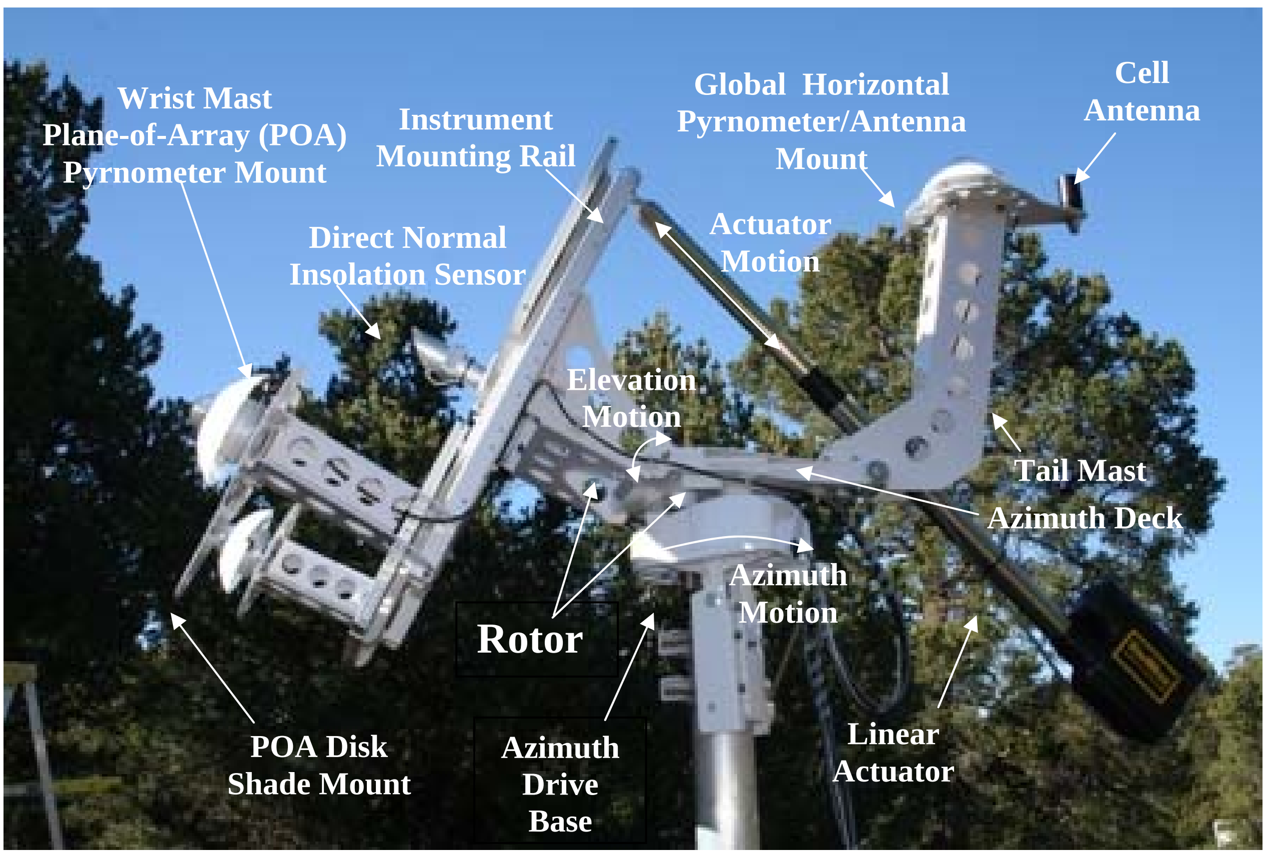
- The longitude and latitude of your SolarTrak Prospector Mule installation, accurate to within one-hundredth of a degree.

Tools Required:

- ¾” Open/Box Hand Wrench
- ¾” Socket and Ratchet Handle (or 2 of previous)
- 13mm Deep-Socket or Hand Wrench
- Qty. (2) 5/8” Open/Box Hand Wrench
- 9/16” Open-End Hand Wrench
- 3/16” Hex Key (T-Handle Driver or Allen Wrench, included)
- 7/16” Nut Driver, Socket or Open/Box Wrench
- #2 Phillips Screwdriver
- #3 Phillips Screwdriver
- Small terminal screwdriver (included)
- Two hex keys for Met 1 Wind Instruments are kept in the storage box, inserted into the Styrofoam
- Stiff, fine-grain wire brush
- Two-foot Carpenter’s Level
- Laptop with internet access, LoggerNet and SolarTrak PC Interface software installed
- DB-9 extension serial cable 6-9 feet, male/female, with USB-DB-9 adapter

Overview

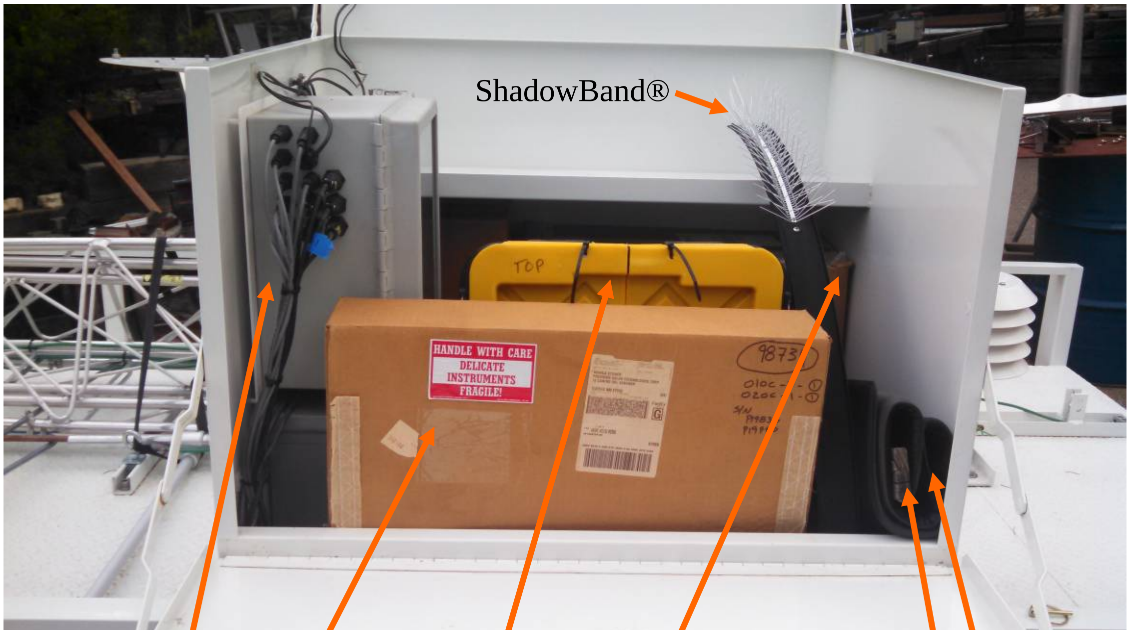
The SolarTrak® Prospector™ with its optional models; the Assayer™ and Observer™ is a compact, single-pole-mounted solution for solar radiation and weather data collection and reporting. The Prospector offers a two-axis tracking platform for direct-normal solar radiation sensors and plane-of-array global or diffuse radiation sensors as well as single-axis mounts for measuring diffuse solar radiation with a shaded global, horizontally-mounted radiation sensor. The unique geometry and resulting appearance provide non-conflicting sight lines for up to twelve solar radiation instruments, a six-piece weather station and the dependability of stand-alone power provided by photovoltaic panels and high-capacity batteries. The standard Prospector model utilizes a high-quality datalogger equipped with cellular-modem Internet communications and an on-board Compact Flash card and hardwire Ethernet connection. The Assayer™ model also includes additional differential or single-ended voltage inputs for monitoring energy production and thermal data from nearby solar collection systems. The Observer™ model includes an outdoor-rated, high-quality video camera for site monitoring and visual data confirmation.



Shipped Components

- Prospector Mule Trailer
  - SolarTrak Prospector Instrumentation Platform
  - Electric brakes
  - Break-away Brake activator
  - Spare Tire
  - Class 4 Outrigger hardware
- Meteorological Tower
  - Reference-altitude Wind Sensor Crossbar
  - Lightning Rod, grounding wire and earth-grounding rod with jumper cable
  - Low-altitude Wind Sensor Mounting Struts
  - Video Site Camera Mounting Rod
- Storage Box
  - SolarTrak Tracking Controller
  - Met 1 Wind Speed, Direction, Barometric Press., Ambient Temp. and Relative Humidity sensors
  - NRG Wind Speed and Direction sensors
  - CSI CC-640 Video Camera
  - T-Tail attachment with (2) Hukseflux SR-11 Pyrnometers (GHI & DHI) and ShadowBand®
  - Hukseflux DR-01 Pyrheliometer (DNI) radiation sensor
  - NovaLYNX Tipping Rain Bucket sensor

Box Contents - Visual Identification – <u>As you open this box, hold front panel while raising lid, and insert safety strut immediately (see picture below).</u>



SolarTrak Controller

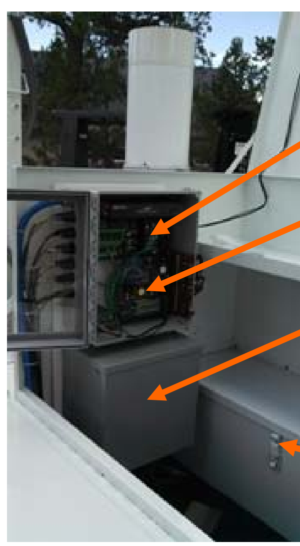
Met One Wind Sensors

Met One Combo Sensor (BP, AT, RH)
NovaLYNX Rain Bucket Sensor

CSI CC-640 Video Camera with Pelco Case
Wind Sensor and Camera Cabling
Calibration Certificates
Instrument Documentation
Hardware Kit

Working Surface Pad

Wood Safety Strut



CR-1000 Datalogger

SolarTrak Controller

Batteries – 24VDC
(2) PowerSonic 12350

T-Tail Assembly with sensors
Hukseflux DR-01 DNI sensor
NRG Wind Speed & Direction

Assembly Procedures

A.1. Position the trailer, deploy the outriggers and pre-level the trailer

A.2. Remove clamp from base of elevation linear actuator (screwjack), Power-up System

A.3. Assemble met tower, mount wind instruments and optional camera, raise tower

A.4. Mount T-Tail Assembly and Direct Normal Insolation (DNI) Bracket

A.5. Level the azimuth drive

A.6. Insert and Connect Met One meteorological module

Note: There are different versions of the Mule trailer… and different instrument sets… the included pictures are *representative* and the concept of 'looks like' should be implemented when necessary. Drastic departures from that will be duly noted…

When installing the Mule in an area known for high winds, be sure to extend the outriggers fully as a precaution. A known data point is that when deployed to the midpoint of all four outriggers a 50 mph wind will cause only an inch or two of motion at the top.

A.1. Position the trailer, deploy the outriggers and pre-level the trailer

A.1.a

Drop the trailer with the tongue pointing DUE Equator... which is to say: due north or south depending on your hemisphere…

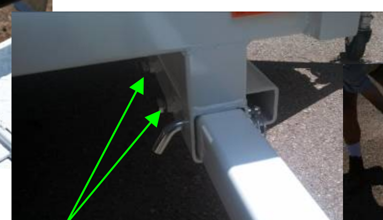
Move the transport vehicle away from the front of the trailer...

If intending to remove the wheels for long-term security, loosen the lugs right now and extend the outrigger jacks about three inches past touching the ground

Due Equator

A.1.b

Deploy all four outriggers at least a foot ...



Start with the aft outriggers... it may be necessary to drop the tongue jack slightly to allow room for the aft jacks to rotate down to lock...

Remove safety and locking pins... Loosen Set Screws

Orientation varies…

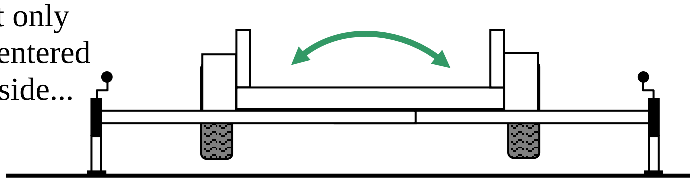
Slide outrigger out until lock-pin holes align...

Then replace locking pins and tighten set screws.

A.1.c – Pre-level

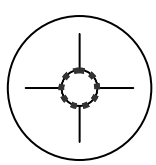
Starting with the aft end, use either a bubble level or small straight level to level the tower mount laterally (side-to-side)...

If using a round bubble level for this aft adjustment, it only needs to be centered from side-to-side...



Pull the jack locking pins and rotate jack downward until the spring lock engages...

Moving to the forward outriggers, refer to the bubble level mounted on the azimuth deck (Pg. 14) to adjust the forward jacks until the bubble is centered...



Extend Jacks just to the ground, then pre-level

A.2. Remove clamp from base of elevation linear actuator (screwjack)

Note: Damage to the equipment may occur if power is **applied** while the clamp is in place.

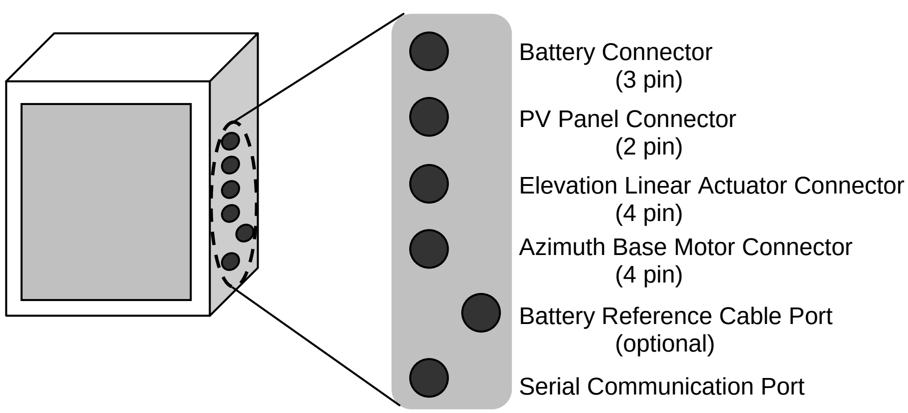
===== Clamp should never be in place while power is ON =====

Loosen clamp bolts at both ends… rotate clamp down off of the screwjack boot. The other end can remain attached to the post.

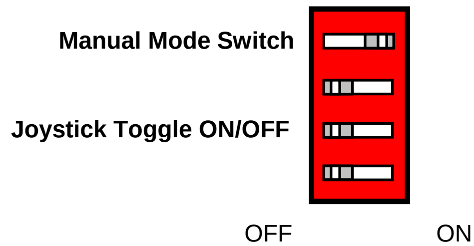
If there are low-level wind instruments, the mounting struts will get cleared from under the clamp a few steps later…

The glass-door box in the control cabinet contains the SolarTrak controller. The box has five (optionally six) weatherproof connectors on the right side.

Each connector will only fit the plug on the correct cable.

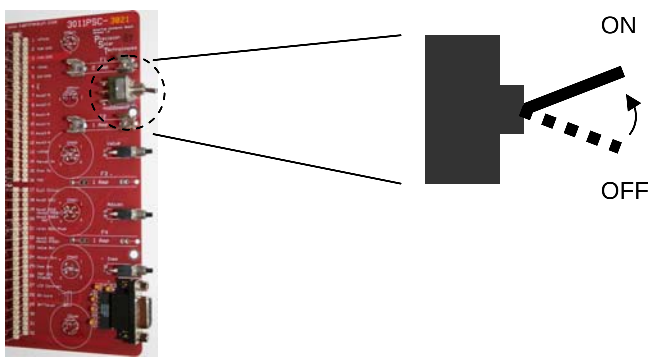


Inside the control box, make sure the SolarTrak controller is switched into manual mode. On the main control board, just under the black joystick, is a red box containing four dip switches. Make sure the top switch is switched to the right (**ON**) and that the remaining three are switched to the left (**OFF**).



On the right side of the control cabinet is a red board with a toggle switch above three small buttons and a serial port.

<u>Turn the toggle switch ON now.</u>



Note: Keep the controller in manual mode until you have finished assembling the Prospector Mule.

The black foam pad is to cushion the drop-down working surface…

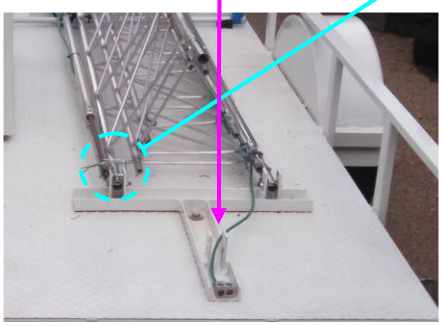
A.3 Assemble met tower, mount wind instruments and optional camera then raise tower

Note: This task should be completed before leveling the tracker.

A.3.a Assemble met tower

Remove the strap holding down the tower sections to the trailer bed. Keep it handy.

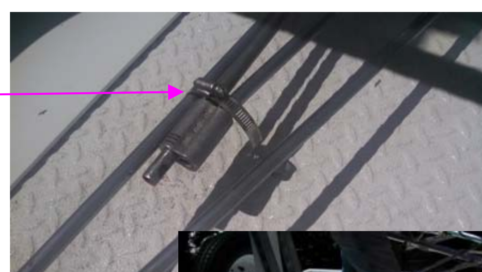
Undo the twisted wire at the hinge base of the tower and remove the pin holding in the grounding rod… this pin will go in the third mount to hold the tower upright.



Unpack the nested tower components… Please go slowly, you will find intermittent snags and hangs… be cautious of the ground wire and connectors getting trapped…

Use the storage tub with the rain bucket and met module to prop up the tower in preparation for attaching the second section…

If low-level wind instruments are installed, one mounting strut is folded and clamped for travel. Remove the clamp then lift the tower base to ease it out from under the rail and fold it under to point the opposite direction.



Once unfolded, use the removed clamp and a second one attached loosely to the opposite rail to securely clamp the mounting arm.

Leave the tower base resting on the tub.

There are three smaller lock pins for each tower connection… Remove them from their storage locations near the base of each section…

Align the ground wires and begin slipping the middle section into the base section… do not use a hammer or anything else on the support rods between uprights, you'll bend them and make this even harder…

Systematically, in a circular pattern, push in one upright at a time while maintaining pressure on the other two uprights to prevent them from backing out… rotate around, a little at a time until you can get a screwdriver in one hole… then it gets easier…

Insert the three locking pins then use the black strap to lash the two assembled pieces to the front of the trailer… the newer models have a convenient spare tire right there to accommodate… others have a rubber pad…

Fixing the tower to the trailer lends support to the ensuing wiggling necessary to insert the third section... when that is done and clipped in, slide the trident mount into the top of the last tower section… orient the crossbar horizontally with the ground and tighten the bolts using a 9/16” wrench…

Use a fine-tooth wire brush to clean the copper pigtails of the ground wire then connect to the clamp using the 3/16” T-bar hex driver included…

A.3.b Assemble and Mount Wind Instruments

The Met One wind instruments in the large, flat box are stored partially disassembled… each has a registration post on the stem and a matching slot in the rotating heads…

There are two small hex wrenches stuck into the foam inside the wind instrument box. The little one is for attaching the rotors to the masts.

Each mast is labeled… the wind speed mast gets the anemometer cups and the wind direction gets the vane. The larger of the two hex wrenches is for the set screws in the mounting sleeves on the tower crossbar…

The wind direction sensor has a screw plug near the bottom that indicates where south is according to the reading from the instrument… in the northern hemisphere it will be oriented straight down or up in the southern hemisphere.

Slide the bases into the sleeves on the crossbar and use the larger of the two hex wrenches in the box to snug down the set screws on both devices.

Insert the instrument connector ends of the wind signal cables through the struts where the attachment bolts are… Each is marked as to whether it is speed or direction. Wrap each cable once or twice around the crossbar loosely and attach the cables to the base of the respective wind instruments. Leave the wire loose enough for 4" droop loops…

Begin threading the cable down inside the tower frame… run them along the rail opposite the grounding wire… there are some cable ties included, put one every five feet down to the top of the base section… there are several more cables to add to the bundle from there…

Both of the black, NRG wind instruments (found in the inner storage box with the T-Tail) have this connector that attaches to the end of each mounting strut…

Please do not handle the moving rotors – Damage to the bearings could occur…

The wind direction vane goes on the same side as the storage box. Slide the connector on to the strut and tighten the set screw while lightly wiggling the instrument bracket to fully seat the screw n the hole provided. The anemometer cups go on the other side. Wrap each instrument wire loosely with the same 4" droop loop around each strut and direct the wires down the same path inside the tower as the other wind instruments.

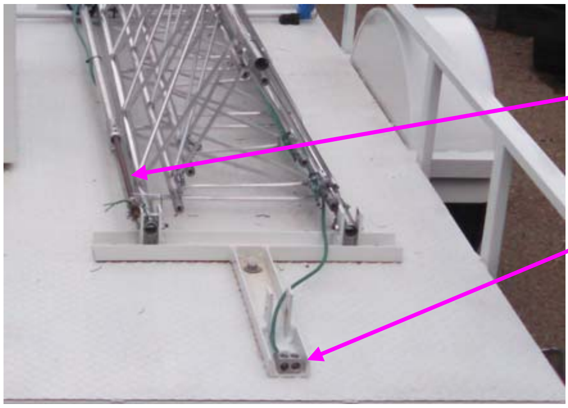
A.3.c Mount Optional Site Camera

The site camera is mounted on a short rod already attached to the tower base just above the low-level wind instruments which extends out to the right side of the trailer. It should be oriented at a right angle to the tower base rail and with that orientation will offer a reasonable sky shot as well as the Prospector unit itself in the lower left corner of each frame as a monitoring mechanism. Experience indicates the u-bolt must be very firmly tightened to avoid rotation from gravity.

Route the wires to the interior of the tower base and bundle them with the wind instrument cables.

Under the radiation shield on the back of the storage box, attach the wind instruments and camera to the labeled connectors.

There is generally enough room under the storage box to slide extra wire length to keep out from under foot since this is the ingress route to clean instruments.

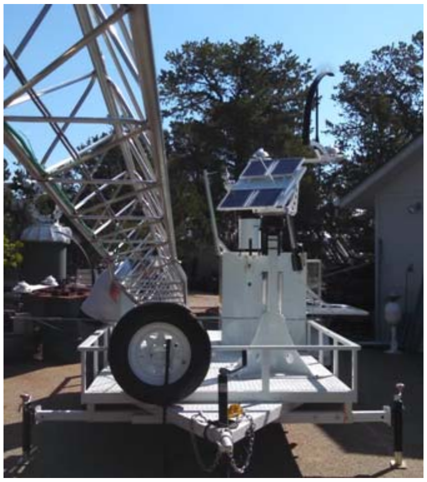


Sink the included eight-foot grounding rod within two feet of the rear of the trailer then connect it to the connector at the back of the hinge plate.

A.3.d Raise Tower

Caution! It is inadvisable to perform this task in windy conditions… large forces relative to normal human strength are generated by very low wind speeds.

Note: Although normally 70 pounds, it IS advisable to have two strong backs to raise the tower when there are extra instruments and a camera; which brings the weight to about 100 pounds.



The tracker should be rotated slightly and raised about twenty degrees (joystick up) so that the tower will miss the tracker and the wind vane mounting strut will miss the base of the screwjack.

Note: If the NovaLYNX Rain Bucket has already been installed, the wind strut should still clear…

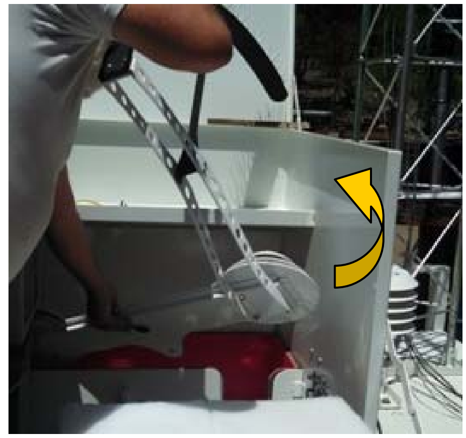
Fully insert the rear tower rail into the mounting flange, aligning the two top holes and insert the locking pin.

A.4.a Mount T-Tail Assembly and Direct Normal Insolation (DNI) bracket with sensor

Remove the DNI sensor (in small cardboard box) from the covered storage compartment then the T-Tail assembly.

The T-Tail is removed and inserted in an arcing path such that the left end of the assembly (without the ShadowBand) is first in – last out… this is the intermediate state in both insertion and extraction.

Replace packing materials for future storage and transport.



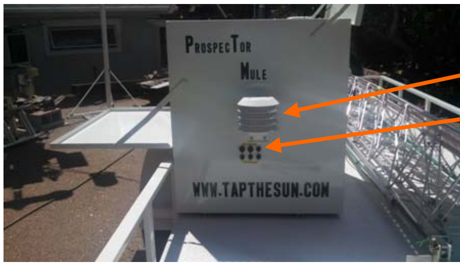
You will need the four ¼-20 x 1" screws out of the hardware box and a #3 Phillips screwdriver

Mount T-tail to top of Tail Mast and plug in the two instruments to the nearest connectors. These connectors have a locking ring that must be lightly twisted until the plug seats fully then locked with a 180-degree clockwise turn.

Use four 10-32 x 3/8" screws and a #2 Phillips to mount the DNI bracket to the side rail opposite the ShadowBand – two screws on top and two on the side.

This should be the result…

A.4.b Insert and Connect Met One meteorological module



Radiation Shield

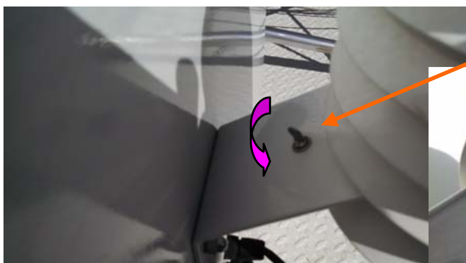
Connector

The Met One meteorological module is stored in a small box inside the rain bucket tub…

Unscrew locking tab to stop…

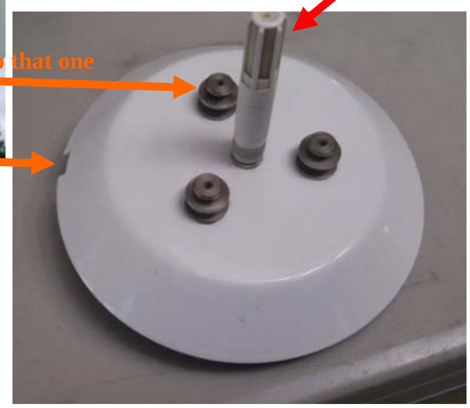
Insert module and rotate to engage slots…

Be sure tab notch aligns with tab…



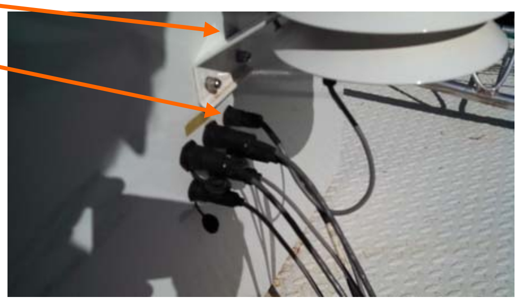
This one to that one

DO NOT HANDLE SENSOR



Reengage locking tab

Plug in connector…



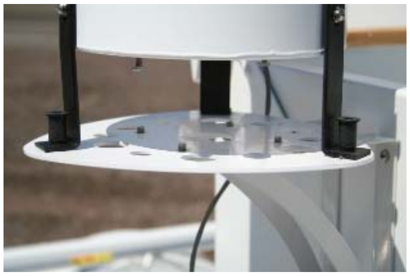
A.4.c Mount NovaLYNX Tipping Rain Bucket

Remove packing material, screens and locate the cable tie inserted in the collection hole…

Remove the cable tie and black funnel…

Insert secondary funnel if present…

Replace the funnel and screens…



Attach the feet to the mounting plate such that the wire is toward the corner of the storage box…

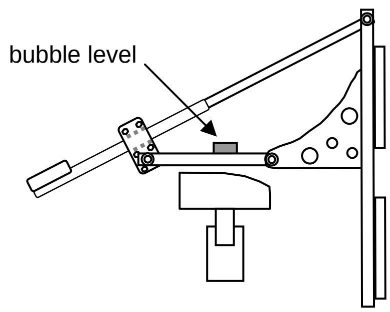
Remove the dust cap from the small receptacle beneath the mounting plate and attach the rain bucket signal cable.

A.5 Level the Azimuth Drive

For this procedure you will need

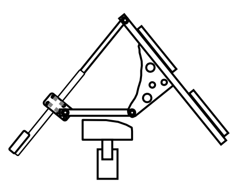
- 5/8” open end wrench (2)
- ¾” socket or wrench (2)
- 9/16” open end wrench

The prospector comes with a bubble level mounted above the azimuth base motor to help you level it.

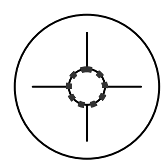


Level the Prospector facing each direction, east, south, and west (east, north, and west in the southern hemisphere). Compare the measurements. It is better to have the level be off by the same amount in each direction than to have it perfectly level in one direction and farther off in another.

1. Use the joystick on the control panel to tilt the Prospector to about 50° from level.

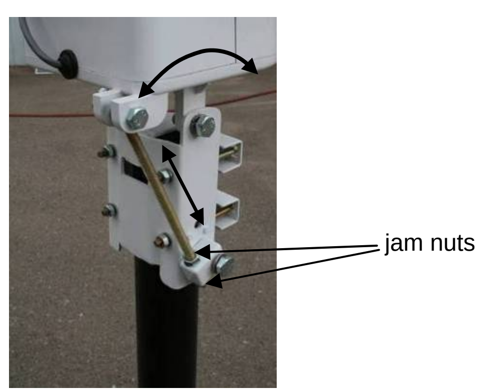


2. Use the joystick to turn the prospector to face east.
3. Read the level.

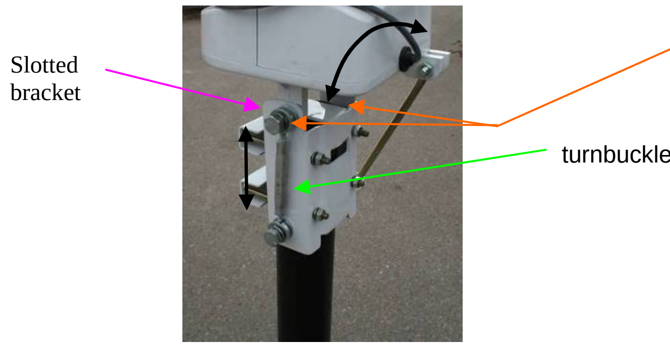


   On this first measurement, adjust the level as closely as possible to level.

4. Adjust the pitch by alternately loosening and tightening the jam nuts to shorten or lengthen the adjust screw.

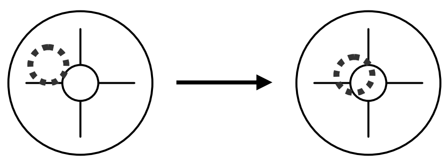


5. Adjust the roll by loosening or tightening the turnbuckle after loosening the main clamp bolts.



6. Snug down main bolts
7. Turn the prospector to face south.
8. Read the level

   If the level is off, adjust the level of the Prospector so the bubble is half way between where it reads and perfectly level. For example, if the bubble is fully outside the circle but touching it, then adjust the prospector so that the bubble is just halfway across the line of the circle.



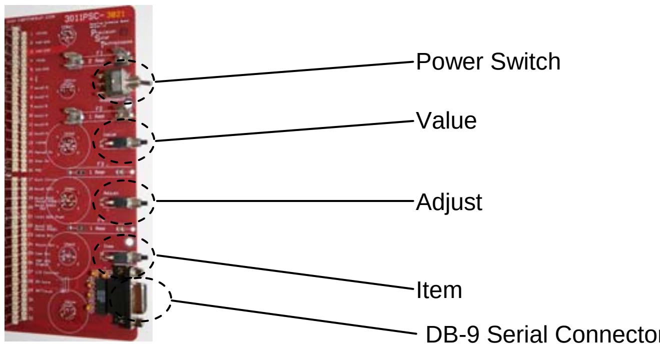
9. Turn the prospector to face west.
10. Read the level and level the Prospector to split the difference between the new measurement and where you last adjusted it.
11. Repeat the level adjustments in all three directions until the bubble remains off the wall of the casing for the full range of motion.

Be sure to tighten bolts after each adjustment before moving the tracker.

Configuration Procedures

Before you can start the SolarTrak Prospector, you need to give it the information it needs to track the sun accurately.

Most of the configuration procedures use the buttons on the control panel. On the right side of the control cabinet is a board with a toggle switch above three small buttons and a serial port. The buttons are labeled **Item**, **Adjust**, and **Value**. **Item** is the lowest button, close to the serial port.



You will use these buttons to adjust and configure the Prospector:

1. Press* the **Item** button to cycle through the display to the parameter or command you want to set.
2. Press the **Adjust** button to put the controller in adjust mode. The cursor will blink over the first digit of the value or the name of the command will blink.
3. Press the **Value** button to change the value or activate the command. Each press of the value button will increase the value of the digit you are changing. When you reach the top value (for example **9**, the value will start again at the lowest value, for example **0**. Therefore, if you want to change the value of a digit from *8* to *1*, you would press the **Value** button three times to change it to *9*, *0*, and then *1*.
4. Press the **Item** button to move to the next digit.
5. Press the **Adjust** button again to accept your changes.

***Note**: The buttons have a one-second delay to avoid accidental input. You must press and hold a button for at least second before it will register. Continuing to hold the button down will repeat what ever its doing once per second.

C.1 Set the Clock

The Prospector uses the time and date to know where the sun should be for your location and time zone.

Important: Set the clock for your local time, but **do not set it for daylight savings time**. If it is currently daylight savings time where you are setting up the Prospector, set the clock one hour behind the local time.

1. On the control panel, the LCD display should be flashing between **`TIME`** and **`MODE: MANUAL.`** If it is showing a different display, press the **Item** button to change it and move through the different display until you reach the Time/Mode display.
2. In the Time display, press the **Adjust** button.
3. When the cursor is blinking over the first digit of the time, press the **Value** button to adjust the value of that digit. Use 24- hour time (0 – 23).
4. Press the **Item** button to move to the next digit.
5. When you have finished setting the hours, minutes, and seconds, press the **Adjust** button to accept the change.

C.2 Set the Date

1. Press the **Item** until you see the **`Date MDY`** prompt.
2. In the Time display, press the **Adjust** button.
3. When the cursor is blinking over the first digit of the date, press the **Value** button to adjust the value of that digit.
4. Press the **Item** button to move to the next digit.
5. When you have finished setting the month, day, and year, press the **Adjust** button to accept the change.

Note: The SolarTrak controller does not distinguish between UTC -12 and UTC +12 time zones.

C.3 Enter the Latitude and Longitude

Enter the Latitude and Longitude to the nearest 100^{th} of a degree if possible.

Note: you will enter longitude as a positive number from 0 to 355.99 counting west from the Prime Meridian (Greenwich). Therefore, enter longitude west 0 to -180 as 0 to +180. Enter longitude east 0 to +180 as
360 – east longitude.

1. Press the **Item** button until you see the **`LAT:`** prompt.
2. Press the **Adjust** button.
3. Use the **Value** and **Item** buttons to adjust each digit to your current latitude.

4. Press the **Adjust** button to accept your changes.
5. Press the **Item** button to display the `LONGIT:` prompt.
6. Use the **Value** and **Item** buttons to enter the longitude in *degrees west*.

Note: the controller ignores the +/- sign for longitude.

7. Press the **Adjust** button to accept your changes.

C.4 Enter the Time Zone

Enter the time zone as a value from 0 to 23, which represents the number of hours west of Greenwich Mean Time. For example, the Eastern Time Zone in the US is 5 hours west of GMT, the Pacific Time Zone is 8, and Saudi Arabia is 21. Use the following **Time Zone Value table** to look up the value for some common time zones and locations.

Note: The time zone can only accept whole numbers. If you are in an area where the time zone is a fraction of an hour off, enter 0 and set the clock to Greenwich Mean Time.

Time Zone Value Table

Time Zone Value	UTC Offset	Time Zone / Region
0	UTC	Greenwich Mean Time
1	UTC – 1	Azores, Cape Verde
2	UTC – 2	South Georgia and the South Sandwich Islands
3	UTC – 3	Antarctic Peninsula, Argentina, Brazil, French Guiana, Uruguay
4	UTC – 4	Atlantic Time Zone, Eastern Caribbean Time Zone
5	UTC – 5	Eastern Time Zone, Bahamas, Ecuador, Peru
6	UTC – 6	Central Time Zone, Costa Rica, El Salvador, Honduras, Nicaragua
7	UTC – 7	Mountain Time Zone
8	UTC – 8	Pacific Time Zone, Clipperton Islands, Pitcairn Islands
9	UTC – 9	Alaska Time Zone, Gambier Islands
10	UTC – 10	Aleutian Islands, Cook Islands, Hawaii
11	UTC – 11	Niue, Samoa
12	UTC – 12 (+ 12)	Antarctica, Fiji, Marshal Islands, New Zealand
13	UTC + 11	New Caledonia, Solomon Islands
14	UTC + 10	Australian Eastern Standard Time, Guam, Papua New Guinea
15	UTC + 9	Japan Standard Time, Korean Standard Time
16	UTC + 8	Australian Western Standard Time, China, Philippines , Singapore
17	UTC + 7	Cambodia, Java, Laos, Sumatra, Thailand, Vietnam
18	UTC + 6	Bangladesh, Bhutan, Kyrgyzstan
19	UTC + 5	Pakistan Standard Time, Tajikistan, Uzbekistan
20	UTC + 4	Georgia, Oman, United Arab Emirates
21	UTC + 3	Iraq, Kenya, Saudi Arabia, Sudan
22	UTC + 2	Egypt, Finland, Greece, Libya, South Africa, Turkey, Zimbabwe
23	UTC + 1	Central European Time

1. Press the **Item** button to display the **`ZONE:`** prompt.
2. Press the **Adjust** button.
3. Use the **Value** button to set the time zone.
4. Press the **Adjust** button to accept your change.

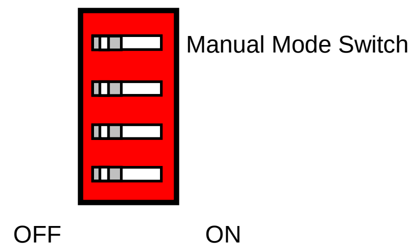
C.5 Perform a Morning Reference Check

In a morning reference check, the controller moves the turns and tilts the Prospector all the way to its limits of motion to reset the zero count for tracking the Prospector's angle and elevation. The controller performs a reference check every time it is turned on and every morning.

1. Turn the power switch on the controller board off.
2. Wait five seconds or more.

Warning: Wait at least five seconds before turning the power switch back on. This allows all motors to reach a full stop to preserve their life and keep the electronics' smoke inside.

3. Turn the power back on.
4. Toggle the Manual Mode dip switch off (out of Manual mode). The prospector is now in tracking mode.



The prospector will tilt to a slightly steeper angle and turn slightly away from sunrise and then pause for four seconds. Then it will tilt all the way to horizontal and turn all the way toward summer sunrise. Then it will pause for four more seconds and then turn to face (what it currently thinks is) directly at the sun.

Note: Since this is presumably an initial installation, and if all your leveling is good, the tracker should wind up very close in elevation and somewhat off in azimuth… we shall fix that in the next section.

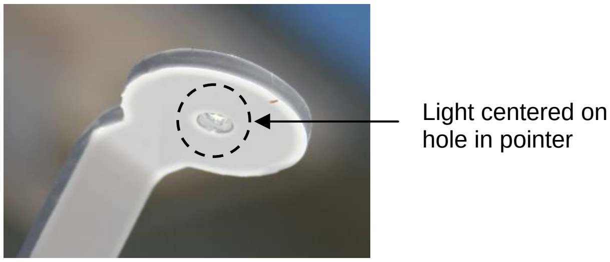
C.6 Set Sun Offset

Setting the sun offset allows you to fine-tune the Prospector's aim at the sun. You need only do this once after setting up the unit or after each time you move it.

Note: You can only set the sun offset when it is bright and sunny outside. You need direct sunlight to aim the Prospector with the reflective pointer.

1. Push the **Item** button until you see the **`SET SUN OFFSET`** command displayed.
2. Push the Adjust button to start the command. The display will now say **`POSITION ARRAY`**.
3. Look up at the underside of the reflective pointer. You should see a dot of sunlight that may be off center of the small hole in the center.*

4. Use the joystick to move the Prospector until the dot of sunlight becomes a halo**, perfectly centered on the hole in the back of the reflective pointer.



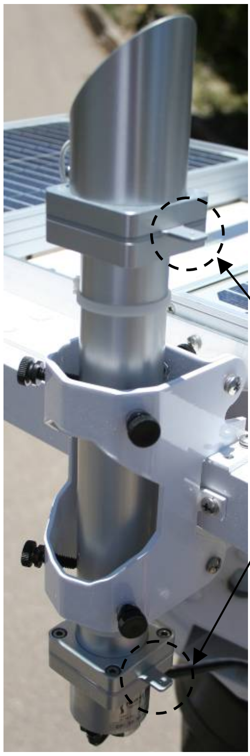
5. Press the Value button to accept this position. The display should switch back to flashing between the time and the **`MODE: TRACKING`** message.

***Note:** If the tracker is more that three degrees off sun, the spot will not show up from the back… looking from the front for a moment, move the tracker until the shadow of the pointer paddle is over the reflector mirror then move behind it again and continue as stated above.

****Note:** When moving the tracker in this operation, consideration must be taken for the necessary mechanical backlash required for geared machinery to operate without binding. It is generally sufficient in magnitude that in this context of high-accuracy tracking the direction of position updating should be used to approach a set point… if the movement goes past the mark, it is better to let the sun catch up than to reverse the motor opposite the direction of tracking.

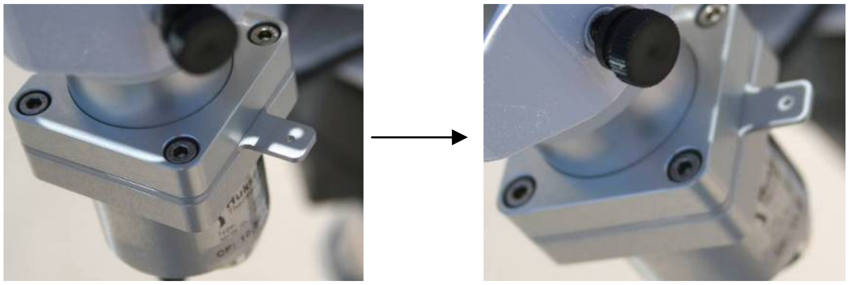
C.7 Align DNI sensor

The DNI sensor has two tabs with aiming holes. The line between the holes is exactly parallel to the center of the instrument.



Note: Only align the DNI sensor once the Prospector is aimed accurately at the sun. It helps to have bright sunlight to aim the DNI sensor

1. Check the reflective pointer on the Prospector to make sure it is aimed correctly at the sun
2. Alternately loosen and tighten the three plastic mounting screws near the lower end to move instrument so that the dot of sunlight from the top aiming hole aligns perfectly with the bottom aiming hole.



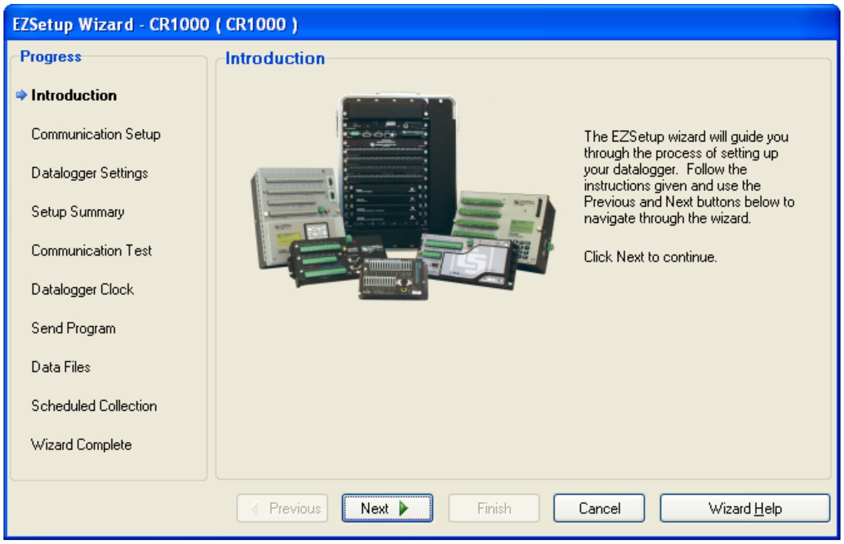
3. Gently tighten the mounting screws to hold the instrument firmly. Be careful to preserve your alignment while tightening the screws.

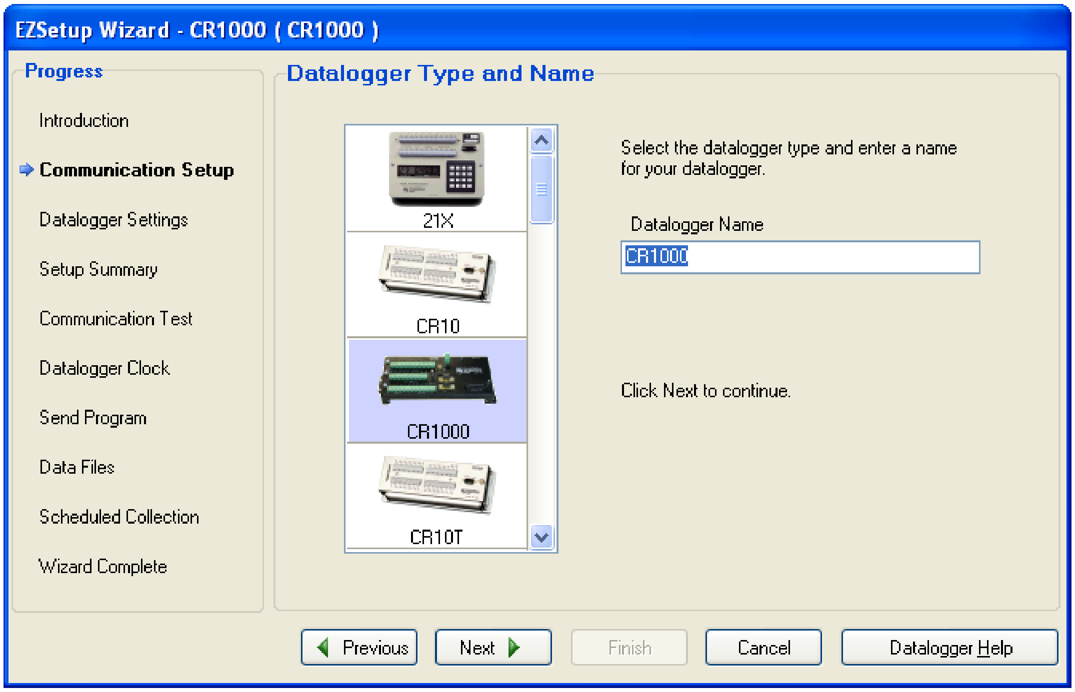
C.8 Set up data collection

Start up the LoggerNet software using the ‘LoggerNet’ desktop icon provided to get the following window.

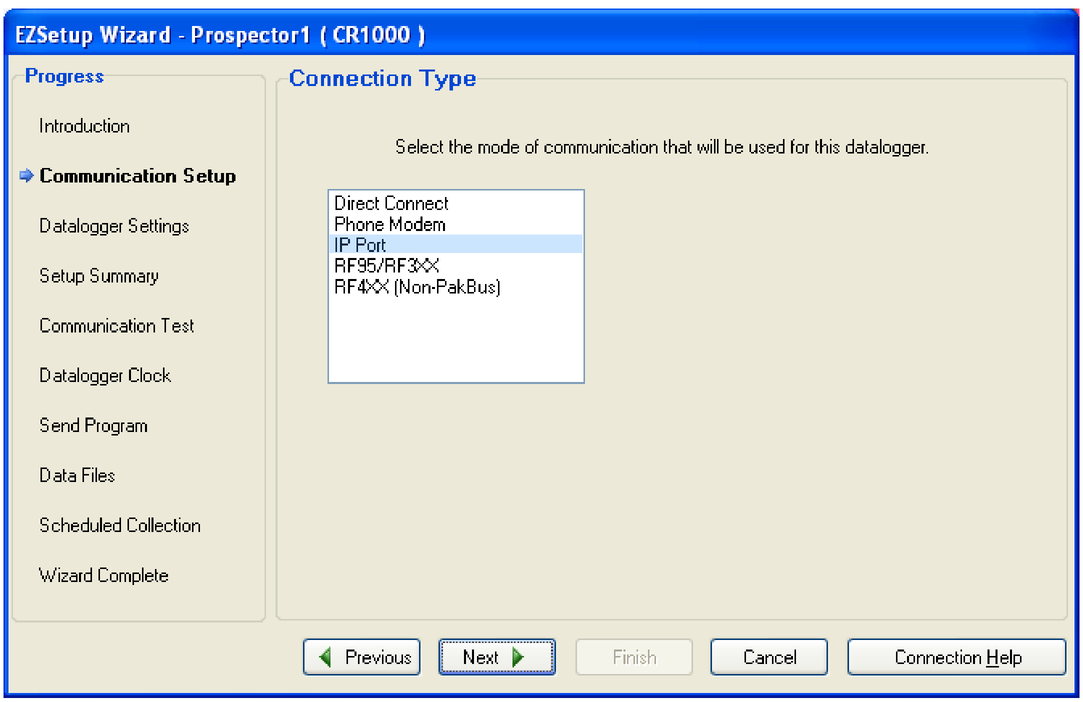
As you move the mouse over the left column categories you will see the right column change to present various operational utilities. i.e.: Move the cursor over ‘MAIN’ then move straight to the right to access the ‘Main’ category menu selections’

In order to proceed, you will first need to ‘Setup’ LoggerNet to talk to your CR-1000 datalogger. Click ‘Setup’ on this window found under the ‘Main’ menu selections then click ‘Add’ on the menu bar to get the following dialog box: Then click ‘Next’.





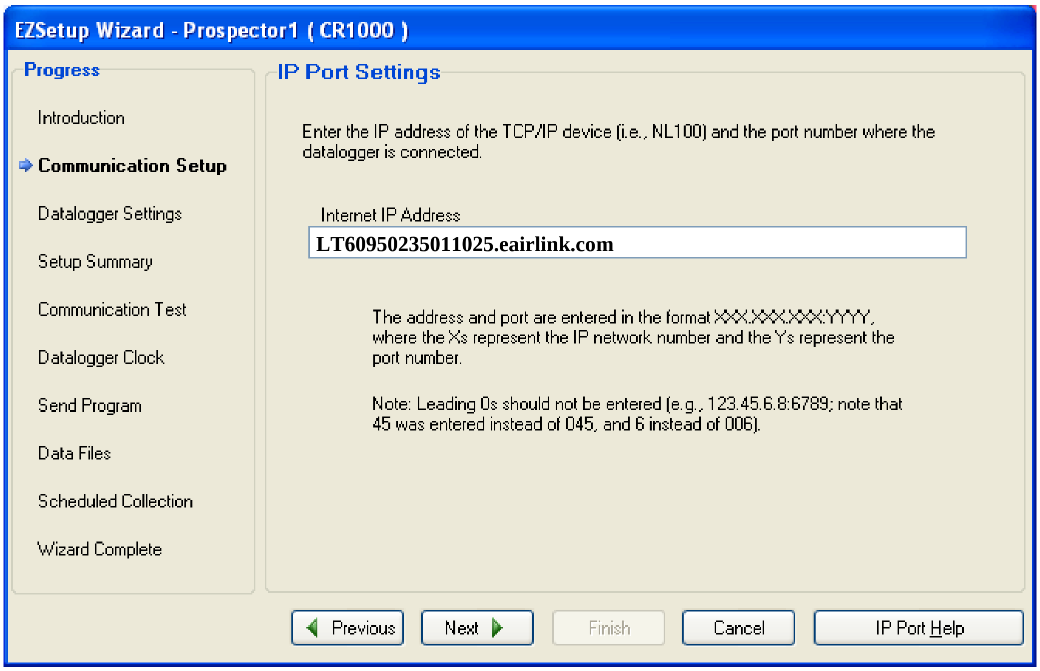
Select the CR1000 from the picture menu selections then change the highlighted 'CR1000' to 'SR_Mule_1' and click 'Next'…



Select 'IP Port' for an Ethernet hookup. …then click 'Next'…

Enter the Modem Name (Dynamic IP): **LT60950235011025.eairlink.com**

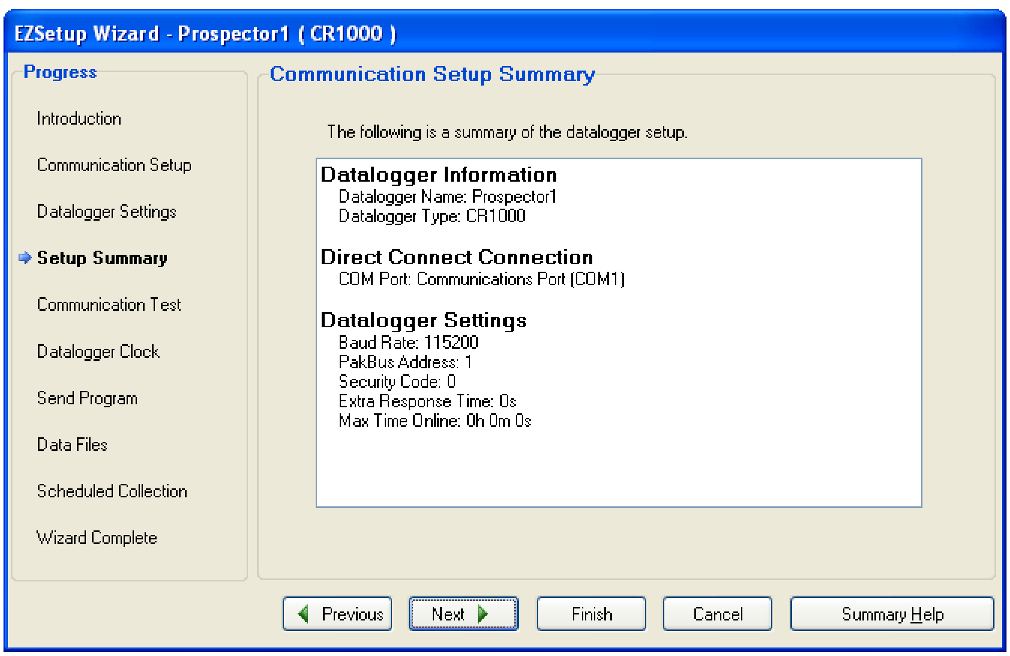
Your Prospector CR-1000 datalogger has been preconfigured to be ready for automatic IP generation (DHCP) by the modem and is internally set to 0.0.0.0 & port 6785… If problems arise, then you will need to run the Device Configuration Utility to check on things and troubleshoot the problem.

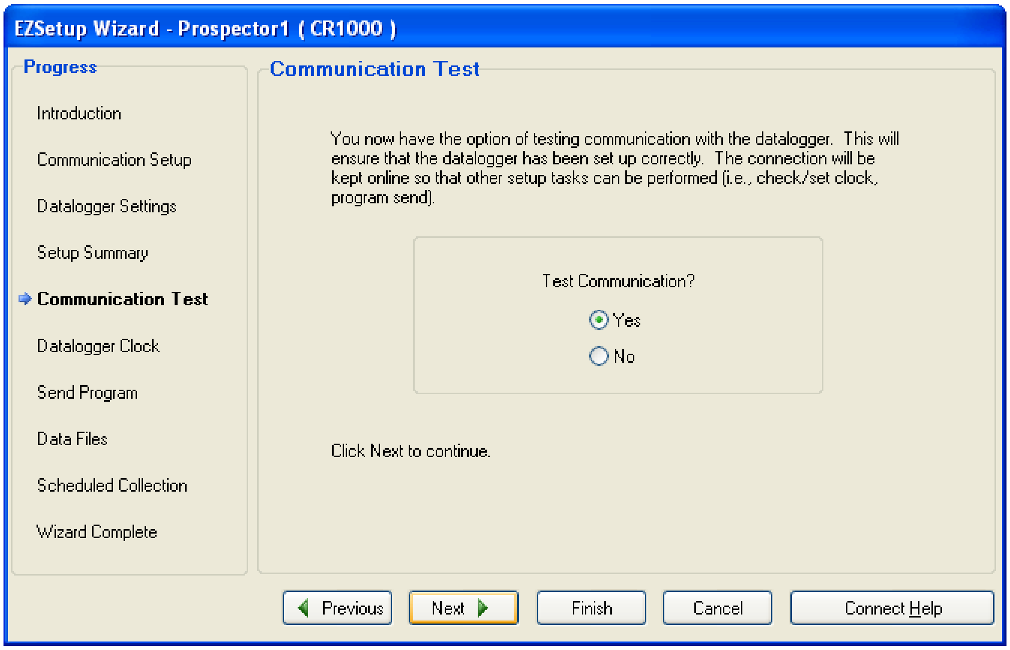


Press Next…

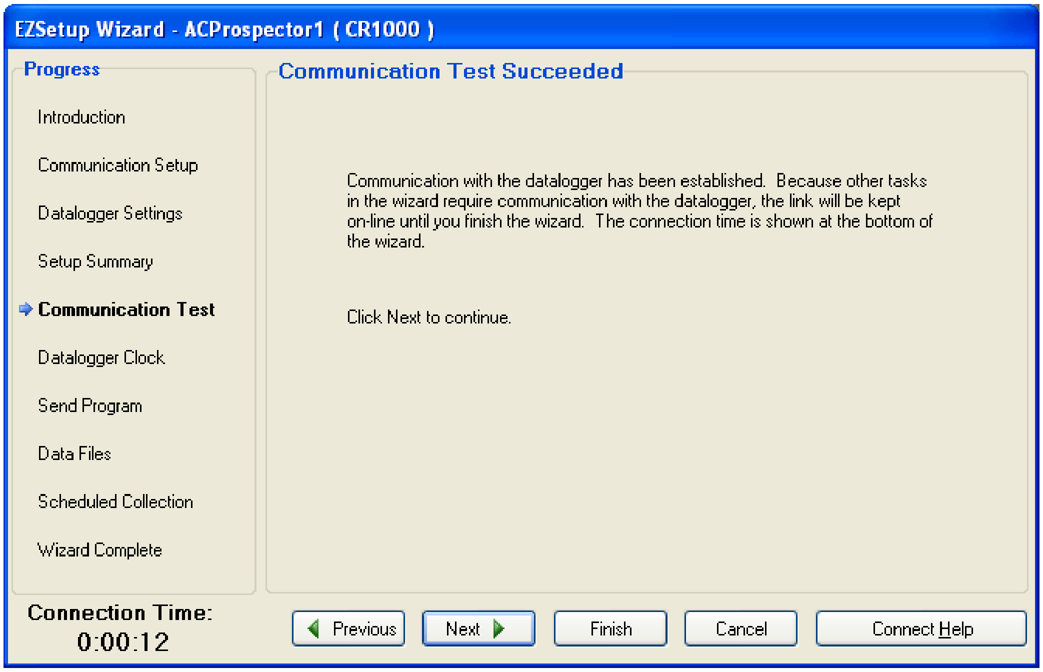
This next page will confirm either the direct connection comm port or the selected IP address for Ethernet…

If you have already connected an appropriate cable between your computer and the datalogger and have configured the datalogger for the appropriate communication mode, this will test the connection…




EZSetup Wizard - Prospector1 (CR1000)
Progress
Introduction
Communication Setup
Datalogger Settings
Setup Summary
Communication Test
Datalogger Clock
Send Program
Data Files
Scheduled Collection
Wizard Complete
Communication Test
You now have the option of testing communication with the datalogger. This will ensure that the datalogger has been set up correctly. The connection will be kept online so that other setup tasks can be performed (i.e., check/set clock, program send).
Test Communication?
Yes
No
Click Next to continue.
Previous
Next
Finish
Cancel
Connect Help

If the communication test works correctly, the timer at the bottom left of the dialog box will start running…

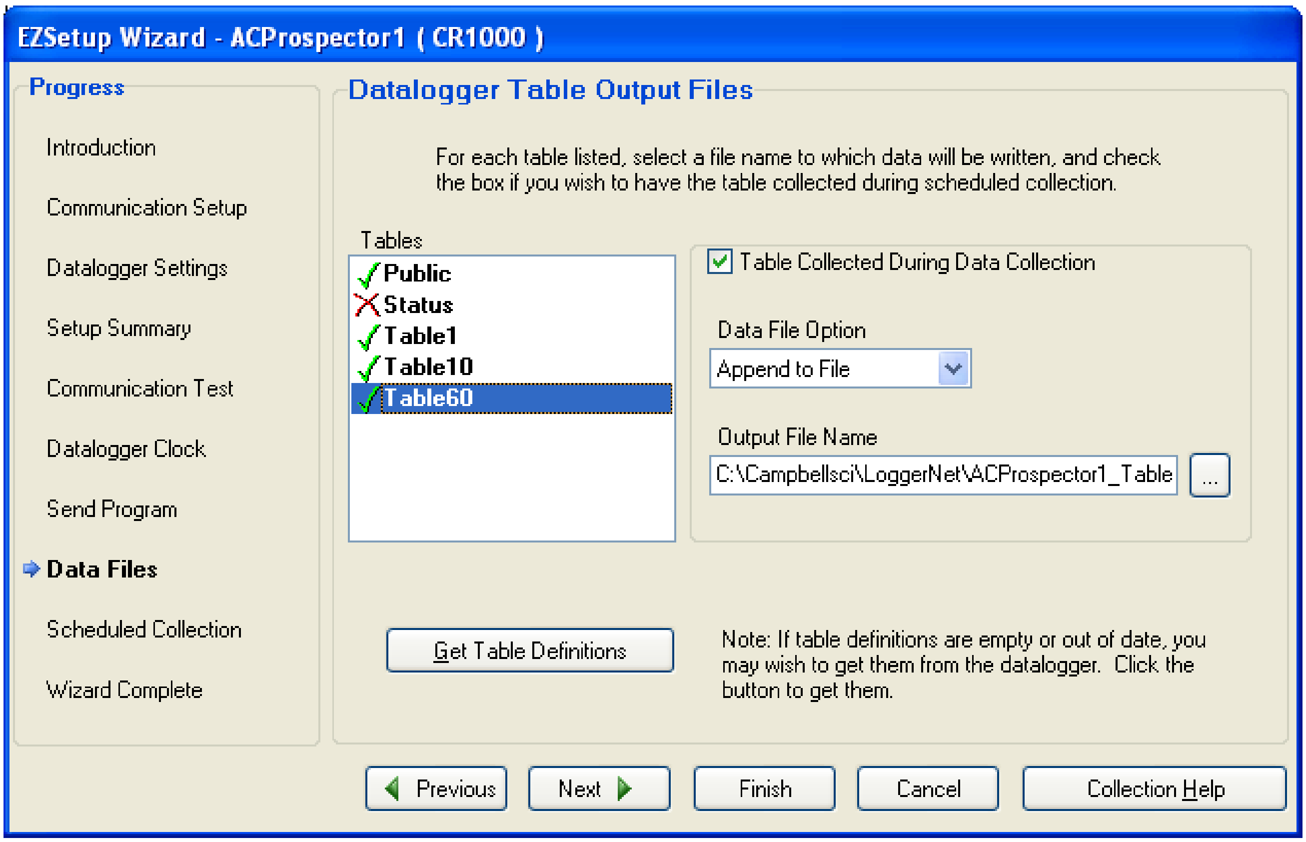


For now, click ‘Finish’…

Setup for Scheduled Data Collection

This setup procedure accommodates long-term data collection and storage as well as routine real-time monitoring.

Re-enter 'Setup' under the 'Main' category of selections, select the target datalogger station and click the 'Edit' icon up on the task bar… then, on the left sidebar menu select 'Data Files'.



The 'Public' table is actually a type of 'internal common block storage' for the sampled data, computations, status variables and other working variable applications through which tasks are accomplished or controlled in the datalogger program. The green checkmarks correlate with the check box to the right labeled 'Table Collected During Data Collection'.

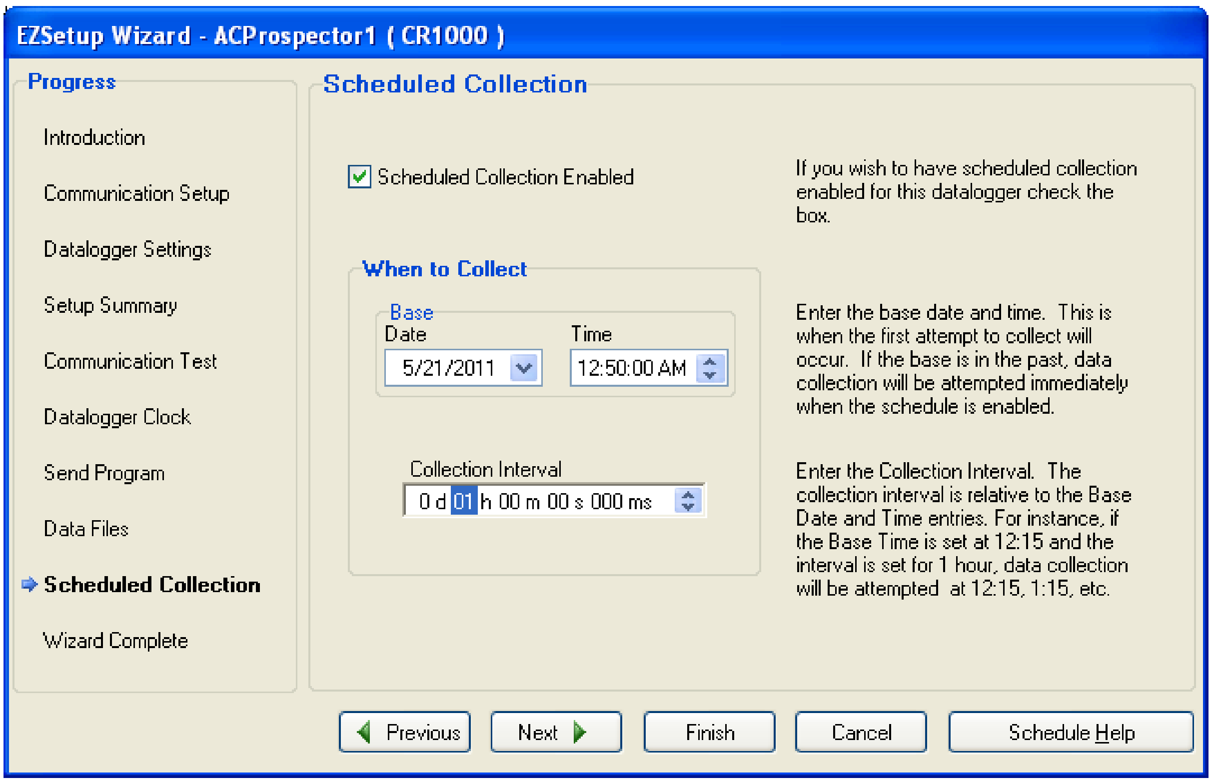
If using the real-time monitoring functionality (RTMC, see below), the 'Public Table' is useful for status alarms, instantaneous data values and progress meters, among other things. The other three tables, 'Table1, 10 and 60', are 1-minute, 10-minute and 60-minute averages recorded by the datalogger using the sampled data recorded in the 'Public' table. Each table can be accessed individually or simultaneously for comparison in tables, charts, graphs and other data display mechanisms. All data is stored in 'CSV' (comma-separated-values) text format that can be easily imported to such applications as MS Excel, Access or other data manipulation software packages.

It is generally not useful to save the 'Public' data in a file and in the 'Data File Option' pull-down selection you should select 'No Output File'. For the other three, selecting 'Append to file' will provide permanent retention of all data is a single, growing file. Selecting 'Overwrite File' will assume that the historical data is either not needed or has been saved in a discrete file through another process such as 'Task Master', another LoggerNet utility (not addressed in these instructions as yet).

It is suggested to download at least the three average tables which are stored internally by the datalogger but are in storage areas (ring buffers) that will, after a period of time, overwrite the oldest data. Each table name will default to a filename and folder including the station name and table name such as:

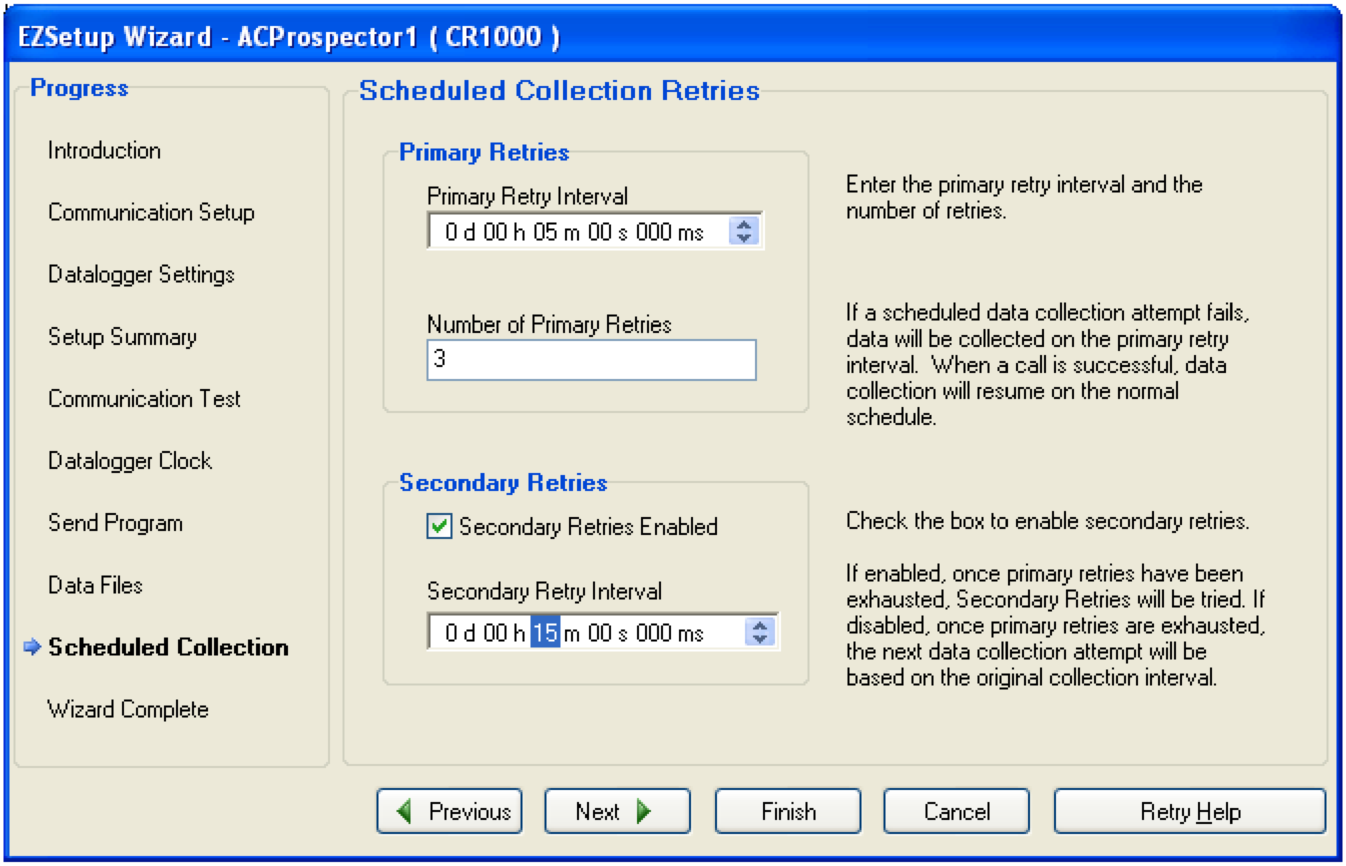
C:\Campbellsci\LoggerNet\ACProspector1_Table1.dat

With these definitions in place, now select 'Scheduled Collection' from the left sidebar.



The scheduled collection interval and 'first download' base time are selected here. Clicking next will allow the specification of retry intervals if the first attempt is not successful. There are two stages of 'retries' designated 'Primary' and 'Secondary' each of which can have a different interval.

An example would be a ‘Scheduled Collection Interval’ of one hour (01h) with a ‘Primary Retry Interval’ of five minutes (05m) and a ‘Secondary Retry Interval’ of fifteen minutes.



This is the last step in setup so click ‘Finish’.

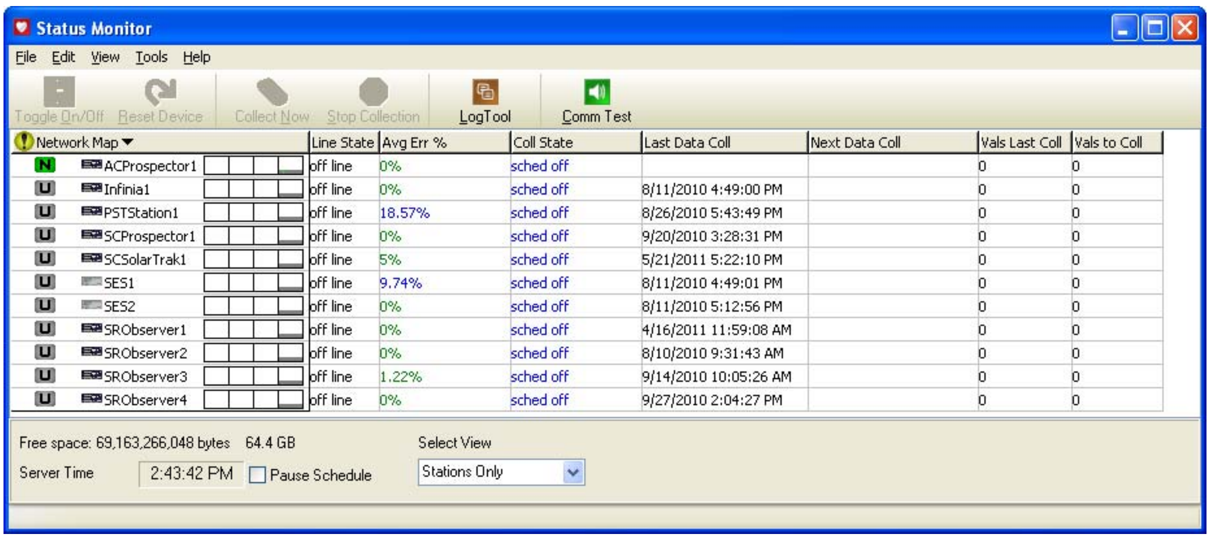
'**Status Monitor**', found under the '**Main**' LoggerNet category will show the status of active data collection and results. It will indicate success or failure and when the next download attempt will occur. There are four different quick-check icons possible at the left of the window under '**Network Map**'… each a box with a letter in it:

N – Normal Operation, No Problems [Green Box]

M – Medium Communication Status, intermittent difficulties encountered while downloading [Blue]

C – Communication Failure (also accompanied by an exclamation point) [Yellow]

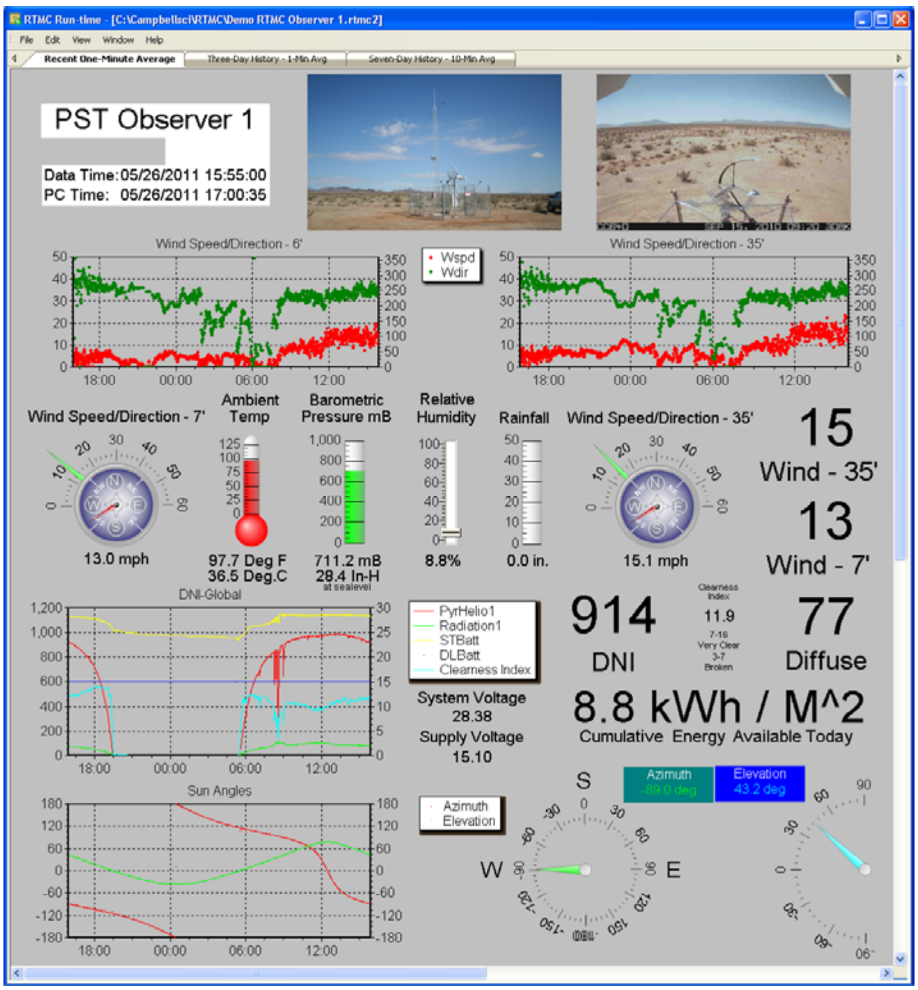
U – Undefined status, Awaiting scheduled or Manual download [Gray]



RTMC – Real Time Monitoring and Control Software

It is usually desirable to have a quick access display of data available. The RTMC utility (under the ‘**Data**’ LoggerNet category) is an easy-to-create, easy-to-use application for accomplishing this task.

This is an RTMC data monitor screen for a standard Prospector with DNI (Direct Normal Insolation) and DHI (Diffuse Horizontal Insolation), six meteorological sensors for wind S/D, rainfall, barometric pressure, temperature and relative humidity as well as indicators for system battery voltage and the datalogger supply voltage. It also notes the date of the most recent data collected and offers a PC system local time display.



This screen layout is designed for at-a-glance assessment of current and recent solar and weather conditions. Its pictorial GUI presentation of data (meters, dials, slides, etc.) is augmented by digital fields with the actual number and units represented.

RTMC is a wide-open option for the customer to arrange things to suit the current needs. A screen has been provided with the Prospector CD that can access and display the data from the Prospector instruments through the datalogger. That screen file can be loaded into the ‘**RTMC Development**’ utility, modified and re-saved to achieve whatever custom presentation that may be desired. After modifications are complete the **RTMC Run-Time** utility is used.

At the bottom of this RTMC Monitor Screen (above) are indicators showing the Azimuth and Elevation sun angles that correspond with the sensor data recorded. This information is provided through a communication channel with the SolarTrak controller operating the tracker and providing power for the datalogger and instruments. This channel is two-way and allows the datalogger to monitor the time and date of the SolarTrak, set it if necessary and change a selection of values that are useful for custom tracking control like precision displacements off-axis to test receiver responses. These displacements can be 'set by hand', made to increment on a timed schedule over a range of values and can also be programmed using text-format 'scripts' stored on the CompactFlash backup storage card included with all datalogger systems.

C.9 Calibrate the Clock

The crystal that provides timing pulses to the clock chip on the SolarTrak® has two modes of deviation that must be accounted for in order to provide accurate time over long periods. The first is operating temperature variation and the second is variations in the original crystal fabrication within published tolerances for the part.

Temperature is accounted for through the mathematical integration of operating temperature applied to a formula provided by the crystal manufacturer. The SolarTrak® is equipped with an onboard thermistor-based device (thermometer) mounted adjacent to the crystal that allows local operating temperature to be sampled once per minute. The time adjustment is applied automatically once per day at midnight.

The fabrication variation issue must be dealt with using empirical methods. The required correction is reduced to a daily and weekly correction keeping the time within plus or minus ten seconds of the correct universal time, corresponding to about one-tenth of a degree of sun motion.

The clock on the SolarTrak Prospector is calibrated before being shipped but you should observe it for a few days to see if it needs further calibration. Variations of up to 6 or 7 seconds off of local 'atomic' time may be noticed due to the fact that the clock is only corrected internally once per day at about midnight. At that time the thermal correction is computed and added to the current time. The second two corrections, seconds-per-day and seconds-per-week, are then added to that result (as appropriate) to correct for daily and weekly variations of the crystal frequency.

Note: Proper clock calibration procedure requires several observations over several weeks.

The best devices for setting the clock are GPS hand held devices or WWV radio clocks… cell phones are typically the next best or an on-line application hooked into NIST or similar service… cell phones and I-Phones can have as much as 15 seconds difference and that will cause more problems with calibrating the clock than not.

The basic computation for determining the correction is simply the number of days since the clock was set exactly on universal time divided into the number of seconds of observed deviation over that time frame. If that value is applied to the current clock value by the processor once per day, the time will remain accurate.

Since the time is not kept in fractional parts within the clock calendar device, the correction is broken into two parts, seconds-per-day deviation plus seconds-per-week. Seconds per month might be applicable but there are space constraints associated with internal storage for parameters and program code that makes the addition less than optimal.

The PC Interface software provides an automated method for performing this calibration provided that the operation is performed with the respective clocks on those devices set to precisely universal time. The SolarTrak® stores the last time-set date as an internal, non-volatile parameter and performs the required calculation at each time-set operation from the PC, reducing the overall deviation to an update of the seconds-per-day and seconds-per-week in integer (whole numbers) rather than fractional form.

This operation can be done by hand using several iterations by performing the following steps.

1. Set the clock/calendar to universal time. Note the day it was set.

2. Progressively extend the time between time-set operations from a few days to a few months over three or four iterations.

3. Note the time deviation (in seconds) for the elapsed time (in days), divide out to produce seconds per day and add that deviation (using only the integer part with the sign convention + was running slow, - was running fast) to any previously computed value.

4. Take the remaining seconds of deviation not accounted for by step three (seconds-per-day times elapsed time in days) and divide by the number of elapsed weeks (use fractional divisor if not whole weeks, adding that integer value to the seconds-per-week parameter using the same sign convention.

5. Repeat steps 1-4 three or four times over several weeks time using progressively longer periods.

The same progressive time lapse between operations should be applied to the automated methods as well.

Proper calibration of the clock/calendar will produce clock error within the twenty-second window over as long as a year without further updates. Note that someone will need to clean the instruments at least once per week (ideally once per day) and even if the clock is off, it takes only a few seconds to reset.

Instrument Maintenance Procedures

The solar radiation sensors delivered with a Prospector Solar Weather station are highly sensitive to changes in solar flux to the point that a telephone or electric wire hundreds of feet away passing between the sun and the sensor will register as much as a 1% change in output. Heat waves in the atmosphere will cause noticeable variations in fast response instruments such as the Hukseflux DR-02 and DR-03 pyrheliometers as well as the SR-20 Secondary Standard global pyrnometer.

In order to maintain this level of sensitivity, the lenses should ideally be cleaned every morning just before sunrise in a scientific research setting, every other morning for industrial/commercial applications involving field control and at a minimum, twice weekly in all other applications. In addition, lenses should be cleaned as soon as possible after weather events such as rain, blowing dust or high humidity where particulates and soluble elements in the rain can be deposited on the lens. A typical squall-like summer storm, beginning with light rain and followed by blowing dust, can reduce the signal response by as much as 25% in a matter of minutes.

With the range of Prospector styles and the variety of installations to be considered, it can be problematic to accommodate this requirement of nearly daily access, both physically and financially, but it is, in fact, necessary and should be factored into any plan to implement this caliber of scientific instrument system.

While cleaning instruments up in the air (as much as ten feet for the horizontally mounted pyrnometers on the Prospector T-Tail) issues of both safety and system calibration come immediately to bear.

Considering safety first, a Prospector on a standard eight-foot post requires at least an eight-foot a-frame ladder. A ten-foot ladder would normally be preferable for cleaning the higher instruments because is necessary to get good visibility on the lenses in order to perform the cleaning operation effectively. It will seldom work to try cleaning the lenses ‘blind’ where the cleaning operation is initiated from behind the instrument. Given the short post on a Mule™ trailer version, no ladder is necessary to clean instruments.

From a system calibration standpoint, nothing should be attached or leaned against the support structure after the initial calibration and commissioning has been performed.

A part of the cleaning process should be observation of proper operation (on sun), accurate solar time on the LCD monitor of the controller and cleanliness of the solar panels that charge the system batteries.

Proper cleaning will require one-time-use optical quality, soft, absorbent wipes, a directed spray (not mist) bottle containing 25% alcohol and 75% distilled or DI (deionized) water and a clear view of each lens to be cleaned. The cleaning process should be performed in a manner that the sun continues to hit the lens (keep the shadow of the head or hands out of the way) such that particles and smears can be readily detected. The resulting appearance of a properly cleaned lens is literally a black hole for the pyrheliometers with no detectable specks or smears, or a clear gloss surface for the pyrnometers with special attention to making sure there are no ‘spectrums’ glancing off the surface which indicate the presence of oil-based soiling.

The process begins with spraying the lens with the directed spray to remove dust and other particulates as well as dissolving the oil-based components. Not using the spray WILL result in scratching the lens and permanently reducing sensitivity. Follow this with careful wiping of the lens until all traces of moisture or oily film are gone.

The rain bucket should be periodically inspected for debris clogging the screens.

Communicating With the SolarTrak Prospector

--- See the SolarTrak PC Interface Manual ---

Please install the following two LabVIEW runtime engine components for the SolarTrak PC Interface software then unzip the attachment (after changing the extension back to 'zip') and copy the folder to My Documents or your desktop… this software will run on Windows 7 or 10, I haven't checked anything else. If for some reason you're still using XP like I am, I have a version for that also.

http://www.ni.com/download/labview-run-time-engine-2011/2536/en/

http://www.ni.com/download/ni-visa-run-time-engine-5.3/3826/en/

You will need a DB-9 serial cable; male on one end and female on the other… You will also probably need a USB-DB-9 serial converter like the one found at this link by CoolGear; http://www.coolgear.com/product/mini-usb-rs-232-serial-adapter-db-9-male

There are others available but some don't work with this program for some reason.

Contact: Precision Solar Technologies Corporation

www.precisionsolartech.com

10 Camino del Senador
Tijeras, New Mexico 87059-7631
505-281-0399 Voice
505-250-4991 Cell/Text