Owner's Manual

For

The SolarTrak® Industrial Solar Tracking Controller
Revision 4

The Powertracker™ Single-axis Tracking System

Originally Distributed By:

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Powered by

The SolarTrak®
Industrial Solar Tracking Controller

Single-Phase 208 AC
Solid-State Power Control

Three-Phase 208 AC
Solid-State Power Control

Designed and manufactured by

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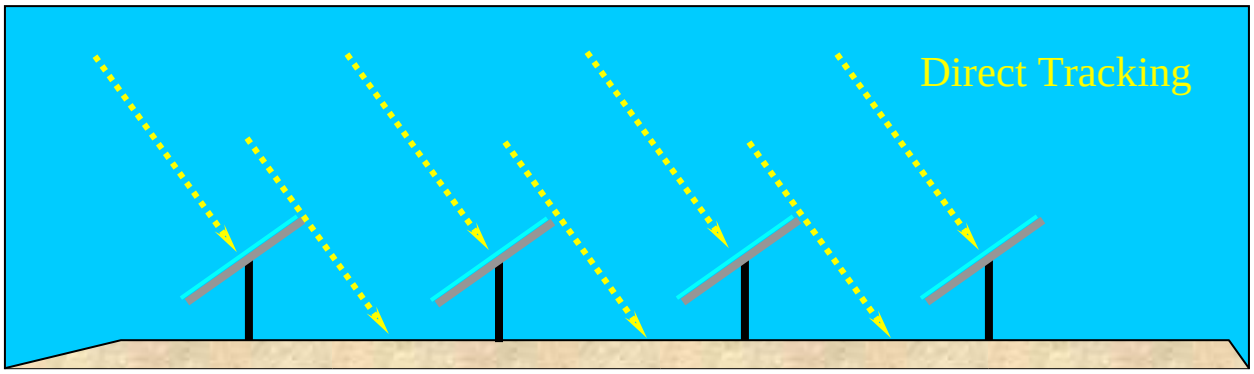
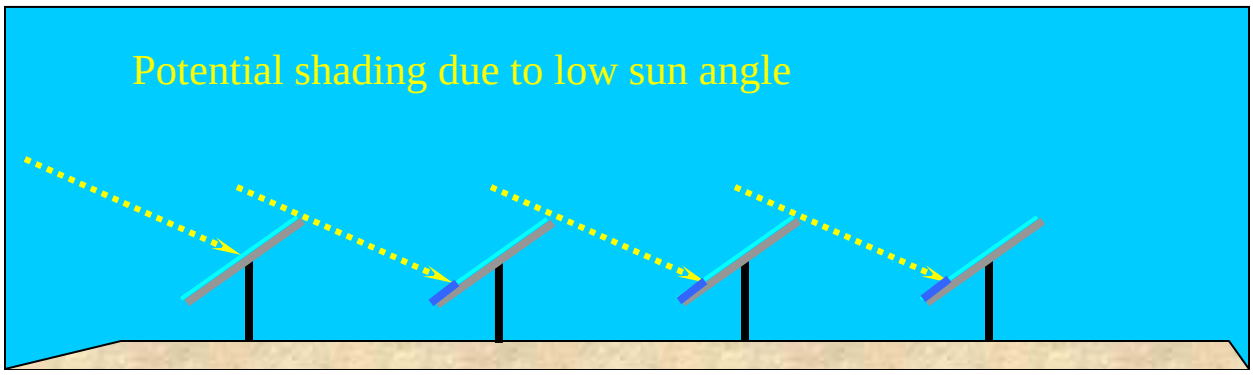
The Powertracker™ Drive Unit Standard Operation:

The Powertracker™ Drive Unit is equipped with a ½ horsepower AC bi-directional motor. The motor is controlled by the SolarTrak® Controller software via three high-power solid-state relays, two for directional control on one of the AC phase legs and one more to disconnect the second phase leg, leaving the motor cold to AC power when the unit is not actively driving. The 3-phase version utilizes a solid-state H-bridge which swaps two legs of the 3-phase power to produce the reversing function as well as switching the third leg on and off to create the same effect and requires five solid-state relays.

The Powertracker™ utilizes an optional SolarTrak® function referred to as 'Backtracking'. This function, when applied to single-axis flatplate PV at low sun angles such as in the early morning and late afternoon, prevents shading of one row by another thereby maintaining equal illumination on all of the cells at all times.

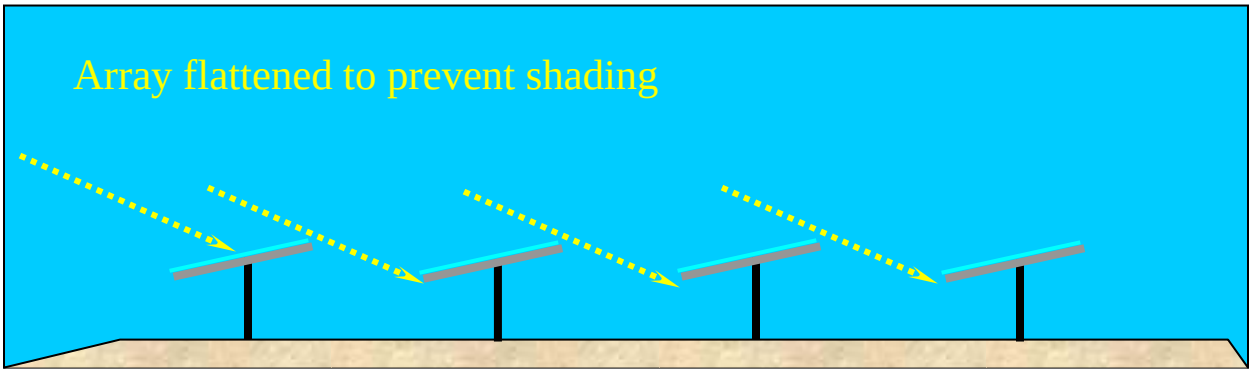


The range of motion of a typical multi-row system is seldom more than +/- 45 degrees. As long as the Sun is higher than that in the sky, the panels can be positioned to maximize the isolation angle of incidence, however, as the Sun angle decreases in the afternoon or before it has risen high enough in the morning, shading of panels by those in adjacent rows will occur.



Although PV cells in parallel can be individually shaded and simply lose that much proportional power, those that are in series are affected differently. If a single cell in a chain is shaded, it will stop conducting and deactivates the entire chain. If there is enough power involved, the shaded cell can be permanently damaged.

In a trade-off between power output and cell damage, the SolarTrak® instructs the array to discontinue tracking the Sun directly and moves away from it instead, hence, backtracking. This tracking strategy further reduces the already diminishing angle of incidence but provides illumination of all cells equally thereby preventing damage and continuing to put out energy.



A normal daily cycle of Backtracking-based control has the array beginning in a level position at sunrise then moving incrementally *toward* the Sun, always keeping the shadow of one row just off the adjacent row, until facing directly at the Sun without shading the adjacent row. The array then tracks normally until one row would otherwise begin shading the next row as the Sun sets, then begins incrementally *backing away* from the Sun, again keeping the shadow of one row just off the next row, until the array is once again level just at sunset.

Overnight, the Powertracker™ can be stowed at a slight angle such that chance rain showers will tend to clean the panels and drain properly without puddling or collecting dirt.

The following is a diagram of the major I/O components of the SolarTrak® Controller Board:

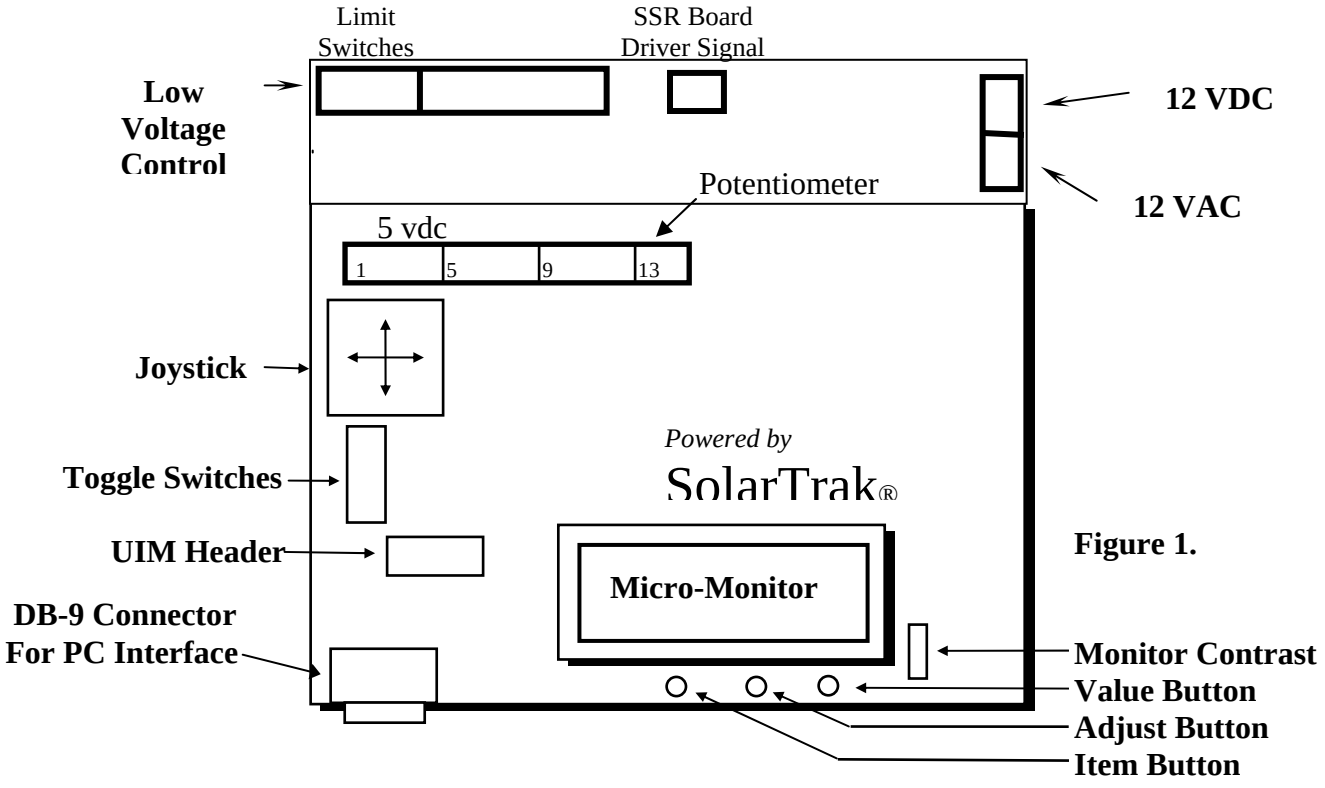


Figure 1.

The SolarTrak® ST-2011-IAC Control Board

Determining the Current Operational Mode

The current operational mode is displayed on the micro-monitor (Figure 1) alternating once per second with the current time. This alternating status screen is the default display and implicitly indicates that the SolarTrak® Controller is functioning normally in one mode or another. Other display screens are available containing status or configuration data that can be viewed by pressing the *Item Button*, and when applicable, edited with the *Adjust Button* and *Value Button*. The display will return to the default display screen after one minute of idleness except while in the *Adjust* mode. Please see section on Displaying and Editing Parameters.

Operational Modes

- **Tracking Mode:** All toggle switches to LEFT (Joystick Inoperative)
  System goes through standard tracking scenario: Track during the daytime and assume a programmable Night Stow position while the Sun is below the horizon.

- **BackTracking Mode:** Indicates direct tracking will produce shading.

- **Night STOW:** Normal tracking Function for standard overnight position.

- **Emergency STOW:** Bottom switch (STOW) to RIGHT (all others LEFT)
  Array moves to level (facing up) position.

- **Manual Mode:** Top switch (MANUAL) to RIGHT (Overrides STOW and tracking). All motion other than Joystick input is prevented.

Manual Control Mode - The manual control mode is an override to all motion functions of the controller. It is used when the array motion must be halted for safety while maintenance is performed or when the array must be moved to some unusual position.

Manual mode is turned on using the MANUAL toggle switch at the lower left of the controller board under the joystick. The Manual switch is at the top of the red and white switch block.

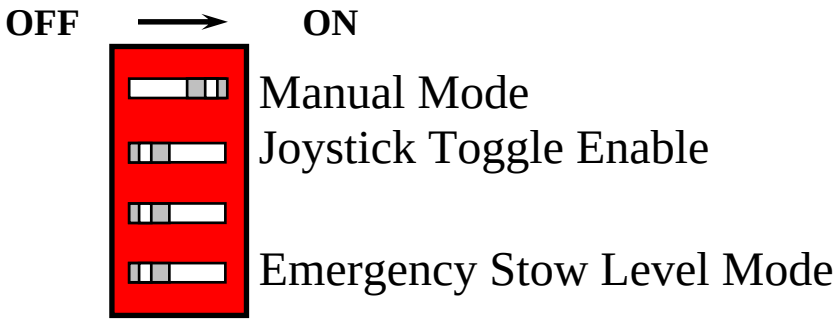


Figure 2.

Joystick Operation – Manual Mode – SolarTrak facing north, operator facing south:

EAST ← LEFT
RIGHT → WEST

- With MANUAL switch only ON, joystick runs motor only while held and only when six seconds have passed since the last joystick input. The delay prevents 'pounding' the systems, mechanical and electronic.

- With 'Opt 1' switch (second from top) as well as MANUAL, Touch and release to toggle ON then touch joystick in any direction to turn OFF. Toggle activation may be delayed by 6-second delay function but cut-off in immediate. If toggle fails to catch, press the joystick down (towards the bottom of the box) and release, wait the six seconds then try left or right again.

The Controller enclosure is always to be mounted facing to the NORTH, to minimize direct sun and heat build-up in the Controller enclosure. While performing any Controller calibration or troubleshooting operation, the operator will therefore always be facing SOUTH while looking into the controller enclosure.

Once MANUAL mode has been activated, the joystick may be used to move the array. Pushing the joystick toward the EAST (toward the LEFT side of the Controller board) will always move the array to point further to the EAST. Pushing the joystick toward the WEST (toward the RIGHT side of the Controller board) will always move the array to point further to the WEST.

To EXTEND the screw, push the joystick TOWARD the side of the array where the screwjack is mounted or AWAY to RETRACT it.

If the direction of travel of the array or the drive screw does not coincide with that described above, the Controller must be reconfigured, possibly including wiring changes. Until the Controller configuration has been performed, the array should remain in the horizontal position, with the power OFF.

***** NOTE:** The Manual switch should always be **ON** and the FINGER GUARD in place when powering-up the controller to prevent unexpected motion of the array or electric shock.

Emergency Stow Mode - Emergency stow mode is used to manually interrupt tracking and move the array to a pre-defined position, typically where wind resistance is minimized and the array can be left parked without incurring damage. The Emergency stow switch is at the bottom of the toggle switch bank.

Installation and Check-out Instructions

*** WARNING ***

This device operates on 208 VAC (with spikes to 600 VAC), develops over 10,000 pounds of force and 30,000 foot-pounds of torque.

Installation, operation and maintenance by unqualified, inexperienced or inattentive individuals could result in bodily harm by dismemberment or electrocution, possibly resulting in death.

Use CAUTION at all times while wotking with this machinery.

Do not remove Finger Guard while power is ON!!

Do not use fingers, screwdrivers or other tools to check or modify controller wiring while power is ON!!!

Troubleshooting should be coordinated with Powerlight Corp. or EEInc.

BE CAREFUL!!

Precision Solar Technologies Corp. will not accept responsibility for accidents or damage resulting from ignorance, inattention or unwillingness to excercise appropriate caution while working with this machinery or failure to follow these instructions including failure to supervise motion tests prior to completion of installation and certification for unattended operation.

Component Layout

Powertracker™ – Single-Axis in NEMA 4X J-Box

Single-Phase Power Option

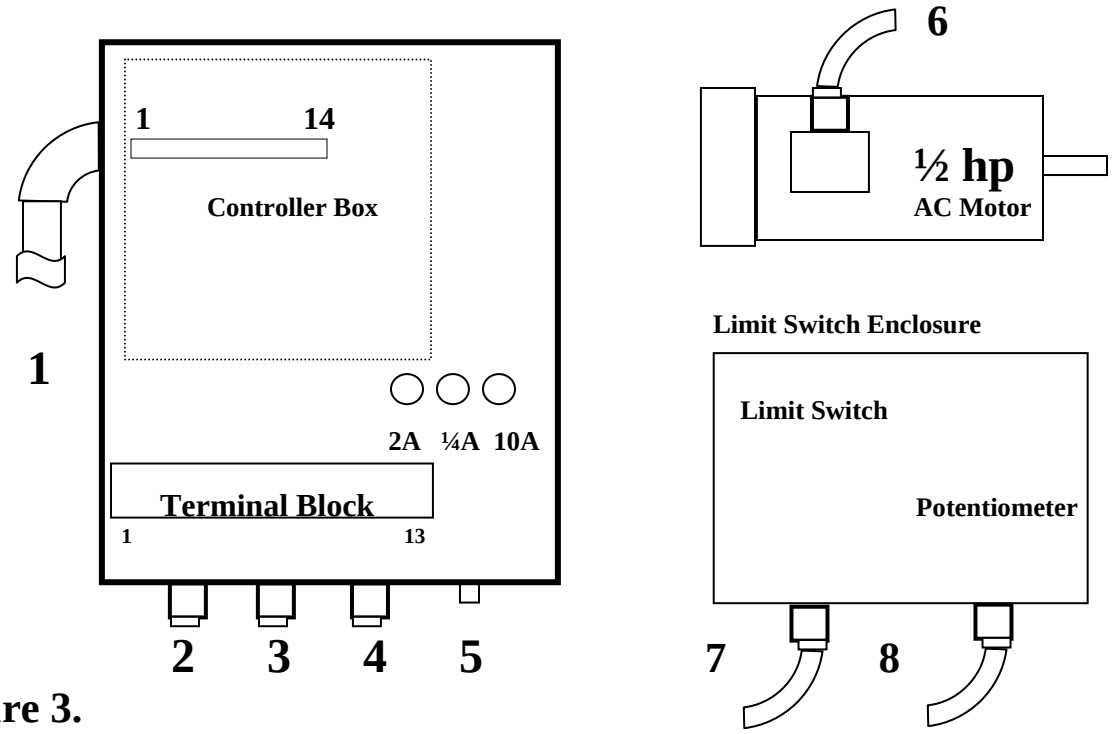


Figure 3.

Single-Phase Connections:

1. Potentiometer Conduit – SolarTrak® Terminal #

Black	**– Ground**	**1**
Red	**– +5V**	**3**
Green	**– Signal**	**14**

2. Limit Switch Cord -- > Connection 7 Term Block

Red/White -- Extension Limit Sw. Pair	**1,2**
Green/Black – Retraction Limit Sw. Pair	**3,4**

3. Motor Power Cord -- > Connection 6

Red – CCW Direction Lead	**5**
Black – CW Direction Lead	**6**
White – Common Lead	**7**
Green – Chassis Ground	**8**

4. Dual 208 VAC Power Source w/Ground

Green – Earth Ground	**9**	
Black – } **208 VAC phase pair**	**10**	**SolarTrak® Power**
White – }	**11**	
Orange – } **208 VAC phase pair**	**12**	**Motor Power**
Red – }	**13**	

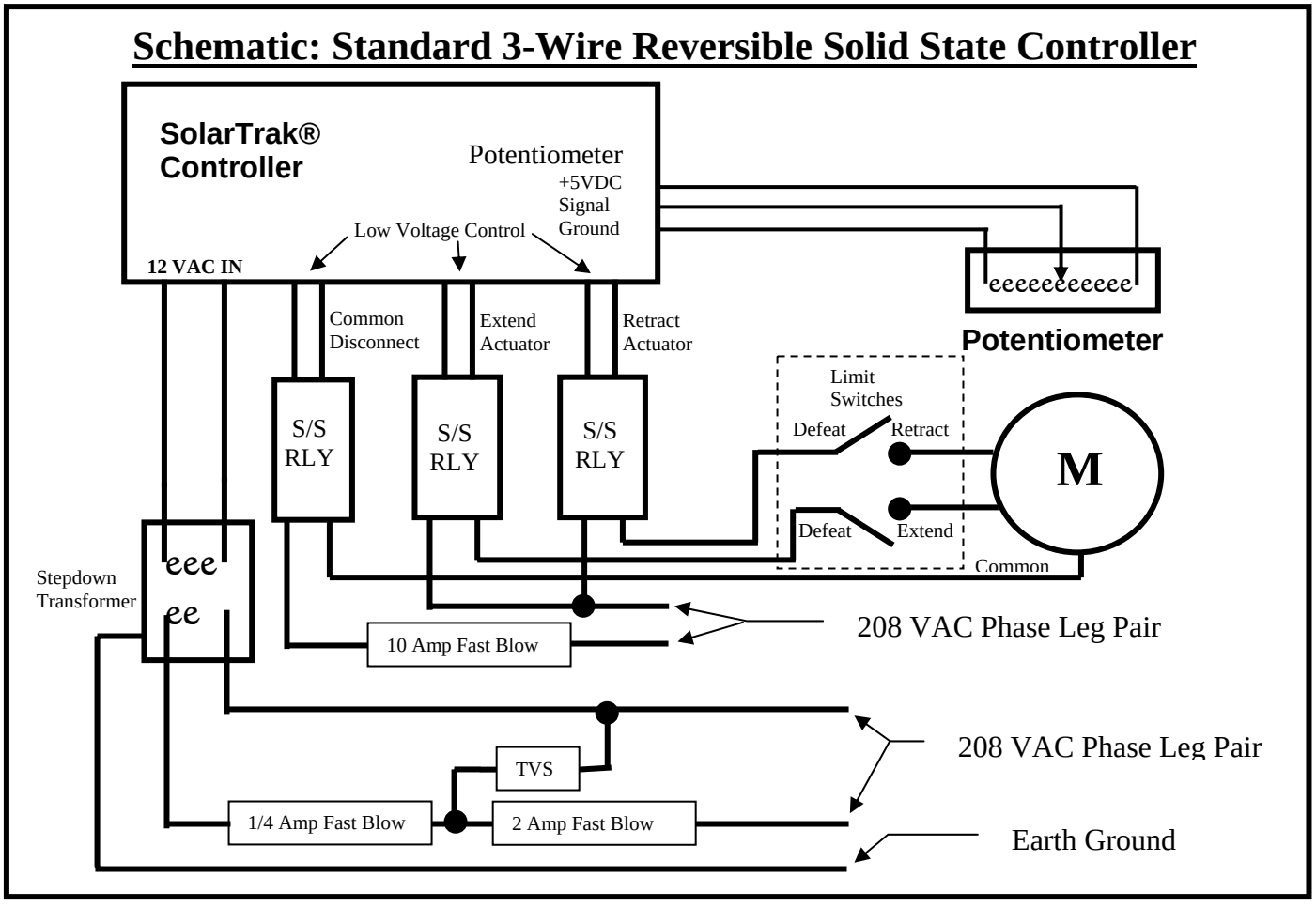
5. External Earth Ground Lug

6. Motor Power Cord – Motor Lead #
- **White – Common 1**
- **Black – Retract**
- **Red – Extend**

7. Limit Switch Cord
- **Green/Black – Retraction Limit Switch**
- **Red/White – Extension Limit Switch**

8. Potentiometer Conduit
- **Black – Retracted End Potentiometer**
- **Red – Extended End Potentiometer**
- **Green – Wiper**

Schematic: Standard 3-Wire Reversible Solid State Controller



Powertracker™ – Single-Axis in NEMA 4X J-Box

3-Phase Power Option

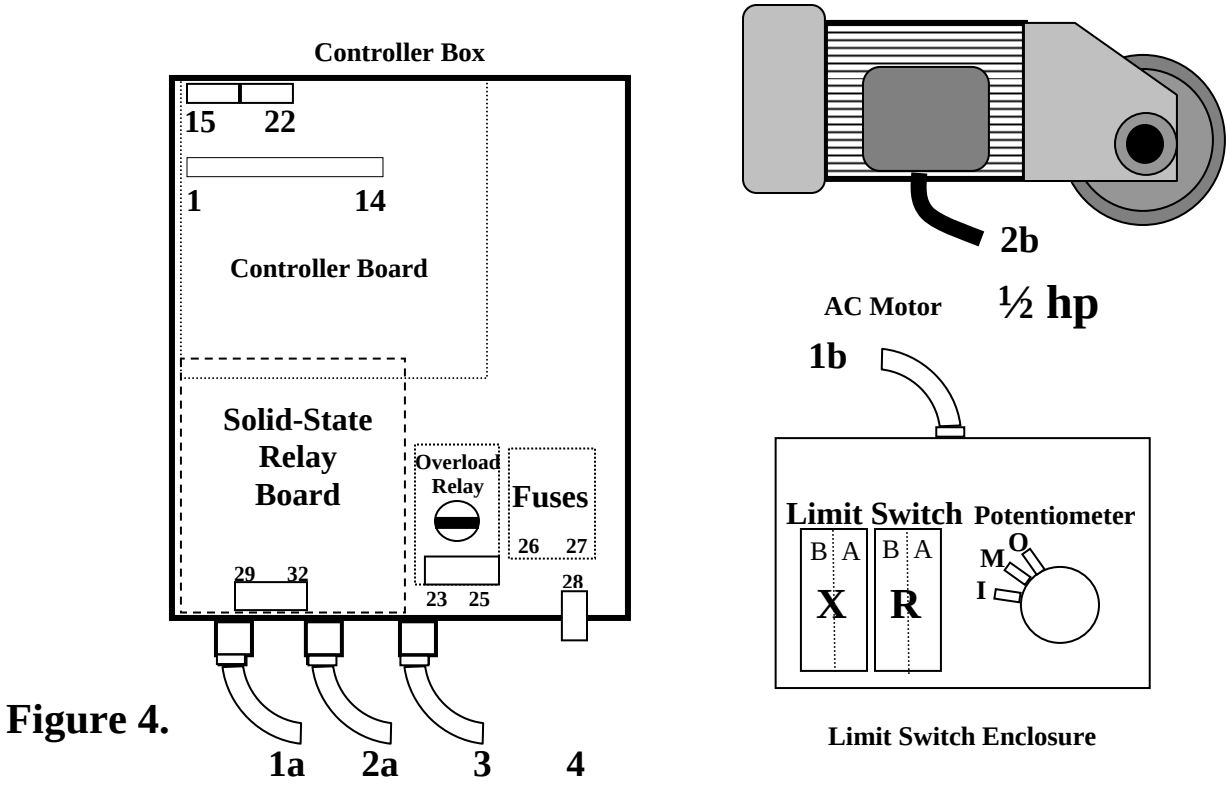


Figure 4.

3-Phase Connections:

1. Potentiometer Conduit – 1a – SolarTrak® Terminal #

Black	**– Ground**	**1**
Red	**– +5V**	**3**
Green	**– Signal**	**14**

2. Limit Switch Cord -- > Connection 1a

Green/Black – Retraction Limit Sw. Pair	**15, 16**
Red/White -- Extension Limit Sw. Pair	**17, 18**

3. Motor Power Cord -- > Connection 2a

Red – T3	**29**
Black – T2	**30**
White – T1	**31**
Green – Chassis Ground	**32**

4. 208 VAC Power Source w/Ground -- > Connection 3

Red	**– 208 VAC L3 phase leg**	**23**
Black	**– 208 VAC L2 phase leg**	**24**
White	**– 208 VAC L1 phase leg**	**25**
Green	**– Earth Ground**	**28 Ground Stud**

5. External Earth Ground Lug -- > Connection 4

6. Motor Power Cord – Motor Lead # -- > Connection 2b

White	**–**	**T1**
Black	**–**	**T2**
Red	**–**	**T3**
Green	**–**	**Ground Stud**

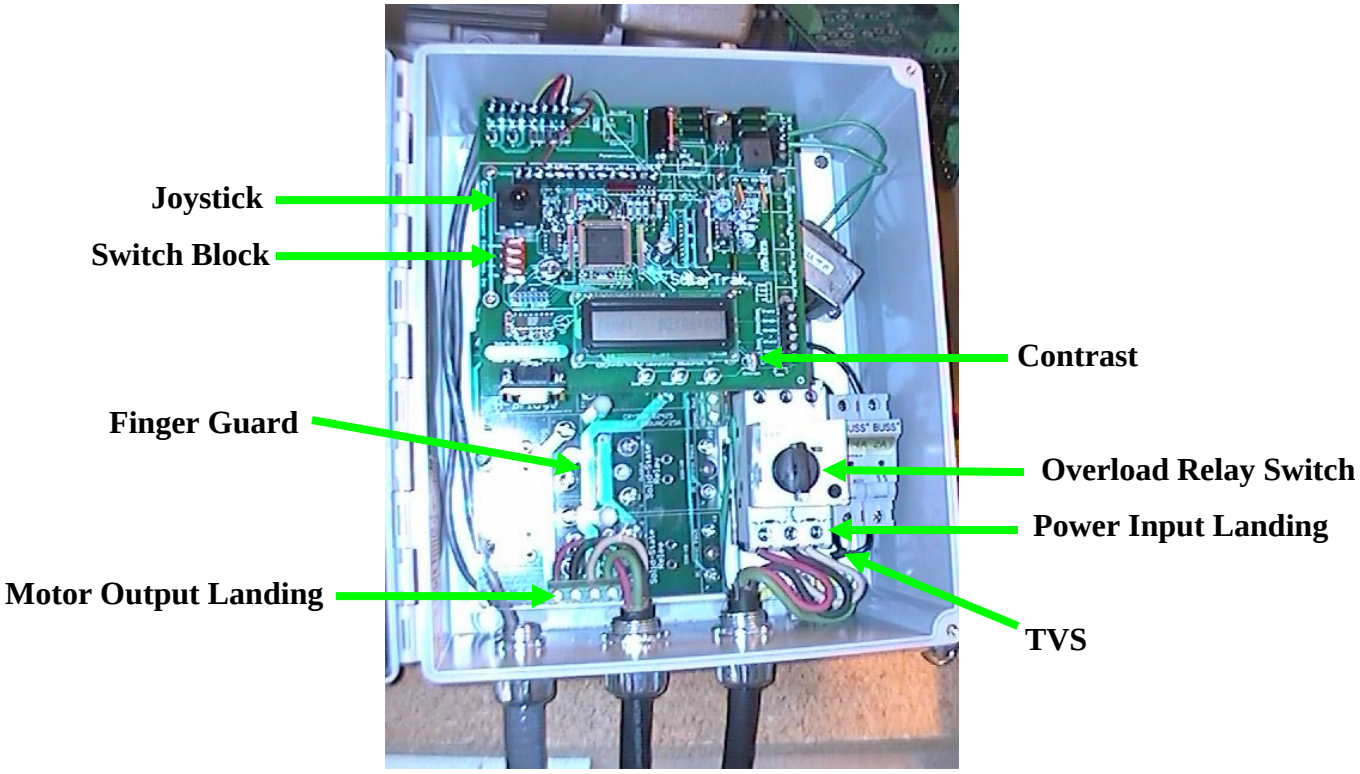
7. Limit Switch Cord -- > Connection 1b

Green/Black – Retraction Limit Switch (R, B-Side)
Red/White – Extension Limit Switch (X, B-Side)

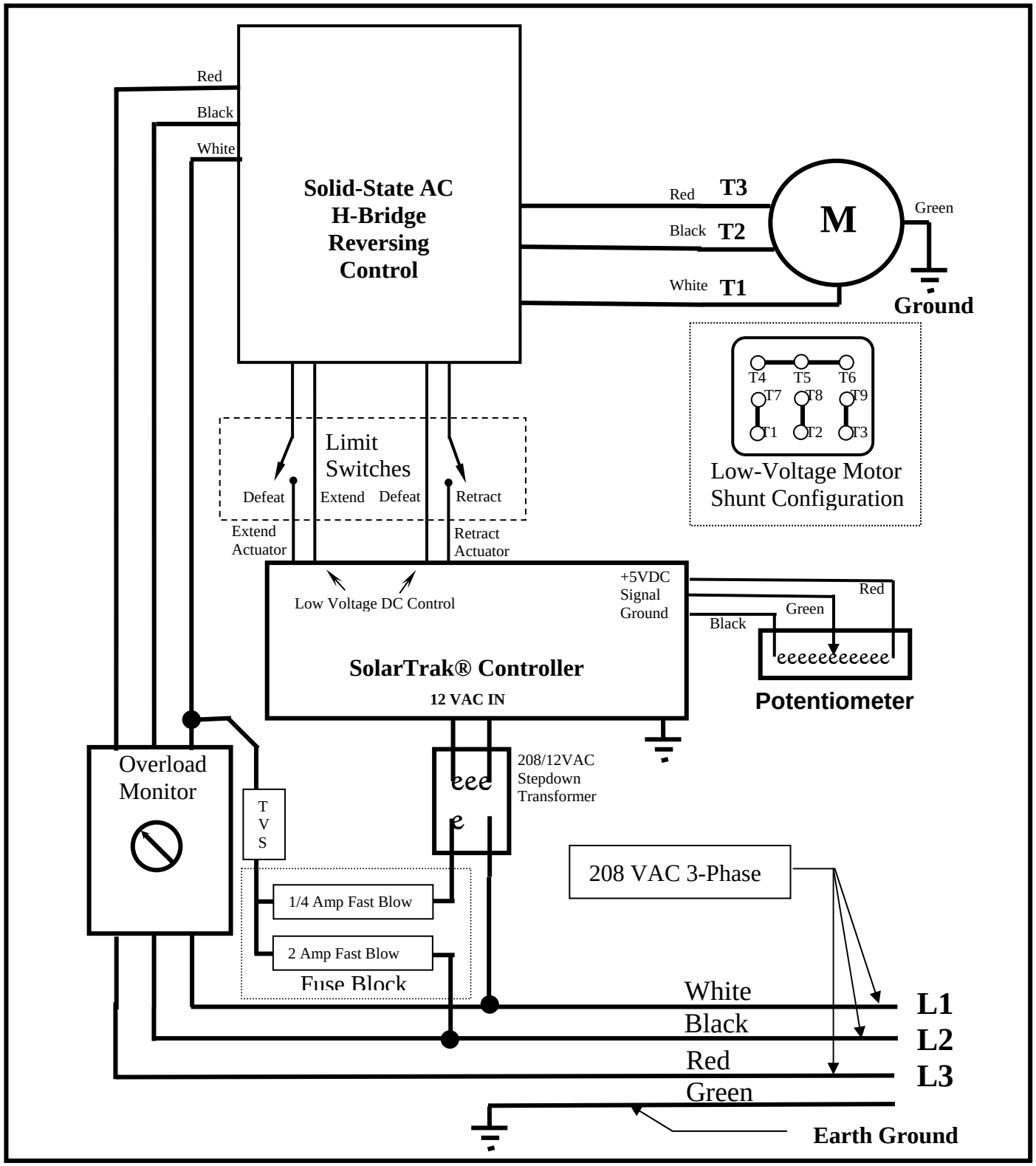
8. Potentiometer Conduit -- > Connection 1b

Red	**– +5VDC Power**	**- I(nner)**
Black	**– Ground**	**- M(iddle)**
Green	**– Wiper**	**- O(uter)**

9. Transient Voltage Suppressor (TVS) attaches between 25 & 26



Schematic: 208VAC/3-Phase Reversible Solid-State Power Controller:



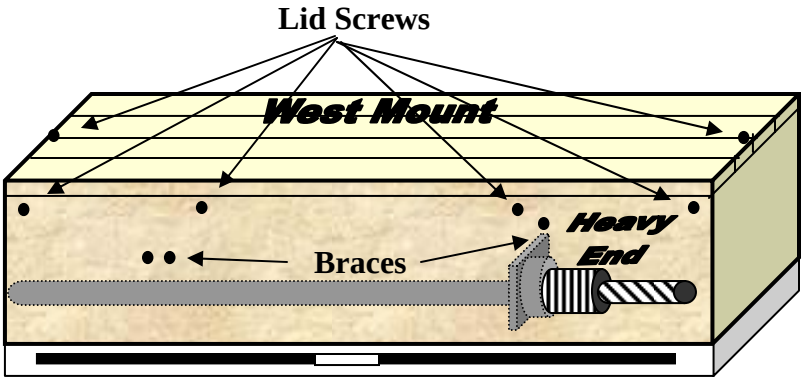
Uncrating and Installation:

Each shipping crate is marked with the orientation of the drive unit. **East Mount** means the drive unit is configured to be installed on the EAST end of the PV array it is driving, a **West Mount** goes on the WEST end.

These instructions assume that the array is level prior to attaching the screwjack. The pre-configured Powertracker™ screwjack is shipped at the software LEVEL position with the screw manually retracted to fit in the box.

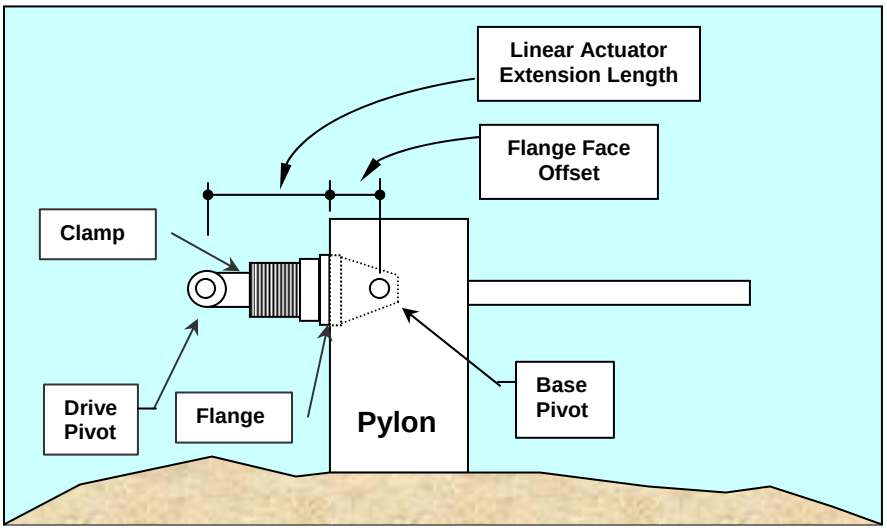
Remove screws around the top/side of the crate lid. There is a hidden one at each end of the lid in the center crack. The lid comes off in one piece.

Remove the screws from the cross braces over the motor/geardrive and control box. The one holding down the cover tube can stay.



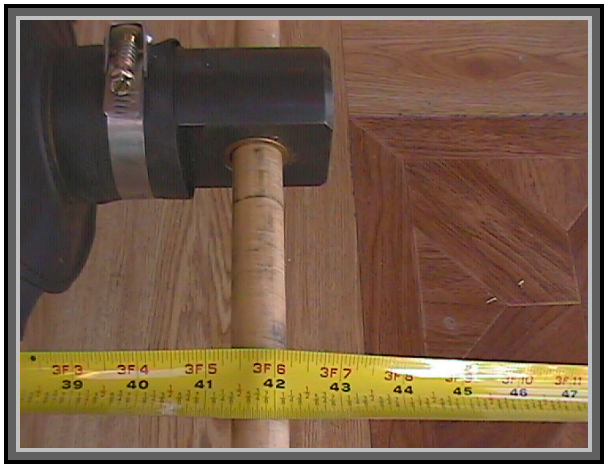
Place the control box and coiled cable on top of the geardrive and screw then lift that end slightly while sliding the cover tube out from under its hold-down brace.

Attach the geardrive to the pylon then mount the control box to its mounting plate.

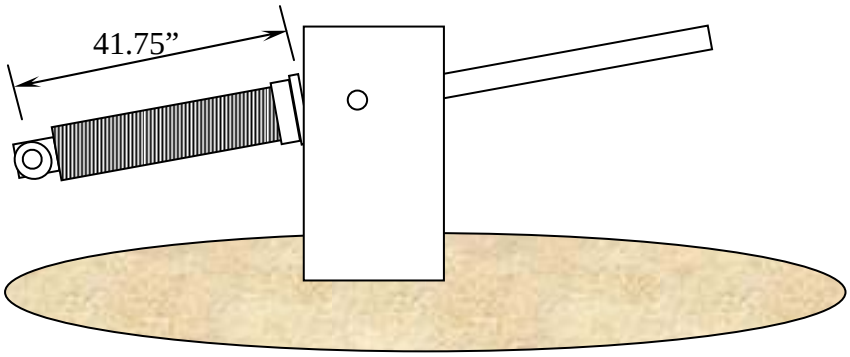


The two points of measurement for the Linear Actuator Extension Length are the centerline of the clevis kingpin opening and the back face if the actuator mounting flange where it joins with the base pivot bracket.

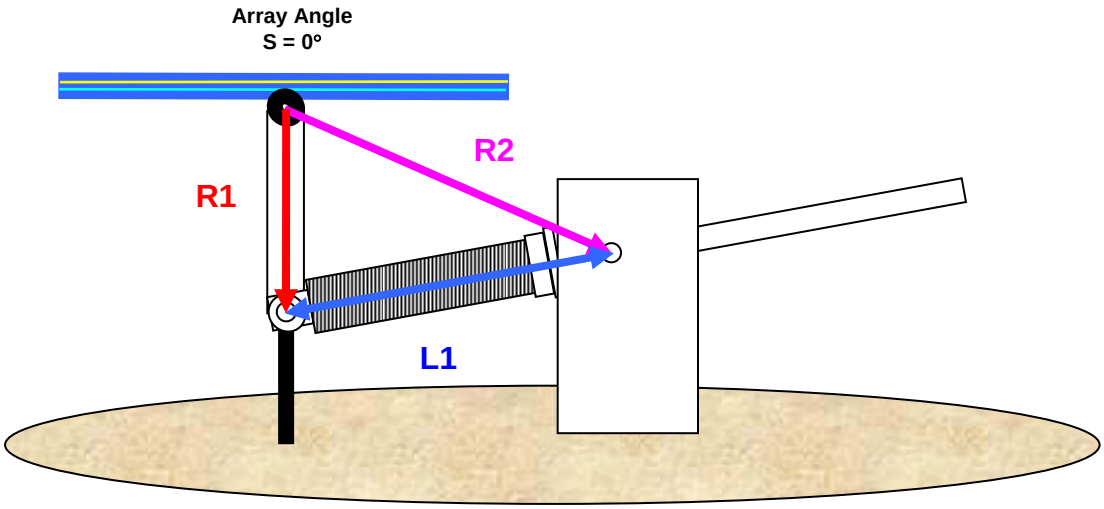
Loosen the clamp at the clevis end of the screw and boot.



Unscrew the actuator screw until the measurement **L** is 41.75 inches. All other things being correct, the clevis pin should fit right through the clevis and torque arm of the array. If the holes do not align it will be necessary to measure **R1** and **R2** then recompute the actuator parameters as defined in Appendix **C**. Lengthen or shorten the screw to fit with the torque tube and note the actual length.



Pull the boot out to cover the metal stop at the clevis and reattach the clamp.



Western Mount Position – View Facing South

Level, Face-up Position

Power Connection and Startup Sequence:

1. Attach the three 208 VAC phase legs, WHITE to L1, Black to L2 and RED to L3. L1, L2, and L3 may be refered to as A, B, C or X, Y, Z or even T1, T2 and T3. The official 3-phase polarity is CBA. GREEN is Earth Ground/Chassis. The unit is shipped with a five-foot, 4-conductor, 12-gauge power pigtail.

2. Just below the Joystick on left of SolarTrak® board, verify the top toggle switch is flipped to the RIGHT – Manual ON.

3. Power-up the 3-phase circuit. Turn ON the activation knob on the Overload Relay. ON is when the handle of the rotary switch is straight up and down. Turn the handle slowly to be certain that the relay latches on properly. The motor will jump slightly at power-on but will stop immediately as the computer takes control.

4. Verify SolarTrak® display is alternating between MODE MANUAL and TIME.

***** NOTE: The following test will assure proper polarity of the motor before full operation is initiated. It is important to carefully monitor the retraction/extension length during this process to avoid damage to parts of the actuator.**

At both ends of screw travel, there are both software limits of operation which have effect only in automatic tracking mode and hardware limit switches which are to prevent accidental over-travel when all else fails. The hardware limits, not reached during normal controller operation, are set just outside of the software limits, and would only be reached in Manual operation or in the event of controller failure. The hardware limit switches interrupt the power to the drive motor relays. The hardware retraction limit switch is set to interrupt power at 13.5 inches. The extend limit is at 67.5 inches. These values are measured from the mating side of the drive mounting flange to the center of the drive screw kingpin.

IF THE POLARITY IS WRONG, THE LIMIT SWITCHES DON'T WORK RIGHT!!!

1. Using the Joystick (Manual ON without the 'Latch function'), run the actuator in the **Retract** direction. (See page 6: Joystick RIGHT for drives on array EAST side; Joystick LEFT for drives on array WEST side.) If the screw extends instead of retracting, the polarity must be reversed. Assuming the declared color code is correct, this should be done at the 3-phase source by swaping the L2 and L3 legs.

2. Once the polarity has been verified, the unit should be run in retract until it stops at the 13.5-inch hardware limit. If it does not stop before a minimum of 13.25 inches, it MUST be turned off before the actuator reaches 13 inches. If it does not turn off in time on its own, terminate the Installation Procedure immediately, leave the unit with Manual mode ON, and turn power off. The limit switch will need to be reset to conformity but there may be other considerations as well. Contact EEInc for further instructions, 505-281-0399.

3. If the unit successfully stops at the 13.5-inch limit, switch the Manual toggle OFF, and switch the Emergency Stow toggle (bottom one) ON. After a brief delay, the unit should begin to extend the screw, eventually reaching and automatically stopping at a screw extension that corresponds to a horizontal array position, at a distance of about 41" from the screw pin to the mating side of the drive mounting flange surface. It will probably stop one or two counts (~1/2") from exactly level. Check the Ax1 Count screen using the ITEM button to verify that the count is ~121. If the unit does not extend or stop at the horizontal array position, terminate the Installation Procedure, switch the unit to Manual ON, and turn power off. Contact EEI for further troubleshooting instructions, 505-281-0399.

4. If the unit successfully stops at the horizontal array position, switch the Manual toggle ON and switch the Emergency Stow toggle OFF. Using the Joystick, move the array to exactly level using some type of levelling device. Go to the 'Set Level Offset' screen, Press the Adjust button to display 'Level Array' (it's already level) so then push and hold the VALUE button until the display returns to the Time/Mode heartbeat.

5. Leave the unit in Manual Mode and continue extending the drive screw (you may want to use the Joystick "Latch" function at this point) until the screw reaches the fully-extended hardware limit, at a distance of about 67.5". During this process, which will take 30-40 minutes, carefully monitor the progress of the screw, periodically checking the inches of screw extension. If the unit does not stop at the fully-extended hardware limit before it reaches 68", terminate the Installation Procedure, leave the unit in Manual ON, and turn power off. Contact EEInc for further troubleshooting instructions, 505-281-0399.

6. If the unit successfully stops at the fully extended hardware limit, switch the Manual toggle OFF, and switch the Emergency Stow toggle ON. After a brief delay, the unit should begin to retract the screw, eventually reaching and automatically stopping at a screw extension that corresponds to a horizontal array position, at a distance of about 45" from the screw pin to the mating side of the drive mounting flange surface. If the unit does not retract or stop at a horizontal array position, terminate the Installation Procedure, switch the unit to Manual ON, and turn power off to the controller and drive motor. Contact EEI immediately for further instructions, 505-281-0399.

If Step 6 is successful, the Installation and Check-Out Procedures have been successfully completed and the array will be ready to go into automatic tracking mode after the time, date, latitude, longitude and time zone have been checked.

Display/Edit Parameters on SolarTrak® Controller Board

Displaying Parameters with LCD Micro-Monitor

The LCD Micro-Monitor allows display of a limited combination of calibration parameters and status values. It may be necessary to adjust the contrast using the thumb-pot just above the LCD. (See Figure 1). The standard display shows the current Time alternating with the current controller Mode. The three pushbuttons just below the monitor are, from left to right, ITEM, ADJUST and VALUE.

The mode will be one of the following:

1. Tracking	Array is tracking normally
2. Night Stow	Array is parked for the night (will wake in morning)
3. Emergency Stow	Array is parked manually
4. Manual	Array is in Manual Mode

There are several parameters and status values that may be displayed on the micro-monitor screen. The following values are accessible:

1. Time/Mode	Local 24 Hr. Standard, NEVER Daylight Savings
2. Date	Year 2000 compliant
3. Turncount	Potentiometer reading (0 – 255)
4. Temperature	Use 'VALUE' to toggle between C & F
5. Set Level Offset	Calibration Command Function
6. Seconds/Day	Clock Correction each day
7. Seconds/Week	Clock correction once per week
8. Latitude	+ Northern Hemisphere, - Southern (+/- 90 degrees)
9. Longitude	0 = Greenwich, UK (Range 0 – 360 degrees West)
10. Time Zone	0 = Greenwich, 5 = East Coast, 8 = West
11. West Error	
12. BackTracking	Use 'VALUE' to toggle to Width/Spacing Ratio
13. Version	Version Series and Date

These values may be displayed, one at a time, by pressing the ITEM button, located just above the monitor. (See Figure 1). Due to space limitations on the screen, the above item descriptions will most often be abbreviated. The buttons are scanned once per second so it may take a moment to see the response. The button should be held down until it registers. The button will repeat its function once per second as long as it is held. After the last screen is displayed, it will start over with the Time. After approximately one minute of inattention, the display will revert back to alternating between the Time and Mode.

Editing Parameter Values: On-board LCD/Button I/O

***** NOTE: It is strongly recommended that the array be placed in MANUAL mode prior to changing parameters to avoid jumps, spurts and wasted time**.

ADJUST MODE is indicated by a flashing cursor square on the screen. This must be turned OFF by pressing the ADJUST Button before the ITEM Button can be used to change screens again.

To Modify a Parameter:

- Select a parameter that needs to be changed using the ITEM Button.
- The VALUE Button may be required to access a 'second-screen' value.
- Press the ADJUST Button
- Use the ITEM Button to move the cursor Right to the digit to be changed.
  (The cursor position will 'wrap' back to the center of the screen at the end)
- Press the VALUE Button to increment the value or change the sign.
  . All values have bounds and will wrap automatically in most cases
  . In order to create a negative number from or through zero (the sign will go positive at zero), the number must be made non-zero before changing the sign to negative.

- When all digits are changed, press the ADJUST Button to revert to the normal mode.

Section 5. Calibration to Onsite As-Built Parameters

In the extreme, the hardware limit switches on the screwjack may need adjustment to allow enough extension. **Do not exceed the linear actuator operational extension limit.**

There is NO MORE ROOM at the fully retracted limit! Further retraction will crush the boot spacers. Instructions for adjusting the limit switches and the required hex Allen wrench can be found inside the cover plate of the limit switch enclosure. The switch with the RED wire and the RED hex adjuster are the extension pair. Green and green are the retract pair.

Several software configuration parameters must be redefined if the as-built measurements are out-of-spec.

1. The Level Reference Offset – Calibrate array to Level (Facing straight UP)
2. The East and West software limits – Set mathematical limits inside actual hard limits
3. The Night Stow position – Overnight 'Sleep' Position
4. The Emergency Stow (Level) Position – Position to assume with Stow Switch ON
5. The Screwjack Mount Geometry definitions – Coefficients for Law of Cosines

The first two can be performed using the buttons and joystick on the SolarTrak®. The rest require either a User Interface Module (UIM)* or a PC Interface (PCI)* software hookup. Only small adjustments on the order of ½" to ¾" of extension should be made without changing all of the above parameters.

It will first be necessary to record the turncount values where the new soft limits should be as well as the two stow positions. The turncounts are displayed on the third screen (right after the date).

The new screwjack parameters can be computed from the equations in the screwjack appendix. Care must be taken in choosing signs and angle quadrants. Making the Law of Cosines work is not an exact science.

Once all the new parameters have been determined they will need to be stored in the controller's memory. To do so, use the following procedures.

* Available separately from Enhancement Electronics, Inc. (505) 281-0399

Set Level Offset

1. Use the Item button to select the screen that displays 'Set Level Offset'

2. Press the Adjust button until the screen reads, 'Position Array'

3. The array is now in Manual Mode though it will not be displayed.

4. Use the joystick on the controller board or the UIM to position the array level.

5. Press and hold the Value button on the controller board until the display reverts back to the Time/Mode display screen.

Set East and West software limits

Position the array to each soft limit and record the turncount from the SolarTrak® screen (third screen right after the date). This should be at + and – 45 degrees (East and West, respectively), however, do not reduce the lower limit (Ax1 –Lmt) below the factory setting (18 - 22).

If you will be using the UIM to do screwjack parameters and such, these values can go in more easily when you do the rest or use the following steps on the SolarTrak®:

1. Use the Item button on the controller board to scroll to the screen that displays ‘Ax1 +Lmt 215’
2. Press the Adjust button so the dark, blinking cursor appears.
3. Change the number to the desired value.
4. Press ADJUST to end first edit.
5. Press VALUE to change screen to ‘Ax1 –Lmt 19’
6. Press the Adjust button so the dark, blinking cursor appears.
7. Change to desired value (>18).
8. Press ADJUST to end edit.

Calibration of the SolarTrak® Real-time Clock/Calendar

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 variation of fabrication within published tolerances for the part.

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

The fabrication variation issue must be dealt with using essentially empirical methods. The required correction can be reduced to a daily and weekly operation if the overall time is kept within twenty seconds of the correct universal time, corresponding to about one-tenth of a degree of sun motion.

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 both 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, reducing the overall deviation to an update of the seconds-per-day and seconds-per-week in integer (whole numbers) rather that fractional form.

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

1. Set the clock/calendar to local standard time. Note the day it was set in a log book.
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 lapsed 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 and divide by the number of lapsed 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 the course of a few months.

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.

Appendix A:

SolarTrak™ STNetPCI

Instructions

Install Software

Win 7/10:

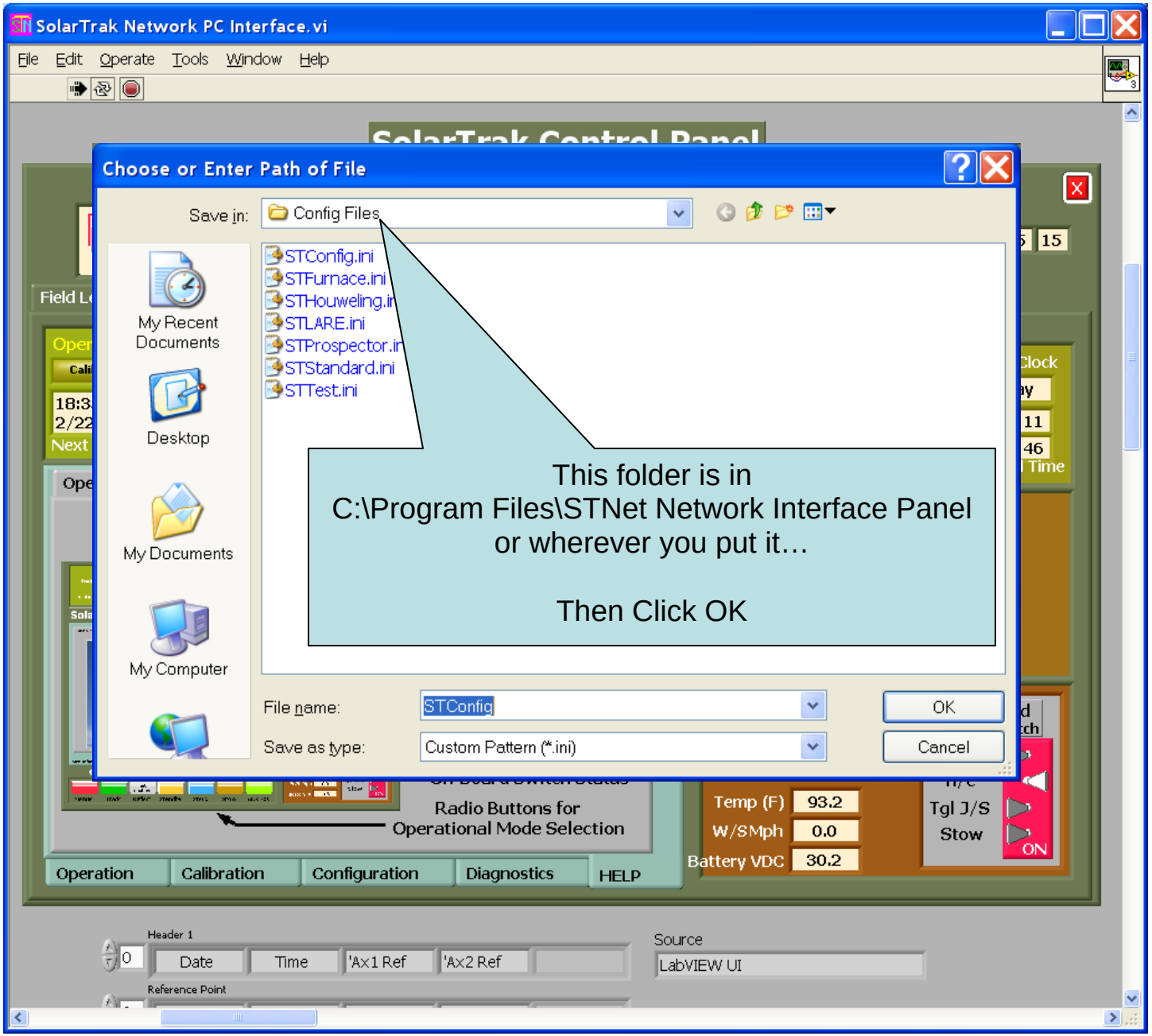
- **http://www.ni.com/download/labview-run-time-engine-2011/2536/en/**
- **http://www.ni.com/download/ni-visa-run-time-engine-5.3/3826/en/**
- **LabVIEW-based SolarTrak Network PC Interface Win 7/10 (16 MB)**

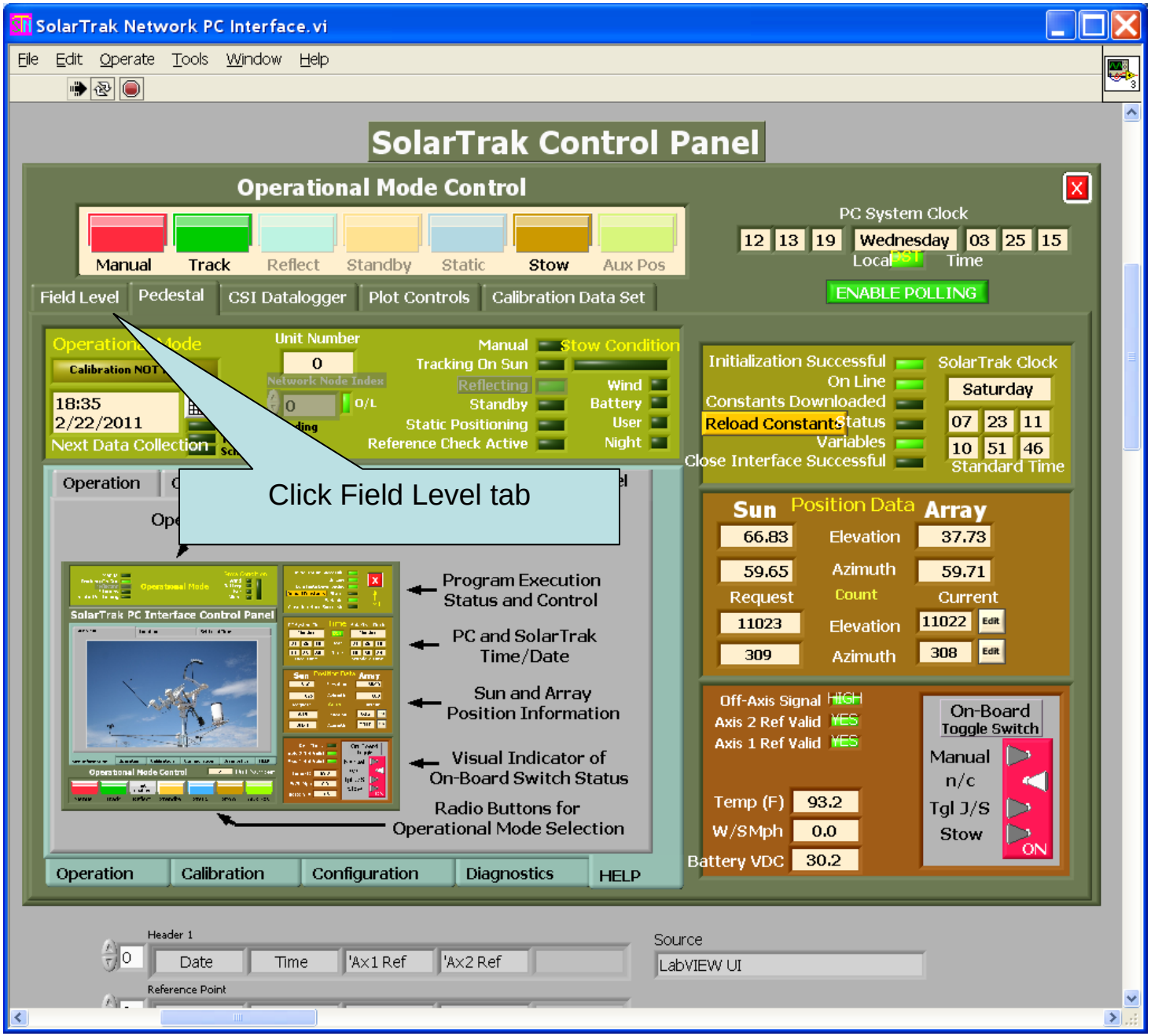
Win XP:

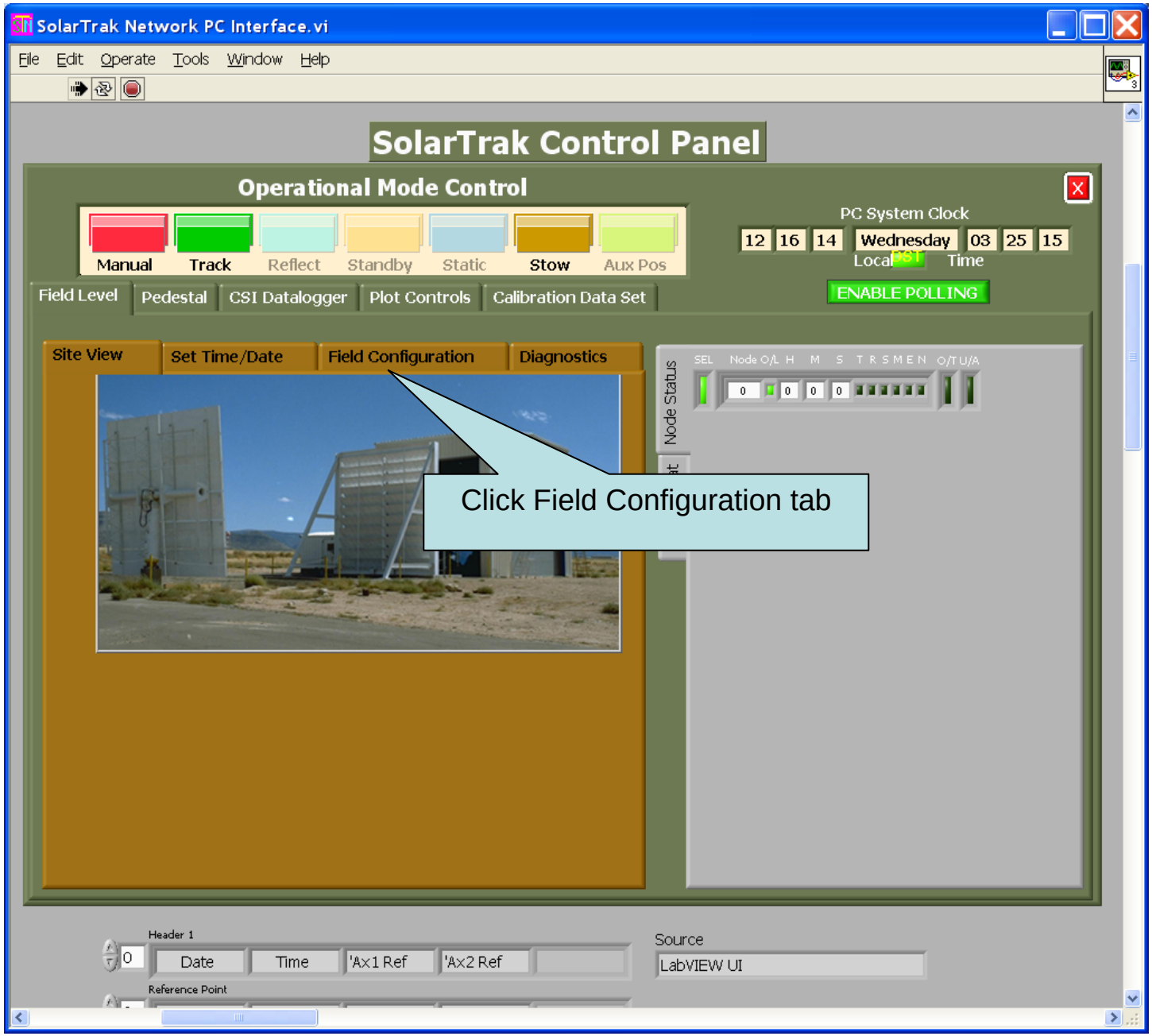
- **http://www.ni.com/download/labview-run-time-engine-8.2/679/en/**
- **http://www.ni.com/download/ni-visa-run-time-engine-4.2/832/en/**
- **LabVIEW-based SolarTrak Network PC Interface Win XP (17 MB)**

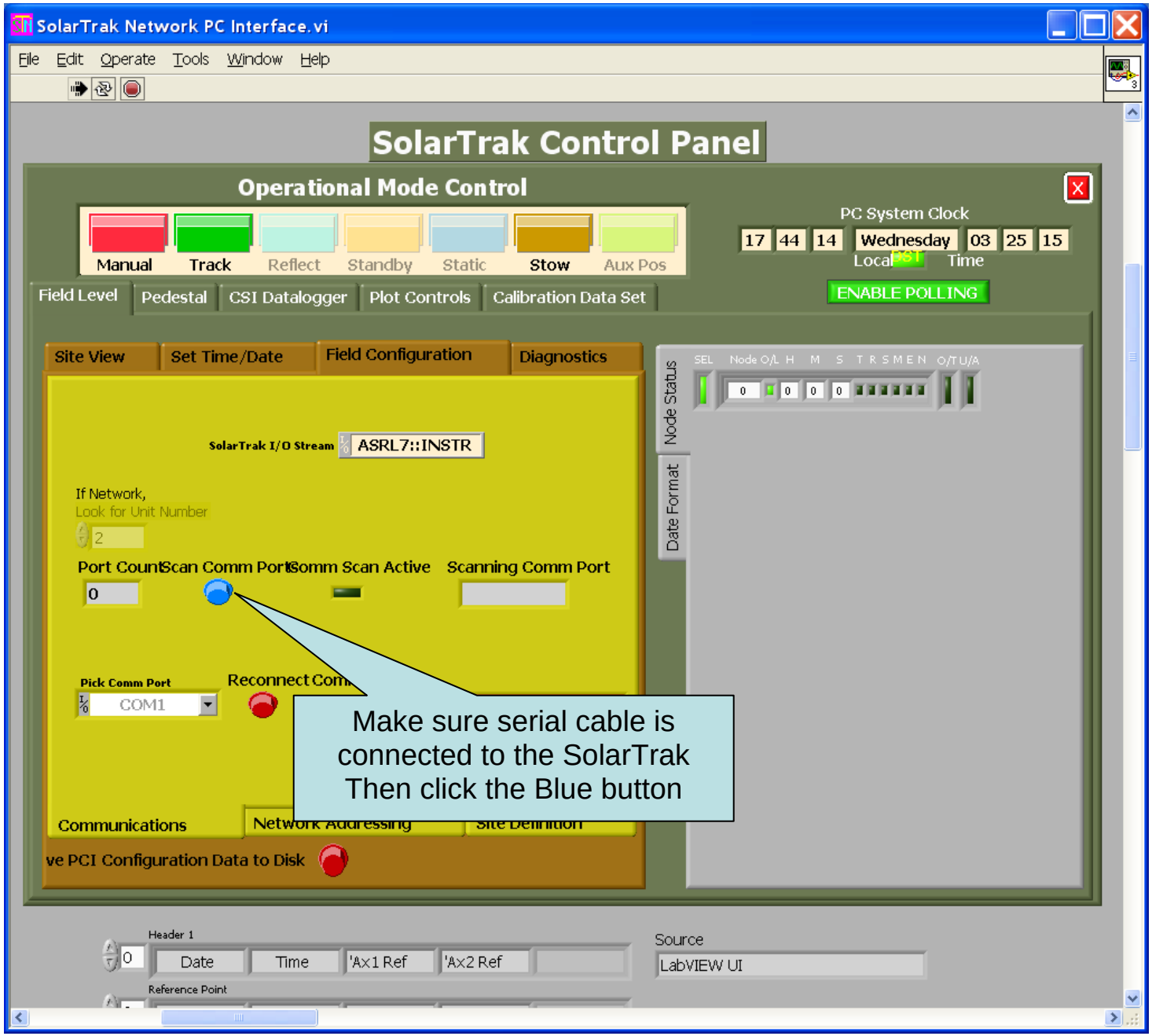
- Download and install both runtime components
- Download and unzip PC Interface software

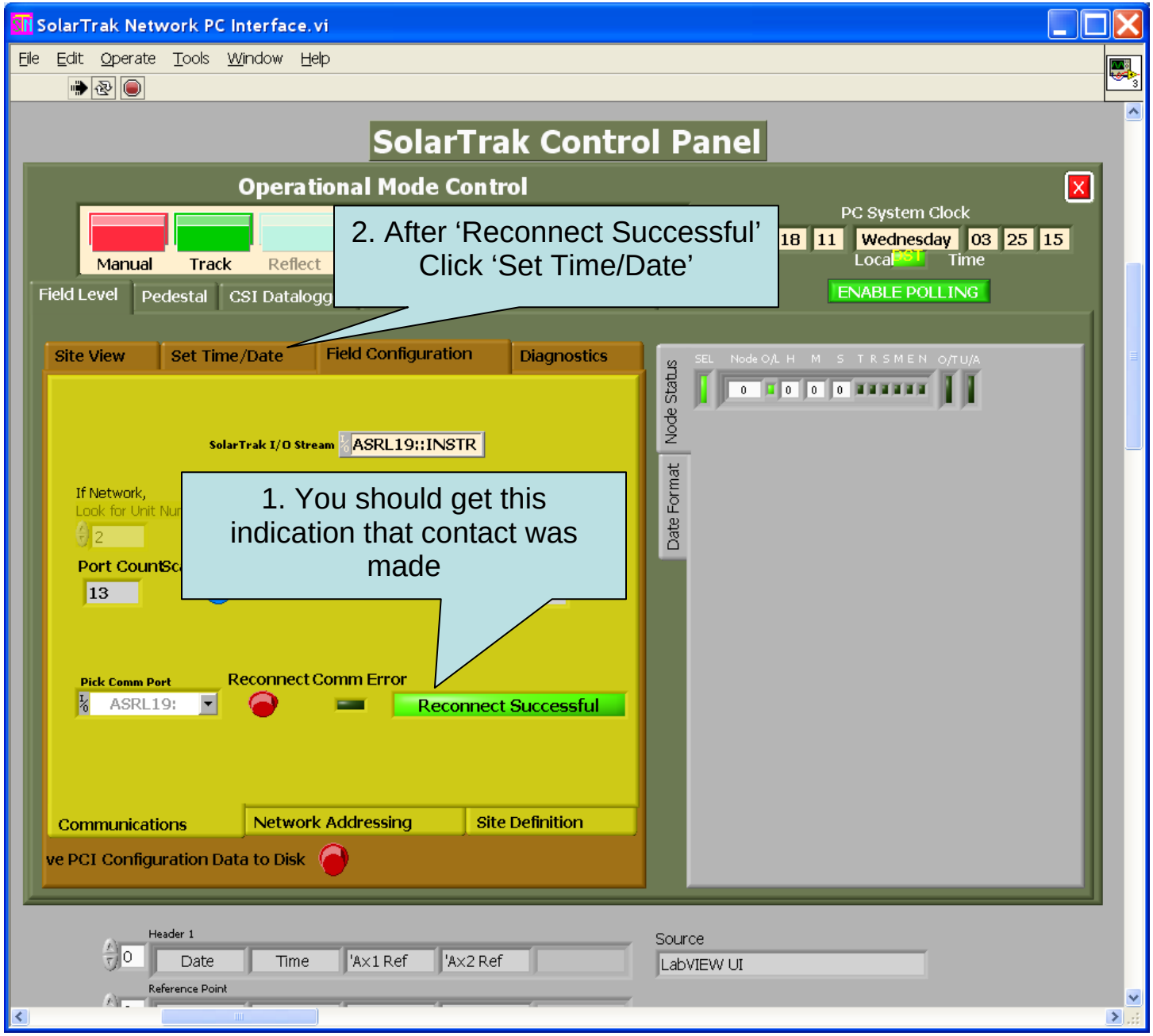
Click STNet.exe to start

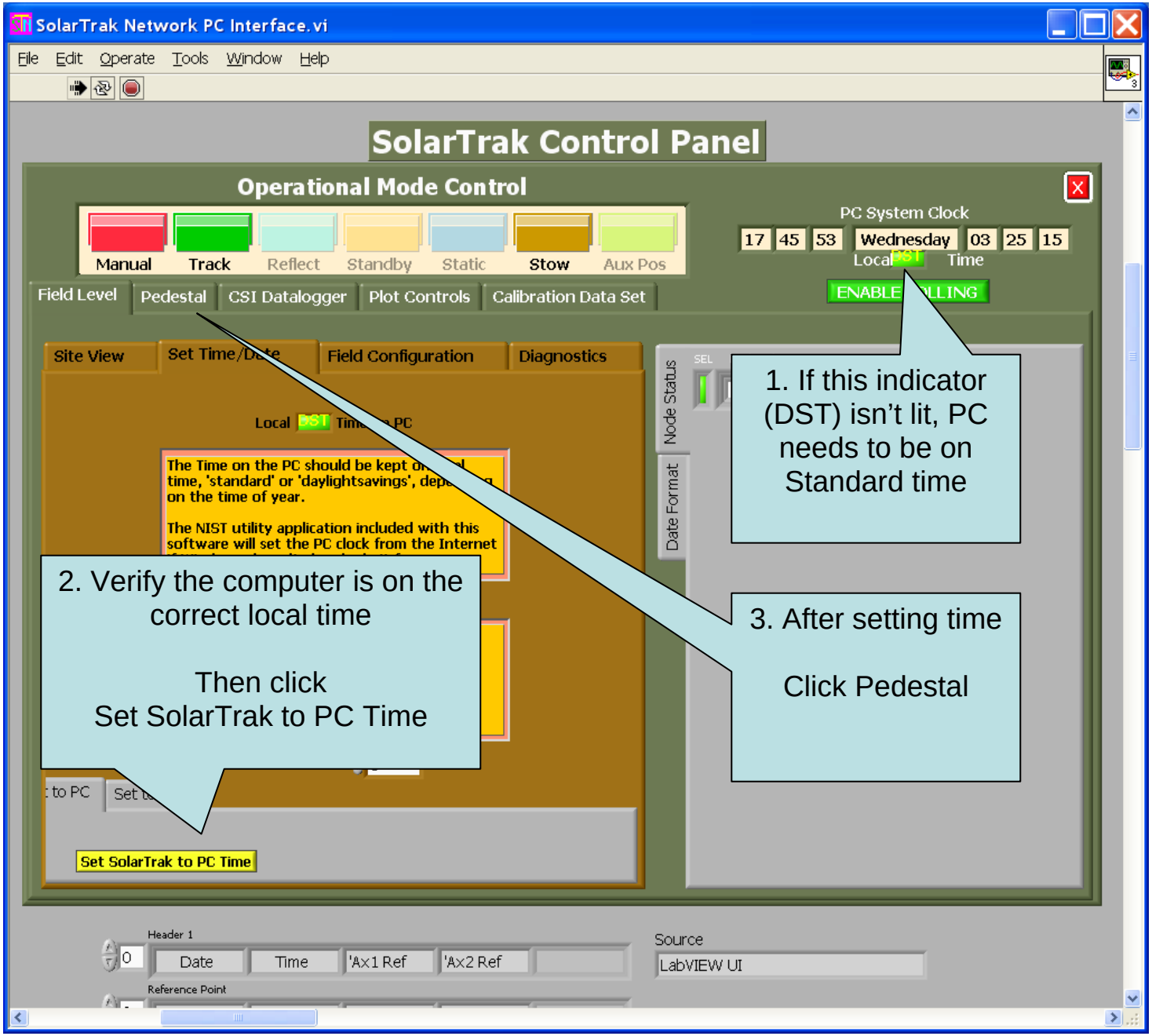


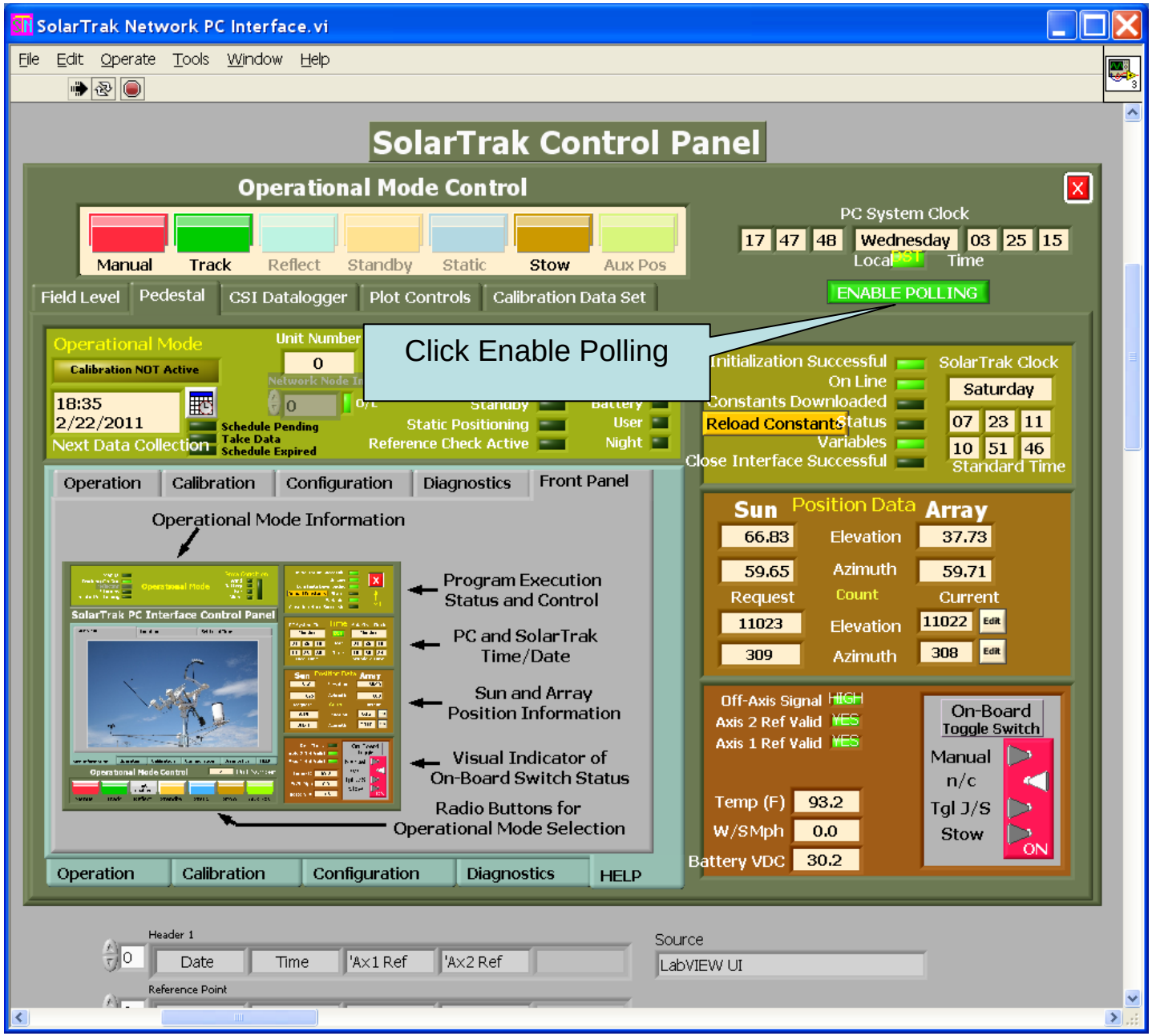


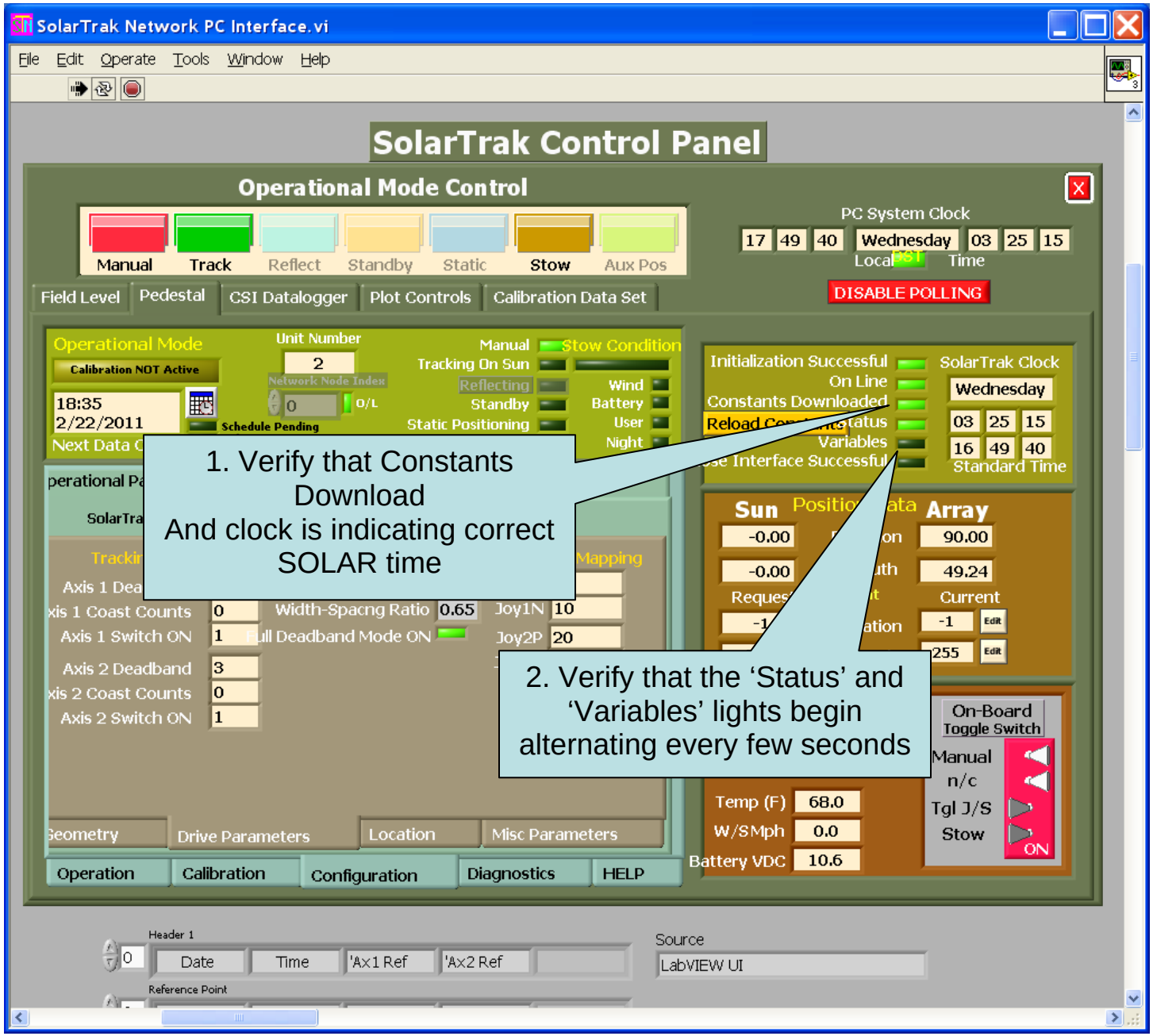












Parameter Template Operations

There are myriad tracking and system control configurations supported by the SolarTrak control technology. There are many settable values stored within the MCU computer chip that if slightly wrong, can produce improper operation.

When configuring and calibrating a new tracking control system, it may very well be necessary to set each one individually, and sometimes over and over, in order to accomplish the task, but once done, the entire parameter block can be copied and saved on disk or recovered from a disk file and uploaded to a SolarTrak MCU as a unit, without setting each individual parameter every time.

When storing individual parameters or changing operational values like an Angle-of-Incidence offset, the polling function should be enabled to allow updating the values after the change. Typically, the PC Interface places the controller in Manual Mode while it changes a parameter, then puts the controller back in whatever mode it had been in prior to the setting change.

The necessary efficiencies of field maintenance can require the replacement of electrical components that have failed, hopefully not the SolarTrak itself, but it is usually easier to replace an entire control box than to replace a solid state relay in the field.

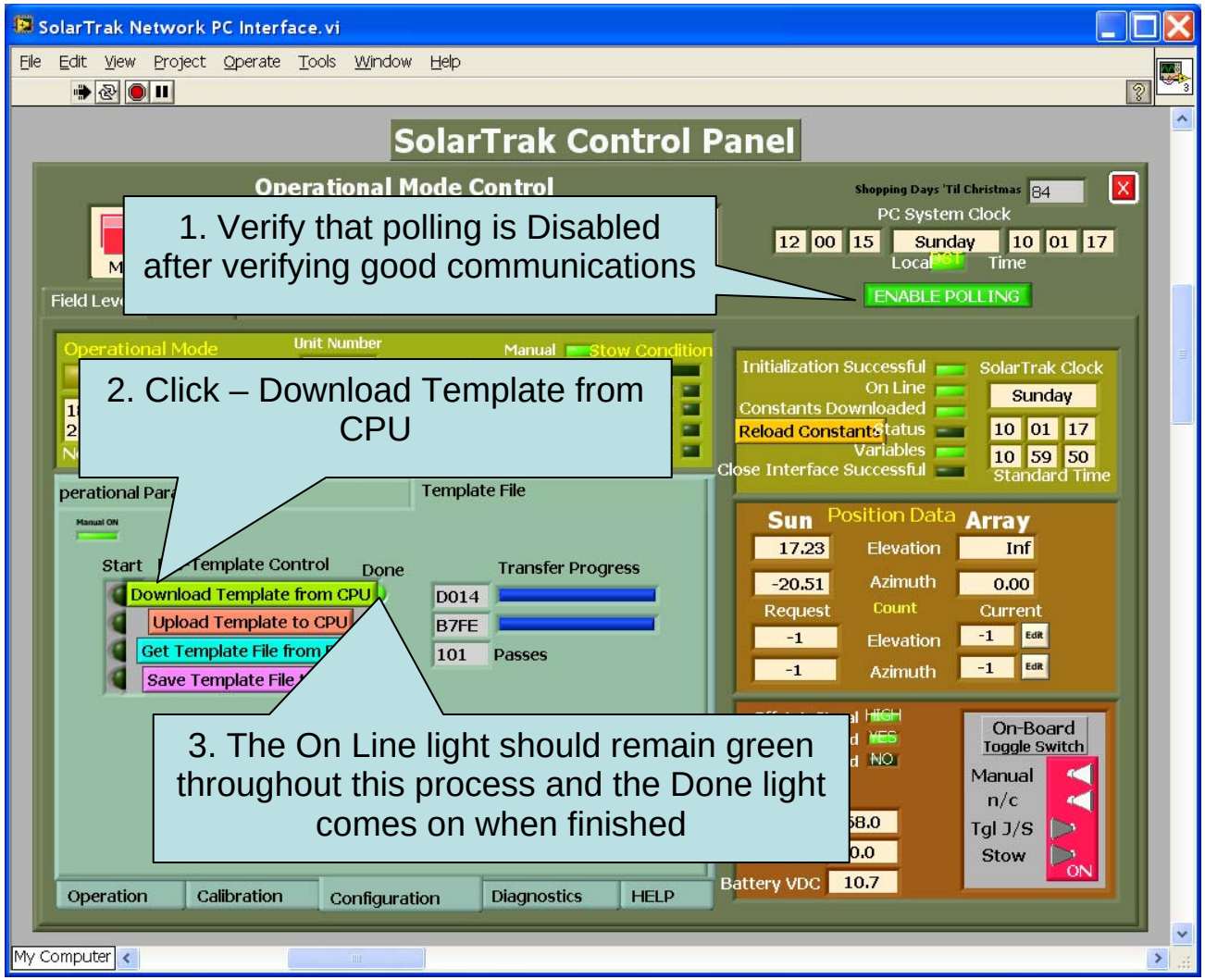
The use of parameter template transfer makes this rather straight forward. In preparation to utilize the PC interface in this manner, templates should be downloaded from all active controllers and stored on disk as a data base.

When a controller must be replaced, temporarily power up the replacement and upload the appropriate template file for that unit before going into the field.

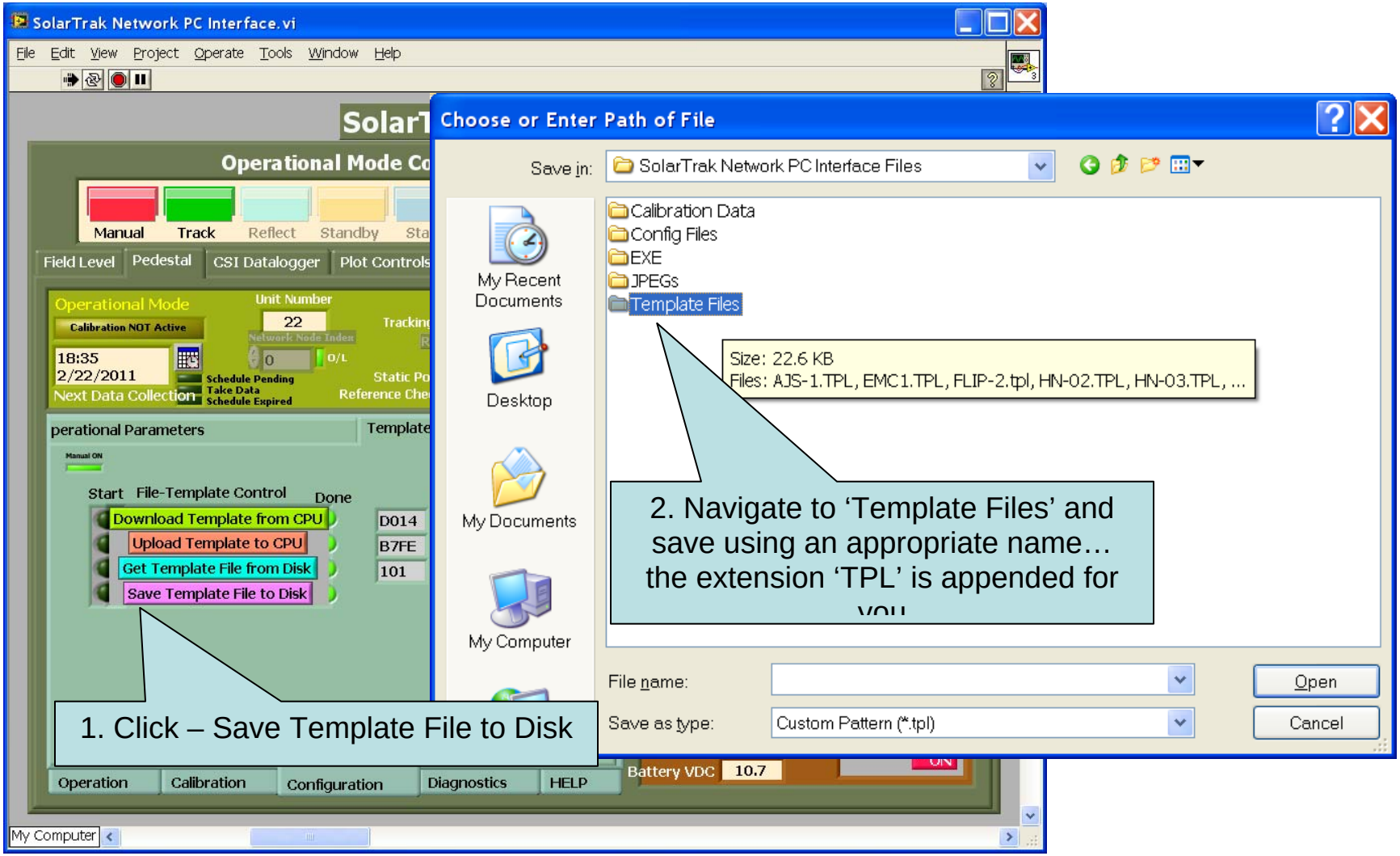
As a note though, in general, the SolarTrak MCU chip, containing all these parameters, is not damaged by any electrical incident that may occur, and can usually be removed from the old board and inserted in the new board without the need for all this computer stuff.

The following frames indicate first downloading and saving templates then retrieving and uploading them to the controllers. Polling should be disabled during this process to reduce communication complexity.

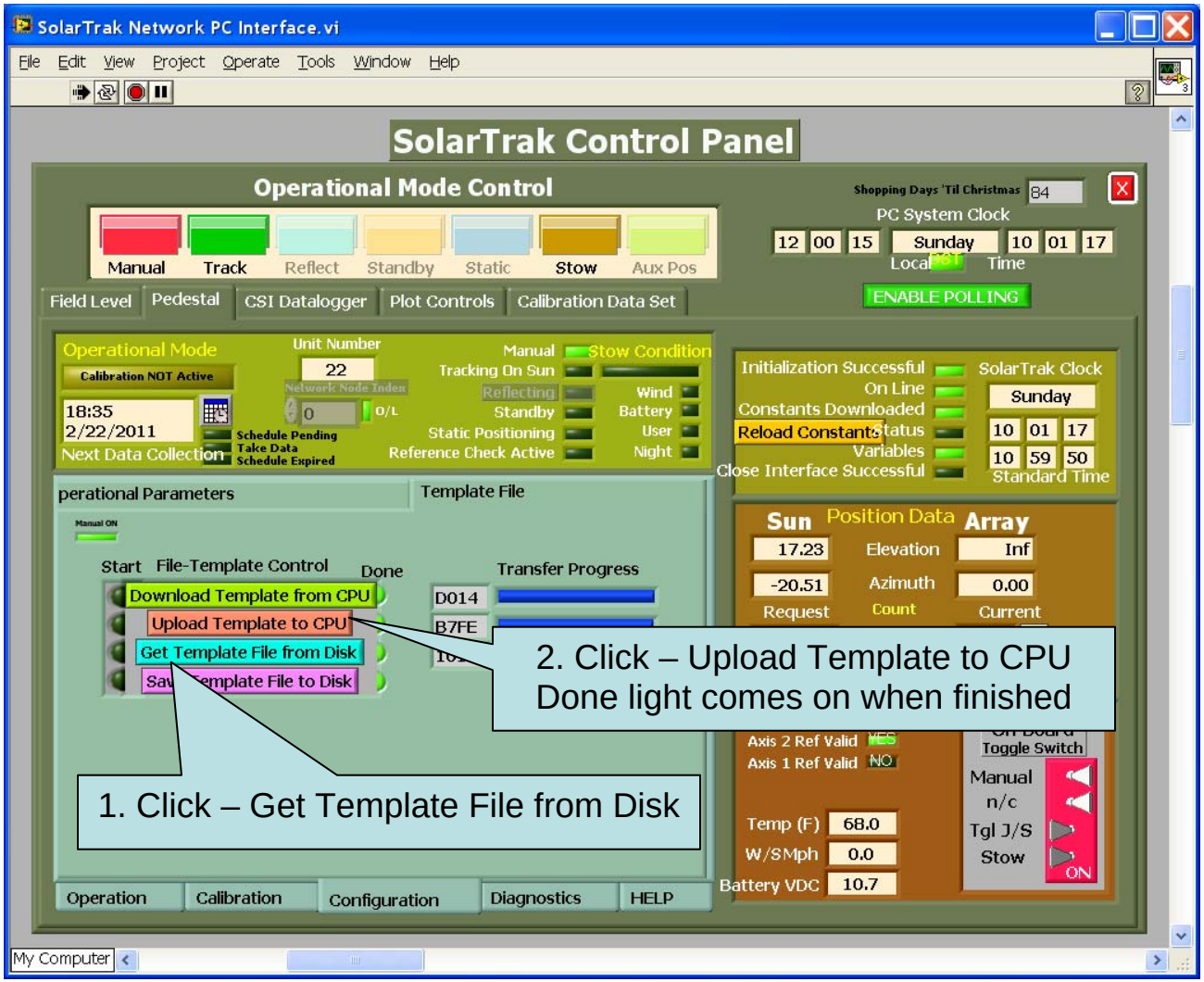
Download Parameter Template



Save Parameter Template



Retrieve and Upload Parameter Template



Appendix B:

Powertracker Field Troubleshooting Guide

Initial Observations:

The most obvious sign of trouble is an array segment (operated by a single geared actuator) being at a noticeably different orientation than the rest of the field.

In order of increasing severity:

1. Time/Date Wrong
2. Controller Display Heartbeat Frozen (not alternating Time & Mode)
3. Controller Display Blank
4. Motor Cycling On & Off Frequently
5. Motor Buzzing when Activated but not Moving
6. Motor Silent (doesn't move) when activated – controller operational
7. Breaker Switch will not Reset
8. Position Wrong – Non-of-the-above – Not jammed – still running
9. Geardrive jammed at end-of-travel

The most common problem, causing almost random symptoms, is the effect of thermal cycling (high temperature in the day, low at night, every day) that loosens screws in the wiring terminal blocks with repeated metal expansion and contraction over long periods of time. Although three months in desert conditions is often sufficient.

First Steps:

- Turn Power Off then Check/Tighten All Terminal Screws.
- Place in Manual Mode and Turn Power back ON.
    i. #2 will be taken care of by doing this – continued monitoring is necessary to establish if there is a recurring problem

As a Preemptive Maintenance procedure, this operation should performed any time it is convenient while the box is open regardless of the symptoms. Terminal screws will eventually loosen and cause a problem if not tended.

Other Things that Tightening Loose Screws Didn't Fix

1. If the time and date are wrong the following might apply:

   - Clock/Calendar is improperly calibrated
     a. Follow clock calibration procedure (previous section)
     b. Set Time/Date

   - There was a power interruption and the SuperCap that backs up the clock/calendar power is worn out (~10-year service life)
     a. Replace SuperCap
     b. Set Time/Date

   - Somebody thought it should be set to Daylight Savings Time
     a. Inform other maintenance technicians that coltroller time should either be on local STANDARD time and zone or GMT (time zone = 0).
     b. Set Time/Date

2. Controller Display Heartbeat Frozen (not alternating Time & Mode)
   - From time to time meteorological disturbances cause electromagnetic energy that can confuse the processor.
     - Place the unit in Manual Mode, turn the power off
     - Wait five seconds then turn the power back on
     - Turn off Manual Mode (all four switches to LEFT)

   - This symptom can also be caused by a defective clock/calendar chip. If the event happens often, the clock/calendar chip should be replaced to cover that base and monitor the unit for further occurrances.

3. Sometimes the LCD monitor contrast Thumbwheel gets out of adjustment… roll it upward to increase contrast – then, if no effect:
   a. If tightening screws did not help fix the problem, use a volt meter, set on AC low voltage, and check the output of the power transformer on the AC terminals (usually with green wires) at the top-right of the control board. The reading should be around 18-20 VAC.

   b. If there is no voltage, check the two line fuses and power out of the overload relay.

c. If the AC voltage is there, switch to VDC on the volt meter and check the output of the 12V DC regulator using the two empty solder holes just above the AC terminals at the very top-right of the control board.
d. If the DC voltage reading is much above 12 VDC (greater than 12.5), the regulator has failed and needs to be replaced. Send the control box back to the PSTC factory.
e. If the DC voltage is there (should read 11.5 – 12 VDC) Check the 5-VDC terminals just above the joystick. If the voltage is below 2 VDC something on the board has blown or is drawing down the 5-volt DC regulator. Send the control box back to the PSTC factory.

4. Motor Cycling On & Off Frequently
    a. Look at the Turncount screen on the monitor to see if the count is fluctuating; both while not moving then turn on the motor and see if the value jumps around when the motor runs.
        - Verify that the main system grounding lug is attached to field ground and that the shield ground from the potentiometer cable is grounded to the controller mounting lug
        - Some systems create noise in the position feedback signal and require a small capacitor (~(10-100)uF/10V Electrolytic) to be added between the green signal lead (labelled potentiometer) and ground.

5. Motor Buzzing when Activated but not Moving
    a. Check 3-phase leg voltages on both sides of the motor start breaker
    b. Check 3-phase inputs to solid-state relay board
    c. Activate joystick and check 3-phase motor outputs
    d. If (a) & (b) OK and one phase leg missing from motor, solid-state relay board is bad. Return control box to factory.
    e. If all three legs are active to the motor, remove the J-box cover on the side of the motor.
    f. Check the J-box for water accumulation – there are supposed to be three drain holes in the motor J-box, fan housing and armature case.
    g. Check voltages (with joystick still activated) on motor terminal plate connections
    h. If all three legs are getting to the motor, the motor is bad.

6. Motor Silent (doesn't move) when activated – controller operational
    a. Set volt meter for DC voltage – place probes on black and white wire terminals at top center of the control board (wires go to solid-state relay board)
    b. Activate joystick and check for voltage of ~15 VDC, either polarity ; then move the joystick in the opposite direction (remember there is a five-second pause between joystick inputs) and check for the opposite polarity at approximately the same voltage magnitude.
    c. If the first test works check that the bi-polar signal is getting to the solid-state relay board terminals.
    d. With the joystick activated, check the motor output leg voltages. If one or more missing, send control box back to factory.
    e. Check motor as in section 5.

7. Breaker Switch will not Reset
    a. The Motor Start Overload Relay (breaker) is designed to trip if a 3-phase leg drops out or if there is an overload. (> 2.4 amps)
    b. Contact Factory for further instructions.

8. Position Wrong – non-of-the-above wrong – Not jammed – still running
    a. It is possible for the postion encoder unit to lose its calibration with the actual position of the geardrive.
        - On the Gemco encoder the little worm gear in the small gear box at the end of the motor shaft is probably starting to skip teeth from unlubricated wear. Improper lubricant was delivered with the original series of jacks (both inadequate volume and had a tendency to harden) and needs to be augmented with extra grease to fill in air gaps as a preventative maintenance measure.
        - The SIKO (soda can-sized) encoder uses planetary gears without the Gemco vulnerability. There are screws than can come loose but not easily. Problems founmd with the SIKO should be reported to the factory.
    b. Place the unit in Manual mode and roll the array flat (level)
        - The turn count for a Gemco unit should be in the vicinity of 121 when the array is facing straight up
        - The turn count for a SIKO is about 81
        - If the counts are incorrect, see the next section, #9.

- Place the array back into automatic and see if it goes back to where you found it (accounting for sun movement since then).
- If you get this far and nothing is fixed contact the factory

9. There is a known problem with the Gemco (rectangular gray box opposite the motor on the same shaft)
    a. The little brass worm gear in the small gear housing at the end of the motor shaft when improperly lubricated can skip gears or fail entirely allowing the unit to dead-head into a metal stop and jam. Follow suggestions in Sec. 8-a if nothing has broken yet. The gear shold be inspected for wear twice per year.
    b. If the gear is worn (teeth assume a sharp edge rather than blunt) the gear needs to be replaced… contact factory for further instructions
    c. If the geardrive has jammed metal to metal a great deal of care must be taken to drive the two components back apart. It is suggested that the factory be contacted and provided with pictures of the circumstances prior to taking action.

In all cases, if there are questions, please contact the factory with the following information:

Observations of problem, pictures when visual information is involved, tests performed and their results, steps taken and current status.

Many other issues are addressed in other documents on our Technical Page…

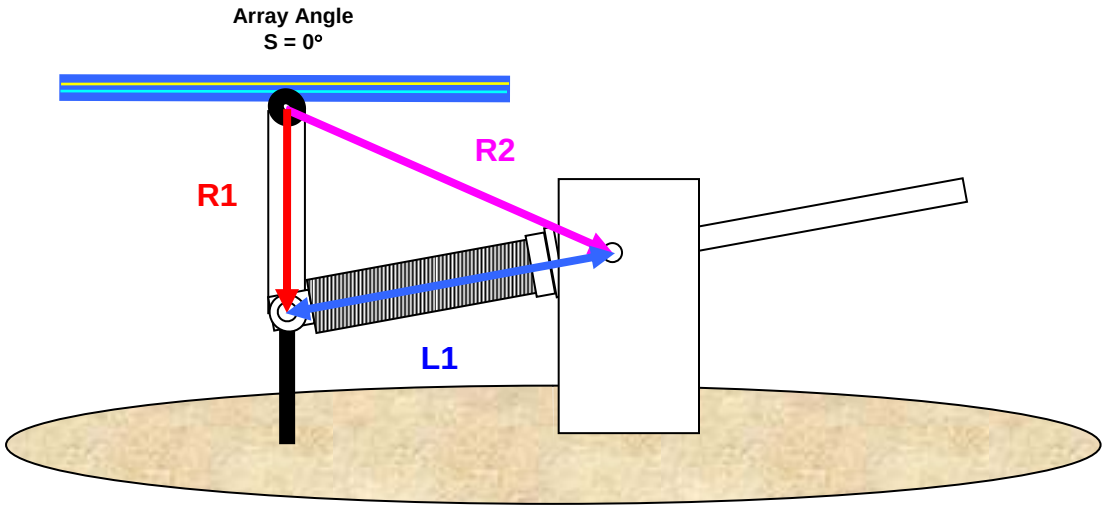
http://tapthesun.com/technical.html

or, if you can't find it there

TMLeonard@TapTheSun.com

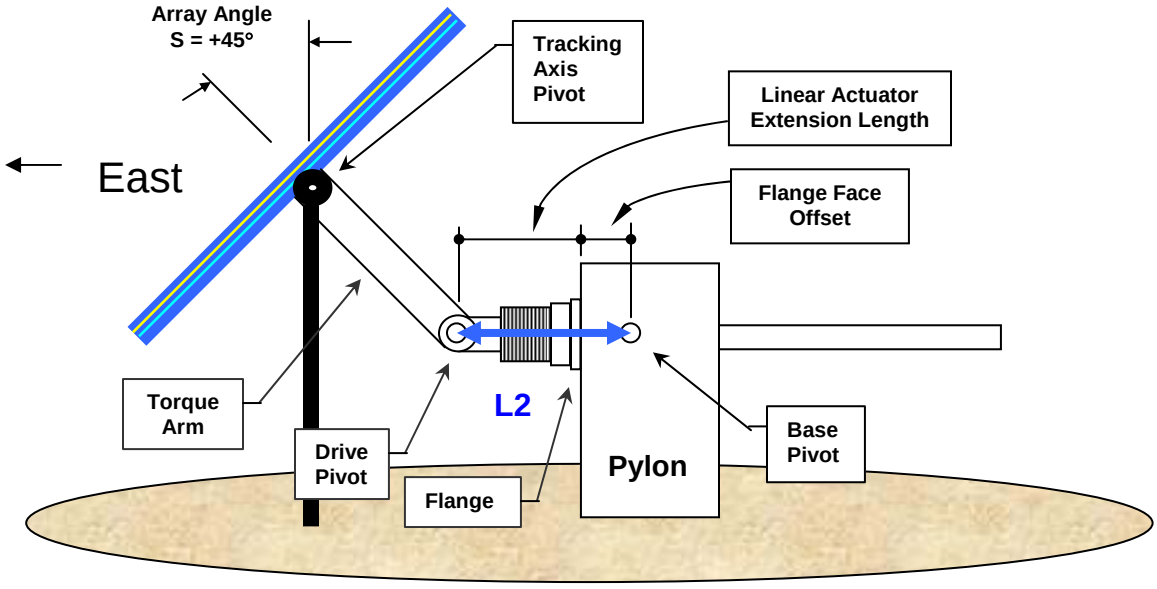
Appendix C:

screwJACK Parameter Computation

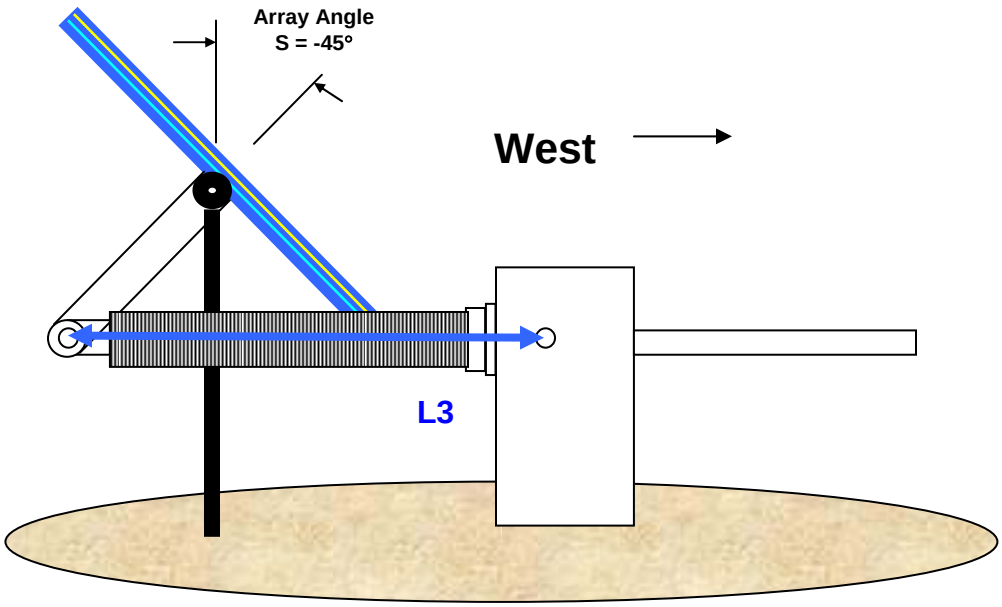


Western Mount Position – View Facing South

Level, Face-up Position



Unit Retracted to Soft Limit, S = 45°



Linear Actuator at Full Extension to Soft Limit, S = -45°

There are three screwjack parameters stored in the SolarTrak® in the **'Drive Parameters'** screen**, SJP #1-3, c**omputed from the quantities **R1**, **R2**, **L1-3** defined above. Lengths are in inches.

The Law of Cosines is applied to convert the requested angular position to a specific actuator extension. The fundamental equation relating the actuator length and array angle is**:**

(1) $L = \sqrt{R1^2 + R2^2 - 2 * R1 * R2 * \cos(S + \beta)}$

Where **L** is the length of the actuator, **S** is the requested array angle and β is an angular offset based on the relative positions of **R1** and **R2** when the array is facing straight up **(S = 0).** Since some of the computations for these terms need only be performed once, the parameters are stored as pre-combined coefficients producing the equivalent equation **(2).**

SJP #2 = (+/-) 2 * R1 * R2 **(+West Mount, -East)**
SJP #3 = R1^2 + R2^2

(2) $L = \sqrt{SJP\#3 + SJP\#2 * \cos(S + \beta)}$

(3) $\beta = \text{ACOS}\{(L^2 - SJP\#3)/ SJP\#2\} - S$ **SJP #1 = β**

Equation (1) above is used for converting a specific Sun angle to a specific screwjack extension point. Equation 3 should be used to determine **β** for **L** equals each of the measurable quantities **L1 (S = 0), L2 (S = 45, in radians)** and **L3 (S = -45).** The result found for **β** should be the same in each case.