Quantum Harvest®

Faraday Enclosures

Portable Solar Power Stations

Diagnostic Manual

Quantum Harvest Model ST Series

This manual contains detailed explanations of the diagnostic tools built into the control system of the ST series solar power systems. It also contains instructions on how to update the ECU firmware, and a separate section that details the steps in installing a new ECU.

Table of contents

Overview of the control system on the Quantum Harvest ST-Series.

The ST Series control system consists of several modular components, designed for easy repair/replacement. The main components consist of the ECU (Electronic Control Unit), the control panel, the motor controller, and the junction box. The last 3 are all connected to the ECU by shielded data cables. Secondary components that are individually replaceable are the 4 limit switches, the compass module, the OLED display, the rotary encoder, the directional photosensor, and the 2 motors that power the array in 2 axis of motion.

In operation, the ECU receives positional data about the array via the 4 positional limit switches (CCW limit, CW limit, tilt-up limit, and tilt-down limit), the compass module that returns the direction the chassis frame is pointed, and the rotary encoder, which tells the ECU precisely where the array is pointing in relation to the chassis. The ECU also receives light-intensity and direction data from the directional photosensor, and user commands from the control panel. The ECU uses all this data to determine a course of action, and outputs commands to move the motors, in direction, speed, and amount, automatically accelerating and decelerating to avoid undue stresses. It also outputs data for the OLED display, and the status LEDs on the control panel.

Initial setup in a new location consists of the operator deploying the outrigger-type stabilizers, and turning on the main switch. The ECU boots up, runs a self-diagnostic, checks it's sensors and motors, and prompts the operator to first raise, then unfold and lock the array panels. It next goes through the homing process, where it first turns all the way counter-clockwise until it encounters the limit, then all the way clockwise, mapping the light intensity as it does so.

It then determines the chassis orientation from the compass data, and will use this and the input from the rotary encoder to always know which direction the array is pointed. Once it has finished it's lightmap, it returns to the brightest spot, angles the array to maximize power output, and settles into it's normal operation, checking the sun's position, the battery bank voltage, and the array position several thousand times a second, and periodically issuing commands to the motors to keep the array centered on the Sun until nightfall.

A normal day of operation starts when the photosensor, which was turned to face East the previous evening, detects the first morning light. It wakes up the cpu, starts some timers, and monitors the light level until it reaches a sufficient intensity to generate power from the solar panels, at which point it begins tracking the Sun. On shady or overcast conditions, it still keeps the array pointed at where the Sun should be by calculating the Sun's arc through the sky. When it gets too dark to generate power, it swings the array around to face the East, and shuts down for the night.

This machine was designed and built with great care to ensure a long and trouble-free service life, but things can go wrong with any complex system. To aid in the diagnosis of problems, there are several trouble-shooting functions that are accessed in the Diagnostic Mode, which are explained in the following pages.

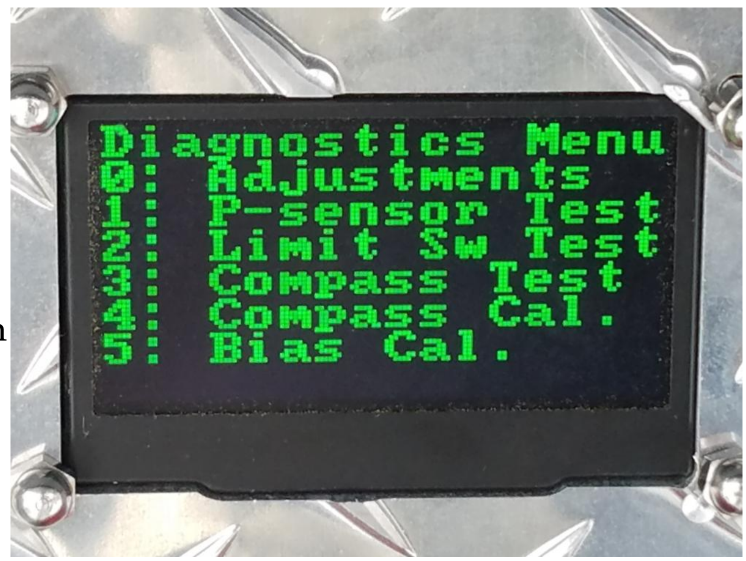
Accessing Diagnostic Functions

To access these functions, flip the Diagnostic Mode/Manual Control switch down. Use the rotary selector switch to select from the menu .

Rotary selector switch

Diagnostic Mode / Manual Control switch

This brings up the Diagnostics Menu. The numbers on the left represent the rotary switch setting to call up that item. Turning the rotary switch clockwise one click at a time advances through the list to perform the listed functions. There are six functions detailed in order on the following pages. Select the desired function on the rotary selector switch, and move the joystick in any direction, or wait a few seconds to continue.



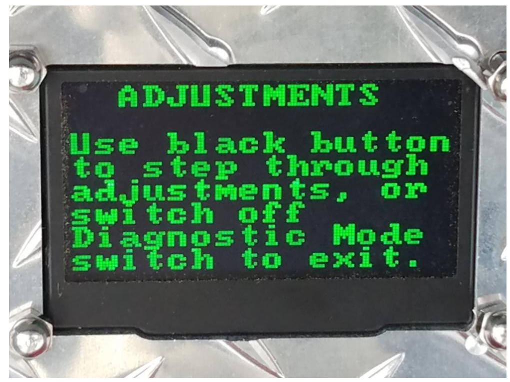
Position 0 (Fully counter-clockwise) brings up the adjustments menu..........(Next page)
Position 1 (1 click clockwise) brings up the photosensor test.........................(Page 19)
Position 2 (2 clicks clockwise) brings up the limit switch test........................(Page 20)
Position 3 (3 clicks clockwise) brings up the compass test..............................(Page 22)
Position 4 (4 clicks clockwise) brings up the compass calibration routine......(Page 24)
Position 5 (Fully clockwise) brings up the bias calibration routine.*

*This last routine is not available at the time of this manual, as it requires further development.

Section 1 Adjustments Menu

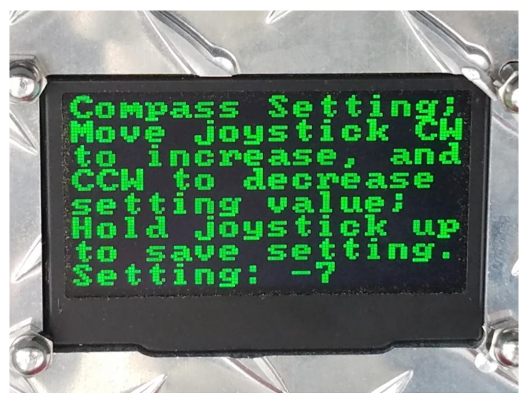
Diagnostic Mode Switch On (Down); Rotary Selector Switch at Zero

There are 26 separate parameters that can be accessed and adjusted through the control panel. Although it is doubtful that most will ever need to be used, I felt it important that they be available if needed. The default values which are loaded when an ECU is started for the first time can usually be left as they are. The most likely adjustments to be used are the first in the menu, and less likely to be changed items are further down.



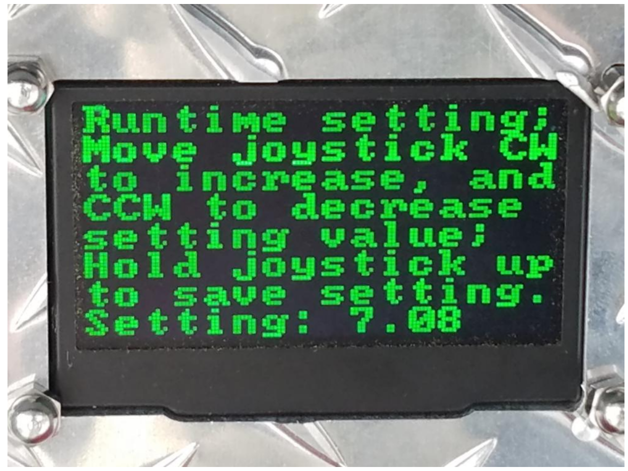
From the Diagnostics Menu screen, move the joystick in any direction, or simply wait a few seconds, and the screen on the right will come up. As the screen says; use the black button on the control panel to step through the menu. When you are finished, flip the Diagnostic Mode switch to the center position.

Adustment 1; Compass Correction



The first press of the black button brings up the compass correction setting adjustment. The joystick is used in a similar fashion on all the adjustments; moving it left, or toward the CCW position decreases the setting, and moving it right, or toward the CW position increases the setting. When the setting reaches the desired value, hold the joystick up until the screen indicates the setting is saved. If you inadvertently save an incorrect value, simply change it and resave it. When you are finished, pressing the black button will advance to the next adjustment, and flipping the Diagnostic Mode switch back to the centerposition will exit the entire menu and return to whatever the computer was doing before it was put in the Diagnostic Mode.

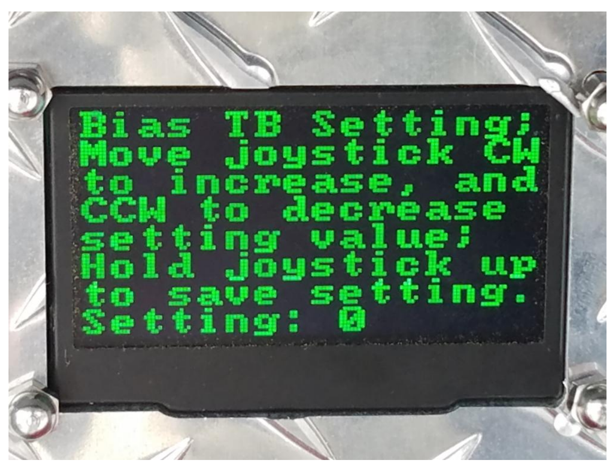
Adustment 2; Run Time setting



The second screen is the runtime setting. This is the amount of time elapsed since Sunrise, and used to determine the approximate position of the Sun in the sky. Since the Sun travels 15 degrees per hour, this value is important. In normal operation, this value is started at sunrise, and reset to zero at sunset. The only time this adjustment is needed is if this timekeeping function is interrupted by either a reboot or program change at midday. It adjusts in ½ hour increments, and should be set to reflect the amount of time since sunrise. For example, if sunrise was approximately 7:00 AM, and it is now 2:30 PM, the setting should be 7 ½ hours. This is the last adjustment that would commonly need to be made; the following adjustments should probably be left alone unless you are instructed to change them.

NOTE: The following adjustments will most likely never need to be changed from the default settings.

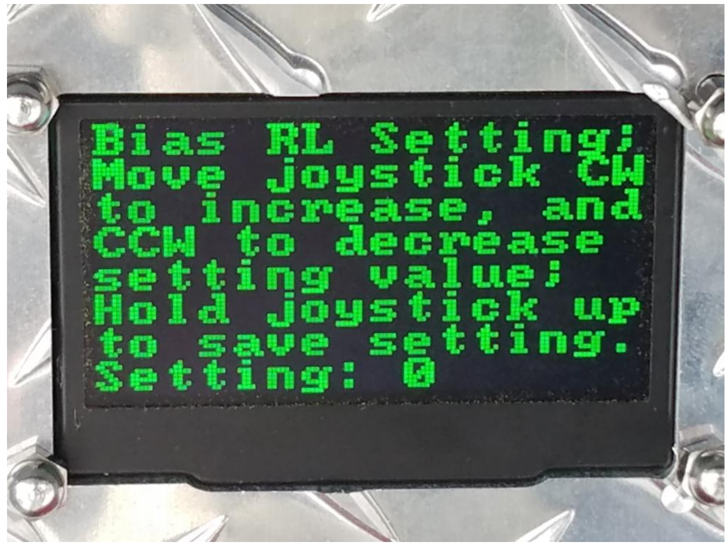
Adustment 3; Bias TB setting



The third screen is the setting that sets the Top/Bottom photocell bias. Increasing the value causes the top photocell to be favored over the bottom cell. A negative value has the opposite effect.

Adustment 4; Bias RL setting

The fourth screen is the setting that sets the Right/Left photocell bias. Increasing the value causes the right photocell to be favored over the left cell. A negative value has the opposite effect.

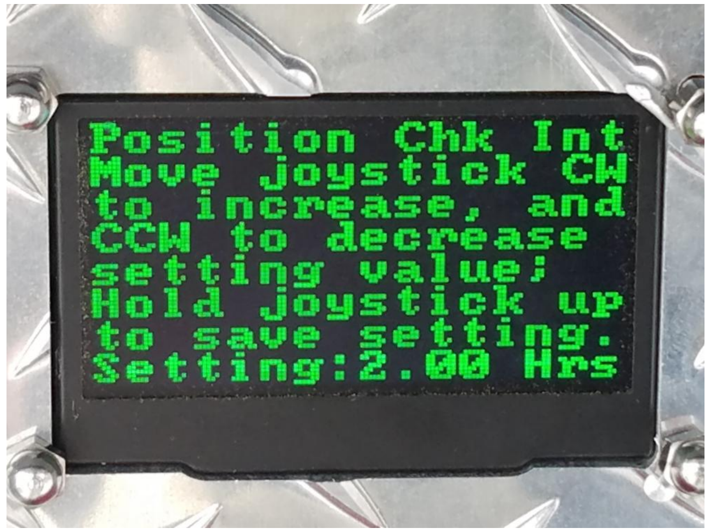


Adustment 5; Allowed Deviation from Calculated Sun Position

The fifth screen is the amount in degrees that the array position is allowed to deviate from the calculated Sun position. This should rarely need to be changed from it's default of 70 degrees.

Adustment 6; Position Check Interval

The sixth screen is specifies how often the array position is checked against the calculated Sun position, and moved if necessary. The default time is every 2 hours.

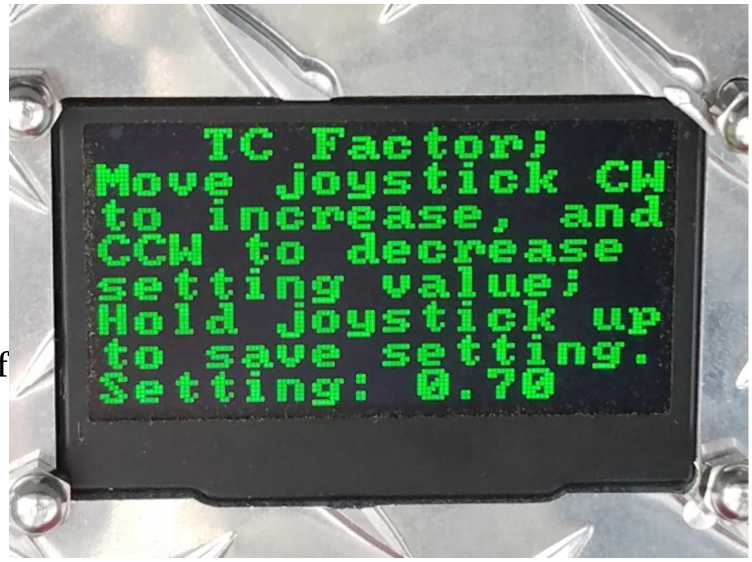


Adustment 7; Degrees per hour settings

The seventh screen is the amount of movement of the Sun per hour, in degrees. The default is 15 deg/hr.

Adustment 8; Tracking Correction Factor

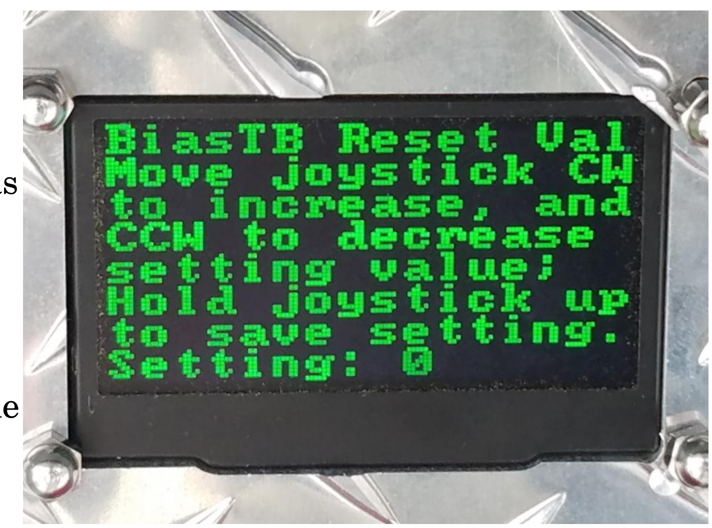
The eighth screen is the ratio of the tracking correction amount to the calculated difference between the right/left and top/bottom photocells. For example, if the allowed difference between the right and left photocell is 10; a TC factor of 0.7 means that if the difference is greater than 10, the array is turned until the difference between the cells is less than 7.



Adustment 9; Bias TB Reset Setting

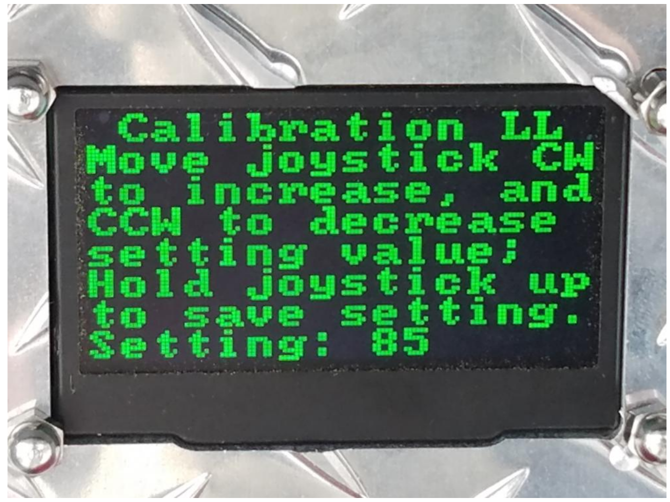
If the array is in a horizontal position, and the tracking algorithm calls for further depression of the array, the computer interprets this as an error condition, and raises the array to a 30 degree angle and also lowers the Top/Bottom Bias by 5 to prevent a recurrence.

The ninth screen represents the photocell average above which, the BiasTB value is reset to the saved value. The default is 96, so the screen to the right is wrong.



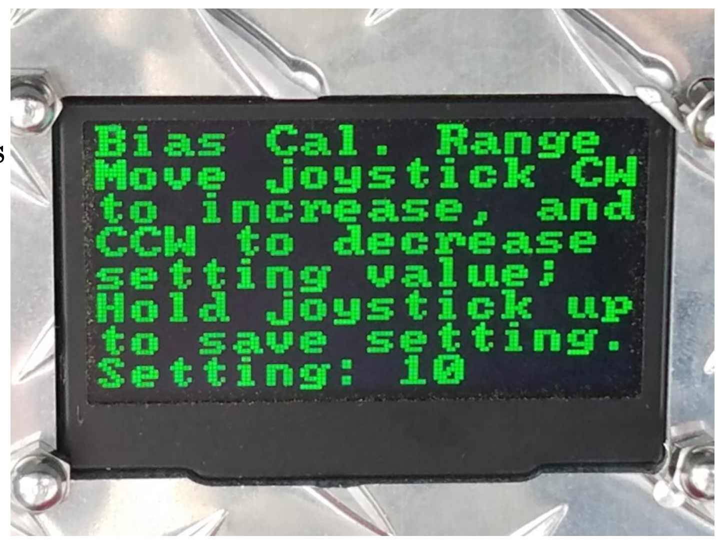
Adustment 10; Minimum Calibration Light Level

The tenth screen is a setting that is currently not used, but represents the minimum photocell average where a bias calibration is allowed.



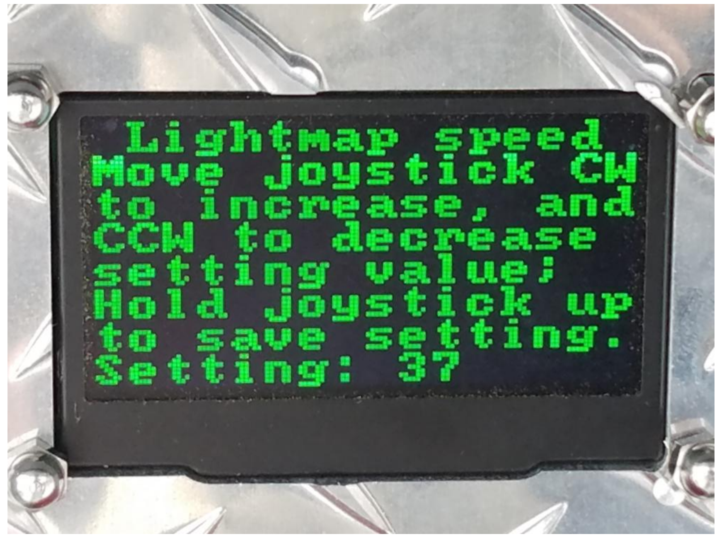
Adustment 11; Bias Calibration Range

The eleventh screen is also a setting that is currently not used, but represents the range of bias values that are tested during a bias calibration. The default setting of 10 means that biases of from -10 to 10 are tested for optimum panel output.



Adustment 12; Lightmapping speed

The twelfth screen is a setting that represents the speed, in percent, that the array travels during the initial light mapping that the machine does during startup.

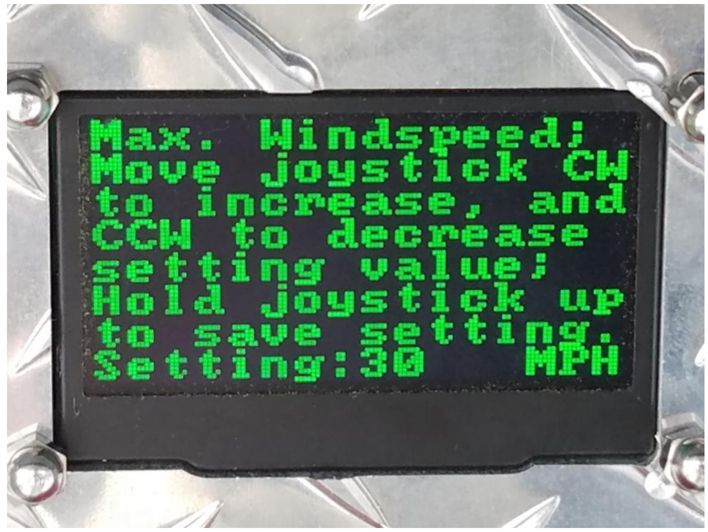


Adustment 13; Minimum Rotational Speed

The thirteenth screen is a setting that represents the minimum allowed rotation speed, as a percentage. Setting this too high leads to overshooting the desired position, and jerky movements. Too low, and the motor may not move at all, especially in windy conditions. Trial and error has found the default setting of 28% to be the best compromise.

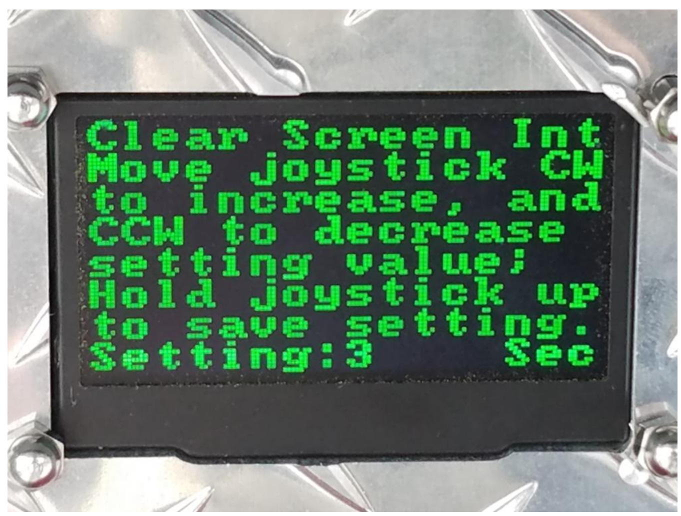
Adustment 14; Maximum Windspeed

The fourteenth screen is a setting that is only used on units equipped with an anemometer, and represents the maximum allowed windspeed before the array is stowed to prevent wind damage.



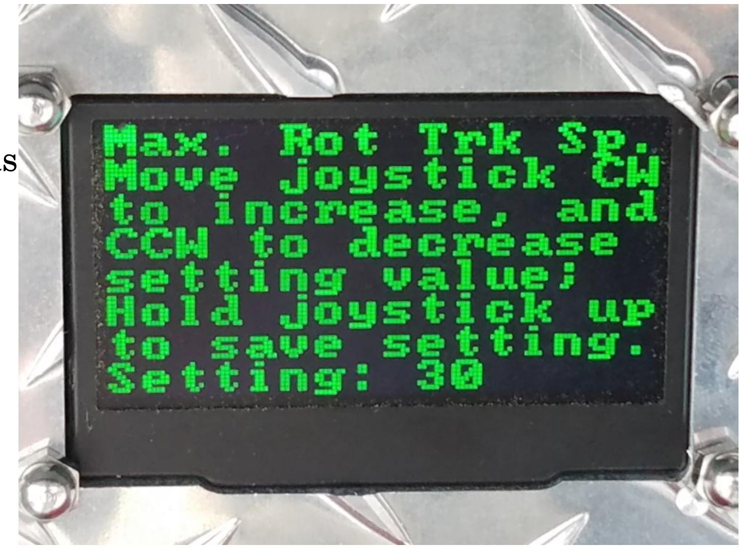
Adustment 15; Clear screen interval

The fifteenth screen represents a setting that determines how often, in seconds, the screen data is refreshed during normal operation.



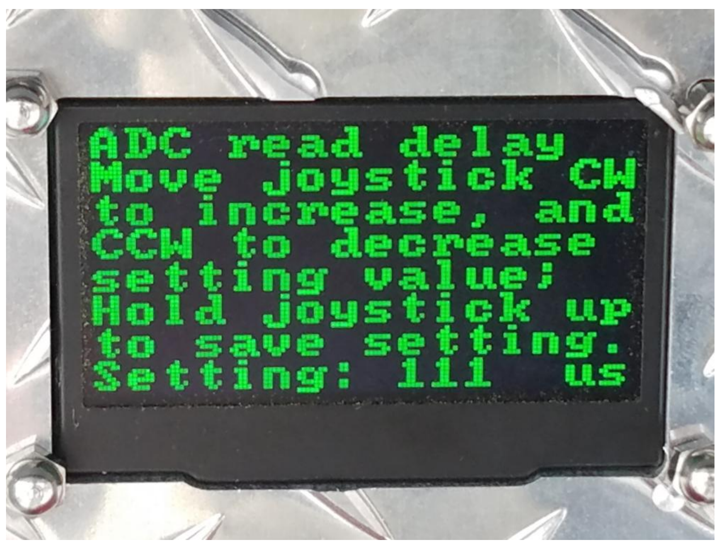
Adustment 16; Minimum Rotational Tracking Speed

The sixteenth screen is a setting that represents the minimum allowed tracking rotation speed, as a percentage,



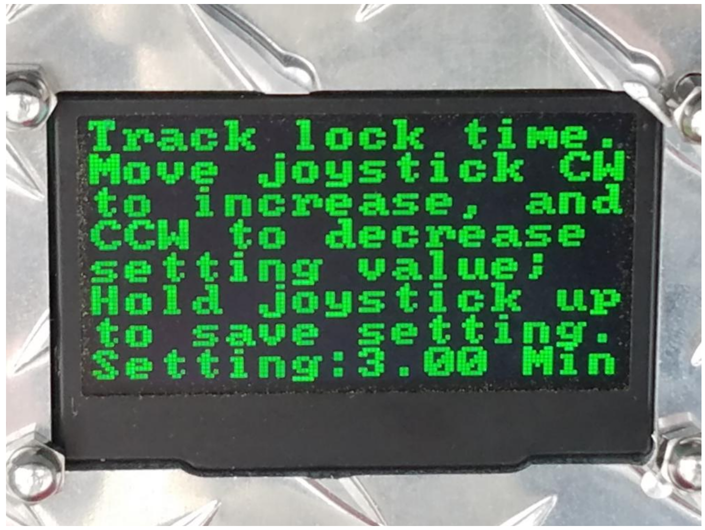
Adustment 17; Delay uS between ADC reads

The seventeenth screen is a setting that represents the delay, in microseconds, between subsequent calls to the analogRead function. This gives the ADC capacitor time to drain, increasing the accuracy of readings.



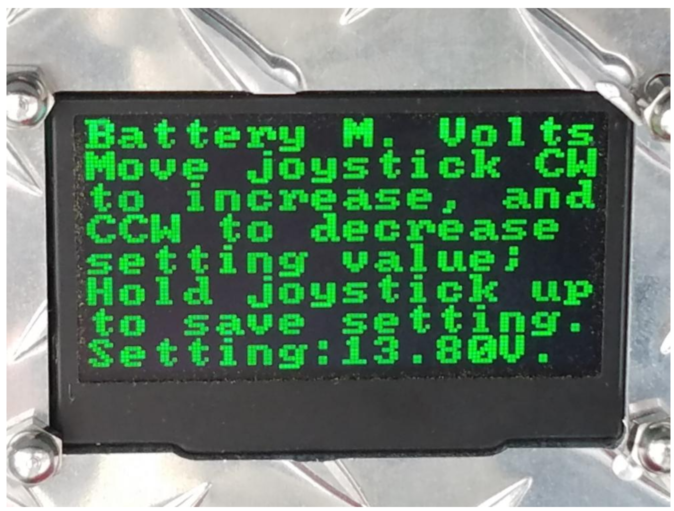
Adustment 18; Tracking Lockout Timer

The eighteenth screen is a setting that represents the minimum allowed time between tracking movements. This helps prevents wig-wagging during less than optimal light conditions. In other words, the array can only make a tracking movement every 3 minutes.



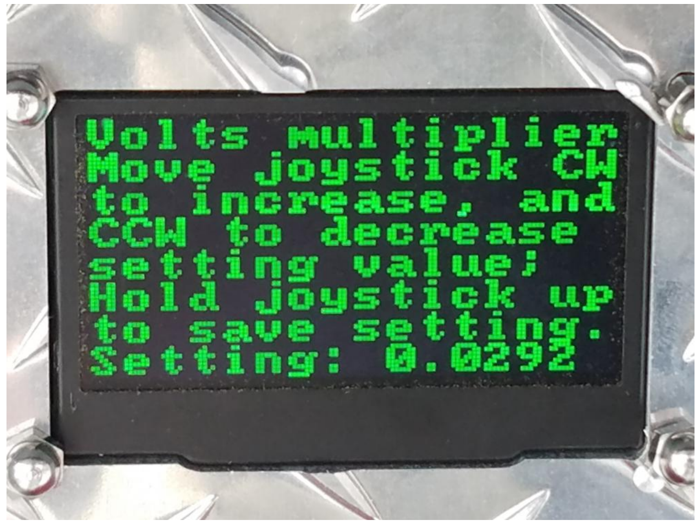
Adustment 19; Battery Median Voltage

The nineteenth screen is a setting that represents the median battery bank voltage. This value is used to calculate the states-of-charge of the battery bank.



Adustment 20; Voltage Multiplier Setting

The twentieth screen is a setting that represents the value used in the algorithm that calculates battery bank voltage.

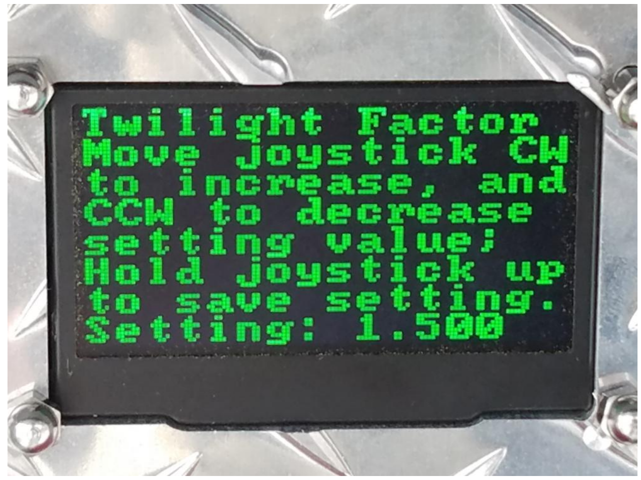


Adustment 21; Amperage Multiplier Setting

The twenty-first screen is a setting that represents the value used in the algorithm that calculates charging amperage.

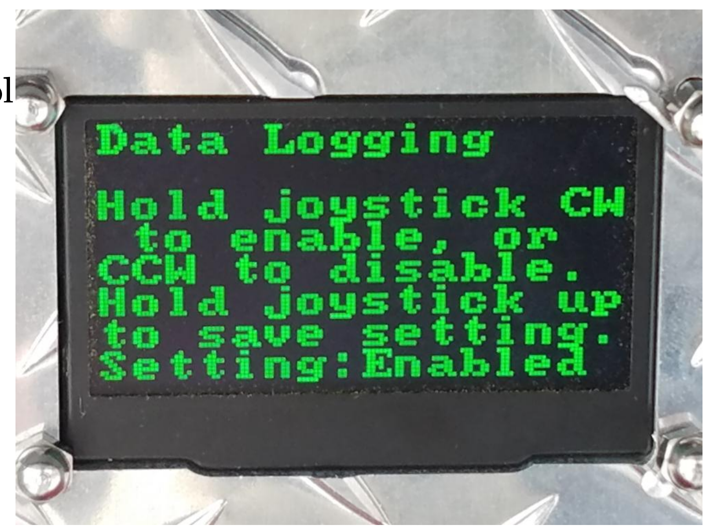
Adustment 22; Twilight Factor

The twenty-second screen is a setting that is used to determine when the machine wakes up in the morning, and goes to sleep at night.



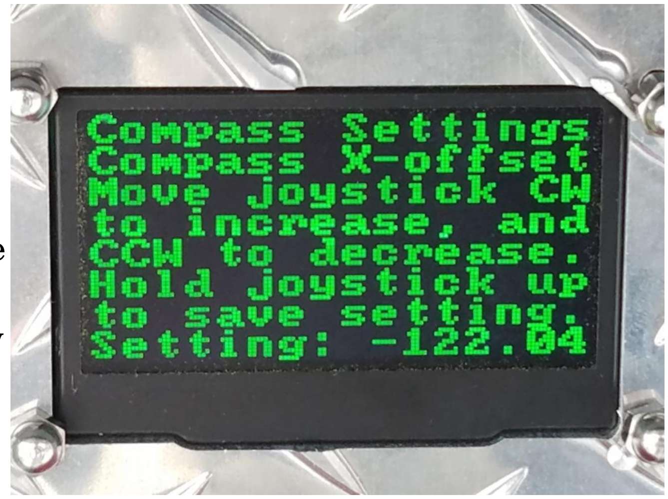
Adustment 23; Data Logging

The twenty-third screen is the control that turns data logging on and off on machines equipped with a data logging module. The default is disabled.



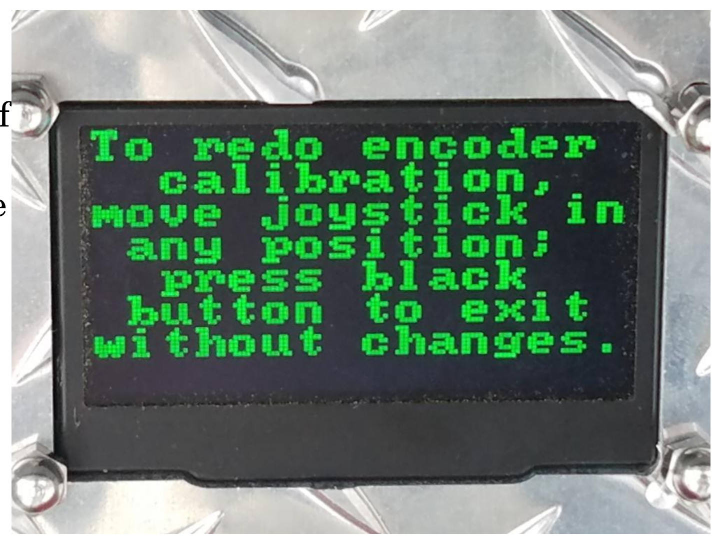
Adustment 24; Compass Calibration Matrix

The twenty-forth screen is the first of 6 sub-screens that allows the compass calibration matrix values to be inputted manually, vs, doing a compass calibration. This should definitely not be changed without being instructed to do so, and also being supplied with the new values.



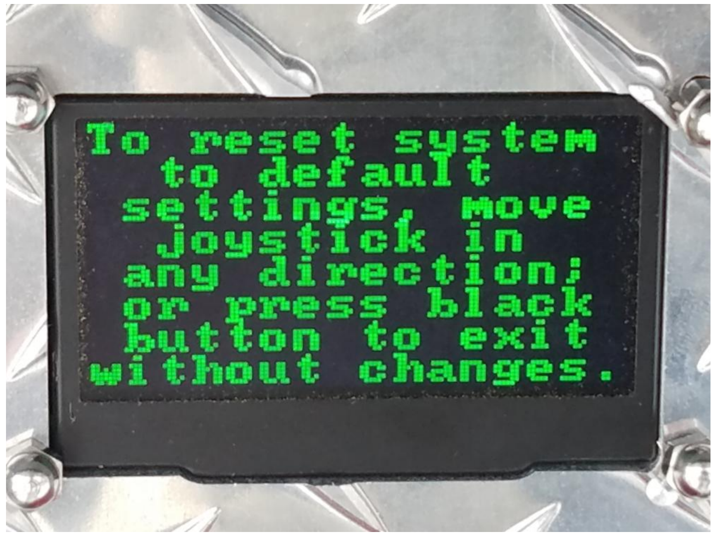
Adustment 25; Encoder Calibration Reset

The twenty-fifth screen gives the option of resetting the system to allow the encoder to be recalibrated. This does not affect the compass calibration.



Adustment 26; Factory Reset

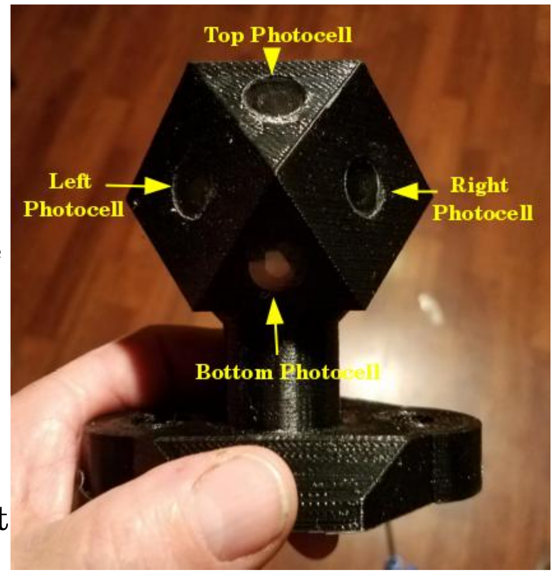
The twenty-sixth and last screen gives the option of clearing the memory and resetting the system to factory defaults. This has the same effect as intalling a new ECU.



Section 2 Photosensor Test

Diagnostic Mode Switch On (Down), Rotary Selector Switch 1 click clockwise

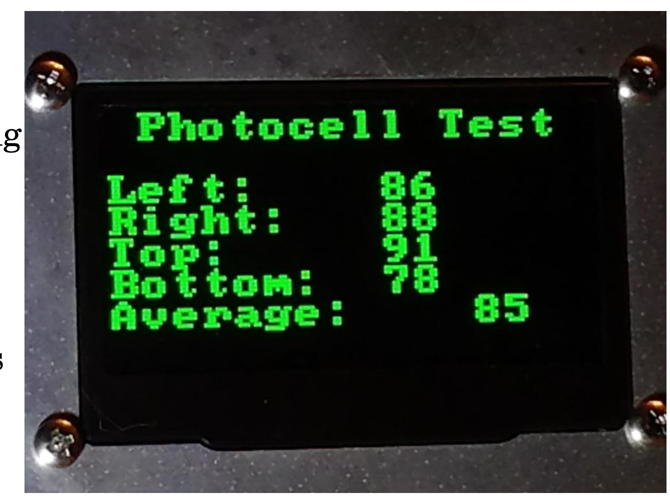
The photosensor is mounted on top of the array, and the 4 lenses face the same direction as the solar panels.



They are labeled as shown to the right, facing the sensor.

A reasonably bright day, even if it's overcast, will still give ample light for the test.
When the Photosensor Test is running, control of the array is handed off to the joystick.

I have found that the easiest and quickest way to check the photosensor function is to rotate the array until the back of it is facing the control panel, and then tilt it down until you can easily place your hand over the face of the photosensor and see the display at the same time.

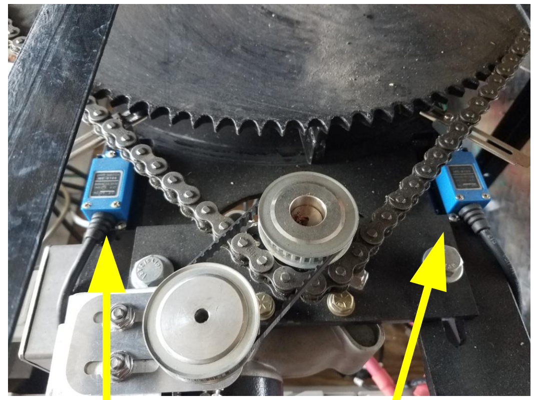


Cover each lense in turn with your thumb or other opaque object to block the light, and observe the corresponding reading on the screen. A covered lens should return a reading of near zero, and should give a fairly high reading when uncovered. If this is not true, the photosensor is easily replaced. There is no special procedure to replace it, just move the array down to where it is easily reached, shut off the machine, remove the screws securing the sensor, and unscrew and disconnect the pigtail connector. Reverse the steps to install the new one.

Section 3 Limit Switch Test

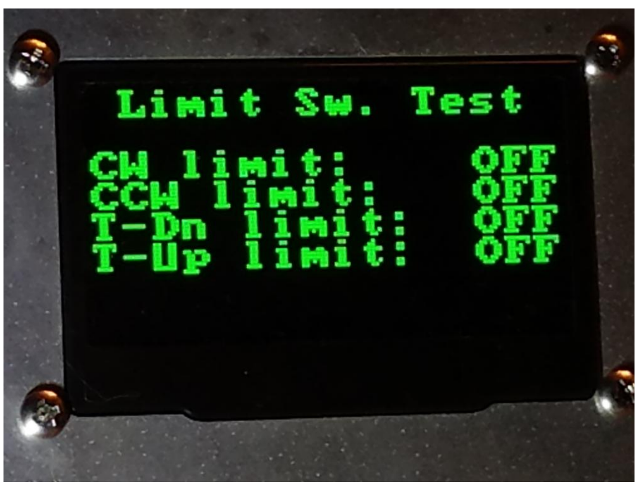
<u>Diagnostic Mode Switch On (Down), Rotary Selector Switch 2 clicks clockwise</u>

This procedure tests the proper function of the limit switches. These are the 4 switches that report to the ECU when the array comes to the limit of it's motion. Two are mounted in the rotary mechanism and detect when the array is at it's clockwise or counter-clockwise limit of rotation, and two are mounted on the tilting mechanism and detect when the array is tilted all the way up or all the way down.



Clockwise limit switch

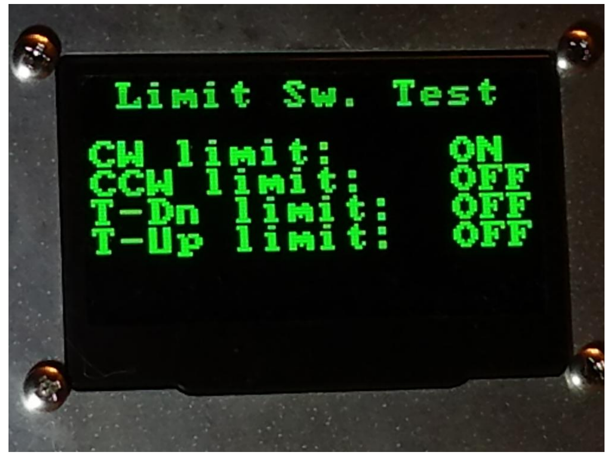
Counter-clockwise limit switch



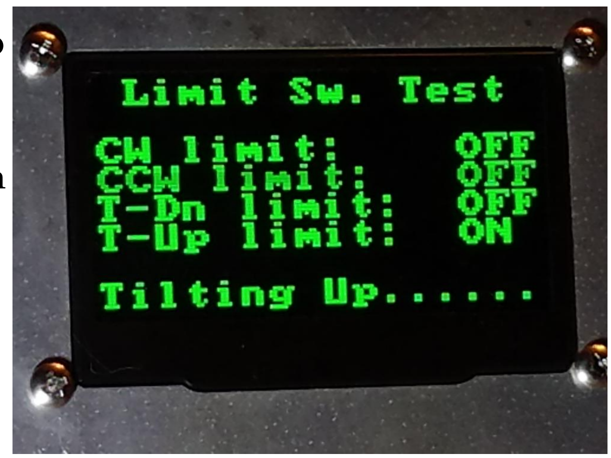
Tilt-down limit switch *Tilt-up limit switch*

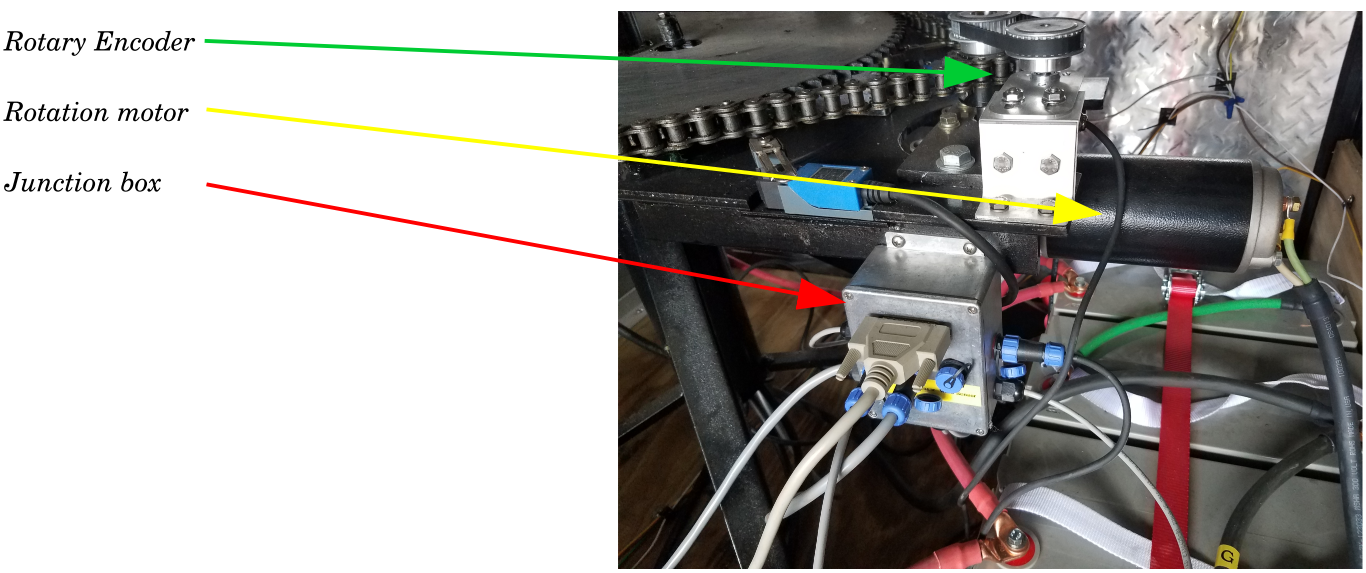
When the Photosensor Test is running, control of the array is handed off to the joystick. Use it to move the array through it's range of motion, and note the screen.

The screen to the right shows the array at it's clockwise limit, and the screen below that shows the array at it's upper tilt limit (fully vertical). There are also LED cues that tell the status of the switches. All of the red LEDs on the bottom right of the LED panel are lit when the limits are off, and when one is on, the red LED goes out, and the LED above it is lit.



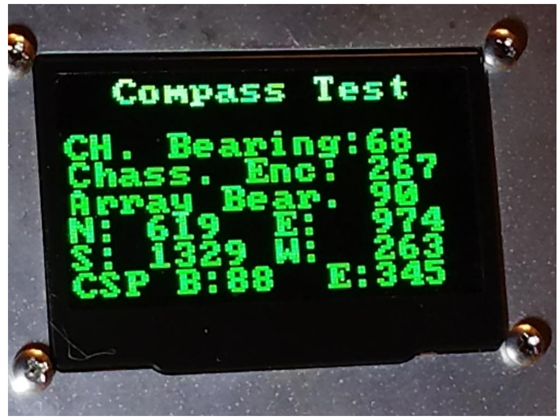
The limit switches are easily replaceable, being secured with 2 screws, and plugging into appropriately labeled sockets on pigtails leading out from the junction box. Note that the tilt limit switches wires lead down through the center of the array center-post. The clockwise, counter-clockwise, and tilt-up switches will need their levers adjusted to match the angles of the originals.





Section 4 Compass Test

<u>Diagnostic Mode Switch On (Down), Rotary Selector Switch 4 clicks clockwise</u>



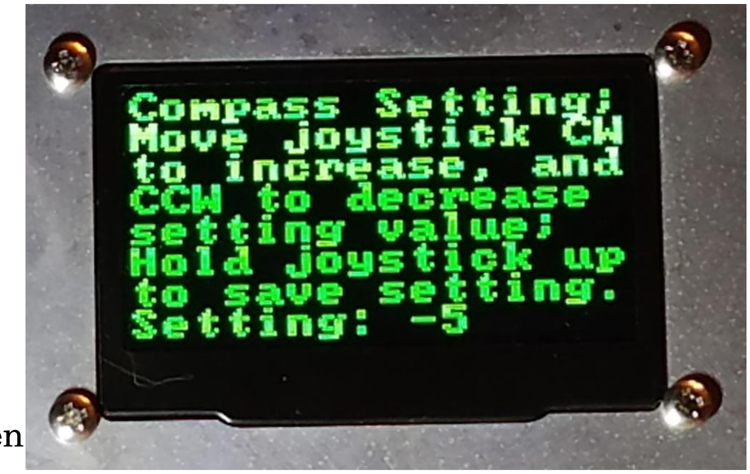
This function tests the compass, and also calculates and displays in order from the top:

CH. Bearing: The current direction the rear of the chassis is pointed. This is the important one!

Chass. Enc: This is the CH. Bearing value converted to encoder pulses.
Array Bear: The current direction the array is facing; in this case it is facing due East.
N: The calculated North direction, converted to encoder pulses.
S: The calculated South direction, converted to encoder pulses.
E: The calculated East direction, converted to encoder pulses.
W: The calculated West direction, converted to encoder pulses.
CSP B: The calculated direction of the Sun.

The screen alternates between this one and the screen above, if the CH. Bearing value is steady but incorrect, it can be adjusted. To do so, press the black button….

Which brings up the adjustment screen, *(Right)*.



Use the joystick to set the desired value, and hold the joystick up to save it.

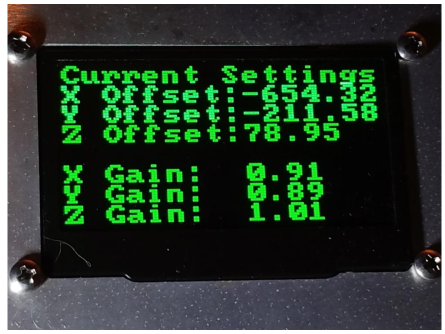
After the new value has been written to memory, it will return to the first screen at the top of the previous page.

To exit, either change the rotary selector switch to do another function, or flip the Diagnostic Mode switch to the middle position to completely exit the diagnostic system.

Section 5 Compass Calibration

<u>Diagnostic Mode Switch On (Down), Rotary Selector Switch 4 clicks clockwise</u>

This is a procedure that needs to be done if the compass module needs replacement. When this function is selected, the first screen shows the current gains and offsets.

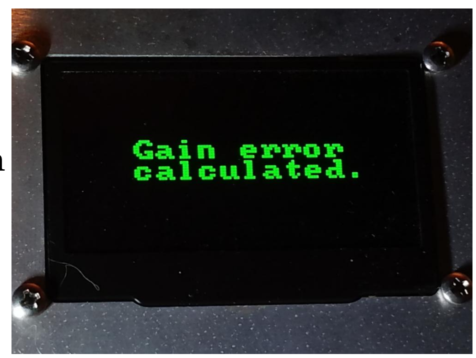


Before starting, obtain an independent reading with a magnetic compass, and find your local magnetic declination at this website: http://www.magnetic-declination.com/

If your declination is negative, deduct it from the magnetic compass reading to get the true direction; likewise, if the local declination is positive, add it to the magnetic compass reading to get the true direction.

Now, press the black button to continue….

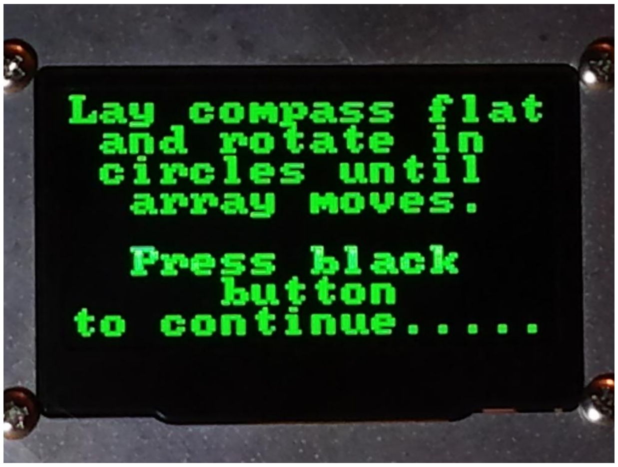
The compass chip initializes in calibration mode and performs it's initial gain error calculations, compensating for local hard and soft iron deviations in the Earth's magnetic field.



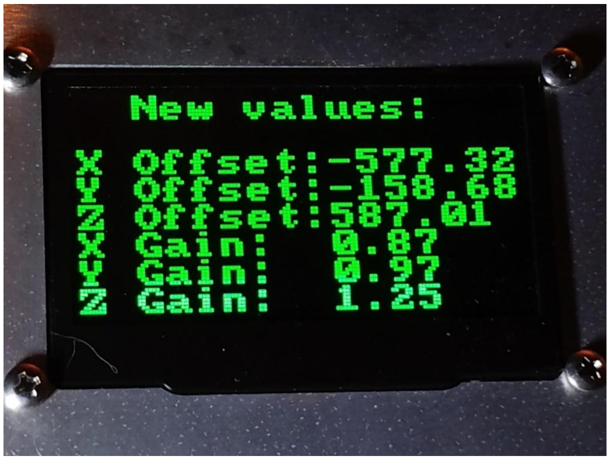
When that is done after a few seconds, the next step is to prepare for the offset calculations:

To do so, First, open the electronics cabinet to access the brass nut securing the compass module, which is shown to the right. Loosen the nut on the bottom of the compass module slightly; just enough to allow it to turn on the bolt, and close the lid on the electronics cabinet. It is important for the compass module to lie flat in relation to the trailer for proper calibration.

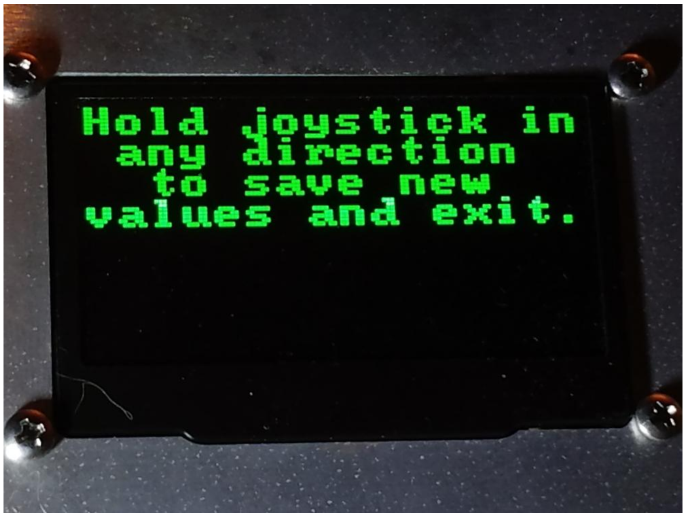
The screen will prompt you to begin rotating the compass module in circles back and forth one or two revolutions each way as the wire allows, until the sequence is finished. (About 45 seconds) **Keep the module laying as flat on the cover as you can while it is being rotated.** Press the black button to start whenever you are ready….



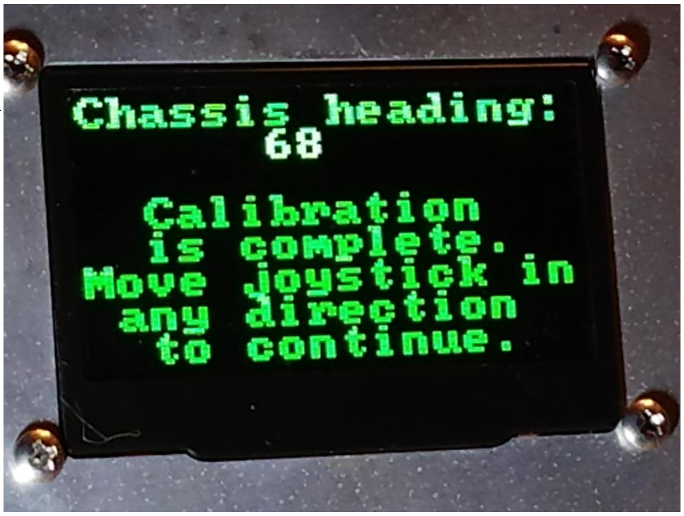
Since you cannot see the display while you are doing this, there is a cue to indicate when it is finished: The array will tilt down for a few seconds and then return to the upright position. When the array stops moving, orient the module so the arrows point straight rearward, and retighten the brass nut securing the compass module to the lid. It should be secure enough to prevent the module from turning on it's own. Close the lid at this time.
The display will now show the new values….



Hold the joystick in any direction until the display indicates the new settings have been saved. *(Right)*.



The last screen shows the current bearing that the back end of the trailer is pointing. Let this display refresh a few dozen times, and if it is steady, with no more than a degree or two difference, and within 30 or so degrees of being correct, you are finished. The most important thing is that it is steady. Note the heading and subract it from the heading you calculated with the handheld compass, and if it needs correction, move the rotary selector switch fully counter-clockwise to the zero position to go to the adjustments section. See page 5.



Section 6 Preparing for firmware updating

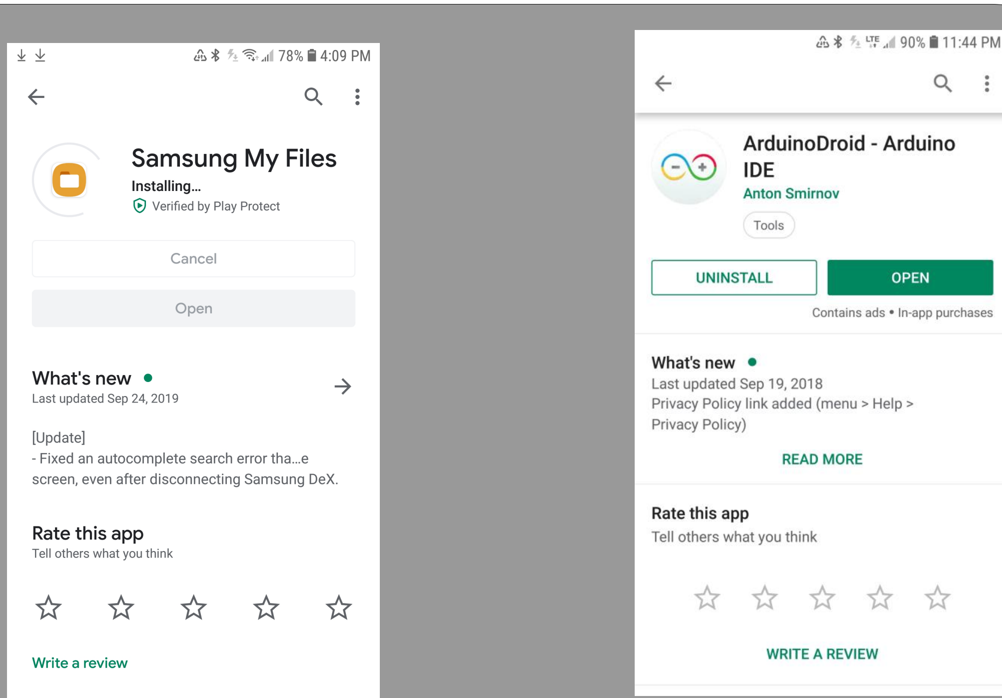
(Android devices)

Because we are constantly developing and improving the instruction set for the controller, it may be beneficial to update the operating system from time to time.

It is quite straightforward, and requires only an Android-powered smartphone or tablet.

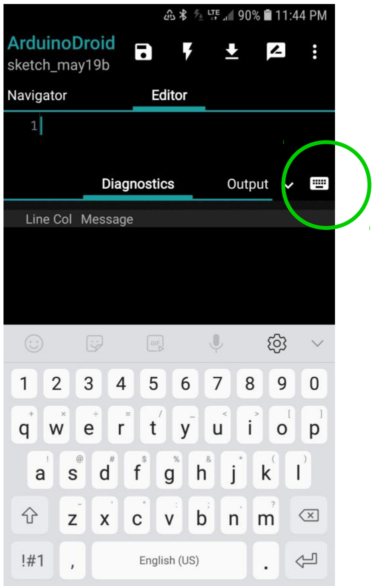
In this section, we will go over what needs to be done to prepare your Android device for a firmware update. The steps in this section only need to be done once for each Android device.

There are two apps that are needed from the Google Play Store. The first is *Samsung My Files** and the second is *ArduinoDroid*. Both are free, and will take only a small amount of memory.

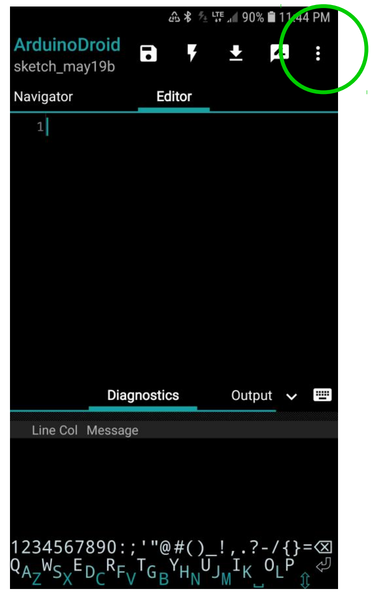


Samsung My Files and *ArduinoDroid* in Google Playstore

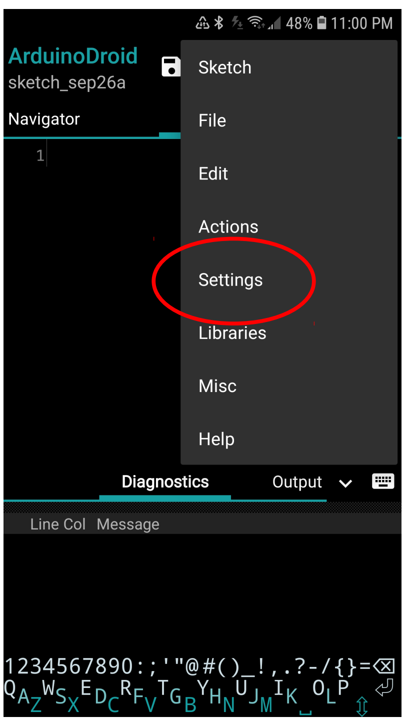
**This is a file manager program, if you prefer something different, by all means use it. Any file manager that can handle unzipping files will work fine.*



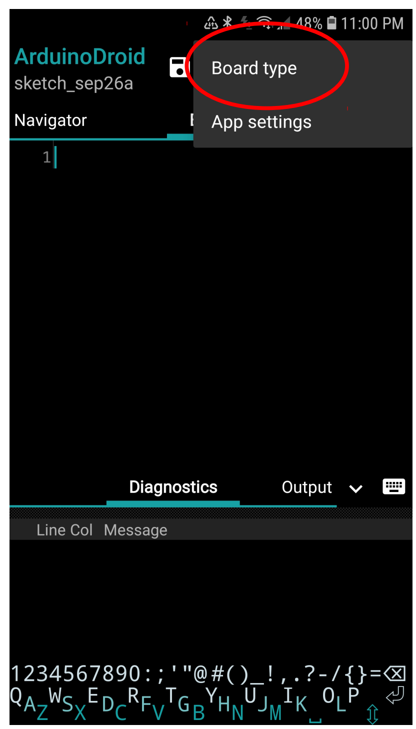
Open ArduinoDroid and touch the keyboard icon to hide the keyboard, as it will not be needed.



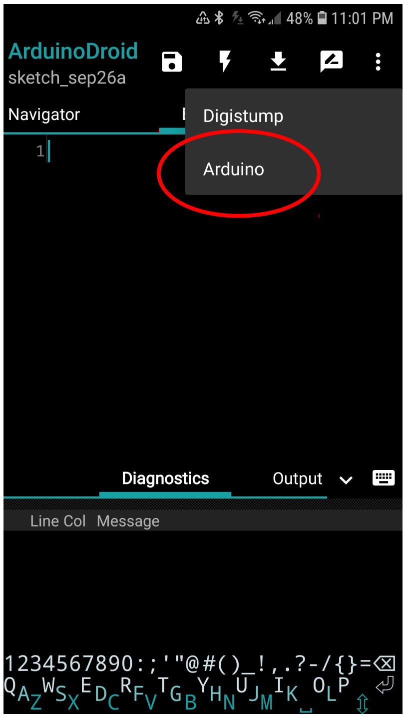
Keyboard hidden, now touch the 3 vertical dots in the upper right corner.



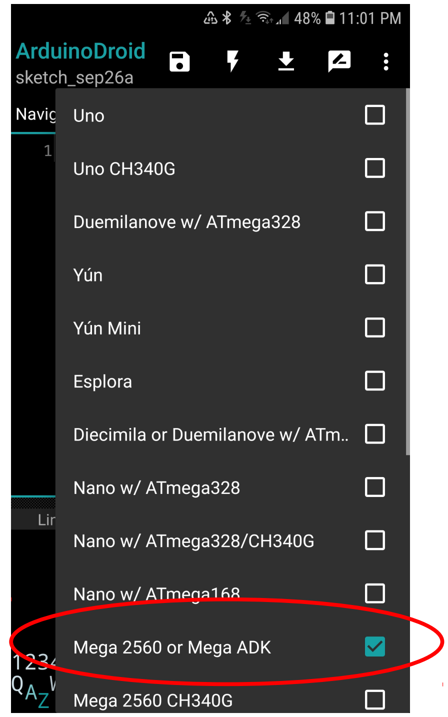
Touch *Settings*….



then touch *Board type*…



then touch *Arduino*...

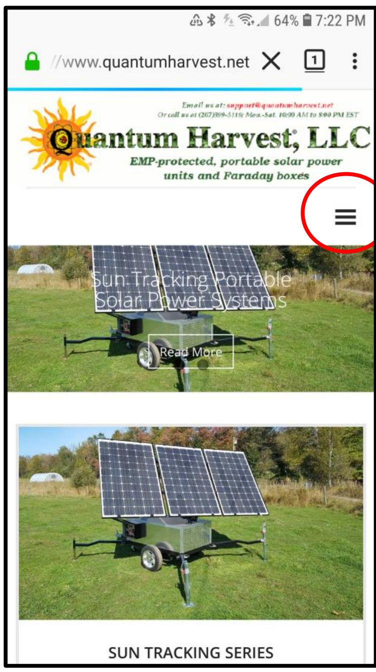


Then select *Mega 2560 or Mega ADK*

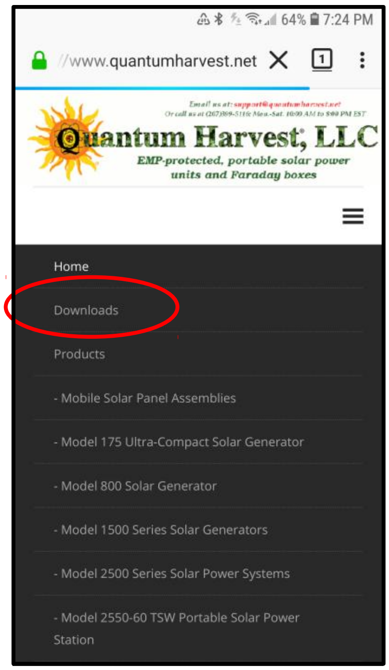
That's it for the initial setup. The app will remember these settings for subsequent uses.

Section 7 Updating the firmware

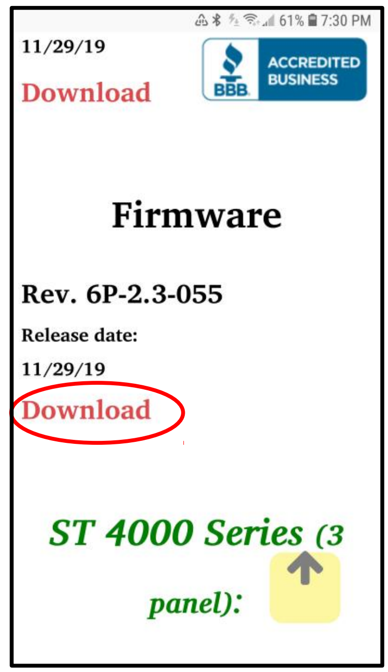
On your Android device, go to the Downloads page on the Quantum Harvest website at https://quantumharvest.net/downloads and under the Sun Tracking Systems header, scroll down to find your model and download the corresponding firmware file.



Go to the quantumharvest.net homepage and touch the 3 bars to bring up the menu….



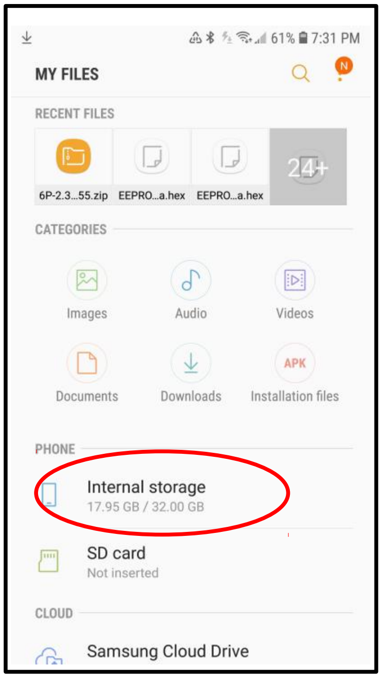
Touch the Dowloads link…



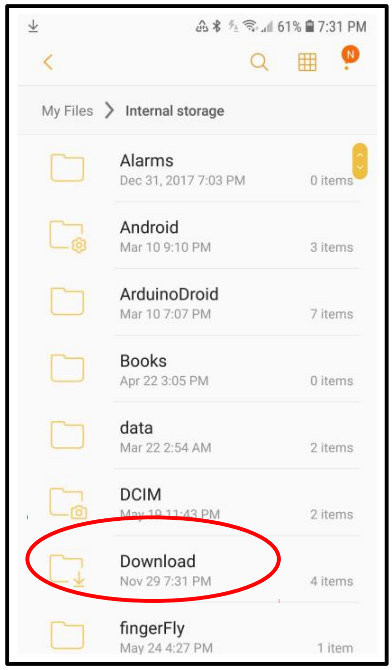
Scroll down the page to find your model, and touch the Download link….

This will download the firmware file and put it in the *Download* folder on your Android device. The files are in .zip format, and thus must be unzipped before use. To see how to do so, see the next page.

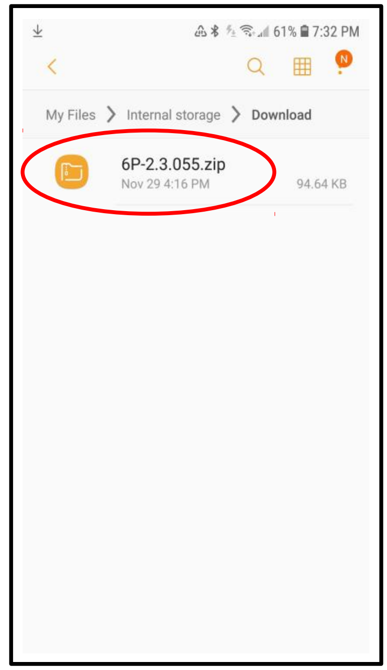
To Unzip the downloaded file……..



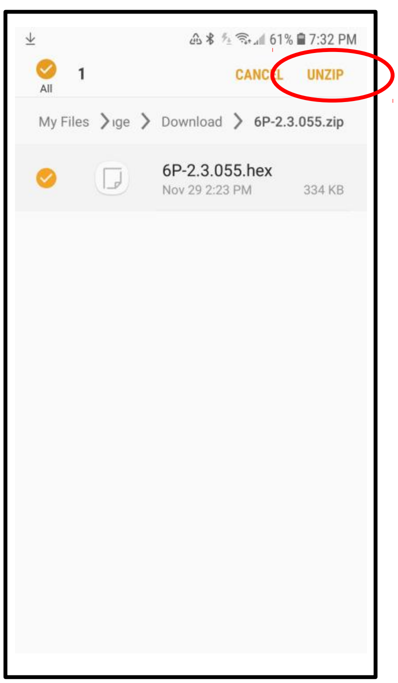
Open the My Files app and touch on Internal Storage…



Then touch on the Downloads folder…..



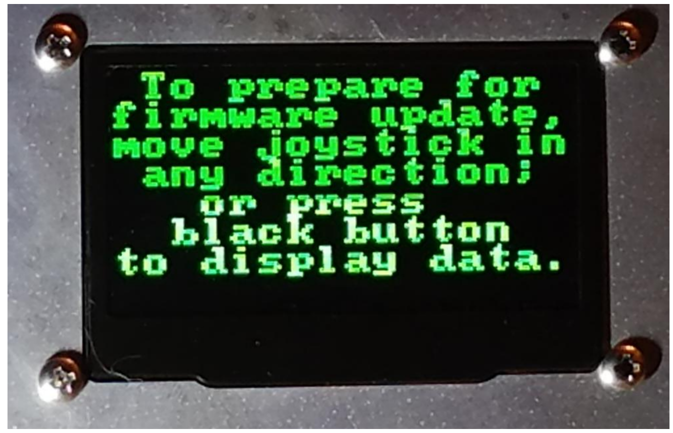
Then touch the file you just downloaded.



Then touch UNZIP….

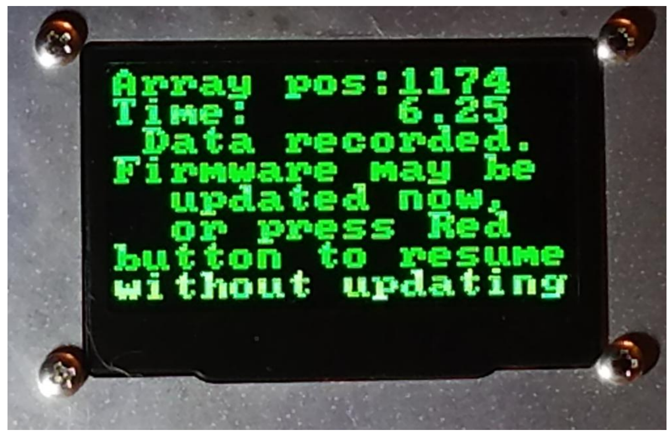
Now there is the original file in a folder of the same name.

The next step is to prepare the machine itself for the firmware update. To do so, press the black button to display the screen on the right.



Move the joystick in any direction to store the current array position and current run time. Doing this first will allow the machine to resume operation immediately after the update, and not have to go through the homing process again.

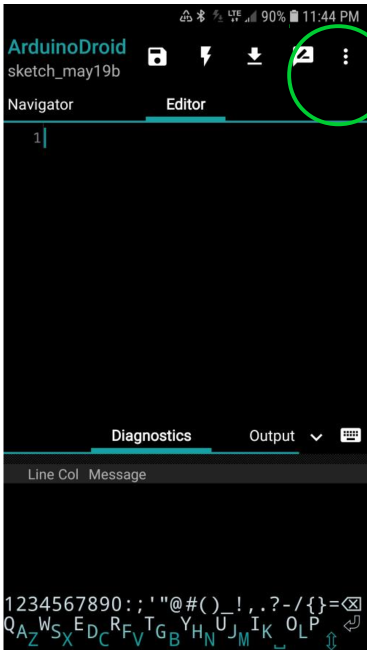
(Don't worry if you forget this part, it won't hurt anything. You'll just have to go through the whole startup sequence and set the run time again.)



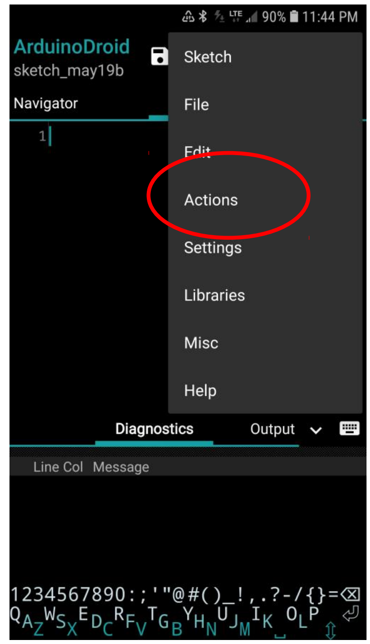
Now, connect the supplied OTG cable to your Android device, and connect the blue USB cable between the OTG cable and the programming port on the machine.

Programming port

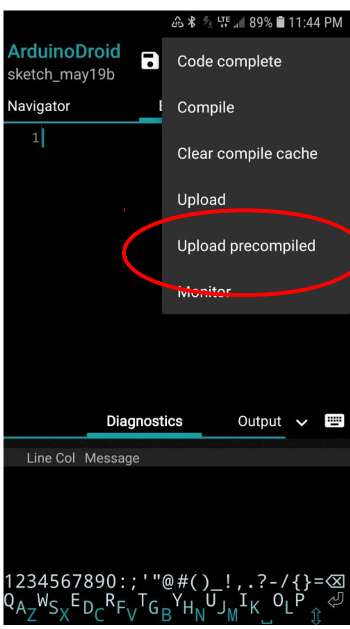
Open the ArduinoDroid app….



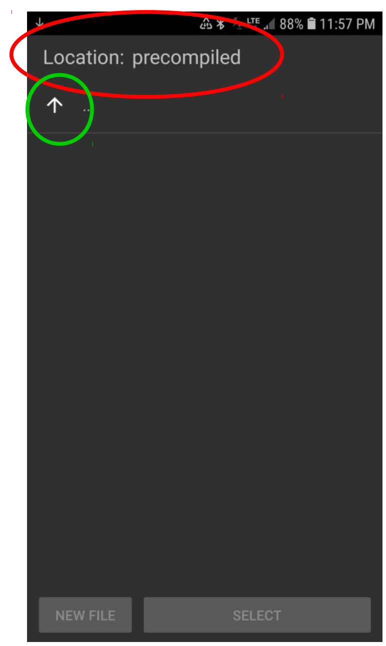
Now, touch the 3 dots….



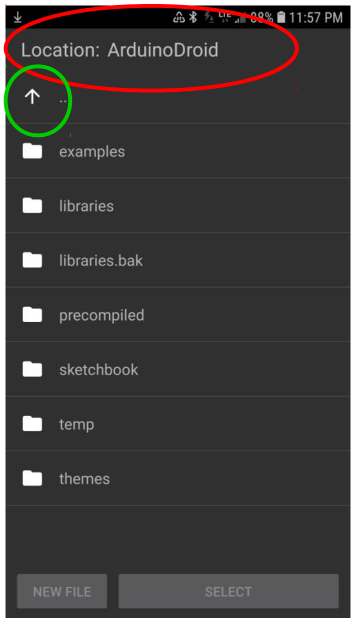
Touch Actions………



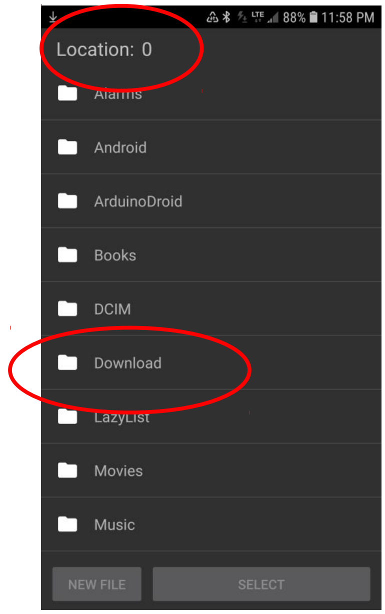
Then touch Upload Precompiled



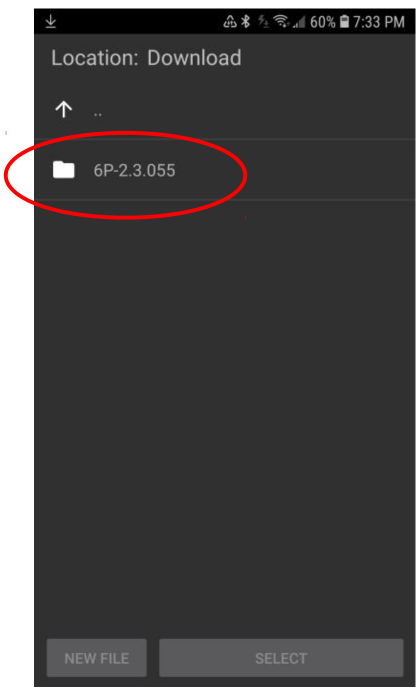
This brings us to the default precompiled folder. Touch the arrow in the upper left corner…..



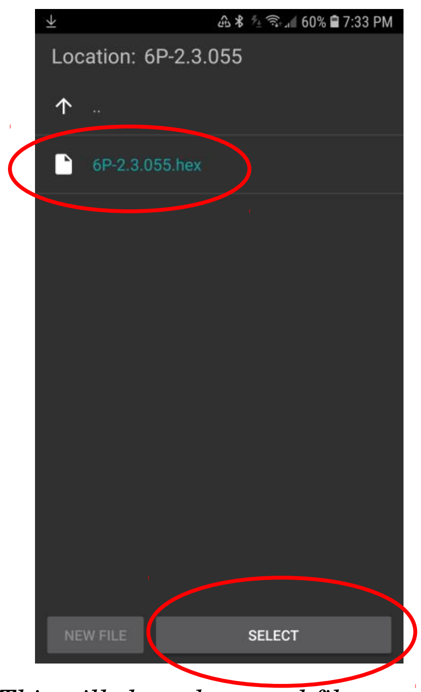
This brings us to the ArduinoDroid; folder; touch the arrow again…….



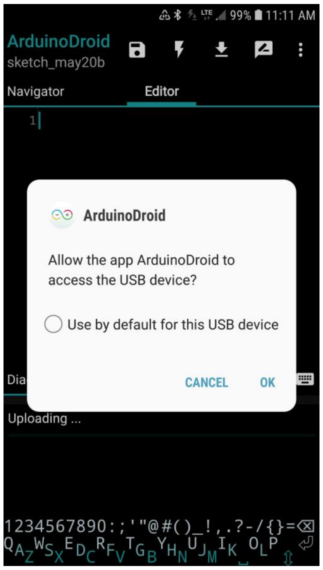
Which brings us to Location 0. You may have to scroll down to see the Downloads folder. When you see it, touch on it….



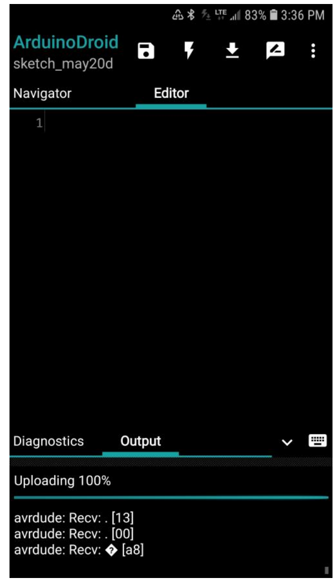
This is the folder from the email we just unzipped... earlier; touch on it…



This will show the actual file we want. Touch the file, then the SELECT button, turning the text blue.



...and this pop-up should appear, asking permission to use the USB device. Touch OK......



....and you will see some rapidly scrolling lines on the bottom as it uploads the program. It will tell you when it is finished, and you will see the display screen on the control panel start it's boot -up sequence. Disconnect the cables, and you're finished!

Procedure for replacing the ECU on all ST models

Because all ST models use the same ECU (Electronic Control Unit) , a new unit must be calibrated to the specific machine it is to be installed on. This addendum explains how to do that.

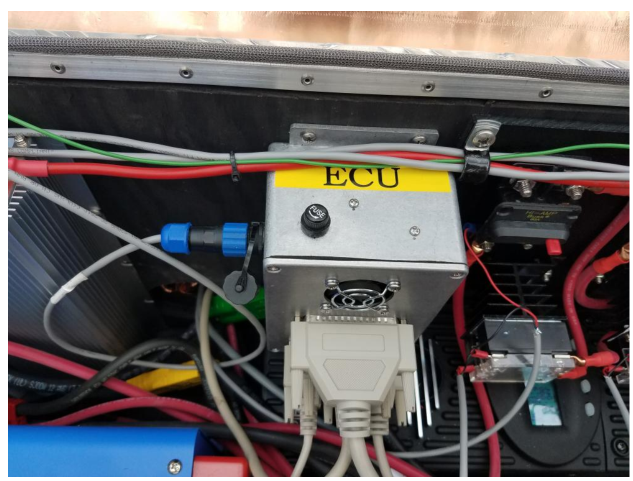
There are 4 steps that must be completed to ensure proper operation:

Physically install the ECU and connect all the cables.
Perform the initial encoder calibration.
Verify/perform the compass calibration.
Setting the run time value.

Step 1: Physically installing the ECU

Unplug all 5 cables from the old ECU, remove the 2 screws holding it to the backboard, and remove it. Attach the new ECU in it's place. Connect the small cable in the side of the ECU. This is a watertight connector supplying power to the ECU. The other 4 cables require dielectric grease applied to the cable ends to prevent ingress of water and the resultant corrosion. Apply grease from the supplied tube into the connector as shown. Plug the connectors into the ECU and secure the screws holding them in place.

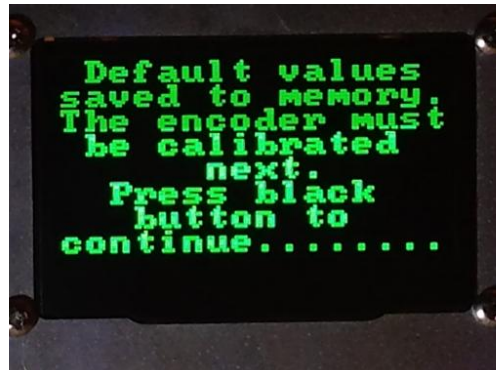
Apply a layer of dielectric grease across the top of the pins on all the male connectors. There is no need to try to pack the socket full, just a layer across the top will suffice!



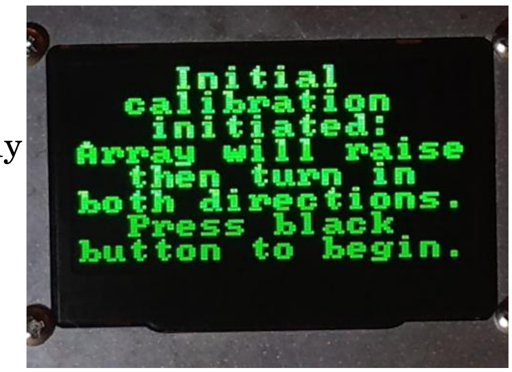
Step 2: Doing the initial encoder calibration

Turn on the main switch, and wait while it goes through the standard startup sequence, checking the LEDs, and the other sensors, motors, etc.

The first time the new ECU is powered on, the onboard memory is formatted, and default values are written and saved. This is all automatic, and requires no intervention by the operator. When this process is finished, it will show the screen to the right. Press the black button to continue….



Press the black button again to continue. It will then do the initial encoder calibration (this is only done once at the first startup of a new ECU).



Follow the prompts during the process, during which the array is turned from stop to stop, and these and other relevant values are determined, other values are calculated, and all that is written to memory.

When this is finished, the array will move to the approximate park position….

When the array stops, the operator will be prompted to use the joystick to rotate the array into the exact position, with the array as precisely aligned with the back edge of the trailer as possible. This step is critical, because all the the array headings and positional determinations are calculated from this position, so it is important to get it as straightly aligned as possible.

(See photos on next page).

When you are satisfied that the array is precisely aligned with the back edge of the body, press the black button to save the data. *(Right)*

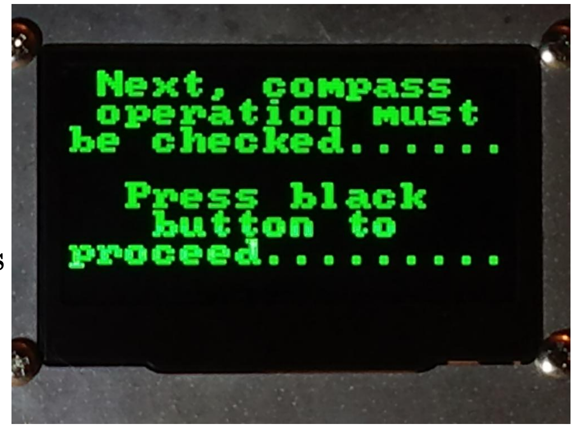
Once that is done, the array will rotate back to the counter-clockwise limit and the display will show the derived values that were written to memory.

Above; Array has been moved into the approximate park position; note that it is off slightly. Being careful to not move the joystick up, use it to rotate the array into a position (CW, in this instance) where the array is aligned like the photo on the right.

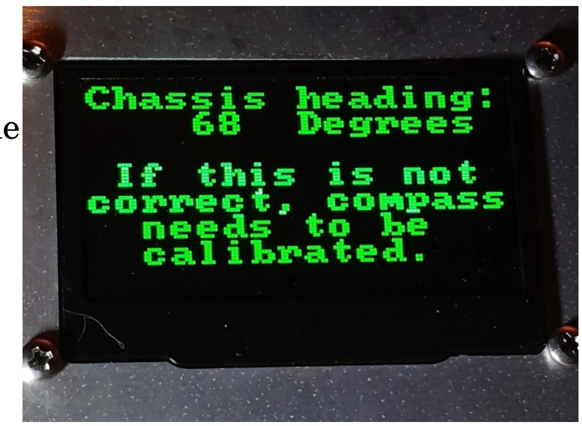
Above; Array has been rotated into alignment with the back edge of the body.

Step 3: Checking and calibrating the compass

Next, proper compass operation must be checked. Before going further, this would be a good time to use a good magnetic compass and see which direction (in degrees) the rear of the unit is facing. *(See the diagram on page 10)* Write it down for later. When this is done, press the black button to continue.

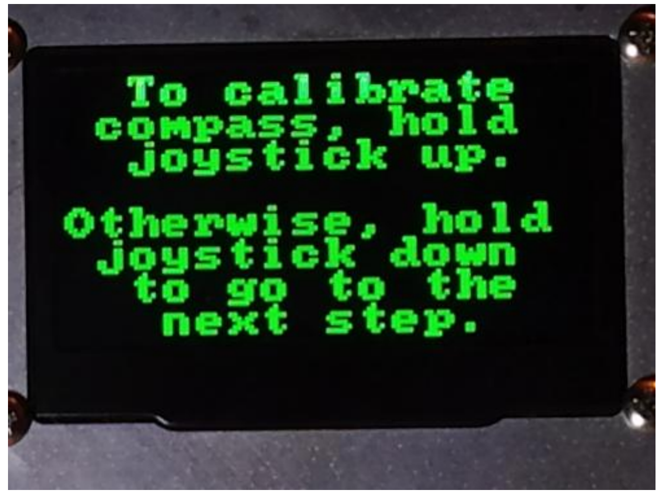


It will then display the direction in degrees that compass thinks the rear of the unit is facing. Let this value refresh 3 or 4 times, and check the displayed headings against the bearing you got with the handheld compass. If the displayed headings are way off, or change more than five degrees between readings, the compass must be calibrated.

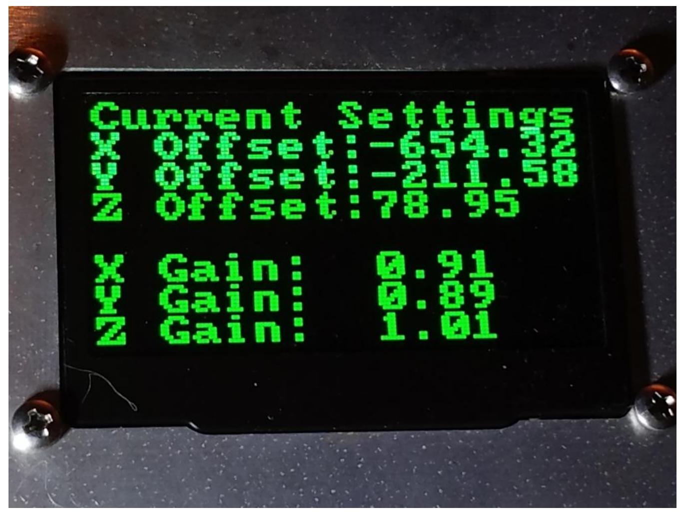


To do so, First, open the electronics cabinet to access the brass nut securing the compass module, which is shown at the right. Loosen the nut on the bottom of the compass module slightly; just enough to allow it to turn on the bolt, and close the lid on the electronics cabinet. It is important for the compass module to lie flat in relation to the trailer for proper calibration.

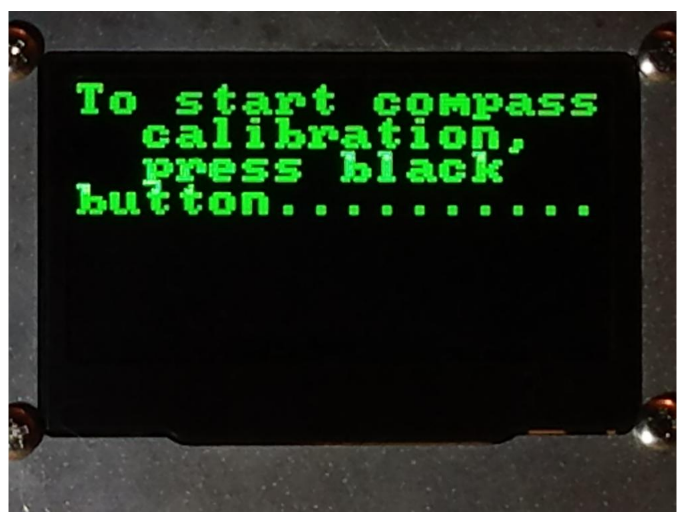
Now, hold the joystick up to start the calibration sequence.



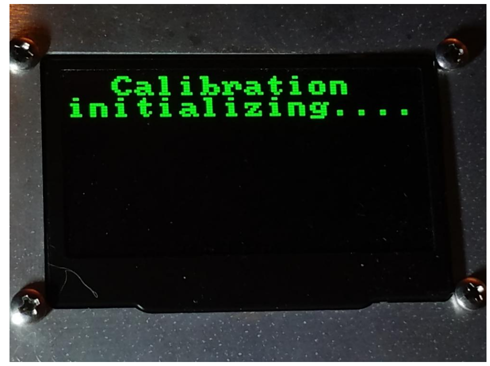
The next screen shows the current values….



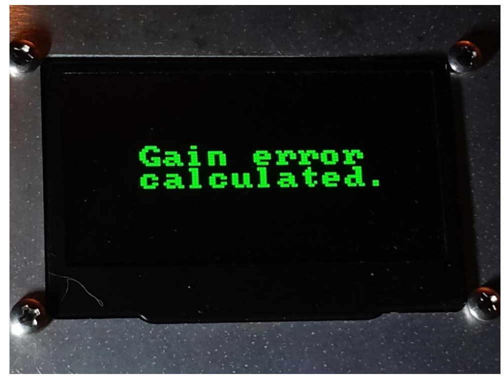
Press the black button to continue.



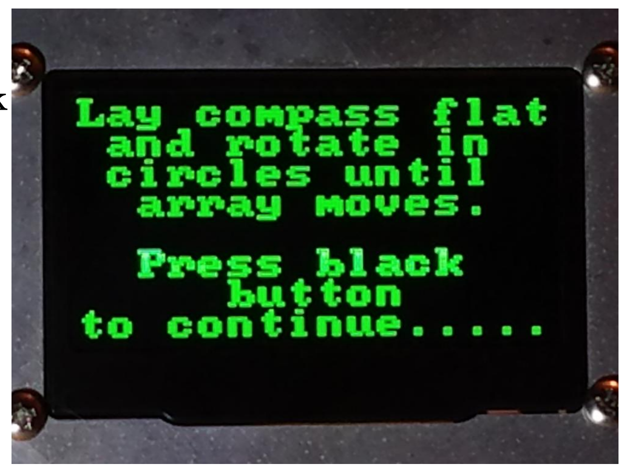
The computer then initializes the compass chip...



and does the gain error calculations….

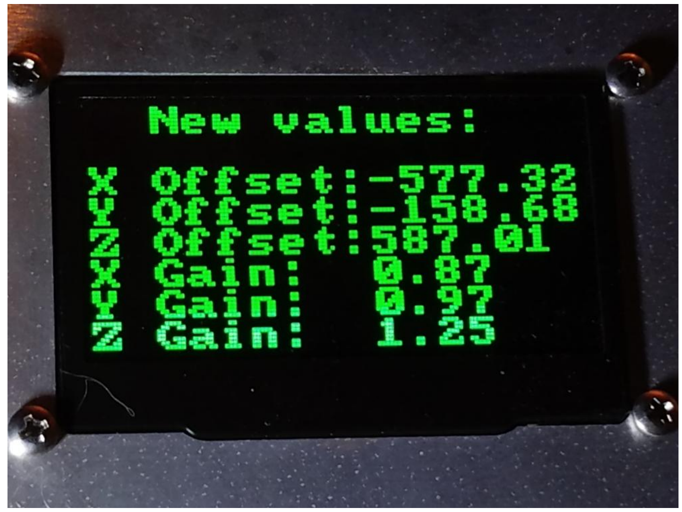


Then the screen will prompt you to begin rotating the compass module in circles back and forth one or two revolutions each way as the wire allows, until the sequence is finished. (About 45 seconds) **Keep the module laying as flat on the cover as you can while it is being rotated.** Press the black button to start whenever you are ready….

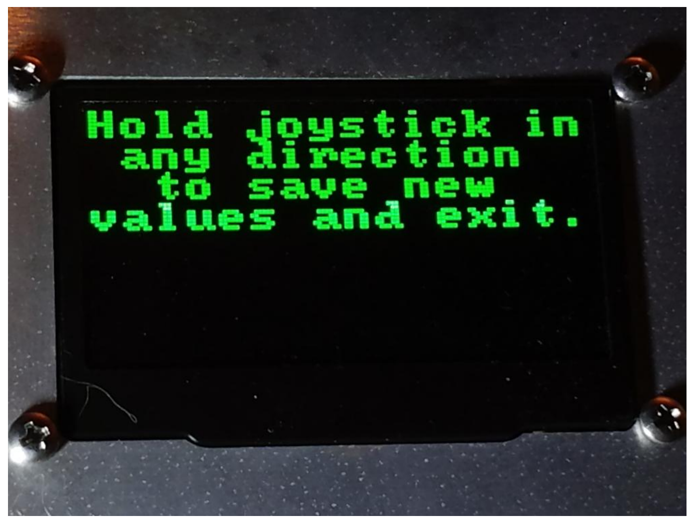


Since you cannot see the display while you are doing this, there is a cue to indicate when it is finished: The array will tilt down for a few seconds and then return to the upright position. When the array stops moving, orient the module so the arrows point straight rearward, and retighten the brass nut securing the compass module to the lid. It should be secure enough to prevent the module from turning on it's own. Close the lid at this time.

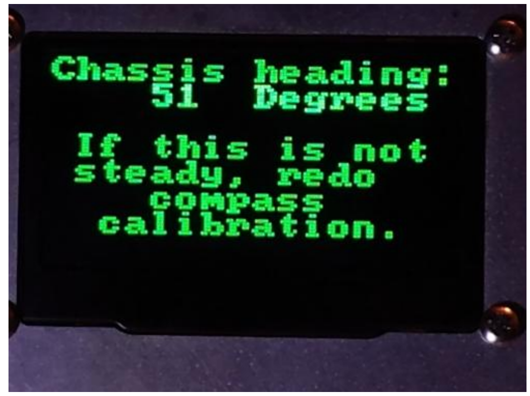
The display will now show the new values….



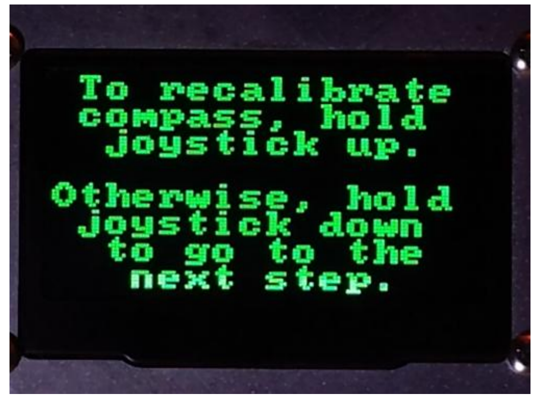
Hold the joystick in any direction until the display indicates the new settings have been saved. *(Below right)*



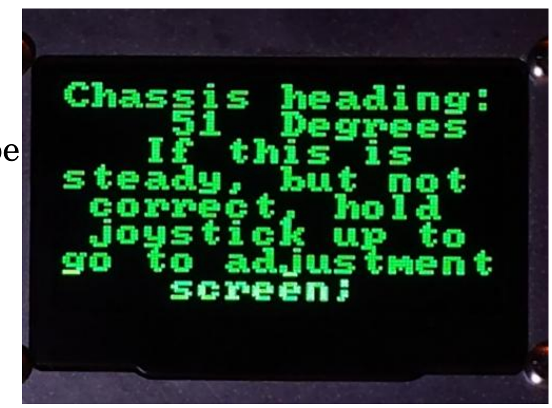
You will be returned to the heading display screen, refreshed every few seconds. It should now be consistent within a few degrees* If so, hold the joystick down to skip to the next screen. If not, hold the joystick up to repeat the calibration process.



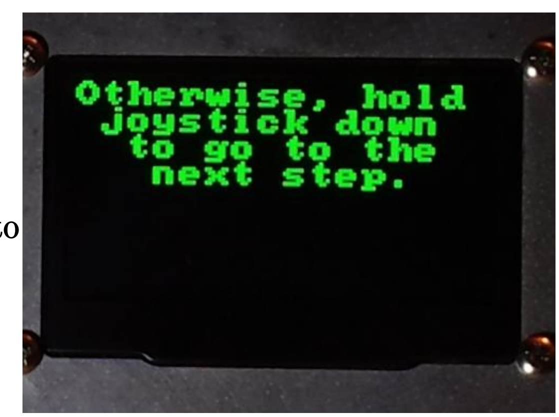
**The important thing now is that the reading is steady, plus or minus a few degrees over a dozen or so readings. It will almost certainly not be exactly correct, as we have not made allowances for the local magnetic declination at this point. It should be steady, and within 20 or so degrees of the true heading.*



If the heading is steady, but off more than a few degrees, the compass correction value needs to be adjusted. Hold the joystick up to go to the adjustment screen.
(Go to Step 4 on the next page)



If the heading is consistent, and within a few degrees of being correct; hold the joystick down to skip to the last step. *(Go to step 5 on page 45)*

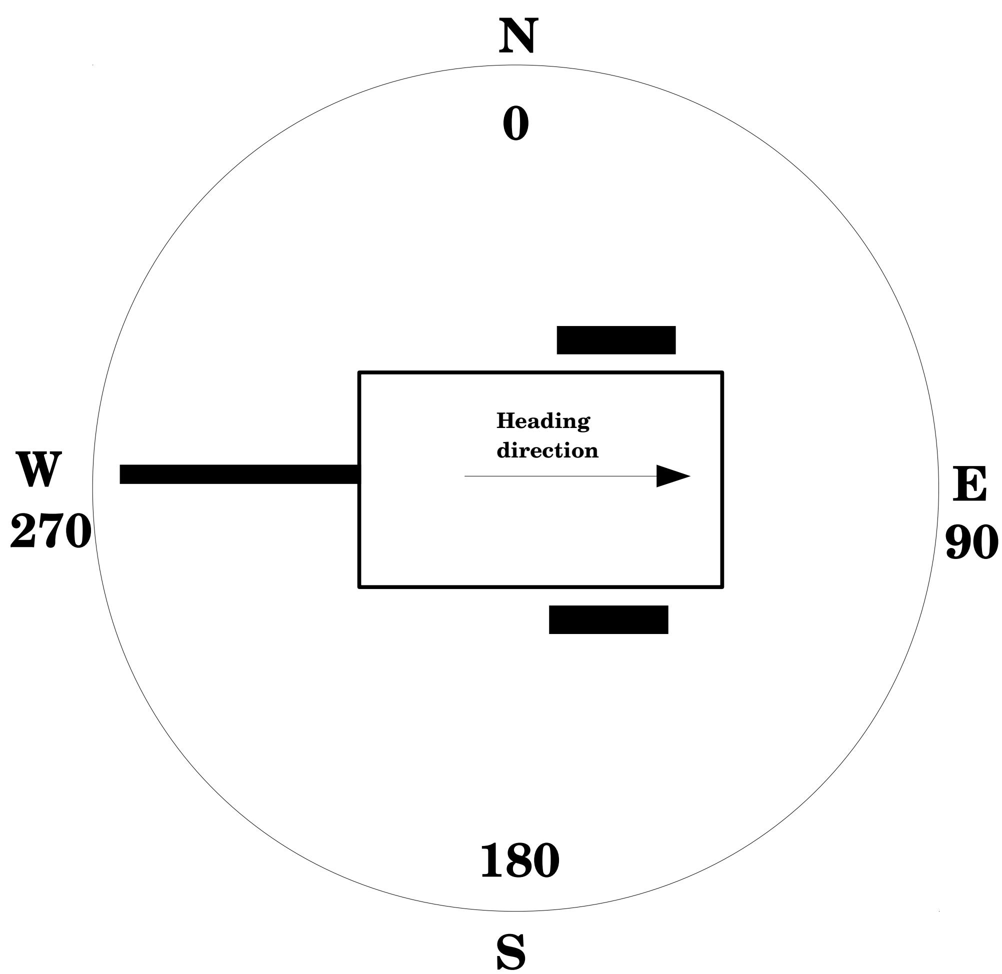


Step 4: Adjusting the Compass Correction Setting.

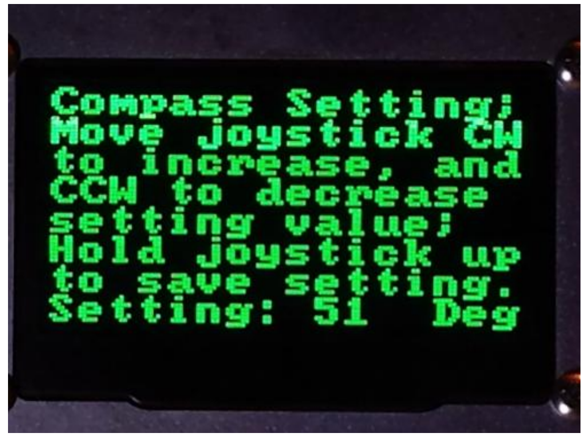
For a variety of reasons, the compass may be steady, but still off by quite a bit; not least of which is the natural divergence of magnetic North from true North, which varies by location, and may be as much as 30 degrees!

As long as the compass returns consistent readings (within a few degrees) it can be adjusted. To do this, first determine how far off it is by subtracting the displayed reading from the reading obtained by a magnetic compass or other means; for example, if the display reads 50 degrees, and the actual bearing is 40 degrees, the correction is -10 degrees. If the display reads 90 degrees, and the actual bearing is 110 degrees, the correction is 20 degrees.

The sketch below shows the orientation direction (the direction the rear of the trailer points.) In the case below, the correct bearing is 90 degrees.



This is the compass correction adjustment screen;



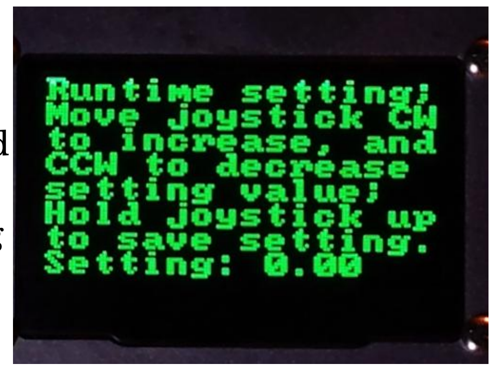
To adjust the compass correction setting, moving the joystick left, or to the CCW position decreases the setting, and moving it right, or toward the CW position increases the setting. When the setting reaches the desired value, hold the joystick up until the screen indicates the setting is saved. *(Below Right)*

Note: If you inadvertently save the wrong value, don't worry. Go to the next setting and finish this operation. This value can be changed later, after the machine is running. See page 5.

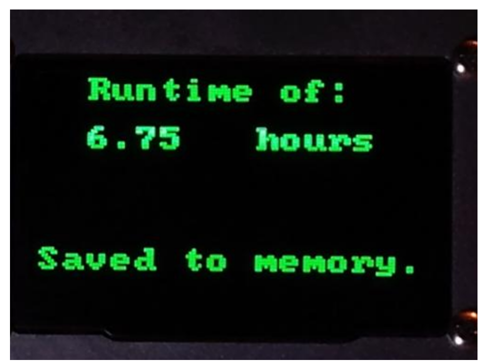
Now, we go to the last step...

Step 5: Setting the Run Time

The last step is setting the run time. This is the time that has elapsed since sunrise. It doesn't need to be exact, plus or minus an hour or so is close enough. It will be corrected the next day when the detectors sense the sunrise. This value is used to calculate the Sun's rough position in the sky, and the machine uses this to ensure it doesn't get confused in cloudy conditions.



To adjust the run time setting, moving the joystick left, or to the CCW position decreases the setting, and moving it right, or toward the CW position increases the setting in half-hour increments. When the setting reaches the desired value, hold the joystick up until the screen indicates the setting is saved.
(Below Right)



Note: If you inadvertently save the wrong value, don't worry. This value can be changed later, after the machine is running. See page 6.

This is the screen we were looking for! Press the ***RED*** button this time to finish. The machine will restart and continue it's startup routine.