

Portable Solar Tracking Panel

Team name: Solar Learning

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Sponsored by Dr. Hannemann

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Introduction

The Solar Learning portable solar panel project was created for the STEM outreach program at UK. The project is an example for k-12 students of what they could be able to create, and to get them interested in the possibility of joining the STEM field in the future.

We constructed it from several premade parts that will be discussed in more detail in the part specs section of this manual. The box was crafted by hand with parts from hardware stores and simple tools such as a drill and a dremel. The total cost of the project was \$494.71 with tax included for everything. The box cost was \$125 this cost could have been lowered slightly but we wanted the box to be as water resistant as possible.

The parts were tested to make sure that they all worked as expected, all of the parts passed testing and were able to be implemented together with very few problems.

Part Specifications

Solar Panel Specifications:

- 10 Watts rated power output
- .51 Amps rated current output
- Dimensions: 13.8 x 8.6 x 1.3 inches

Inverter Specifications:

- Two 110v Ac outlets
- 4 USB ports with a max output of 6.2A
- Silent cooling fan and led indicator
- Intelligent LCD Display screen
- On/Off switch for AC outlets
- Weight of 12.7 ounces
- Dimensions: 7.4 x 5.2 x 1.5 inches

Charge Controller Specification:

- Optimized for a 12V/24V system.
- Rated Charge current: 10A
- Self-Consumption: <10mA
- Max. PV Input Voltage: 130W / 12V; 260W / 24V
- Working Temperature: -31°F ~ 113°F
- Dimensions: 4.68 x 2.95 x 1.08 inches
- Weight: 0.27lbs
- Grounding Type: Negative
- Backlit LCD screen displays system operation, diverse load control, and error codes.
- Integrated 5V 2A USB ports to charge USB devices.
- RS232 Communication Port for BT-1 Bluetooth module and usage of Renogy DC Home App.

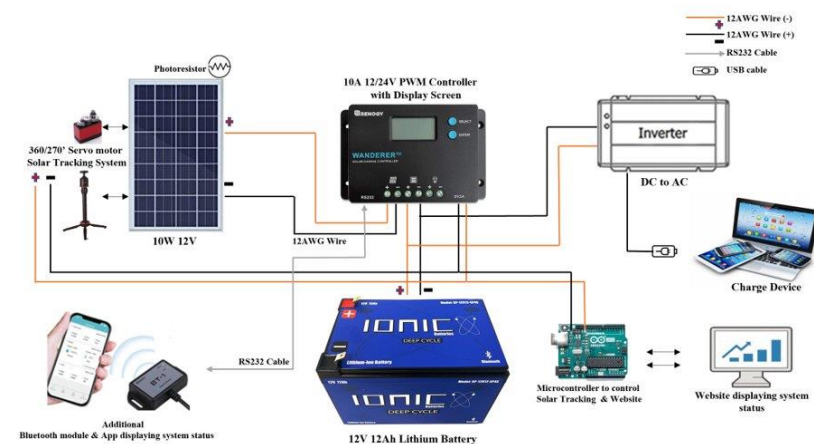
Battery Specification:

- Optimized for a 12V system.
- LiFePO4 type battery
- Run up to 4 in series (max 48V), no limit in parallel.
- Dimensions: 3.96 x 5.91 x 3.99 inches
- Weight: 3.5 lbs
- Capacity: 12Ah (12000mAh)
- Cell balancing and low voltage/over voltage protection, short-circuit protection.
- Built-in Bluetooth module which can be used through “Ionic Blue Batteries” app

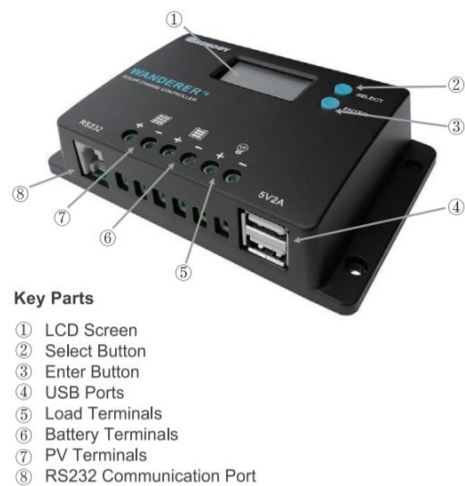
Basic Operation Instructions

Setup

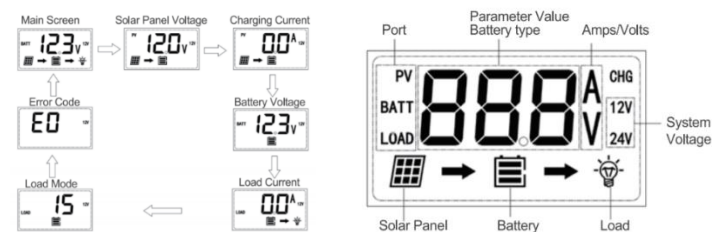
The diagram below is the connection diagram of the whole system:



- The solar panel should be connected to two left terminals on the charge controller.
- The battery should be connected to two middle terminals on the charge controller. The battery also has its own application called “Ionic Blue Batteries”. You only need the Bluetooth to use this application.
- The inverter should be connected to the battery using a cigarette port adaptor.
- The Bluetooth Module should be connected to the RS323 port on the charge controller, and it allows user to use “Renogy BT” application to monitor the solar power system.
- The microcontroller for the solar tracking system and the website should be connected to the USB port on the charge controller. Make sure the Load is turned on and it can be done by pressing the Enter button on the charge controller.



The charge controller has few different display options shown below:



- The charge controller also has different modes for the load terminal. To enter the load programming settings, hover over the Load Mode screen using the Select button. When you reach the Load Mode screen, hold the Enter button then the number will start to flash. Cycle through the Load types using the Select button and press Enter button to finalize selection.



Setting	Mode	Description
0	Automatic (On/Off)	The load will turn on at night when the solar panel is no longer producing any power after a short time delay. The load will turn off when the panel starts producing power.
1-14	Time control	When the panel is no longer producing power, the load will be ON for 1-14 hours or until the panel starts producing power.
15	Manual	In this mode, the user can turn the Load On/Off by pressing the Enter button at any time.
16	Test	Used to troubleshoot load terminal (No Time Delay). When voltage is detected load will be off and when no voltage is detected load will be on.
17	24Hr	The load will be on for 24 hours a day.

- The system is set to 15 at the default which is the Manual Mode. So, the Load can be turned on/off using the Enter button. When the Arduino is not working, make sure the Load is turned on.
- The inverter has an on/off switch that can be used to turn on/off the three prong ports. It is a nice feature to have but the need to turn off the three prong ports was never thought of as needed. On the side of the box with the three-prong port is the display screen showing how much the inverter is outputting to the devices being charged.
- Once everything is connected, the system should operate. If the system is not operating, check and make sure all connections going into and from the controller are tight.

Part Troubleshooting

- If the inverter is not working, there are a few things that should be checked. The first thing to check is to make sure the inverter is plugged all the way into the adaptor as if it is not all the way in then it will not function. The second thing to look at would be the fuse for the adaptor. The adaptor has a built-in fuse that will pop if the load is too much. To check this there is a screw connection on the red wire of the adaptor. Twist the connection until it comes undone and check the fuse. If the fuse is blown the metal inside will not be connected and the glass could potentially be grey. If the metal line is still connected and the glass is still clean, then the fuse is not blown, and it could be one last problem. The last troubleshooting technique is the fuse inside the inverter itself. This one is a bit trickier to check due to the inverter having to be taken out of the box, some screws having to be taken off the inverter to get inside of it. The same general ideas apply to this fuse as the adaptor fuse. These are the

recommended troubleshooting method if the inverter is not working.

- If the battery does not work, the entire system will not be able to power, and the device will not work. In this case, the battery is first checked for discharge using the “Ionic Blue Battery” application, which allows you to monitor the battery status. If the battery is completely discharged, the application will not be able to check the battery’s condition. Therefore, if the battery cannot be connected via the application, it is recommended to charge a certain amount (15-30 min) through the charger provided with the device. When using a charger, connect it to the battery and change it to Lithium type using the button in the center of the charger. Otherwise, check and reconnect the wires connected to the battery. Next, check the display on the charge controller to see if the controller and battery are connected properly. If the battery fails to operate after attempting all of the above methods, the battery is suspected to be defective. At this point, the battery will have to be replaced.

Warning: Connect battery terminals to the charge controller BEFORE connecting the solar panel(s) to the charge controller. NEVER connect solar panels to charge controller until the battery is connected.

Code Troubleshooting

The device is not sending data to the ThingSpeak site

- This is most likely caused by the device not being able to connect to the internet. The code that is running on the Arduino, which can be found on GitHub at "link", includes a secrets.h file which contains the name and password of the network the Arduino will attempt to connect to.

- If the device is being brought somewhere different than its last location, you will need to change these values in the secrets.h file to match the network you want to join and then re-upload the solarLearningDevice.c file to the Arduino. The two files need to be in the same folder on your computer when you upload the solarLearningDevice.c code from the Arduino IDE (the Arduino App).
- To upload the file from your computer you will need to unplug the Arduino from the USB port on the charge controller and plug it into your computer instead. The Arduino IDE should automatically detect what COM port the Arduino is on, but should you run into issues uploading the code, check your device manager to double check that the correct COM port is listed at the bottom right of the Arduino IDE. Also in the bottom right of the IDE, it should list the Arduino model as "Arduino Uno WiFi Rev2."
- This issue could also be caused by an interruption in the internet connection, which disconnects the Arduino. If this is the case, simply press the reset button on the Arduino located on the same end as the USB cord. This will rerun the connection code and should get the Arduino back on the WiFi network.

The device will not face the sun

- This could be caused by a number of things. Start by checking that all four photoresistors are attached to the sides of the panel securely and perpendicularly so that they are all facing the same way the solar panel is.

- If the photoresistors are not the issue, make sure the stand is still tight at the ball joint in the base and the collar beneath the servos. If either of these locations are loose, the torque from the servos may twist the stand and make it appear that the solar panel is not moving at all.
- If neither of those were the issue check that the wires for the servos and the photoresistors are not wrapped around the stand more than once or twice. If they are wrapped too tightly, you will need to manually unwrap them so that the device is free to spin again without these wires becoming tangled.
- If none of these workarounds seem to get the solar panel moving, it simply may be too much of an overcast day for the tracking system to find a better angle for the solar panel.

Safety

- Do NOT touch wires while system is active to avoid electric shock.
- Only open housing unit to hook up battery leads and power inverter for use.
- Locks can be attached to the clasps, so that once the box is ready for use the user can keep hands out of the system.

App Access

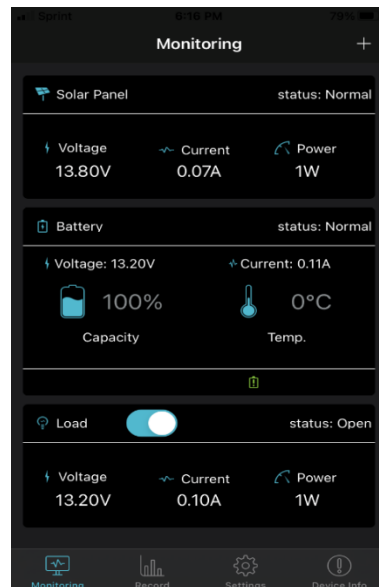
ThinkSpeak ID: 1310828

Link: <https://thingspeak.com/channels/1310828>

- You can access our website by searching for the channel ID above on the ThingSpeak site, or by following the link. The site contains some device data and metrics, our video demonstration, and a link to the GitHub with this document and the code for the Arduino.

Bluetooth app: Renogy BT

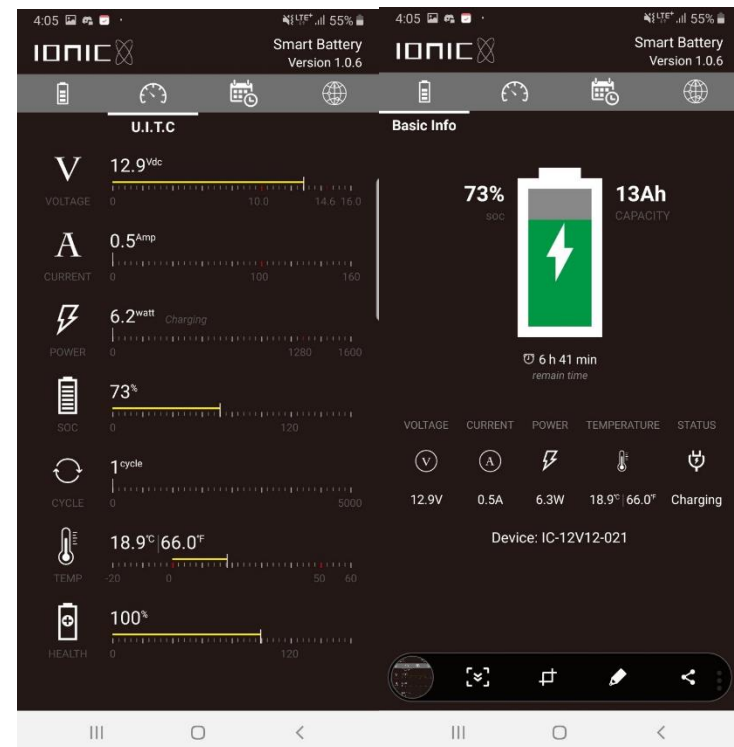
- The charge controller allows you to use Renogy BT application using Bluetooth.
- Requires Bluetooth Module connected to the charge controller through RS232 port.
- Monitors voltage, current, and power of the solar panel, the battery, and the load



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Bluetooth app: Ionic Blue Battery

- The Battery allows you to use Ionic Blue Battery application using the built-in Bluetooth inside the battery.
- The Battery must be charged at least 10% for Bluetooth module operation.
- Monitoring the battery's voltage, current, charge rate, temperature, charging status, and power.



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