Solar Yard Lights
Version 1.0

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Parts For This Project

Quantity	Part	Vendor	Part Number	Source
1	Perfboard	Radio Shack	276-150	www.radioshack.com
1	CdS Photoresistors	Radio Shack	276-1657	www.radioshack.com
2	N-channel MOSFET Transistor	Radio Shack	276-2072	www.radioshack.com
1	PC Board Terminals	Radio Shack	276-1388	www.radioshack.com
2	10K Trimpot	Radio Shack	271-282	www.radioshack.com
1	Assorted 1/4W Resistors	Radio Shack	271-312	www.radioshack.com
1	Inline Fuse Holder	Radio Shack	270-1234	www.radioshack.com
1	12Ah Battery	Radio Shack	230-1219	www.radioshack.com
1	5W Solar Panel	Radio Shack	55038529	www.radioshack.com
1	MAX8211 Voltage Monitor IC	Digikey	MAX8211CPA+-ND	www.digikey.com
1	Pin Headers	Sparkfun Electronics	PRT-00116	www.sparkfun.com
1	12” 2 Wire Jumper	Sparkfun Electronics	PRT-10372	www.sparkfun.com
1	Washdown Toggle Switch	McMaster	7172K21	www.mcmaster.com
1	Porthole	McMaster	1116K21	www.mcmaster.com
4	Wire Glands	McMaster	69915K51	www.mcmaster.com
1	Vent	McMaster	7066K1	www.mcmaster.com
1	2 Circuit Junction Block	McMaster	7527K62	www.mcmaster.com
1	6 Circuit Junction Block	McMaster	7527K66	www.mcmaster.com
1	Junction Box	Home Depot	500015	www.homedepot.com
-	Assorted 6-32 Hardware	McMaster	-	www.mcmaster.com
-	Assorted Wire	Radio Shack	-	www.radioshack.com
-	Assorted Crimp Terminals	Radio Shack	-	www.radioshack.com
-	12V LED Lights	Primo Lights	Various	www.primolights.com

Assembly Instructions

Introduction:

Reducing dependence on non-renewable resources is a hot topic, and for good reason, but it's often much easier said than done. My approach has been to divide and conquer. This spring I took on the exterior lighting at my house. If my garden can be off the grid, there's no reason the lighting around it can't be as well.

This is actually a very simple project. It consists of a solar panel, a battery, assorted 12V lighting, and a circuit to turn the lights on at dusk and off at dawn.

All of the supporting files for this project can be downloaded from:
https://github.com/vinmarshall/Radio-Shack-Solar-Lights

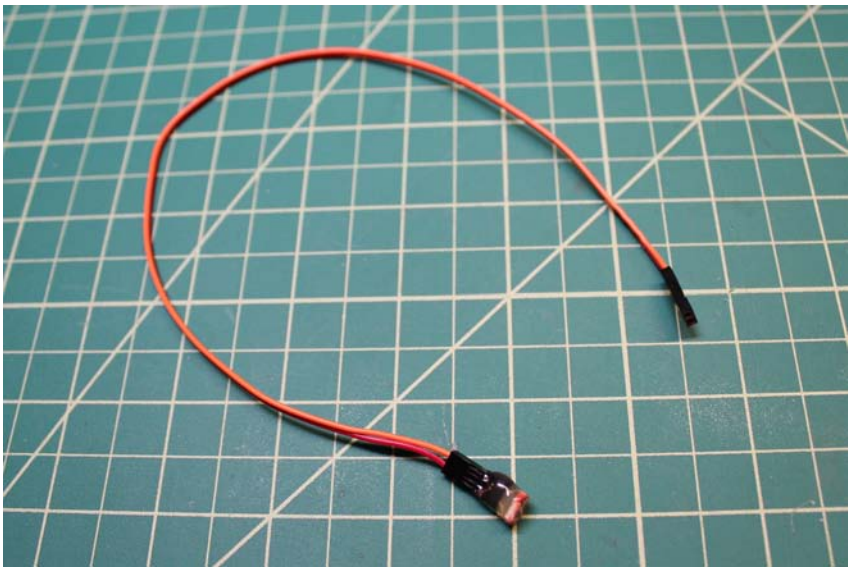
Step 1: Mount The Solar Panel

The solar panel should be mounted in a place where it will see full sunlight for as much of the day as possible. If you're in the northern hemisphere, the panel should face generally south. The opposite applies in the southern hemisphere.

To keep this project simple, I used a fixed tilt angle – chosen as much by what would be easy to make as by solar panel efficiency. If you want to get serious about optimal tilt angles for the different seasons, a web search will turn up all the information you need.

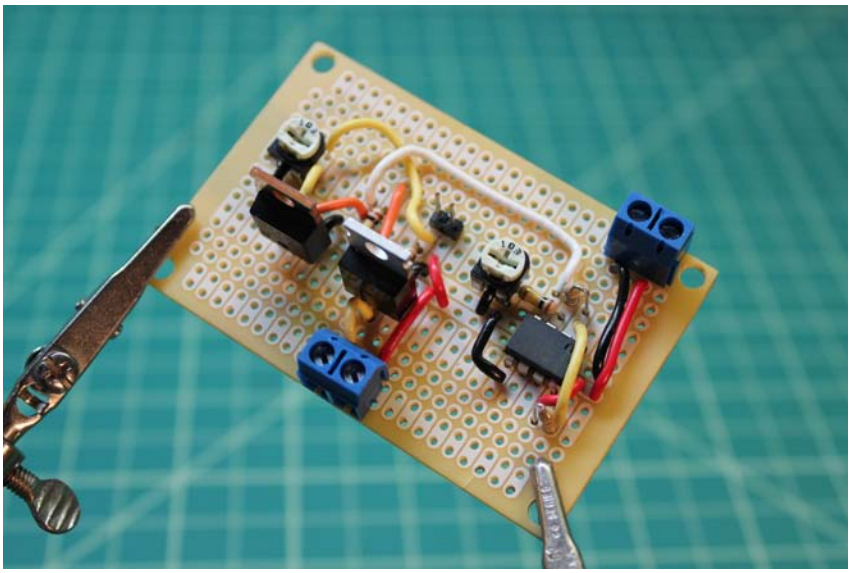
I made a very simple mount from 1” x 10” (nominal) lumber using high school wood shop bird house style construction. If you are planning to mount larger or multiple panels for a larger yard solar system consider the aluminum extrusions made by 80/20. Whatever you build should be strong enough to survive the weather all year round – remember that a solar panel can be like a sail when the wind gets going.

Step 2: Prepare the Photoresistor



Leads need to be attached to the photoresistor for mounting in the front panel. The easiest way I've found is to trim the leads of a photoresistor and insert them into one end of a 2 wire jumper. Pot the end of the jumper and the base of the photoresistor in hot glue to hold everything securely together.

Step 3: Build the On/Off Circuit



The circuit can be built on a Radio Shack perfboard part number 276-150. Referring to the drawing above and the schematic included in the download from github, assemble the circuit in this step.

Test and Calibrate the circuit as follows:

1. Connect the photoresistor prepared in the previous step to the 2 pin header.
2. Connect a string of 12V LED lights to the terminals on the right side of the board (near the MOSFETS). Pay attention to polarity.
3. Connect an adjustable power supply to the battery connection. Pay attention to polarity. Set the power supply to 13.5V
4. With a multimeter, look at the voltage on pin 4 of the MAX8211 IC.
    1. Adjust the trimpot closest to that IC until pin 4 goes to GND when the power supply voltage drops to 12V.
    2. With that adjustment made, pin 4 should return to floating when the power supply voltage is raised to approximately 12.5V.
    3. If this adjustment cannot be made, double check your wiring.
5. Verify that lights come on when you completely cover the photoresistor (you'll probably need to put your hand around it, not just on top of it). If the lights do not come on, double check your wiring.
6. Either now or after you've installed the system, adjust the second trimpot to set the level of light at which the lights turn on.

Step 4: Prepare the Control Box

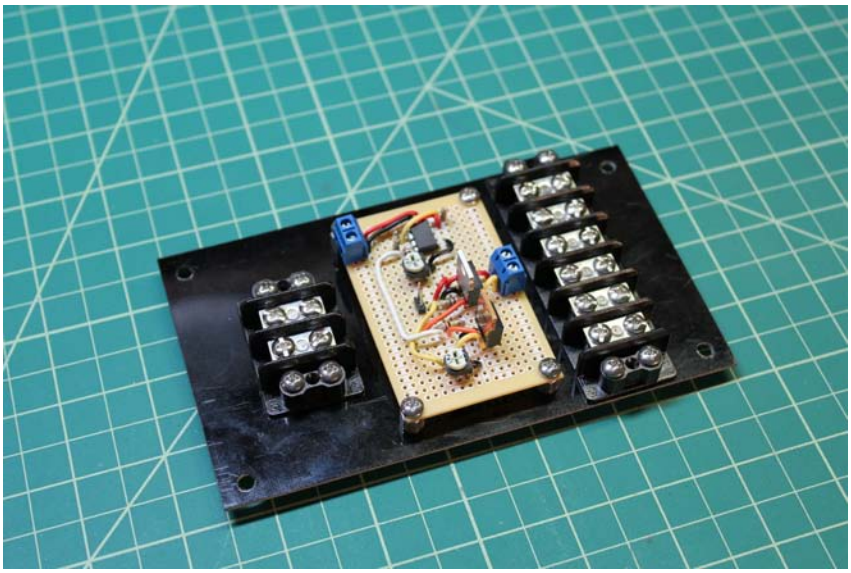
The control box provides protection from the weather for the main components of the project. The parts used aren't cheap, but they are all rated for washdown type environments. The box itself is a junction box suitable for burial. The exact placement of the parts on the box isn't crucial, but stick with the same general areas I've used to keep the wire routing simple.

The porthole for the photo resistor and the main on/off switch are mounted in the front panel. Drill a 3/4” hole for the porthole and a 1/2” hole for the toggle switch.

Wire “glands” keep the junction box water tight where the wires pass through the walls. The glands must be sized to match the diameter of the wires that will be passing through – the glands in the parts list fit wires with a range of diameters from 0.16” - 0.31”. You'll need one gland for the incoming wire from the solar panel (on the left side) plus one for each of the separate lighting circuits you plan to run (on the right side). Drill 9/16” holes and tap for 3/8” NPT. Tap the holes deeply enough that the glands can thread all the way in and press the o-ring against the outside of the box. The lock nuts thread onto the glands from inside the box.

The vent on the top of the box allows any gasses generated by the charging of the battery to vent while still keeping rain out. Use a hole saw to drill a 1 5/8” hole in the top of the box. Tighten the nut on the vent with a big adjustable wrench or some big hands.

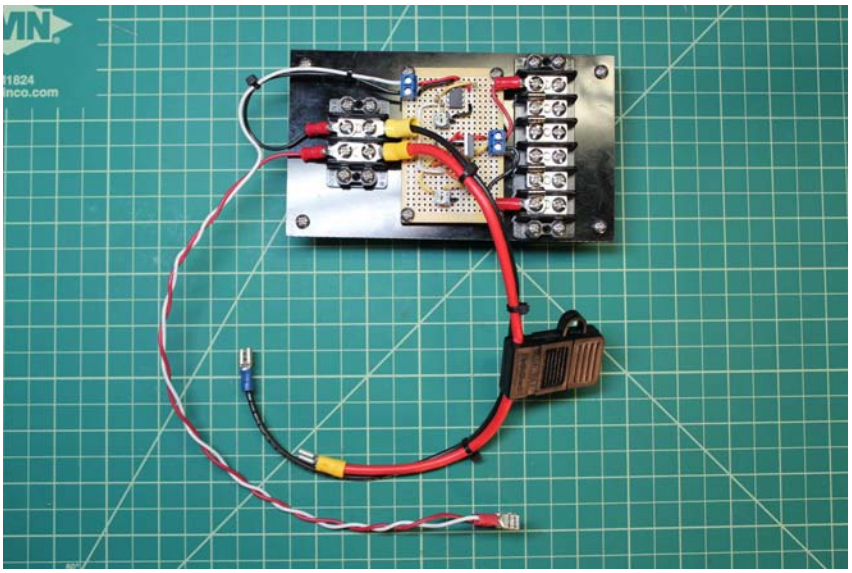
Step 5: Prepare the Circuit Panel



The wiring junction blocks and the circuit board mount on a sheet of G-10 fiberglass inside the box. Everything should be pre-assembled onto this panel before mounting it in the control box.

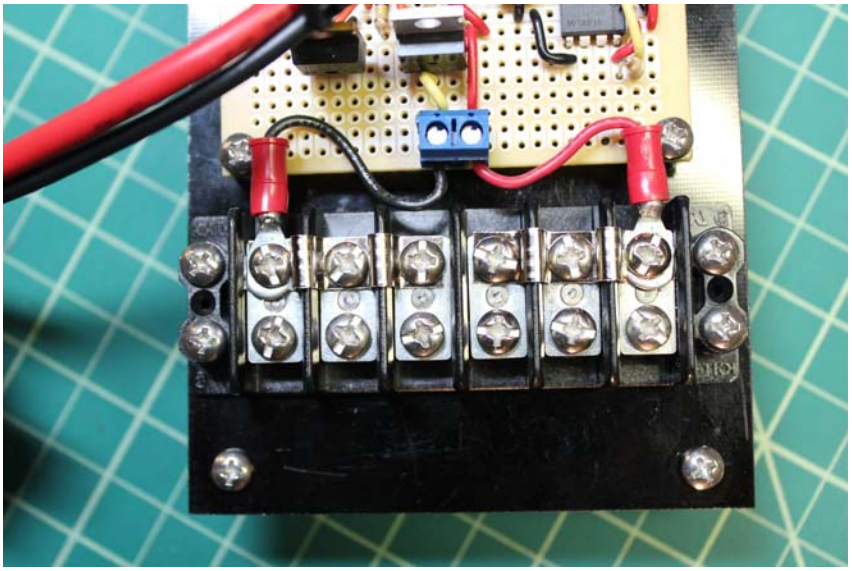
Mount the wiring junction blocks and the circuit board as pictured. Use #6-32 mounting hardware with #6-32 x 3/8” standoffs for the circuit board.

Step 6: Wire the Circuit Panel



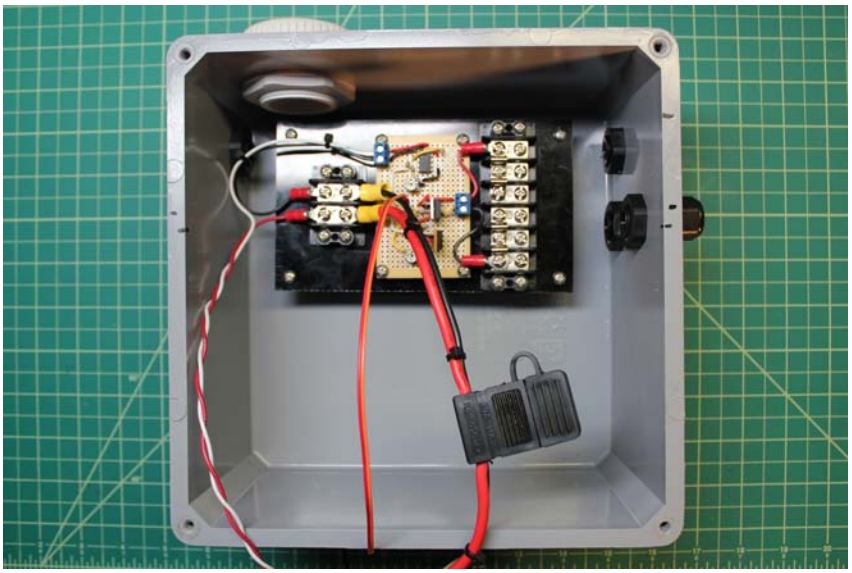
The battery, solar panel, and the switched power to the circuit board all connect to the two terminal block on the left side of the panel. The lighting circuits connect to the six terminal block on the right side of the panel. In this step, all wiring connections except for the solar panel and the lighting circuits are made.

Wire the panel as in the picture above. The large fused lead goes to the battery and the red and white leads go to the “enable” switch on the front panel. The terminals on the right side of the circuit board (switch lighting power) connect to the six terminal block on the right for distribution to the lighting circuits. See the picture below for more detail:



In this step, also drill 4 holes in the corners of the panel and assemble the panel onto 6-32 x 1” aluminum standoffs. These will be used to mount the panel into the junction box in the next step.

Step 7: Mount Everything Inside the Box



Everything in this project other than the lights and the solar panel ends up inside the control box for protection from the elements.

Drill 4 holes in the back of junction box to match the 4 mounting holes drilled in the corners of the circuit panel. Using the aluminum standoffs attached to the circuit panel in the previous step, install the circuit panel into the junction box. Use RTV sealant on the holes through the back of the junction box.

The battery just sits in the bottom of the box, so we'll wait to install that until the control box is mounted.

In this step, also glue the photoresistor into the porthole on the front panel. Disconnect the photoresistor leads from the circuit board before doing this. These leads will get reconnected just before you attach the front panel.

Step 8: Installation

The final wiring and assembly happens after the control box is mounted. Choose an appropriate spot in your yard relatively close to where the solar panel is mounted. The box mounts with two screws.

Once the box is mounted, the following steps will finish the assembly:

1. Bring the wire from the solar panel through the gland on the left side of the control box and connect it to the two terminal block. Pay attention to polarity.
2. Bring wires from each of the lighting circuits through the glands on the right side of the control box and connect them to the six terminal block. Pay attention to polarity.
3. Put the battery in place and connect the two quick connect spade terminals from the circuit panel. The fused one goes to the positive battery terminal. Use an appropriately sized fuse for your expected lighting load – all of my lights currently draw under 1A.
4. Connect the red and white wires from the circuit panel to the toggle switch in the front panel. Polarity does not matter.
5. Connect the lead from the photoresistor to the two pin header on the circuit board.
6. Install the front panel onto the control box.

With installation finished, turn the enable switch on and shade the photoresistor – you should see the lights come on!

Check for the latest version of this document at:
https://github.com/vinmarshall/Radio-Shack-Solar-Lights