Rugged Outdoor Time Lapse
Version 1.0

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Parts For This Project

Part	Vendor	Part Number	Source
0.1uF Capacitor	Radio Shack	272-0135	1
1uF Capacitor	Radio Shack	272-0996	1
Red LED	Radio Shack	276-0041	1
1N4004 Diode	Radio Shack	276-1103	1
Screw Terminals	Radio Shack	276-1388	1
1/4W Resistor Assortment	Radio Shack	271-312	1
Photoresistor Assortment	Radio Shack	276-1657	1
10K Potentiometer	Radio Shack	271-1715	1
Control Knob	Radio Shack	274-018	1
5VDC Reed Relay	Radio Shack	275-0232	1
SPST Toggle Switch	Radio Shack	275-634	1
Red LED Assembly	Radio Shack	276-0270	1
Green LED Assembly	Radio Shack	276-0271	1
Yellow LED Assembly	Radio Shack	276-0272	1
2N3904 Transistor	Radio Shack	276-2016	1
LM7805 Voltage Regulator	Radio Shack	276-1770	1
LM317 Voltage Regulator	Radio Shack	276-1778	1
Canon PowerShot A3300 Camera	Radio Shack	16-1920	1
32 GB SDHC Memory Card	Radio Shack	55041523	1
Sunforce 5W Solar Panel	Radio Shack	55038529	1
12V 1.3 Ah Battery	Radio Shack	23-9080	1
Wire-Tie Mounts	Radio Shack	278-441	1
Heat Sink	Radio Shack	276-1363	1
Heat Sink Mounting Kit	Radio Shack	276-1373	1
DC Power Cable	Radio Shack	270-020	1
0.1” Headers	Sparkfun Electronics	PRT-00116	2
2 Pin Jumper Wire	Sparkfun Electronics	PRT-10372	2
3 Pin Jumper Wire	Sparkfun Electronics	PRT-10373	2
Case – Yellow, No Foam	Pelican	1300	3
Control Panel Mount	Pelican	1200/1300 Panel Frame	3
Control Panel	Front Panel Express	N/A	4
17” Cable Ties	McMaster Carr	7130K21	5
Porthole Window	McMaster Carr	1116K24	5
Small Porthole Window	McMaster Carr	1116K21	5
MIL Spec weatherproof plug	McMaster Carr	8903T21	5
MIL Spec weatherproof socket	McMaster Carr	8903T31	5
#4-40 x 7/16” Nylon Standoffs	McMaster Carr	92745A488	5
#4-40 Nylon Nuts	McMaster Carr	94812A112	5
#4-40 x 3/16” Nylon Pan Head Screws	McMaster Carr	93135A105	5
#6-32 x 1.5” AL Standoffs	McMaster Carr	91780A337	5
#6-32 Nuts	McMaster Carr	91841A007	5
#6-32 x 3/16” Pan Head Screws	Mcmaster Carr	91772A143	5
3/8”-16 Flat Head Screw	McMaster Carr	91771A622	5
PVC angle	McMaster Carr	8659K39	5
Mini Ball Head Camera Mount	Gittos	MH-1004	6
Canon AC Power Adapter	Canon	ACK-DC60	6
SD Card Extension	Beatsonic	SD2C	7
Printed Circuit Board	Vin Marshall	N/A	8

Sources:

1. www.RadioShack.com
2. www.SparkFun.com
3. www.CaseClub.com
4. www.FrontPanelExpress.com
5. www.McMaster.com
6. www.BHPhotoVideo.com
7. sam@beatsonicusa.com
8. vlm@2552.com

Assembly Instructions

Introduction:

This project is an outdoor, solar powered, long term time lapse rig. It is housed in a weather proof and rugged Pelican case and can sit outside taking pictures for as long as there is sunlight.

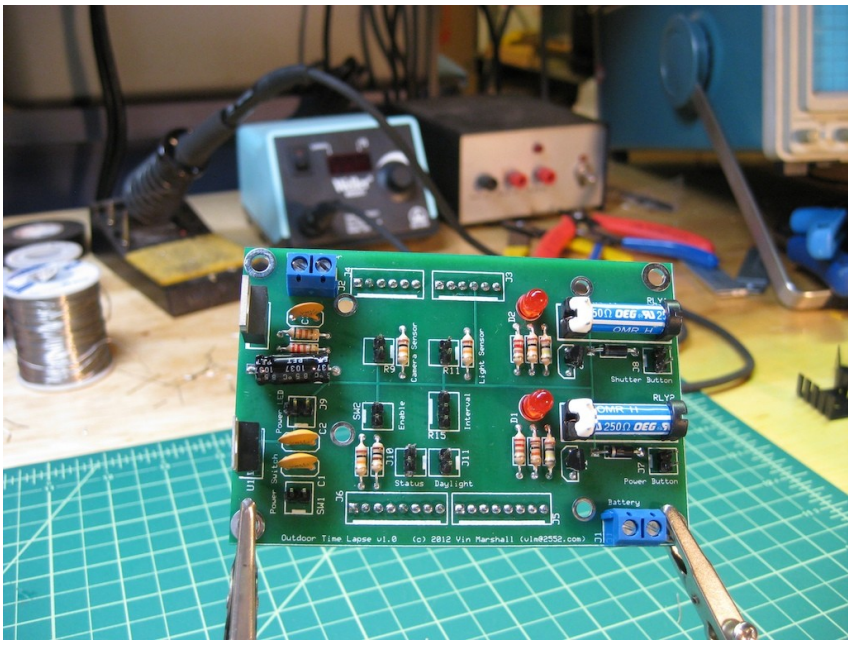
The rig is controlled by an Arduino which turns on and fires the camera periodically whenever there is daylight and the enable switch is on. Daylight is detected by a photo-resistor circuit. The shooting interval is set by the knob on the front panel. The camera's SD card is mounted in the front panel for easy access.

Read all of the instructions before you start building this project.

You can download all of the supporting files for this project by clicking the “ZIP” button near the upper lefthand corner of this page:

https://github.com/vinmarshall/Radio-Shack-Time-Lapse

Step 1: Build The Circuit Board



The printed circuit board layout for this project can be found in various formats in the ./PCB directory of the download.

You can order this PCB from ExpressPCB (www.expresspcb.com), or from me (vlm@2552.com).

If you'd like to make the circuit board yourself, you can etch one on your own – with just a couple of wire jumpers on the top side, this could be a one sided layout – or you can do point to point wiring. I designed the PCB to have the same mounting hole pattern as Radio Shack p/n 276-168.

The parts needed to build this circuit are listed in the ./parts directory of the download. The ordering_BOM file lists the parts to order and the circuit_board_BOM file shows where to place those components on the circuit board.

Populate the board and solder everything in place, being careful to avoid solder bridges and cold joints. Plugging the header pins into the Arduino and then placing the PCB onto those pins makes that soldering operation much easier.

Attach heat sinks to the two voltage regulator ICs. Use the insulation included in the heat sink mounting kits to isolate the heat sinks from the IC body. The two regulators connect different pins to their bodies and should not be allowed to come in contact with each other.

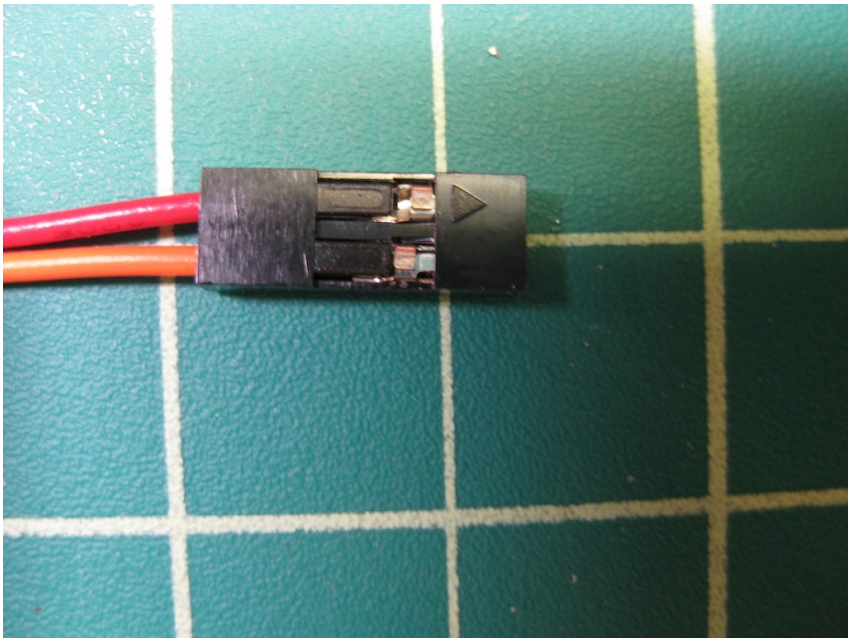
We'll test the board later, after connecting the front panel controls.

Step 2: The Front Panel

A front panel for this project can be ordered from Front Panel Express (www.frontpanelexpress.com) using the front_panel/rs_time_lapse.fpd file from the download.

A DXF with the panel dimensions is also available as front_panel/rs_time_lapse.dxf if you'd like to make it yourself or take it to a machine shop.

Step 3: Wire The Controls



The controls and indicators in the front panel are connected to the circuit board by way of jumpers. The next step is to wire those jumpers. Polarity matters for most of these connections. It is established relative to pin #1 on the jumpers which is marked with an arrow, as shown above.

The jumpers are wired as shown in the following tables.

All Lamps:

Red (+) lead	Jumper pin #1
Black (-) lead	Jumper pin #2

All Toggle Switches:

Center pin	One of the Jumper pins
N.O. Pin	The other (polarity does not matter)

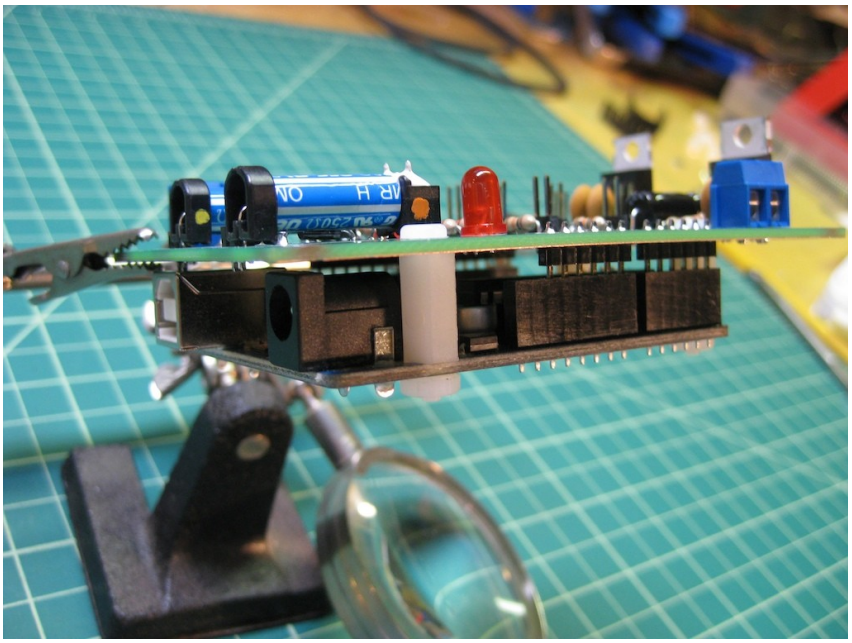
Potentiometer (pins as viewed from the back):

Right pin	Jumper pin #1
Wiper (center) pin	Jumper pin #2
Left pin	Jumper pin #3

Detailed pictures of each of these jumpers can be in ./images/panel in the download.

After all of the jumpers are wired, these controls can be installed in the front panel. Refer to the picture in Step 2 for placement.

Step 4: The Arduino



If you don't already have it, download the Arduino software from http://www.arduino.cc/.

Open the Arduino software and connect the Arduino to your computer via USB. Under the "Tools" drop down menu, select your board type (Arduino UNO for this project) and serial port (/dev/tty.usbmodem***).

The code for this project is in time_lapse_code/time_lapse_code.pde in the download. Open it in the Arduino software and download the program to the Arduino.

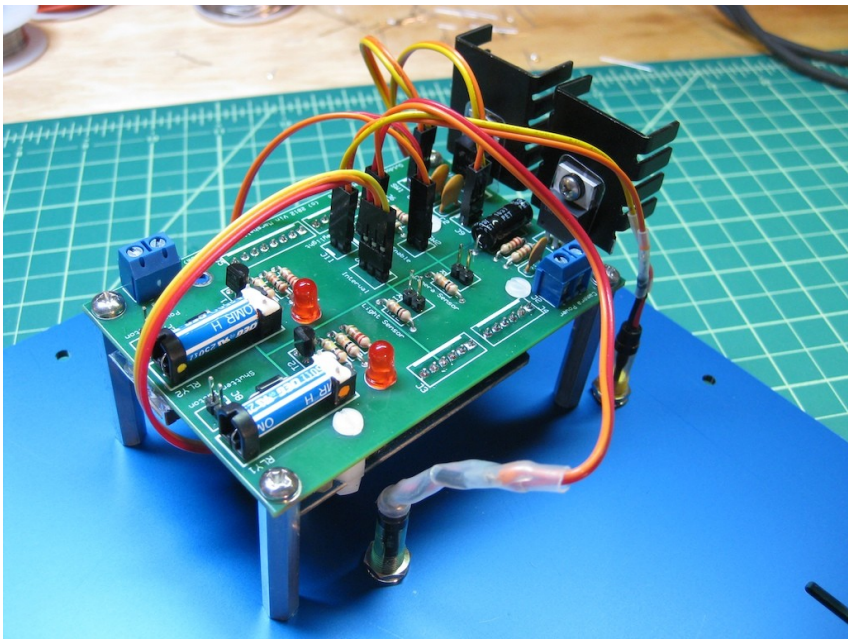
If you have any problems with connecting and programming the Arduino, consult the help available in the Arduino forums at http://arduino.cc/forum/.

Once the Arduino has been successfully programmed, disconnect it from the computer and attach it to the circuit board using the #4-40 nylon standoffs with the USB port facing away from the voltage regulator ICs. Arduino headers connect to the J3, J4, J5, and J6 header pins on the circuit board.

You can always check for the most recent version of the code here:

https://github.com/vinmarshall/Radio-Shack-Time-Lapse/tree/master/time_lapse_code

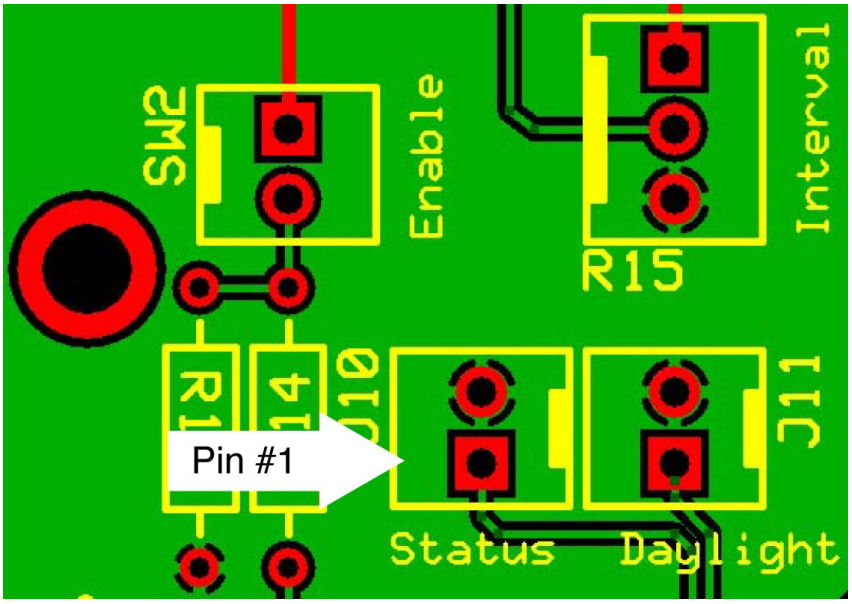
Step 5: Attach The Circuit Board



With the front panel wired and the circuit board built, we're now ready to attach the controls and mount the circuit board.

The circuit board attaches to the back of the control panel with four long #6-32 hex standoffs and eight #6-32 machine screws. Mount the circuit board so that the Arduino is toward the control panel and the components on the PCB are pointing away.

With the circuit board attached, it is time to connect the controls. You will be aligning pin #1 of the jumpers from the front panel (marked with the arrow) with the the corresponding pin #1 (marked with the square pad – see below) on the circuit board as you connect them.



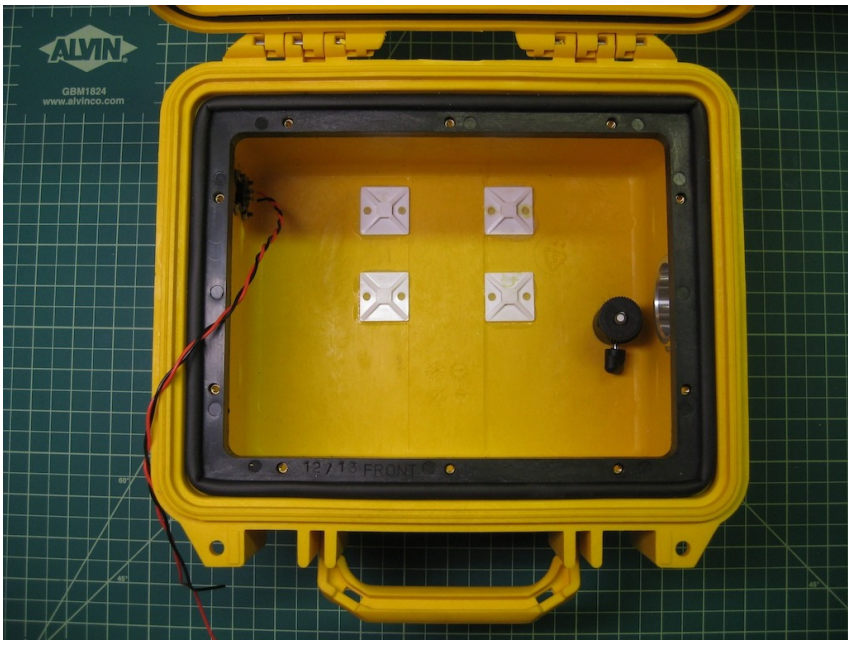
Step 6: Prepare The Pelican Case

The camera, battery, solar panel port, two porthole windows, and a support for the control panel have to be mounted in the pelican case.

First, install the “panel frame” that supports the control panel, following the instructions that came with it.

Then install the rest of the components using the following pictures as guides. The exact placement is not crucial, except as noted on the next page with regard to the camera and porthole.

The overall layout inside the Pelican case is shown below:



Camera Mount and Porthole:

The camera mount and the porthole must be installed such that the camera lines up with the porthole when it has the lens extended, and such that the lens can freely open and close. This is going to be a tight fit and you'll have to pay careful attention to getting it right so that the porthole does not interfere with the lens opening.

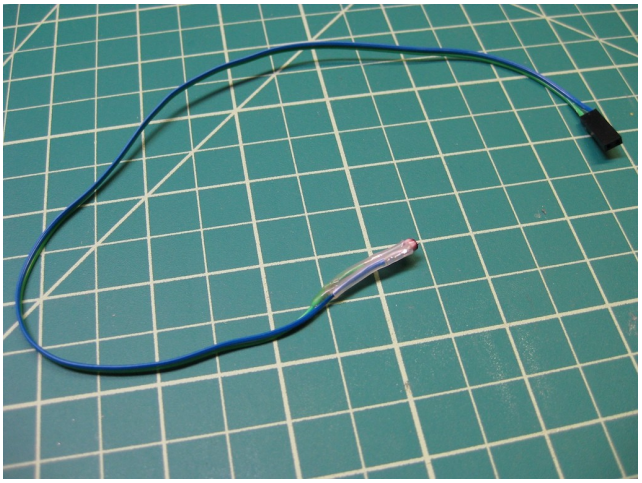
The hole for the porthole can be drilled with a hole saw. Seal the hole for the camera mount's mounting screw through the bottom of the Pelican case with RTV, but do not use RTV on the porthole. The round gasket that came with the porthole should be installed between the porthole body and the outside of the Pelican case.

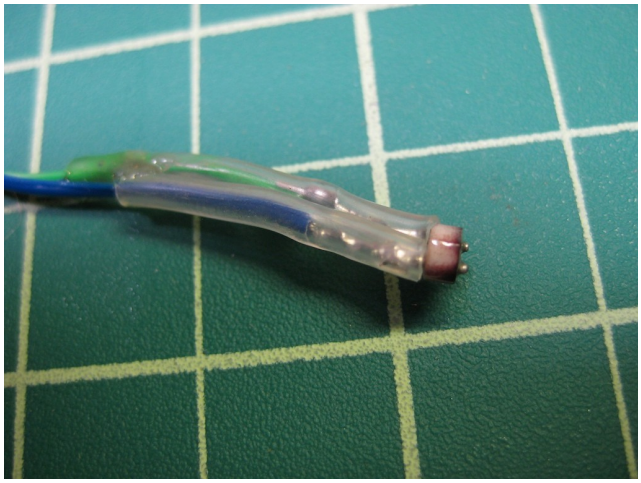
Daylight Sensor Porthole:

The second, smaller, porthole is installed just as the camera porthole was. Position is not crucial for this part.

The daylight sensor and its porthole must first be prepared for installation. As with the jumpers for the front panel controls, cut one end off of a 2 wire x 12” jumper. Solder those wires to the leads of a photo-resistor. Use heat shrink tubing to insulate the connections. Then glue the photo resistor into the porthole so that it faces out of the window.

Installation of the porthole is the same as that for the camera porthole above. Drill a 3/4” hole to mount it. Make sure the included gasket goes between the porthole body and the outside of the Pelican case and do not use any RTV.



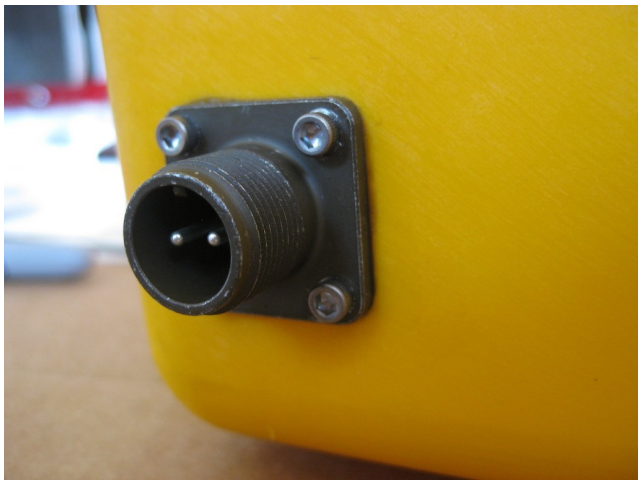


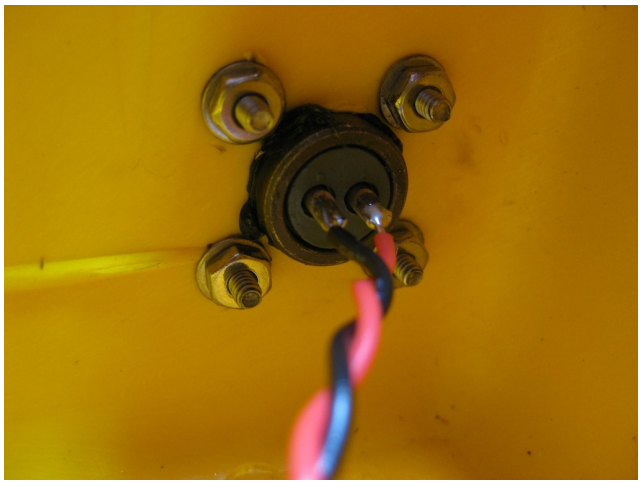
Solar Power Connector:

The connector for the solar panel passes through the side of the pelican case opposite the camera porthole.

Before mounting the connector, solder on power leads.

Drill one large hole for the connector body. Then put the connector in place temporarily and mark the mounting holes. Drill the mounting holes. Apply some RTV under the flange of the power connector before installing it. This will help to seal the opening.

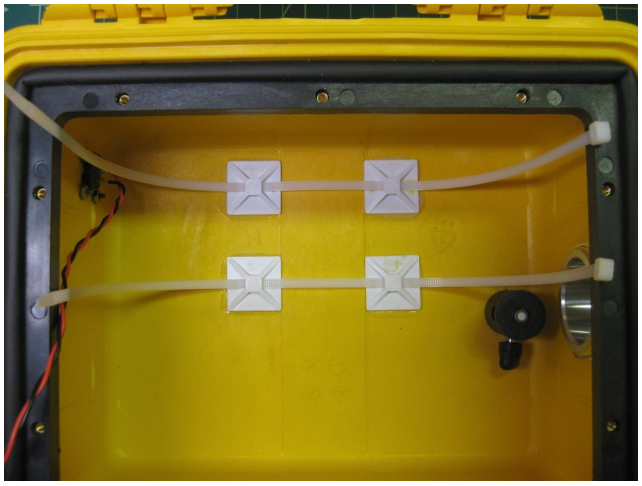




Battery:

Temporarily put the battery in position as shown below. Test fit the wire tie holddowns around the battery as pictured. Then prepare the 3M DP-8010 epoxy and, one at a time, scrape the adhesive off of each wire tie holddown and epoxy them in position around the battery. The battery does not have to be in position for this, but you may want to use something to mark it's footprint to aid in the positioning of the wire tie holddowns.

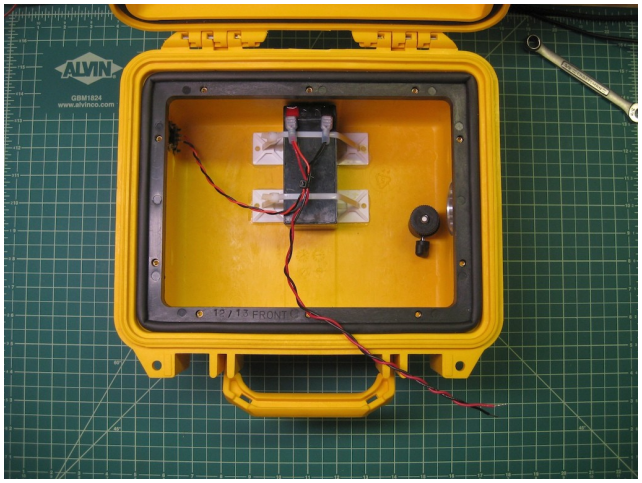
Let the epoxy cure for at least 8 hours before installing the battery. After if has cured, mount the battery securely in place with wire ties.

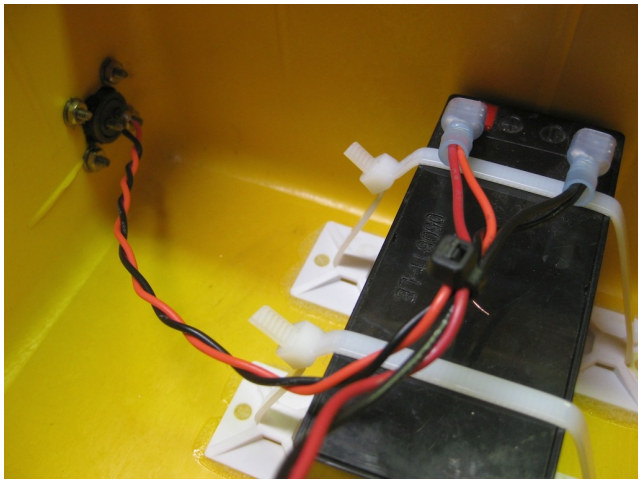


Step 7: Other Wiring

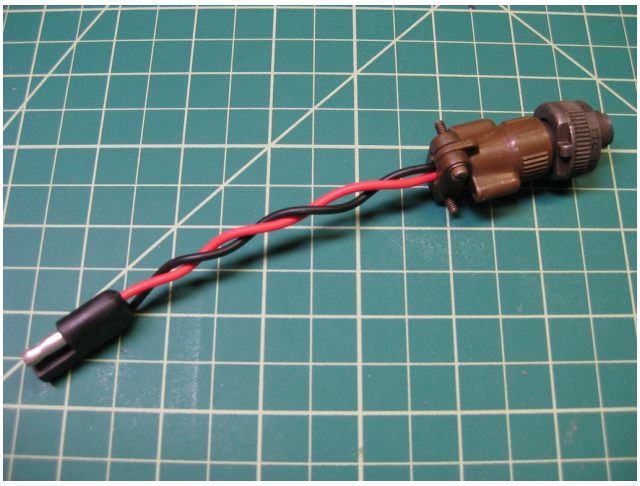
The circuit board and front panel controls should already be wired by this point. In this step, all of the remaining wiring will be completed.

Wire the battery and solar power connections as shown in the images below. Pay attention to the polarity of these connections. Complete the battery wiring before connecting to the battery. Be careful not to short the positive and negative leads together once the battery is connected.

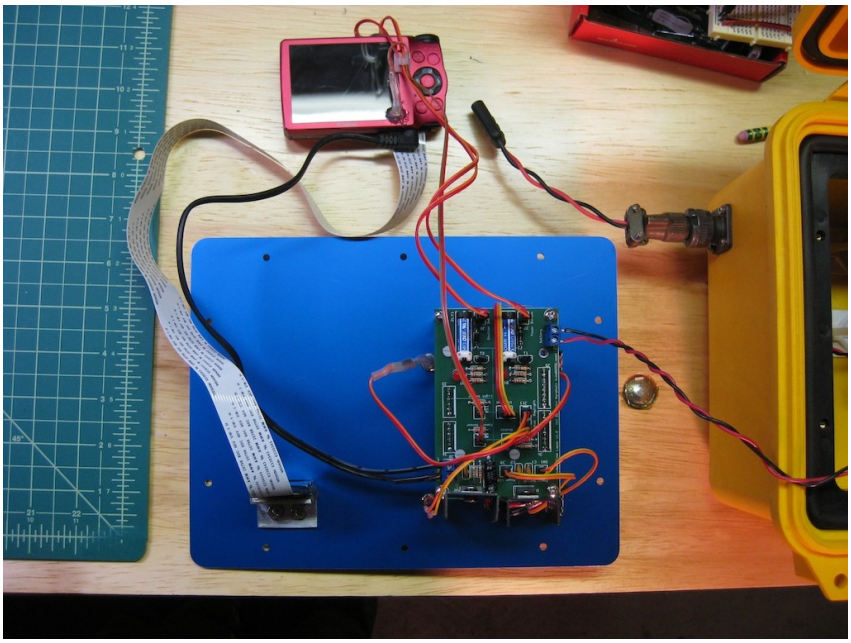




Then, cut the DC power cord in half and wire it to the Mil-Spec connector. This will connect to the solar panel. Pay attention to the polarity – make sure that the (+) from the solar panel will connect to (+) on the battery.



Step 8: Testing

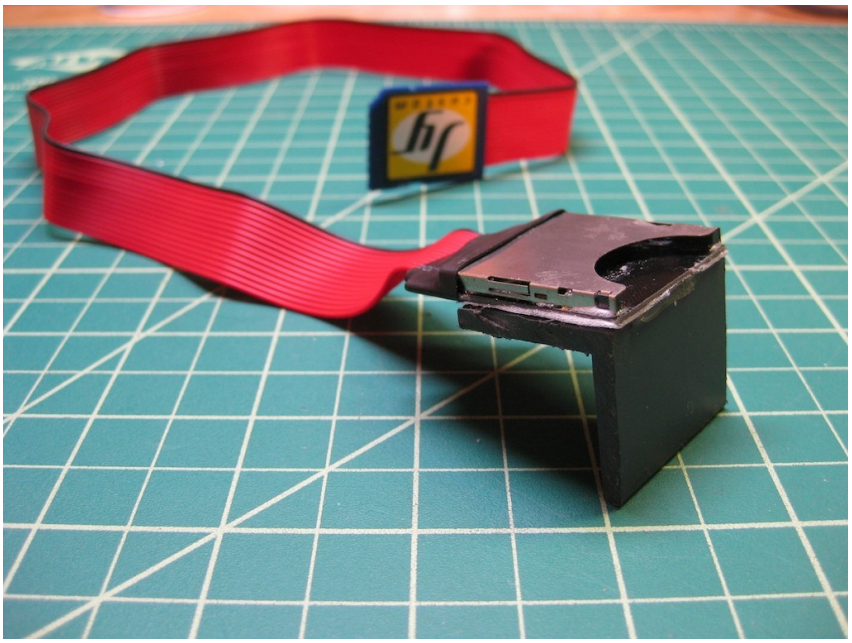


Test the voltage regulation section of the circuit at this point. The camera should not be connected to the circuit yet. Inspect the wiring. Then connect the battery and turn the power switch on the front panel on.

Using a multimeter, verify that regulator U1 is putting out 5V and regulator U2 is putting out 4.2V.

Look for the power LED on the Arduino to verify that it is receiving power.

Step 9: Mount the SD Card Extension



Cut a length of PVC angle to make a mounting tab for the extension SD card socket. Glue the SD card socket onto this tab. Do not use anything conductive for this mounting tab unless an insulation layer is placed between it and the SD card socket. Don't use too much glue or it will flow up into the socket through the holes in its base and cause issues when you go to insert an SD card.

Then position the socket so that the SD card fits through the slot in the front panel and transfer the mounting holes from the front panel onto the SD card socket's mounting tab. Drill the holes and mount the SD card socket to the front panel.

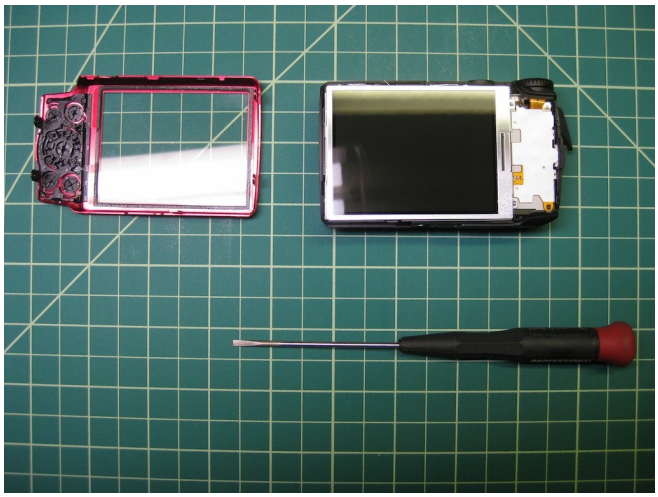
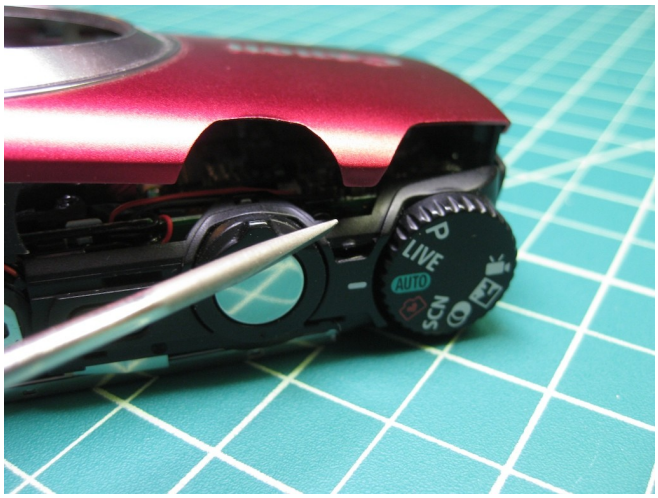
Step 10: Modify The Camera

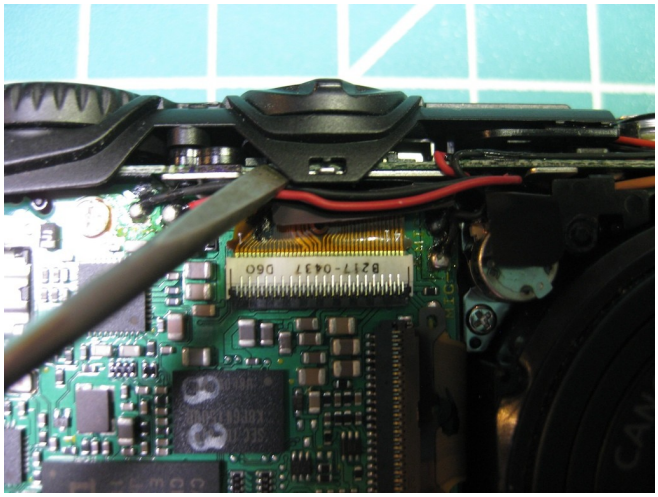
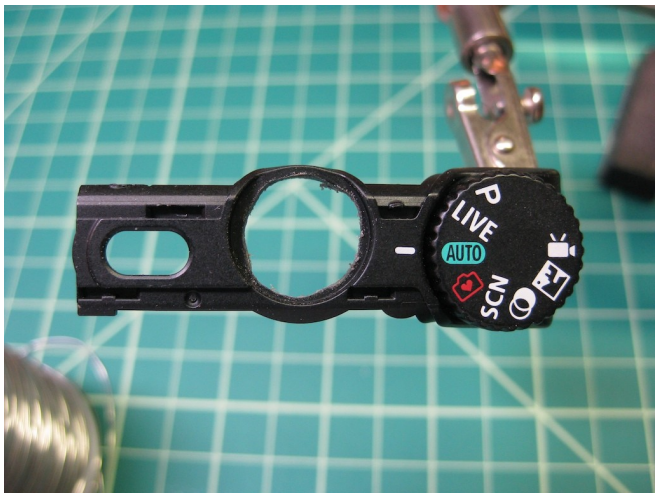
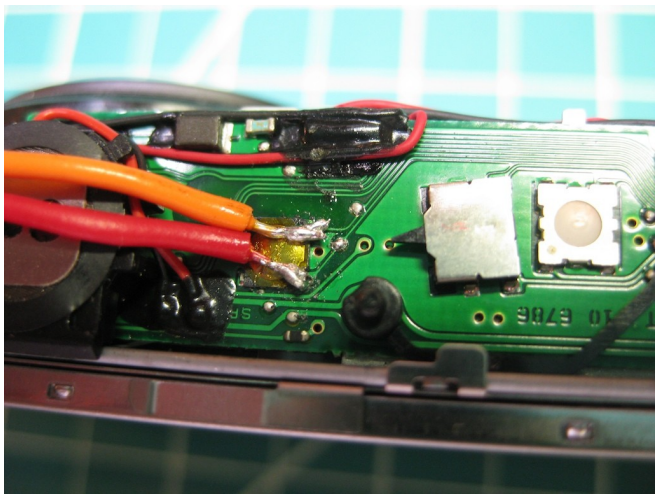
The camera needs to be modified so that the Arduino can take control of the power and shutter buttons. Modifying the camera is, by far, the most difficult part of this project. You will probably first want to practice this procedure a few times on cameras that you didn't just spend over $100 on. You can easily destroy the camera with this step if you are not careful. Remove the camera battery before starting this step.

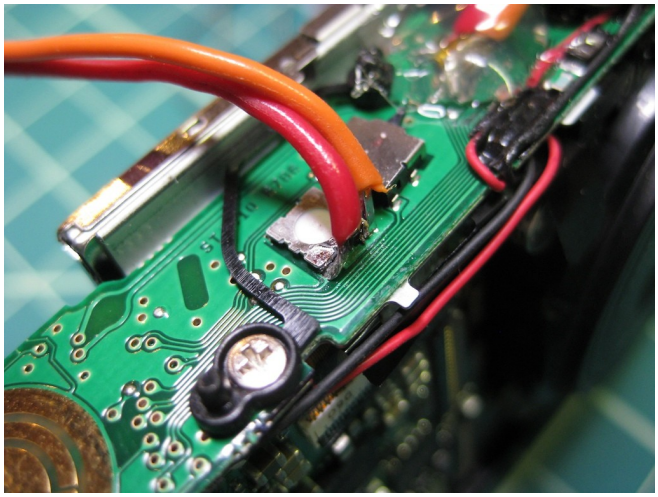
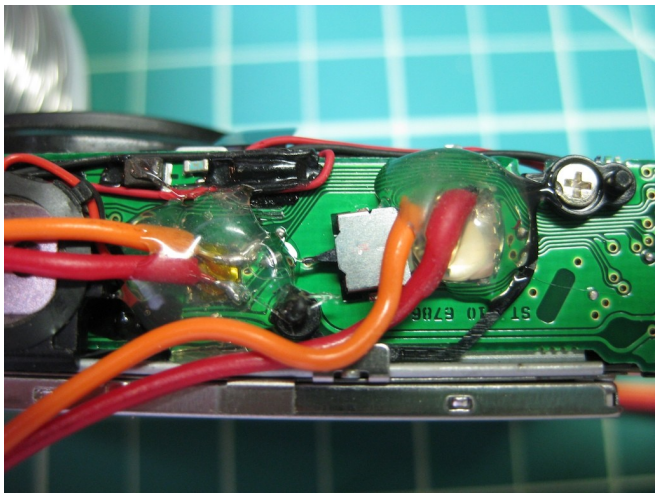
WARNING:

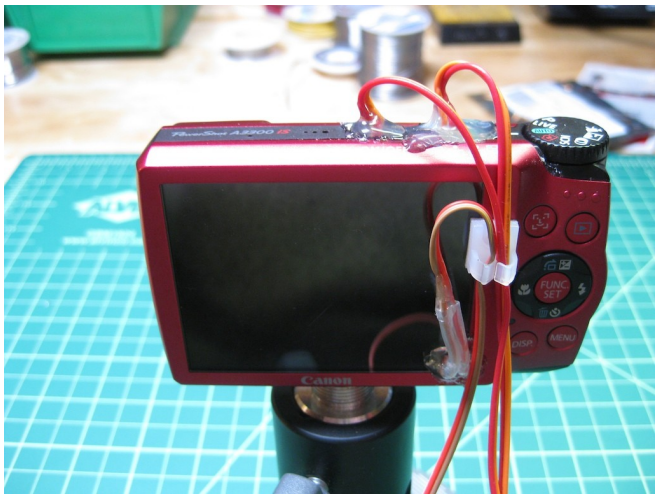
While working with the camera, be extremely careful not to shock yourself with the flash capacitor. It is dangerous and it hurts. Especially the second time.

Avoid contact with any leads or wiring connected to the large capacitor in the front right of the camera. Some of its wiring is close to the power and shutter buttons that you will be modifying. Identify where these leads are before you start the modifications and avoid them.

1. Remove the 4 external screws. The non obvious one is shown.	
2. Carefully pry off the back cover. Separate it from the camera.	
3. Carefully pry off the front cover. It flips up from the bottom with a tab next to the shutter button retaining it at the top.	

4. Pop off the cover holding the shutter and power buttons.	
5. Remove the power and shutter buttons to create openings for the wires to pass through. Drill or cut a hole through where the shutter button was to create extra clearance.	
6. Cut the end off of a 2 wire jumper, strip and tin the wires, and solder it on top of the (very small) leads for the power button. Refer to the pictures for which leads to piggyback on. Visually inspect this through a magnifying glass to make sure that you didn't bridge the solder onto another trace or onto the body of the original switch. Test the camera after doing this. With a battery temporarily in the camera, you should now be able turn the camera on by briefly shorting the two wires in the jumper together. Go back and try again if it didn't work.	

7. Repeat step 5 for the shutter button. Refer to the pictures. There are more pictures in the ./images/camera directory of the download.	
8. Fix the leads in hot glue or epoxy to keep them from getting pulled off of their connections. When potting these leads, keep in mind where the cover will fit and how little space is available. Be very careful with the leads until they are secured in glue.	
9. Fish the jumpers through their respective holes in the plastic button cover that you removed in step 4 and reinstall it.	

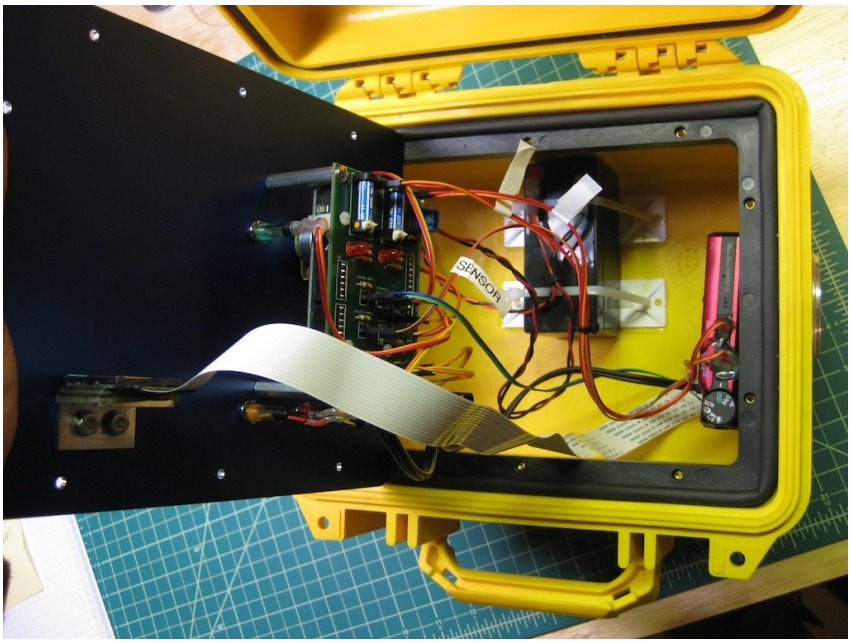
10. Reverse steps 1 through 3 to put the camera back together. Verify that the camera still works by turning on the power and shooting a picture using the new leads. Go back and try again if it doesn't.	
11. Attach a jumper to a photoresistor as you did for the daylight sensor and glue that sensor to the screen on the back of the camera.	
12. Use a cable clamp to secure all of the leads.	

13. Replace the camera battery with the battery adapter from the AC power kit.

    Cut the barrel power connector and approximately 10” of cord from the AC power supply. Strip the ends and tin them with solder.

    Identify the lead that connects to the outside of the barrel connector and mark it as negative. Connect these leads to the circuit board paying attention to the polarity.

Step 10: Put It All Together



Put the camera on the mount, making sure the lens still clears the porthole. Plug in the SD card extension cable and the power cable. Plug the 3 sets of leads from the camera onto their respective headers on the circuit board.

Turn the power switch off. Connect the leads from the battery to the screw terminals (J1) on the circuit board. Take a minute to double check all of your wiring.

Install the front panel into the Pelican case.

Turn the enable switch off. Set the interval knob all the way to the left (minimum interval). Cross fingers. Turn the power switch on. The power light should come on. If you are in daylight or a bright room, the “daylight” light on the panel should also come on. If it isn't on, make sure there is sufficient ambient light.

With the power and daylight lights on, flip the enable switch to on. After about 5 seconds, the green status light should come on and remain on for about 5 seconds while the camera powers up and shoots a picture.

You can adjust the range of the available time intervals. See the Arduino code for more details.

Operating Instructions

The interval between pictures is set by the interval knob on the front panel. Turning the knob to the right takes pictures more frequently. The time lapse will not shoot pictures unless there is daylight and the enable switch is on.

Insert an SD card before turning on the camera. When you need to change SD cards, turn the enable switch off and wait for the camera to power down. You can verify this by looking through the porthole to confirm that the lens is retracted. After swapping SD cards, you can turn the enable switch back on and operation will resume as normal.

Turn the enable switch off and allow the camera to power down before turning off the main power switch.

Check for the most recent version of this file at:
https://github.com/vinmarshall/Radio-Shack-Time-Lapse

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