

## Pocket Photodiode Geiger Counter

PART NO. 2170812



A DIY geiger counter that uses a PIN photodiode as a substitute for an expensive Geiger-Mueller tube. It detects alpha and beta radiation particles. The circuit is soldered onto a small protoboard and everything is placed in an aluminum enclosure. Copper tubing and a piece of aluminum foil is used to help filter out noise and RF interference.

**Time Required: 3-4 hours depending on experience**

**Experience Level: Intermediate**

### Required tools and parts:

Soldering iron and solder

Aluminum foil

Electrical tape

Drill

Step drill bit

Hand tools

Jumper wiring

3 CR1620 coin-cell batteries, or any coin-cell batteries to add up to 9V

2 pieces of copper tubing available at Home Depot:

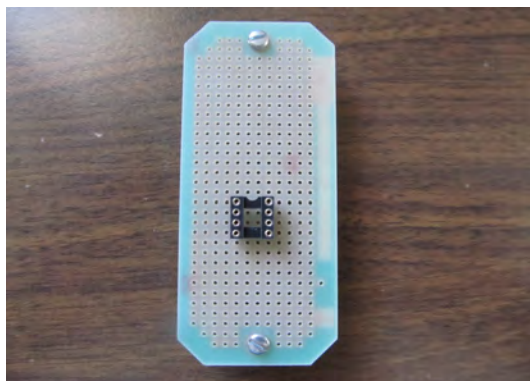
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### Bill of Materials:

Qty	Jameco SKU	Component Name
1	1621132	BPW34 PIN photodiode
1	23966	LM358 Dual Op-amp
1	178597	2N3904 NPN Transistor
1	178669	2N7000 Transistor
2	15270	100nF Capacitor
1	597450	100uF Capacitor
1	15229	10nF Capacitor
1	332487	20nF Capacitor
1	691817	10Mohm Resistor
2	691622	1.5Mohm Resistor
1	691286	56kohm Resistor
1	691382	150kohm Resistor
2	2157159	1kohm Resistor
1	255565	250kohm Potentiometer
1	335557	Piezo Buzzer
1	72161	Toggle Switch
2	234923	Crimp pins
1	108338	2-pin Male Header
1	234704	2-Position Housing Connector
1	264990	Potentiometer Knob
1	51626	8-pin IC socket
1	105102	Protoboard
1	2156156	Flitop Box

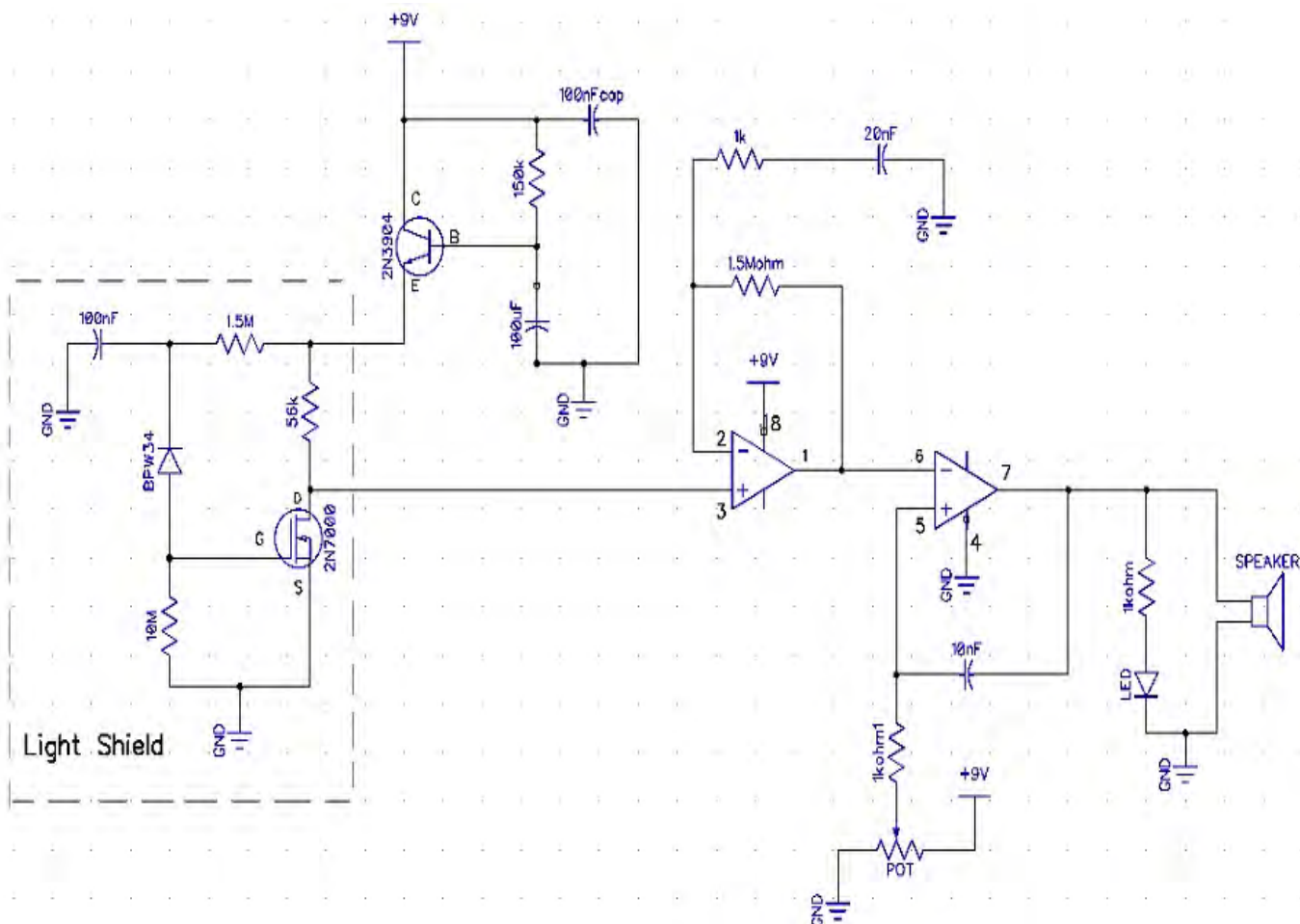
## Step 1 - Position IC Socket

Since there are quite a few components that need to fit onto this small protoboard, positioning of each component is important. The IC socket should be around the middle of the board since the pins need to be accessed as you solder. Make sure the notch of the socket is positioned correctly as you want the IC to be placed.



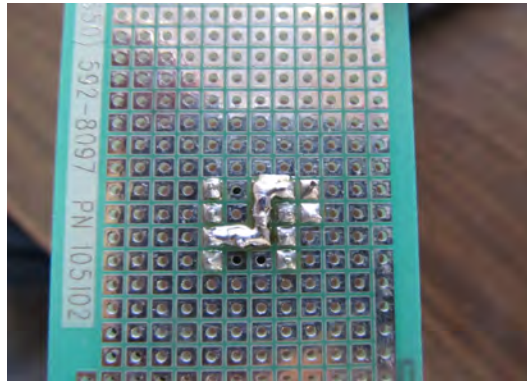
## Step 2 - Build Schematic

Follow the schematic paying close attention to the pinouts of the transistors and dual op-amp IC.



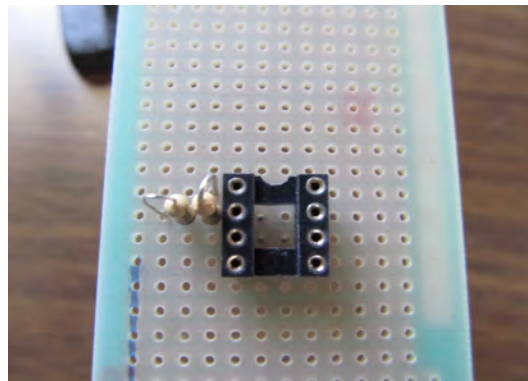
### Step 3 - Back Side of IC Socket

As you can see from the schematic, pins 1 and 6 are tied together. Soldering the two pins from underneath the board is the best way to have a clean connection and save space at the same time. This technique will be used throughout the build to keep the entire circuit compact.

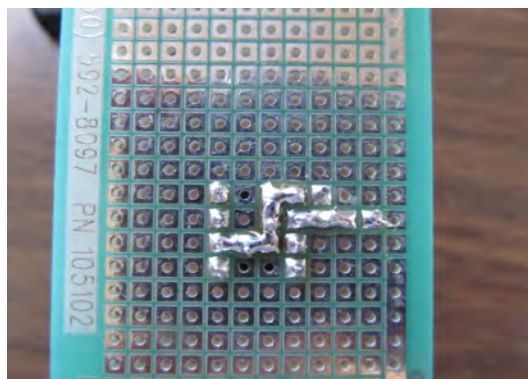


### Step 4 - Place Resistors (Pins 1 and 2)

Solder each resistor so that they only take up 2 solder holes. The connections are made underneath so make sure you do not short any of the components by soldering its own leads together.

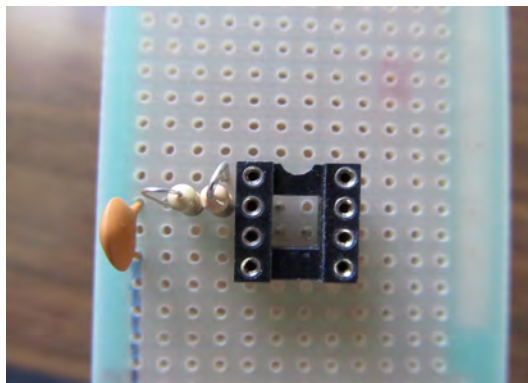


### Step 5 - Back Side of Resistor Connection

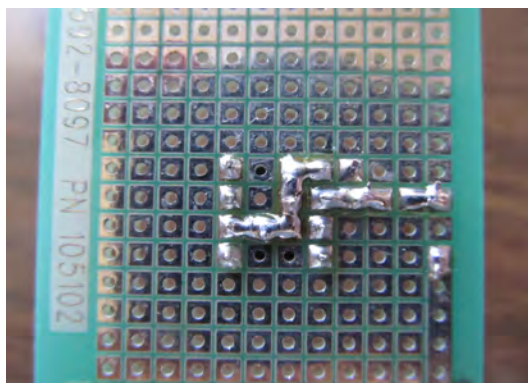


### Step 6 - Place 20nF Capacitor

This capacitor is non-polarized. It connects to ground, which I am using as the bus on the protoboard.

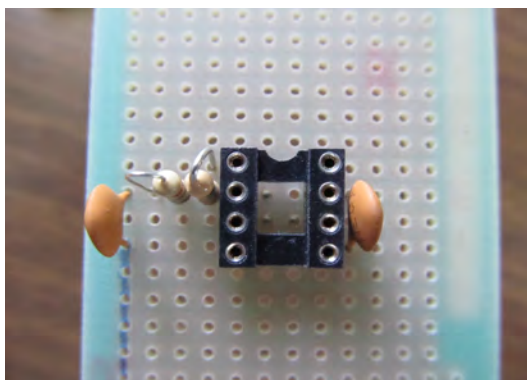


### Step 7 - Back Side of 20nF Capacitor Connection

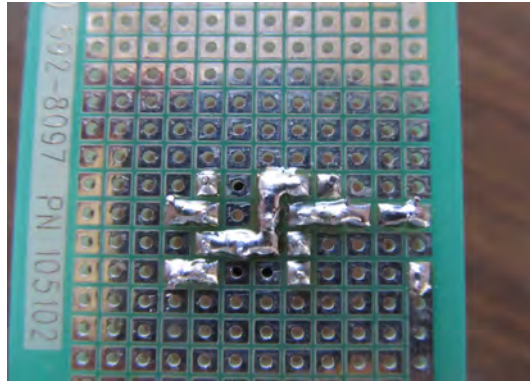


### Step 8 - Place 10nF Capacitor

This capacitor goes from pin 5 to pin 7. It is non-polarized.



### Step 9 - Back Side of 10nF Capacitor Connection



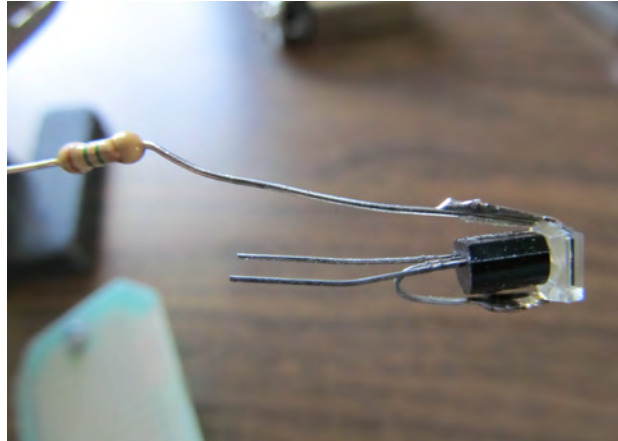
### Step 10 - Light Shield Section

The Light Shield section of the schematic is going to be placed in a copper tube to help block out any electromagnetic interference and light coming into the photodiode. Soldering the components in a tube-like shape ensures a snug fit into the copper tube. Start by placing the photodiode on top of the 2N7000 MOSFET and soldering the gate (pin 2) to the anode of the photodiode (without the notch).



### Step 11 - 1.5Mohm Resistor to Photodiode

The cathode of the photodiode (with a notch) is connected to the 1.5Mohm resistor.



### Step 12 - 56kohm Resistor

Solder one end of the 56kohm resistor to the drain of the 2N7000 (pin 1), and the other end to the 1.5Mohm resistor.



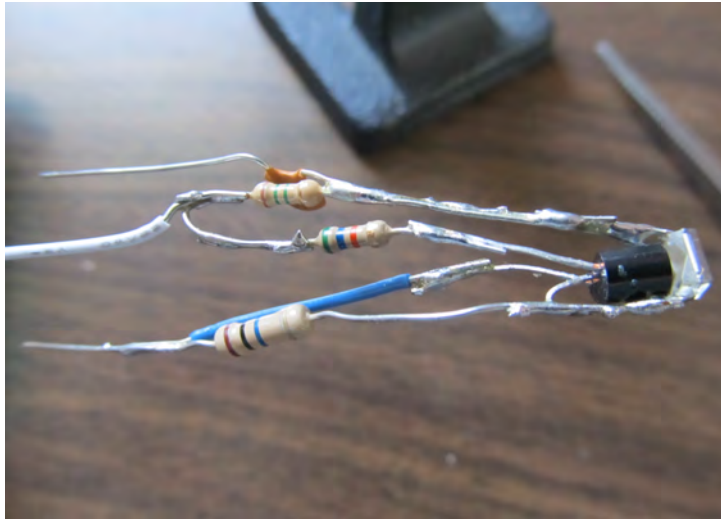
### Step 13 - 100nF Capacitor

Solder the 100nF capacitor to the cathode of the photodiode and leave the other end unconnected.



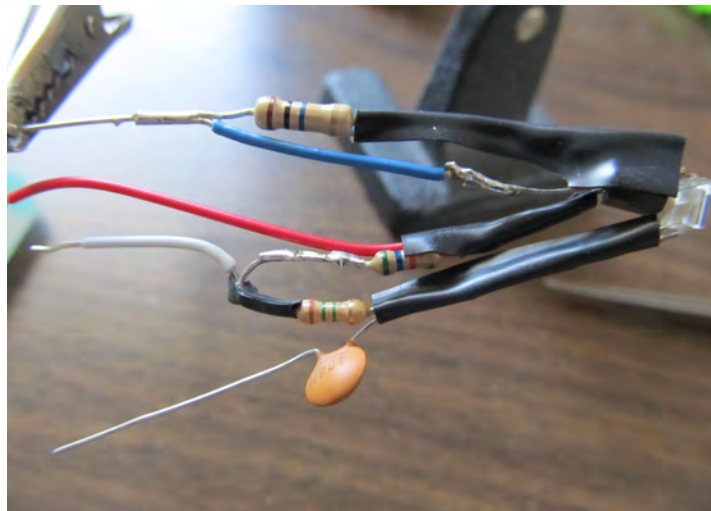
#### Step 14 - 10Mohm Resistor

Solder on end of the 10Mohm resistor to the source of the 2N7000 (pin 3), and the other end to the gate of the 2N7000 (pin 2). Add a jumper wire to the source (this will connect to ground), and another jumper wire to the connection between the 1.5Mohm and 56kohm resistors (this will connect to the emitter of the 2N3904 transistor).



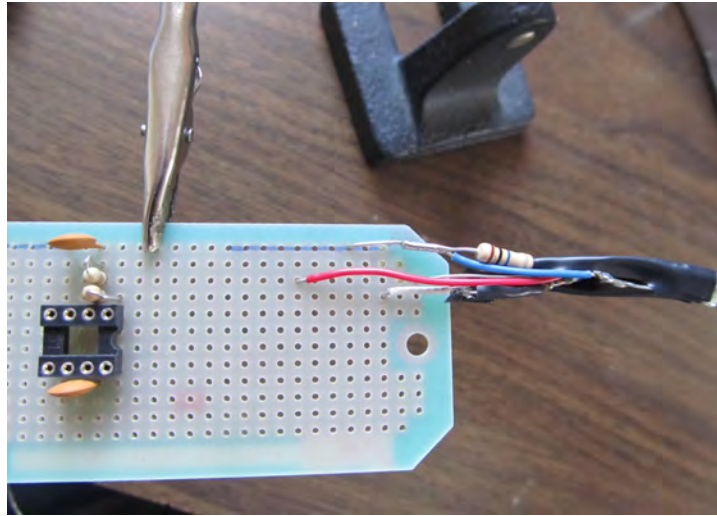
#### Step 15 - Electric tape

Add one more jumper wire to the drain of the 2N7000 (pin 1). This will connect to pin 3 of the dual op-amp IC. To make sure these solder connections aren't accidentally shorted, place electrical tape around each lead.

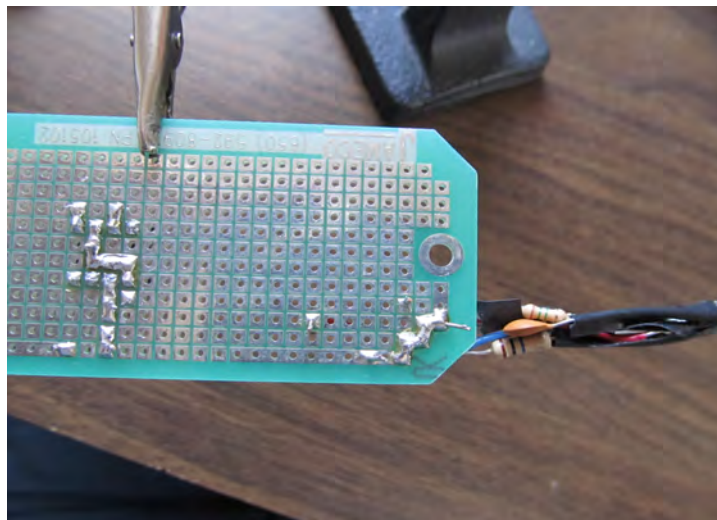


### Step 16 - Solder the Light Shield section to the Protoboard

There will be 4 connections made from the Light Shield section to the protoboard: Two connections go to ground, one connection goes to pin 3 of the dual op-amp, one connection goes to the emitter of the 2N3904 transistor.



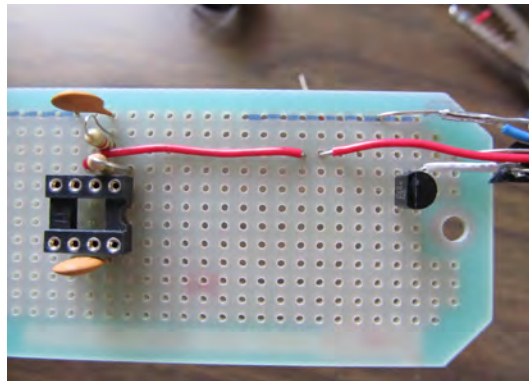
### Step 17 - Back Side of Light Shield Connection





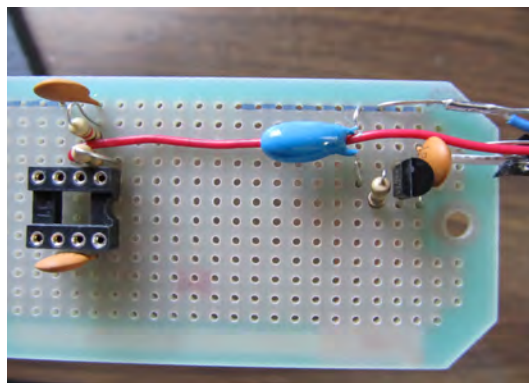
### Step 18 - Jumper Wire to Pin 3 of Op-amp

Add a jumper wire to connect the Light Shield section to pin 3 of the op-amp. Solder the 2N3904 transistor, connecting the emitter (pin 3) to the jumper wire between the 1.5Mohm and 56kohm resistors.

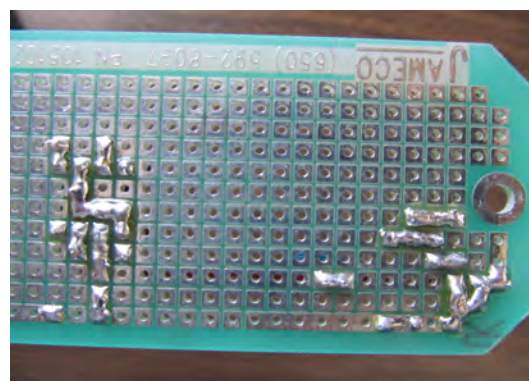


### Step 19 - Solder 100uF Cap, 100nF Cap, 150kohm Resistor

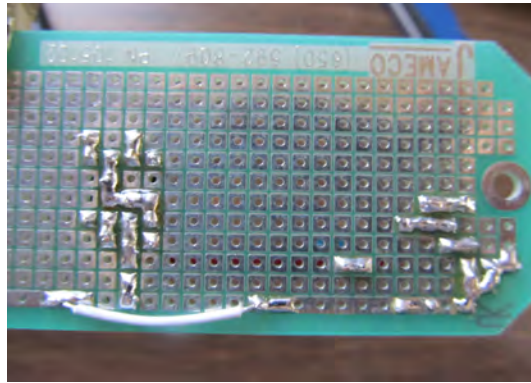
Solder the 100uF capacitor, 100nF capacitor and 150kohm resistor to the circuit around the 2N3904 transistor. Pay attention to the pinout of the 2N3904 and the polarity of the 100uF capacitor. There is a small "+" on one side of the capacitor. Connect the other side to ground.



### Step 20 - Back Side of 100uF Cap, 100nF Cap, 150kohm Resistor Connection



### Step 21 - Connect Ground Busses



### Step 22 - Connect wires to the 250kohm Potentiometer

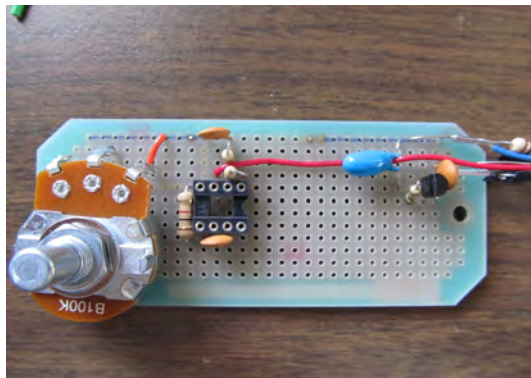
These wires will make it easier to connect to the protoboard.



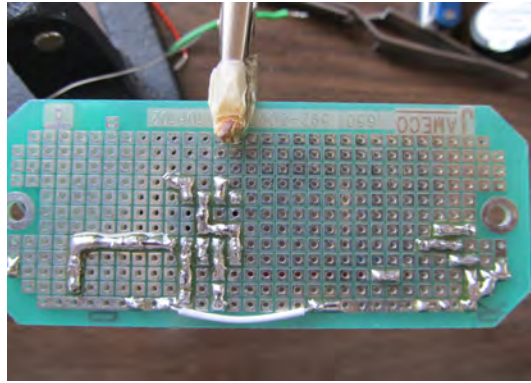
### Step 23 - Solder Potentiometer to the Board

Solder the 250kohm potentiometer and 1kohm resistor to the protoboard.

Note: The photo shows a 100kohm potentiometer, but was replaced with a 250kohm potentiometer.

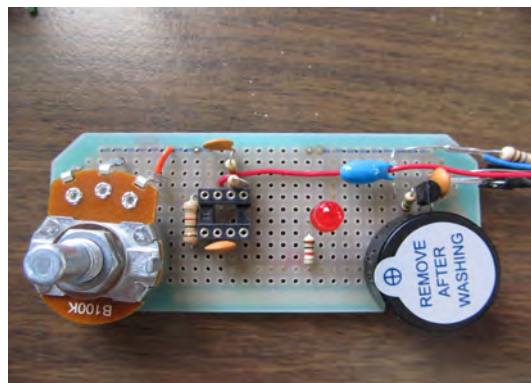


### Step 24 - Back Side of Potentiometer Connection

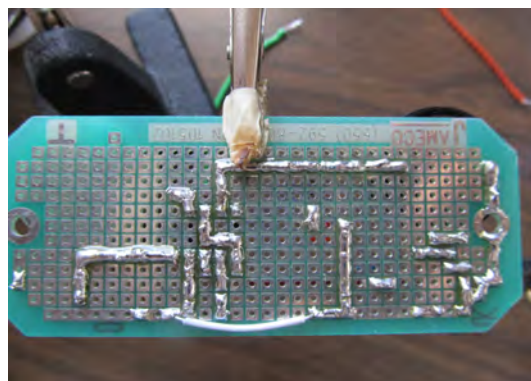


### Step 25 - Add Buzzer, LED and 1kohm Resistor

Make sure the polarity of the buzzer and LED are correct. The buzzer has a "+" on one end of the sticker, and the longer lead of the LED is connected to the 9V supply.

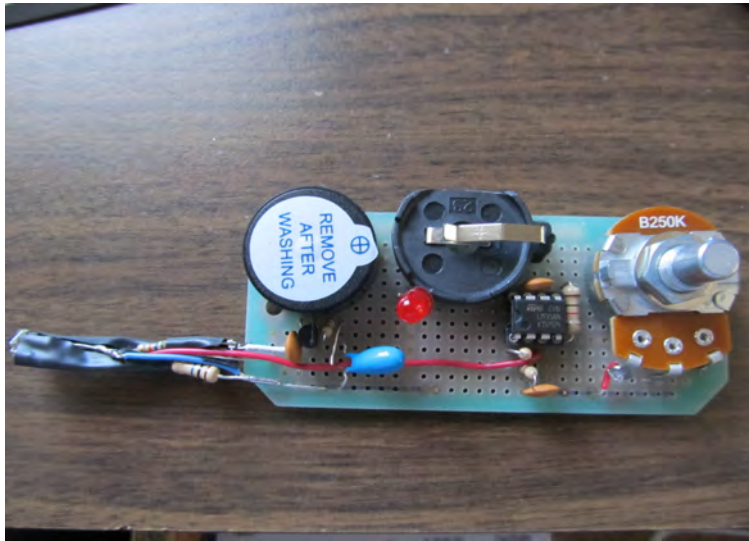


### Step 26 - Back Side of Buzzer, LED, 1kohm Resistor Connection

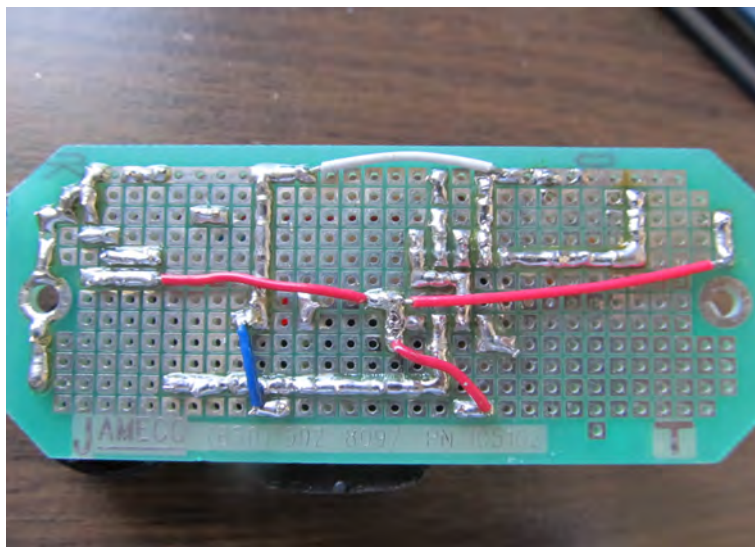


### Step 27 - Add Coin Cell Battery Holder

The coin-cell battery holder is marked with a "+" and "-" on top and bottom. Make the solder connections accordingly onto the protoboard and add jumper wires to the bottom of the board. Part of the battery holder was shaved off in order to fit into the enclosure. If you plan your layout better, you won't have to.



### Step 28 - Back Side of Coin Cell Battery Holder Connection



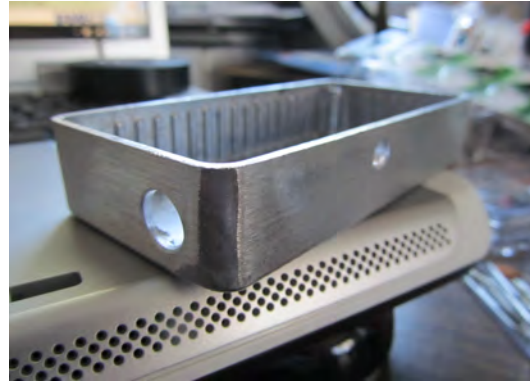
### Step 29 - Copper Tube Light Shield

Get the copper tubes and tape them together with some electrical tape. It should be the approximately length of the Light Shield circuit and fit snugly.



### Step 30 - Drill hole for Light Shield Circuit

Drill a 3/8" hole into the side of the aluminum enclosure where the Light Shield section of the circuit will fit through. Also drill a 1/4" hole on the long side of the enclosure for the toggle switch.



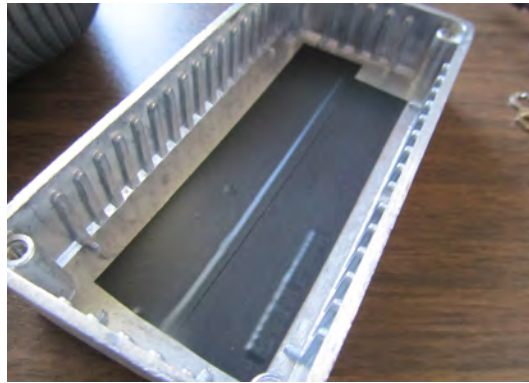
### Step 31 - Drill holes for the LED and Potentiometer

Drill a 3/16" hole and 1/4" hole into the lid of the aluminum enclosure for the LED and potentiometer, respectively. Position the board into the enclosure and mark the lid before drilling the holes.



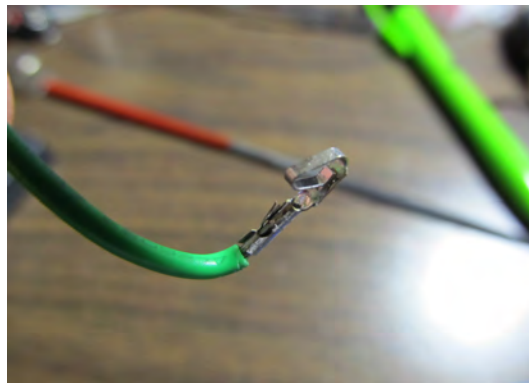
### Step 32 - Prevent Shorts in the Enclosure

Lay down some electrical tape on the enclosure to prevent any accidental short-circuit connections.



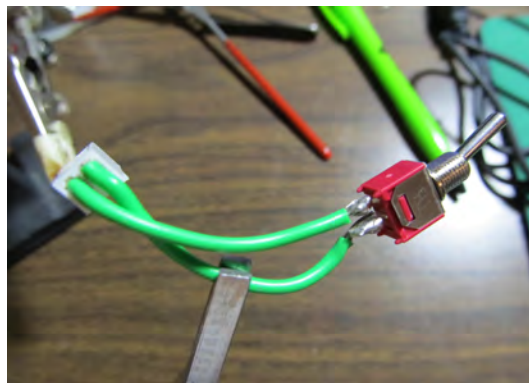
### Step 33 - Prepare Toggle Switch

Connect two small pieces of jumper wire with the crimp pins and solder the other ends to the switch. Slide the crimp pins into the header until it snaps in for a secure fit.



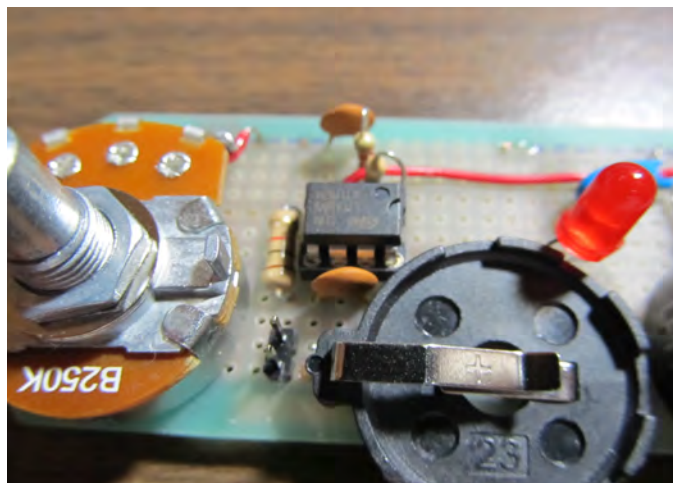
### Step 34 - Toggle Switch

Completed toggle switch connection.



### Step 35 - Solder 2-pin Header

Solder the 2-pin header to the board for the switch connection.



### Step 36 - Insert Switch and Complete Connection

Screw on the toggle switch and insert the socket into the 2-pin header.



### Step 37 - Finish

Everything is now electrically connected. Insert the batteries and screw on the lid. I used three stacked CR1620 coin-cell batteries, but you should be able to use any coin-cell batteries as long as it adds up to 9V. Place the copper tubing over the Light Shield section and place tape around the tubing to keep it from moving around. This also keeps light from interfering with the photodiode. Screw the knob onto the potentiometer and you are ready to begin detecting radiation particles.

Note: This should only be used for recreational and entertainment purposes. It is not safe to be around high sources of radiation and this device should not be used as a reliable source of detecting harmful radiation in the environment.

