luminaria Assembly Guide

Figure 1 *luminaria*

Introduction

Thank you for purchasing a *luminaria* kit from Creations by Peter! *luminaria* is an electronic candle flame powered by an Atmel ATtiny25 microcontroller chip. PLEASE READ THE ENTIRE ASSEMBLY GUIDE BEFORE STARTING! This will go a long way towards ensuring your success.

The software loaded onto the chip sends a pulse-width modulated signal to an ultra-bright LED that emulates the flickering of a candle flame. Even though the brightness of the LED appears to be changing in intensity, it is actually lighting up to its *full brightness* at any given moment!

luminaria makes use of a phenomenon known as *Persistence of Vision*. This is the same phenomenon that causes the apparent motion of a movie or television picture to appear smooth and fluid. By rapidly controlling the width of the pulses used to illuminate the LED, it appears to gently 'flicker' as would a candle flame. This is done by continuously randomizing a specific set of variables within the software used by *luminaria*. The circuit for *luminaria* itself is fairly straightforward, as shown in the figure 2.
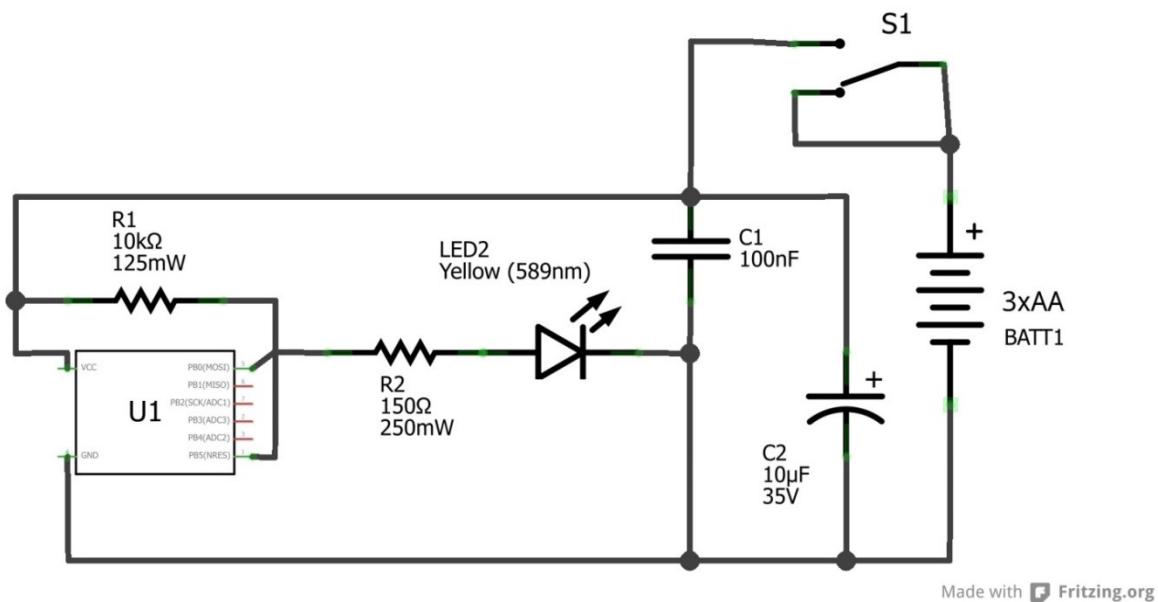

Figure 2. Schematic Diagram

Soldering Skill

You'll need some basic soldering skills in order to assemble *luminaria*. Don't be intimidated if this is your first time soldering, as it just requires a little attention to detail and some patience. Great soldering tutorials online at places like www.Sparkfun.com, www.Adafruit.com, and even NASA has a tutorial at radiojove.gsfc.nasa.gov/telescope/soldering.htm.

Things You'll Need

You'll need some basic soldering and hand tools to complete *luminaria*. Many of these items can be acquired for very little cost at big-box discount stores, well stocked craft centers, and electronic stores. The hot-glue gun, for example, can be found in the craft section of big 'mart' style stores for under $3!

Here's some things to have on hand when you begin assembly:

Safety glasses	Small needle-nose pliers	Paper towels
Soldering iron or station	63-37 flux core solder, 0.025"	Hot-glue gun (high-temp)
Tip-cleaning sponge	Flux-pen (optional)	Hot-glue sticks (multi-temp)
Flush-cut wire cutters	Rubber Band	Panavise Jr. or similar (optional)
Wire stripping tool	Rubbing alcohol	3 AA batteries
Cotton swabs	Multimeter (optional)	3M abrasive pad (optional)

## Parts List

Check the contents of the kit against Table 1.

Reference	Part	Quantity	Description
1	BATT1	1	3 x AA battery holder
2	C1	1	0.1 micro-Farad multi-layer ceramic capacitor
3	C2	1	10 micro-Farad electrolytic capacitor
4	LED1	1	Yellow Ultra-bright 5mm LED
6	PCB1	1	*luminaria* printed circuit board
7	R1	1	10k Ohm resistor
8	R2	1	150 Ohm resistor
9	S1	1	3 position switch
10	U1	1	Pre-programmed Attiny25 Microcontroller IC
11	U1_SOCKET	1	Standard8-pin DIP socket
12	Paper Bag	1	Place your finished *luminaria* inside!

Table 1 Parts List

Before you begin…

Here are a few things you might find helpful:

- ✓ Read the entire guide before you start. E-mail if you have any questions.
- ✓ Cleaning all the component leads with a cotton-swab and rubbing alcohol helps reduce the likelihood of soldering problems.
- ✓ Use good quality solder. Consider the 'no-clean' type so you can skip cleaning the flux from the bottom of the board. Good solder costs a little more, but the results are worth it. MG Chemicals 63/37 flux core solder (cat. no. 4884) was used in the development of *luminaria.*
- ✓ You don't need the most expensive tools to get great results. Simple equipment from a discount 'Mart' type store or Harbor Freight will be more than adequate. Check the craft aisle for small pliers and wire cutters.
- ✓ Use a 25-40watt soldering iron. Again, you don't need a super-expensive iron.
- ✓ Figure 3 is a picture of PCB1 included for your reference
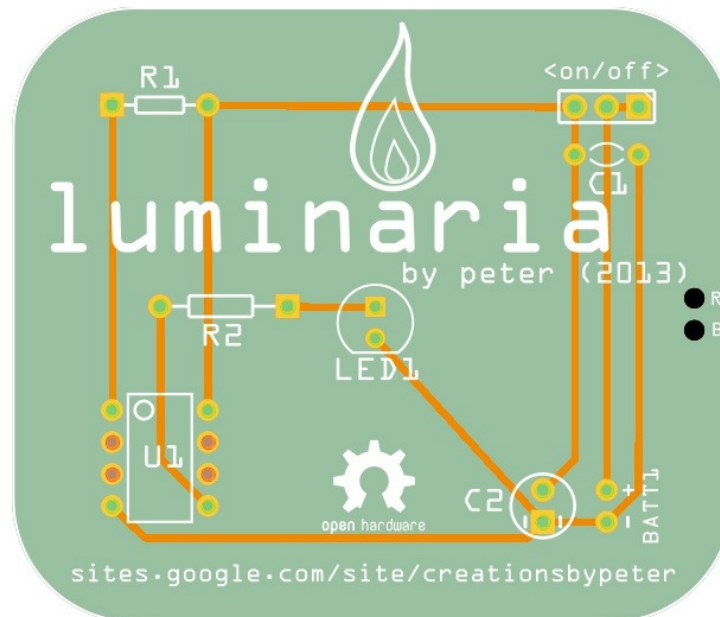
Figure 3 Drawing of *luminaria*

Assembly

1. Clean both sides of PCB1 with a paper towel and some rubbing alcohol.
2. Install R1 (the small resistor), R2 (the large resistor), C1 (the small capacitor) and C2 (the large, black capacitor) into their respective places on the board as marked. Gently bend the leads outward as necessary to hold the parts in place. *Be sure to observe polarity when installing C2* (the longer lead goes through the round solder pad). Solder the components in place and clip the excess leads off the board.
3. Install switch S1 on top of the board. A small rubber band wrapped around the board will hold S1 in place. Position S1 so it is flush with the board. Solder one pin of S1 in place. Remove the rubber band and make sure that S1 is flush against the board. Solder the remaining two pins in place and clip the excess from the pins.
4. Insert the U1_SOCKET into PCB1 so the indentation on one end is closest to the 'dot' marking on the U1 outline. Use the rubber band to hold the socket in place. Solder two socket pins on opposite corners (doesn't matter which corners) of U1_SOCKET in place. Remove the rubber band and ensure the socket is still flush against the board. Solder the rest of the pins in place and clip the excess from the pins.
   o OPTIONAL: You can solder U1 *directly* into the board if you don't want to use the U1_SOCKET. Be sure to orient U1 properly on the board. Using the U1_SOCKET is recommended as it will help prevent heat-damage to U1
5. Insert LED1 into PCB1 with the longer lead going through the square solder pad. Make sure that LED1 is flush against PCB1. You can gently bend the leads outwards a bit to hold LED1 in place. Solder LED1 into place. Clip the excess from the leads.
6. Now it's time to install BATT1 battery-holder. You may want to shorten the leads down to about 2". Strip ¼" from the ends of the leads and tin the bare wire with solder.
7. Thread the BATT1 leads through the top of the PCB into the two holes located on the far right-side of the board. Make sure the red (+) lead goes through the hole nearest S1 and the black (-) lead through the hole nearest C2.
8. Now insert the tinned ends of the BATT1 leads up through the corresponding BATT1 holes located on the lower-right side of the board. Be careful to observe polarity.
9. Solder the BATT1 leads from the top side of the board. Clip the excess from the leads.
10. Now pull the slack wire back through the holes so they are flush against the bottom of the board.
11. Insert U1 into the socket on the PCB, making sure the silver dot is closest to the notch at one end of the socket. Double check that U1 is inserted correctly and completely into the board.
12. It's time to test *luminaria* for the first time! Make sure the switch S1 is in the 'off' position. Insert three AA batteries into the battery holder. IT'S VERY IMPORTANT TO TEST *LUMINARIA* BEFORE YOU GLUE IT TO THE BATTERY HOLDER! It will be much easier to correct any problems if you have access to the solder joints on the back of the board!
13. Slide switch S1 to the 'on' position. LED1 should flash three times in quick succession and then begin 'flickering' like a candle flame. The flickering will be difficult to see directly because LED1 is

very, very bright. Try reflecting the light off a wall and you will see the flickering. If you're having any difficulties check the troubleshooting section of this guide.

14. Now that your *luminaria* is working, you can glue the battery holder to the bottom of PCB1. While you're heating up the glue gun, clean the top of the battery holder with some rubbing alcohol and a paper towel. Scuffing the top surface of the battery holder with a green 3M scrubbing pad will help the hot-glue stick much better.

15. Apply two generous globs of hot-glue to the top of the battery holder on either side of the wire running across the top of the battery holder. Don't get too much on the wire. Now press PCB1 onto the glue and hold it down on the battery holder, aligning the board so it's edges are flush with the battery holder before the glue sets.

16. Your *luminaria* is finished! Turn it on and put it inside the included paper bag. The effect is much more pronounced in a darkened room. Remember, *luminaria* is capable of running for days on end with a fresh set of alkaline batteries. Enjoy!

Troubleshooting Tips

Here's a few thing to check if *luminaria* doesn't work when you turn it on:

- ✓ Make sure the batteries are fresh and inserted correctly.
- ✓ Make sure U1 is inserted with the correct orientation
- ✓ Double check the polarity of both LED1 and C2.
- ✓ Double check the polarity of the BATT1 battery holder leads.
- ✓ Check to see if you missed any soldering joints.
- ✓ Check for cold soldering joints. Use a cotton swab soaked in alcohol to clean away the flux on any suspect joints when checking.
- ✓ If you have a multimeter, check that there is about 4.5 volts DC at the BATT1 soldering joints on the PCB. If not, remove and re-insert the batteries and check again.
- ✓ Rubbing alcohol can be used to release the hot glue after it's cooled if you need to remove the battery holder. Be sure to let the excess alcohol dry before re-installing the battery holder.

Contact

If you have questions about the instructions or if you find any errors you can send e-mail to petercriddell@me.com. For additional information about *luminaria* please visit https://github.com/petercriddell/luminaria.   You can also see more pictures and a video of luminaria in action at https://sites.google.com/site/creationsbypeter/.