Lab 5 C – LED Night Light Soldering

GOAL

The overall goal of Lab 5 is to demonstrate a battery powered LED night light. LED brightness is controlled using a phototransistor and PWM.

OBJECTIVES

Lab5a: (1) Design the triangle wave generator, photosensor, and comparator.
                       (2) Simulate your design in Multisim.

Lab5b: (1) Build a prototype on a breadboard.
                       (3) Test your prototype to validate your design.

Lab5c: (1) Build a soldered version.
                       (2) Demonstrate and hand in a working system.

GENERAL GUIDELINES

1) Each student builds his/her own circuits.
2) Test stations (e.g. oscilloscope, computer) must be shared.
3) You are allowed (even encouraged) to help each other. Of course, Professor Hedrick will be around to provide assistance as well.
4) **Use neat wiring for your circuits! Starting in Lab 2, a messy circuit will cost you 1 pt (out of 10 for the demo).**
5) Keep your circuit components organized to make it easier to do the subsequent labs!
6) Each student must turn in his/her own lab report. See the course website for the template.

   Honor Code Compliance: **You must turn in your own work**! Blatant duplication of circuit analysis, design, simulations, and/or lab reports will result in ZERO points and possible reporting to the Honor Council.

   NOTE: There will be one lab exam near the end of the term. The lab exam will test each student's ability to use Simetrix and prototype a circuit.

PARTS AND MATERIALS

- Power supply, scope, scope probes, banana cables
- Lab kit containing breadboard, wires, wire stripper, and other tools
- LM358 op amp   (one)
- LM311 comparator   (one)
- SFH3310 Phototransistor   (one)
- C503B-WAN white LED   (one)
- Resistors: You choose!   (a whole bunch)
- Capacitors: You choose!   (one)
              0.1 uF for power supply bypass (optional)

- AA batteries   (three)
- AA 3-pack battery holder   (one)

INTRODUCTION

The overall goal of Lab6 (two weeks) is to build a battery-powered LED night light. The LED brightness depends on the ambient light level. You get to keep the soldered version of your circuit (includes battery pack)! The overall specifications are the following:

1) $+V_{CC} = 4.5$ V (three AA batteries) and $-V_{EE} = 0$ V
2) Lamp is a single white LED
3) Automatic dimmer: A light sensor (phototransistor) measures the ambient light level. High ambient light will cause the LED to turn off. Low ambient light will cause the LED to become bright.
4) LED dimming is performed with PWM, where the PWM signal is implemented with a triangle wave generator and comparator.

Some other circuit features are the following:

1) Use a LM358 chip, which contains TWO op amps (suitable for single-supply operation).
2) Use a LM311 voltage comparator (suitable for single-supply operation with output current up to 50 mA).
3) The phototransistor is the SFH3310, which is good for detecting visible wavelengths.
4) The white LED is the C503B-WAN made by Cree.
5) The peak current of the LED should be $I_{LED} \approx 20$ mA (can be slightly higher or lower).
6) You can directly drive the LED with the LM311 comparator – this keeps the parts count low (nice!).


PART 1: BREADBOARD PROTOTYPE

It is a good idea to confirm your breadboarded amplifier still works!

- Clean up the wiring – this produces an easier-to-follow "blueprint" for your soldering.
- Hook up $V_{CC} = +4.5$V
- Use the scope to measure the triangle wave.
- Wave your hand across the phototransistor to change the LED brightness.
- You do NOT have to demo your completed prototype.
- Professor Hedrick can provide assistance if your prototype is no longer working and you cannot figure out the reason.

PART 2: SOLDERING

When you first solder your circuit, you should do the following:

- Use the benchtop supply to power your circuit (see right figure).
- Use the 8-pin IC sockets for the LM358 op amp and LM311 comparator. You can then plug in the actual chips into these sockets.
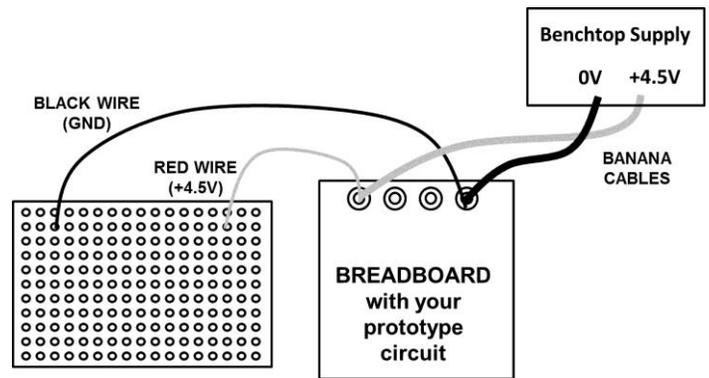
PART 3: TESTING

- Make the following two tests:

  1) Use the scope to confirm the triangle wave peak-to-peak amplitude and frequency.
  2) Wave your hand across the phototransistor to change the LED brightness.

- Once you have confirmed that your soldered circuit works, replace the benchtop supply with the battery pack.

  1) Record a scope trace of the triangle wave output.
  2) Measure the peak-to-peak amplitude and frequency.

  ➢ **Demo your battery-powered LED night light to Professor Hedrick** .
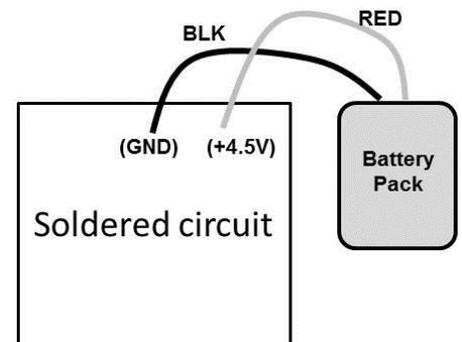
Extra time:

- There is a chance you will need extra time. There will be some soldering irons in N108 for the next week.

(End of Lab 5 part C)