

Night Light Project

The goal of this project is to allow students to learn skills in:

- Understanding simple circuits
- Using a breadboard
- Soldering and circuit assembly
- 3D design

Not all groups may need to complete this project, consult your TA and instructor to determine if this project is optional for your group.

This night light will be powered by a 9V battery and will contain a photo-resistor so that it turns on when it gets dark. It will also contain a switch so that it can be turned off when not in use to conserve the battery.

Circuit

The circuit at the right will serve as our night light (1). The 100K Ohm resistor and photo-resistor form a voltage divider. The resistance of the photo-resistor increases as it senses less light, which increased the voltage at the base of the transistor increasing the current in both the base and through the LED, turning on the night light. The 330 Ohm resistor is there simply to reduce the current through the LED to conserve power as once the LED is turned on to a sufficient brightness, any additional current through the LED is wasted.

Our circuit will use a 9V battery, two LEDs and a switch to turn off the entire night light at times the light is to be stored and not used. There is no reason to have the night light shine in a closed, empty drawer.

Parts List

- 100K Ohm resistor
- 330 Ohm resistor
- Photo-resistor (5mm GL5537)
- 9V battery
- 2N3904 NPN transistor (or similar NPN transistor)
- 2 5mm white LEDs
- Slide switch (<https://www.adafruit.com/product/805>)

In order to learn how the circuit works and test its functionality, students will build the circuit on a breadboard. Breadboards allow prototyping circuits without having to solder and have the added benefit of being reusable. Components will be inserted into the breadboard along already connected strips. Electrical connections will be made between components inserted along the same row or via columns on the outside of the board (see the dark, red or blue lines on the figure). The longer red or blue bus lines are designed to be used as voltage carriers and grounds. After ensuring that the circuit functions properly on the breadboard, groups will work towards a finished product. Components will be inserted into a perfboard and soldered to ensure proper electrical connections and functionality.

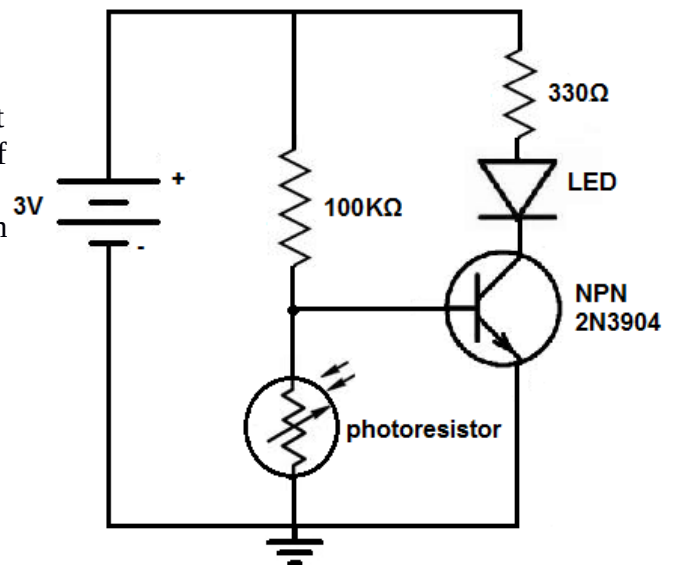


Illustration 1: Night Light Circuit (1)

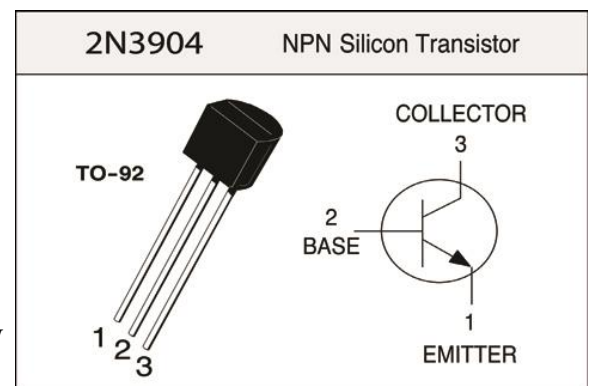


Illustration 2: Pinout of 2N3904 (2)

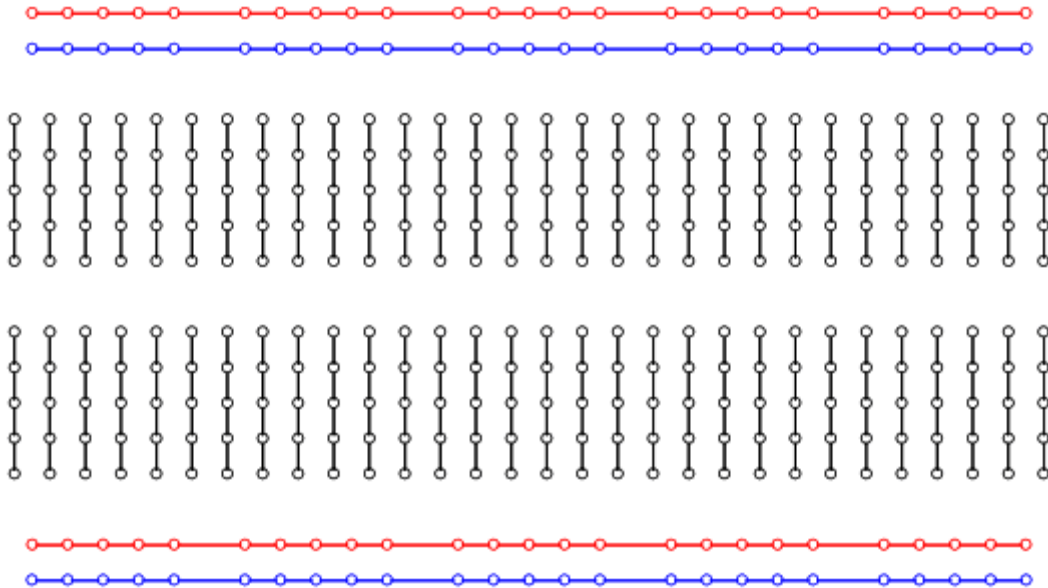


Illustration 3: Breadboard Common Connections (3)

Case Design

A multitude of platforms exist for 3D design. In this class, students will be supported on the OnShape platform⁽⁴⁾. This platform provides a free educational account and can be used within a web browser making it accessible from multiple operating systems. OnShape's also allows users to share projects so that multiple members can edit simultaneously as well as allowing a TA to view designs to avoid early errors.

Several tutorials exist for learning OnShape and it is recommended that you familiarize yourself with the platform. ⁽⁵⁾ ⁽⁶⁾ New users will find it relatively easy to use the shape, dimension, and extrude features to quickly design a basic case prototype. More precise features are covered in the tutorial and can also be explored via OnShape's expansive Learning Center⁽⁷⁾.

While many different CAD file formats exist, it is recommended that STL files be exported.⁽⁸⁾ The STL files will be then be used in Cura.⁽⁹⁾ Cura is software from Ultimaker that will be used to generate gcode files that the Ultimaker printers can use to print parts.

NOTES:

- *Due a bug, when exporting files from OnShape, select units of millimeters. For some reason if inches is selected, Cura will use millimeters anyway.*
- *You should NOT print your parts. The TA and instructor should print all parts.*

An image of a proposed case designed with Onshape shows several key components. 5mm holes for the LEDs and photo-resistor as well as a hole for the switch. The "plugs" are simply to allow a user to place the unit in a standard wall socket and are not intended to conduct. The plug ends have a fillet to allow the ends to be attached more firmly to the back of the case.

Your case need not match the one shown here, this is shown simply as an example that contains various key components required for the case.

Instructions for Project

Not all groups will need to complete all of these steps. If your project will not use parts of the following components, your group may be exempt. Consult your TA and instructor to obtain permission to skip steps. While the entire group is responsible for the project, members may divide the work in an equitable manner.

- Obtain the cost of the parts as well as a supplier for the parts. Put those in either a spreadsheet or word table document.
- Build and test the circuit on a breadboard
- Design a case for the project and show your design to your TA
- Design the layout of the parts of the circuit on paper including the dimensions of your board
- Solder the components on the board
- Assemble and demonstrate the final unit.

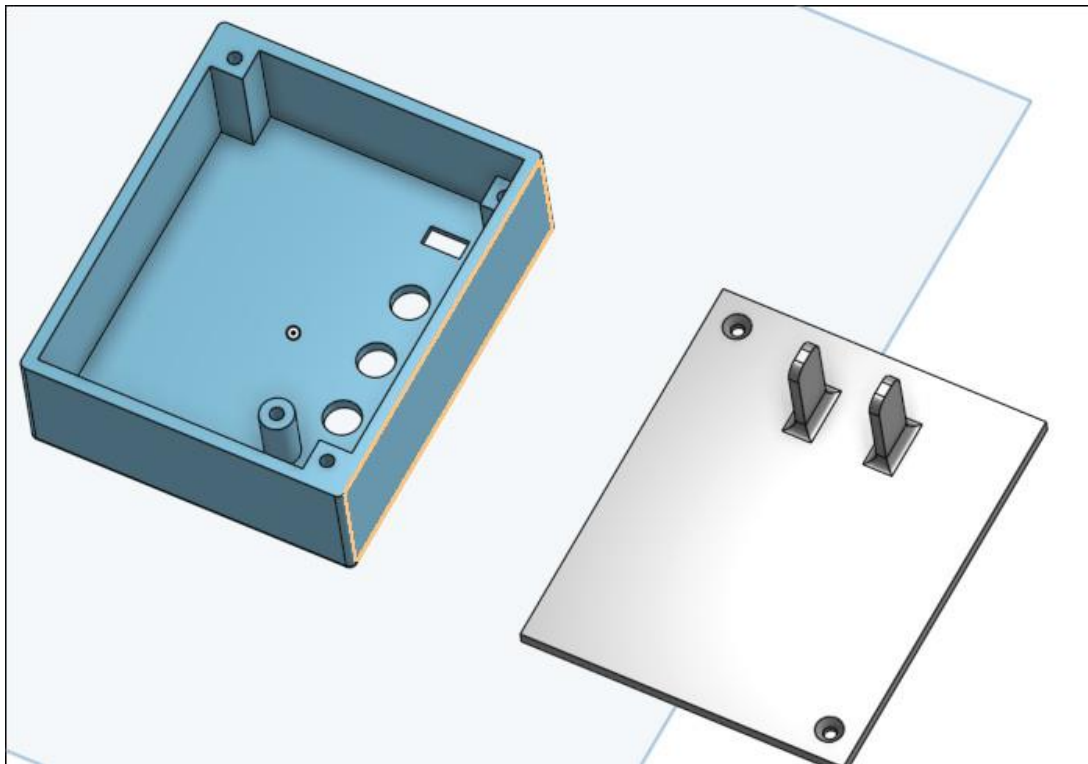


Illustration 4: Image captured from design in OnShape

Resources

- 1) “How to build a dark activated light circuit.”, <http://www.learningaboutelectronics.com/Articles/Dark-activated-light-circuit.php>, accessed 8/2/2018
- 2) “2n3094 5pcs”, <http://robotechshop.com/shop/components/transistors/2n3904-5pcs/?v=7516fd43adaa>, accessed 8/8/2018
- 3) “ECEN 2250 – Introduction to Circuits & Electronics”, <http://ecee.colorado.edu/~mathys/ecen2250/myDAQ01/index.html>, accessed 8/7/2018
- 4) OnShape, <https://www.onshape.com/>, accessed 8/2/2018
- 5) “Beginner Tutorial 1/5 – Onshape 3D CAD – Creating Sketches and Objects”, <https://www.youtube.com/watch?v=pMWnsHpDIQE&t=18s>, accessed 8/8/2018
- 6) “Onshape CAD for 3D Printing Tutorial”, <https://www.youtube.com/watch?v=kj-oZgmRB2w&t=73s>, accessed 8/8/2018
- 7) OnShape Learning Center, <https://learn.onshape.com/>, accessed 8/6/2018
- 8) “STL File Format”, [https://en.wikipedia.org/wiki/STL_\(file_format\)](https://en.wikipedia.org/wiki/STL_(file_format)), accessed 8/8/2018
- 9) “Ultimaker Cura Software”, <https://ultimaker.com/en/products/ultimaker-cura-software>, accessed 8/8/2018