Project 1C - Traffic Light Enclosure

Rapid Prototyping & Fabrication

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Introduction

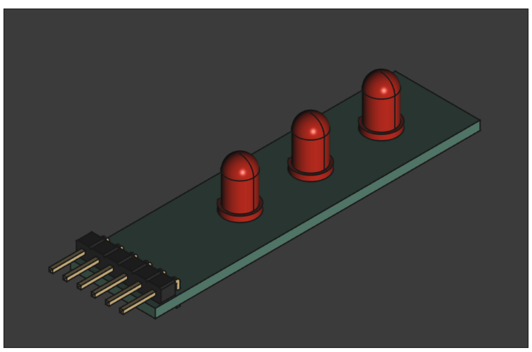
The purpose of this project was to construct an enclosure for the previously protoboarded circuit. The circuit board has three LEDs aranged in a line, resembling a traffic light. Additionally, the protoboard has a 1x6 right angle pin header with 100 mil pitch at the base. These pins are to be connected to a breadboard. The purpose of the enclosure is to protect the electronics from the outside environment and give it a more "finished" look.

Requirements

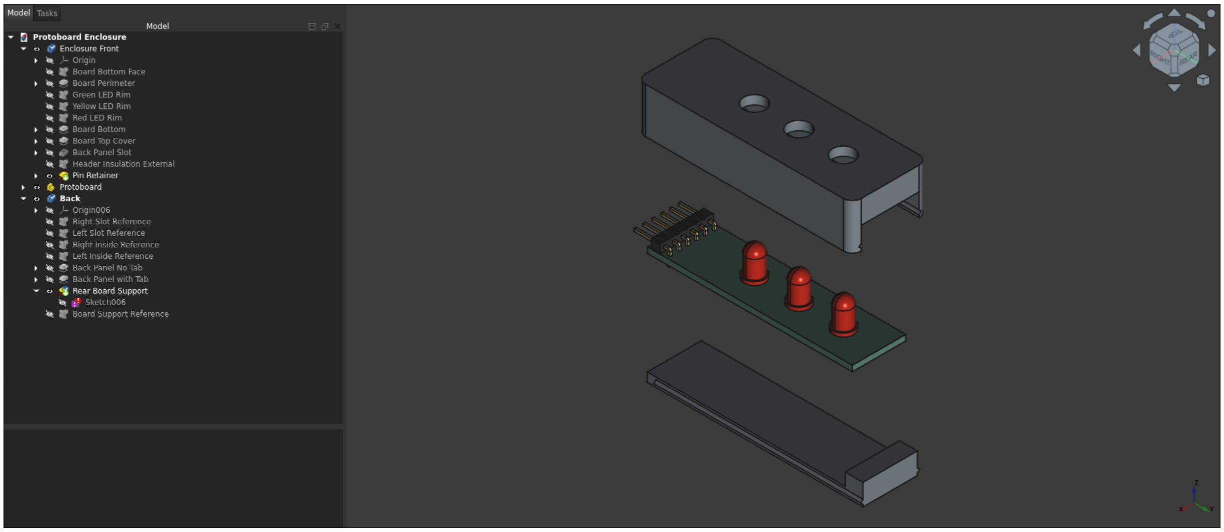
1. Enclosure must have two pieces
2. Enclosure must achieve an IP20 rating
3. LEDs and header pins must extend through case walls
4. All screws must fasten to heat set inserts
5. Two halves must mate mechanically

Procedure

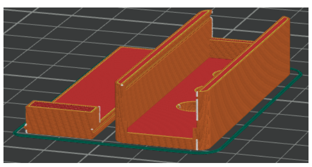
First, we created a low-resolution mockup of the protoboard, with its most prominent features present. This was done in ECAD with standard component libaries to ensure proper sizing. The board edges were also measured, and the final PCB was exported as a STEP file for use in MCAD. This model is seen in the figure below:



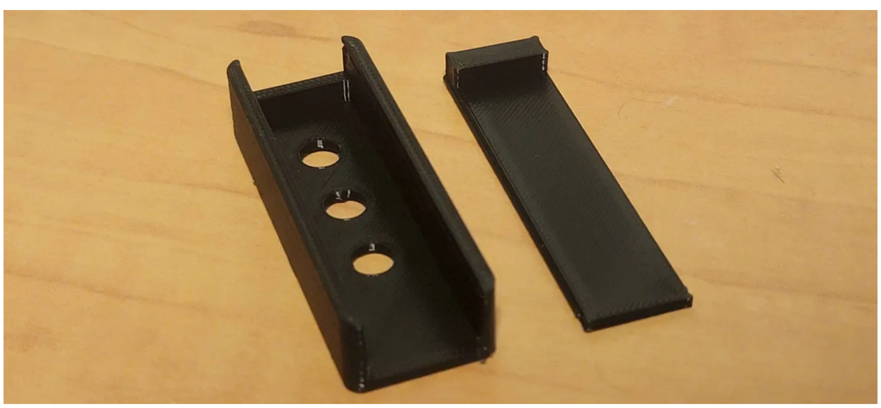
Next, the enclosure front was built up around the model with 25 mil gaps on all sides of the board except the edge with pins to add some wiggle room for the PCB. This shape was extruded vertically, both above and below the board to create the walls of the enclosure. Then the top face was added, using the protoboard model as a guide to cut holes for the LEDs to poke through. Finally, another body, the back panel, was added. This panel adds both a back to the enclosure, further protecting the electronics, and internal support for the PCB to restrict its motion inside the enclosure. Grooves and tabs were added to the front and back pieces respectively to allow them to slide together. The final model is seen in the figure below:



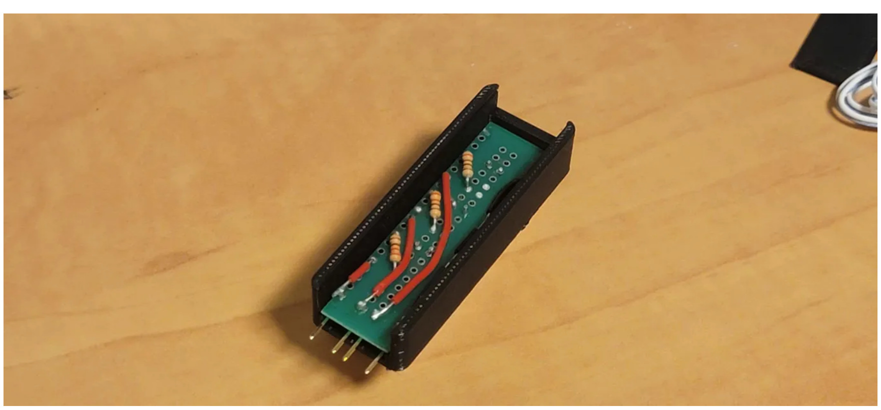
Once the model was done, we exported the two bodies as STL files, and sliced them using Orca Slicer. The sliced gemetries are seen below:



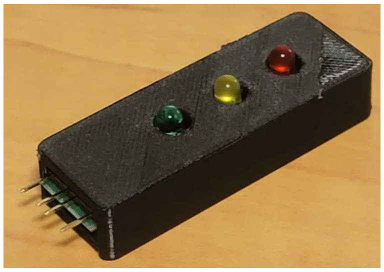
The two parts, fresh off the 3D printer are seen below:



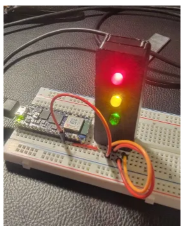
We assembeled the two halves in a final test fit. First, we tested the board fit, as seen below:



We had used a 20mil (~0.5mm) tolerance for the sliding fit (Galiki, Kondo, and Wilson 2023). The final fit was loose, but still acceptable. The fully assembled case with board inside is seen below:



Plugging it in, we can confim that the circuitry still works, and the pins are able to plug fully into the breadboard still, as seen below:



Reflection

Initially, we planned for the top of the enclosure to slide with dovetail-like joints into the bottom half. That way, when the board slid in with the top, it would fall into a pocket, securing the enclosure together. Unfortunately, this design made the pins less accessable, since the board had to be surrounded on all four edges. Fortunately, this was easily remidied, since the design could be easily modified. Speaking of ease of modification, using realtive measurements proved to be highly valuable. Going back and making changes was very simple this way. Additionally, we learned that doing small test prints was very helpful for testing fit, to see if dimensions had to be made smaller or larger. Finally, we learned that using ECAD and MCAD tools together, to combine their strenths, is super useful. Using ECAD to make the PCB model with standard library parts was way faster than measuring all the dimensions of the parts on the board.

References

Galiki, Ofir, Hironori Kondo, and Zachary Wilson. 2023. "3D Printing Tolerances: How to Test & Improve Them." 2023. https://all3dp.com/2/3d-printing-tolerances-test-fdm/.