Final Technical Report

MedTech Prototyping Skills (BME290L)

2023-04-13

Due Date: April 29, 2023 @ 09:00
Late Due Date (no penalty): May 05, 2023 @ 09:00

This final technical report is the culmination of almost all of the skills that you have developed in this course. Technical documentation is just as important in engineering as being savvy at CAD/ECAD. This report will be a single PDF file that you will upload to the associated Gradescope assignment, due the last week of classes.

The following sections should be included in your report…

1 Needs / Specifications

Summarize the stated user needs and associated specifications for the electronics and the enclosure.

1.1 Enclosure

- Ergonomically held in one hand
- Ability to "easily" push the button to turn on the blinking lights with the hand holding the device
- Can be stable placed on a flat surface and operated without picking it up from that flat surface.
- Batteries can be "easily" replaced.
- Power switch will not be inadvertently switched "off" during operation.
- Potentiometer knobs are accessible, but can use a second hand to adjust them.
- Board is securely mounted using your 4 mounting holes.
- Test pads will be accessible for testing the electronics when the board is mounted inside (assuming a cover of some sort can be removed to access the board). In other words, the entire board does not need to be removed for any debugging / testing.
- Wires between the PCB connectors and the peripheral components are purposely routed / secured internally.
- All peripheral components securely mounted in outer shell of the enclosure.
- Batteries securely mounted using 2x2 or 1x4 AA battery holders.

- Size (smaller is better)
- Weight (again, smaller is better)
- Weight balance (”hand feel”)
- Ergonomics / aesthetics. Try to avoid corners and straight edges. Curves are good (and not sharp).
- Stress concentrations if your device fell from 6 ft.

1.2 Electronics

- Specify nominal function of all external items the user interacts with (switches, buttons, knobs, LEDs, etc.)
- Assign specifications (testable target values) for the LED functions (e.g., astable frequency, monostable period). We will assume that ”passing” is having a 95% confidence interval[1] that falls within $\pm 10\%$ of these nominal values.

2 Design Documents

2.1 Functional Decomposition

Please include a complete functional decomposition of your device.

2.2 ECAD

2.2.1 Schematic Capture

Be sure to include all sheets. Demonstrate all best practices in your schematics.

2.2.2 PCB Layout

Show the front and back layers, separately. Instead of ”plotting” the layers, you can take screenshots that best show each layer, with the other layer ”hidden”.

2.2.3 Bill of Materials

This should be generated using KiCad’s tool, including footprints and items excluded from the PCB. Consider using the Interactive HTML BOM extension.

2.3 CAD

- Orthographic mechanical drawings of all parts.
- 3D renderings of the exploded assembly.

[1] For normally-distributed data, 95% CI $\approx$ 2 SD.

3 Testing & Analysis

Note: If your PCB is not working in a reasonable timeframe, we will find another PCB for you to perform all of your testing on.

3.1 Testing to Specification

For each user need / specification outlined in the first section, test how well you met each need / specification, assuming that your test passes if your 95% CIs are within ±10% of the nominal specifications. For measurable quantities with inherent variability, this means that you need to have replicate measurements of these values!

Oscilloscope output can be captured using cellphone screenshots with measurements being displayed on the scope.

For any tests that do not pass, please provide an explanation for why the test didn't pass and what you might change in your design to increase the likelihood of passing if your design was revised. For example:

> The nominal astable frequency was 10±1 Hz, but my astable output was 9.1±0.5 Hz. This performance fails at 95% CI. One reason for this failure was associated with the 15% tolerance on the resistors and capacitors used to configure this astable oscillator. As shown in the table below, Rx and Ry varied by over 10% from the nominal values, leading to a negative bias in the output frequency.

3.2 Test Power Consumption

In addition to the specifications that you designed your device around, please provide an analysis of the battery life of your device. This can be estimated by measuring the current demands of your circuit when "idle" and when blinking the LED.

You will want to indirectly estimate this battery life, and not try to test this by simply running your device with batteries until they fully discharge.

3.3 Optimizations

For the specifications that could be optimized (e.g., size, weight, etc.) comment on how your design optimized these quantities, and given your current insights, how your design could be revised to improve upon these criteria.

4 Microcontroller

You will be uploading your microcontroller firmware as a zip archive to a separate Gradescope assignment, using all of the best practices discussed in lecture. These include:

- Organized inclusion of libraries
- Definition of preprocessor macros
- Consolidated initialization of global variables

- Source code without ”hard-coded” functional values
- Logical, ”action-based” main loop

In this report, include:

1. Testing data of the same LED outputs as your did for the discrete electronics version of your device.
2. Please include a discussion of the ”pros” and ”cons” of implementing the desired LED functions using discrete electronics versus a microcontroller.