EE101 Semester Project

Through the semester several of our labs have been working toward a final project, the 555 timer function generator. Labs 6, 7, 9 and 13 each included portions of the project which culminated with the etching and soldering in Lab 13. The last step is to write a formal report on the project as a whole. This should be a typed, well-written (and proofread) report that documents the stages of this project. This report is worth 10% of your final grade for this course.

This project should be similar to what you may experience in research or industry. You will often be asked to solve a problem or produce a product to serve a particular purpose. You may be given some design parameters that leave you to choose the specific parts and methods needed to implement the design. We will treat this project that way, as it was introduced as a product design project. Typically these projects will involve planning, design, status reports, prototyping, production and a final report. We have been replicating that experience with the related lab exercises, and now it's time to culminate everything into the final report.

Think of it as a project assigned like this, which is basically a summary of the lab design instructions.

> Required Actions
> Design, simulate and test a prototype TTL function generator capable of outputting a square wave with adjustable frequency in the following ranges:
>
> 1Hz - 10Hz
> 10 Hz - 100 Hz
> 100 Hz - 1 KHz
> 1 KHz - 10 KHz
> 10 KHz - 100 KHz
>
> According to design restraints imposed, build and test the circuit which implements the first frequency range of 1-10 Hz. The output should be displayed using alternately flashing LED's in two colors – one to designate a high signal and the other to designate a low.

From this description you would develop an idea of how you can break up this requirement into smaller tasks that you can do piece by piece. A plan of action for the above project might look this:

> **Part I:** Design a function generator around 555 timer chip. First implement the 1Hz to 10Hz range (after we have that working we will add the other ranges later). Draw the schematic in PSpice and simulate it so that you can work out any major bugs before prototyping it.
>
> **Part II:** Add provision for the other frequency ranges in the design and build the function generator on a protoboard. Test its operation for each range from 1Hz up to 100 KHz and alter the design and schematic as necessary.
>
> **Part III:** Generate the circuit trace artwork for implementation of the first frequency range. This artwork will be used to construct a PCB (printed circuit board) from the PSpice schematic.
>
> **Part IV:** Using the circuit traces generated by Pspice, etch the PCB for the function generator, solder components in place, and test functionality.
>
> **Part V:** Formally document your design.

This looks a lot like the way our four labs were divided up doesn't it? So you have already completed most of the steps of this project in prior lab exercises. The only remaining portion is part V, documenting the process in the formal report.

The following instructions outline what should be in your report and how it should be formatted. Remember that this is a formal report. In academia or industry, often the quality of presentation will figure highly in your success at procuring funding, acquiring approval to manufacture a product, or other kinds of evaluations. Be thorough and concise, and remember that quality writing requires several stages of editing and proofreading. Use quality images for your figures, display data in tables, and keep an organized format.

Your report should include the following sections:

1. **Title page:** Including name of project, name of team or division, names of team members and author, and date. In your case, since you are not working on teams, include the title, your name, date, and class.

2. **Abstract:** *This essentially is a preview summary of your report*. An abstract is a concise, one paragraph description of your entire project. This may sound hard to do but it doesn't need to be. In this case a good strategy would be to include one sentence describing the needed features of the function generator you designed and one sentence for each of the four individual labs/parts of the bigger project. Later in the report you will expand on these concepts in greater detail.

3. **Design procedure:** *The goal of this part is to convey what you did in this project*. A description of the total design process. Here you want to describe each part of the plan, each lab you did, with a few sentences in a short paragraph. Talk about what you did in Pspice - how you simulated the design - in one paragraph. In the next paragraph summarize the prototyping and testing process. Another paragraph should describe the construction process of etching and soldering. You don't need to include specific results as there is another section coming for that, instead summarize the results in terms of performance. You also don't have to stick to one paragraph for each section, but remember you don't need to write a book either.

4. **Theory of operation:** *Here the basic idea is to describe how your device works*. Here you should describe how and why the function generator works, including the 555 timer, the circuit built around it, and the LEDs. Include any equations and formulae you developed or borrowed (mention where they came from) that can be used to determine the characteristics of the system. Include the equation for f_{osc} in this part and the process of choosing parts and confirming that it will operate within the design constraints. You should go into enough detail that someone of your own level of expertise could pick up the report and understand the basics of how the device works. Include a block diagram of the system in question (the function generator). The internal workings of the 555 timer, as discussed in class and outlined on the data sheet, should be included here. Remember that we are looking to describe how the RC circuit determines the timing of the circuit and what is happening inside the 555 timer to interpret the RC circuit and toggle the output. Schematics will also be useful in this section.

5. **Results and Conclusions:** *The purpose of this part is to evaluate your implementation of the project*. In this section you detail the performance of the device – whether it does what it was supposed to. Mention what went as expected and what did not. Compare and analyze data sets from theoretical calculations, simulation, and experimental testing. If the design did not meet the specs for each frequency range, explain why and discuss whether the margin of error is acceptable. Describe your conclusions about why it did or did not perform as expected, what went well, and what you would do differently.

6. **Appendix:** Last but not least you should include the following pertinent information in an appendix

    - Data sheet for the 555 timer chip (the title page from the data sheet is sufficient, the point here is to be able to find it and use it.)

    - A BOM or "bill of materials" on which you must list what parts and materials were used in the final product. Specify part numbers, quantity and cost of each item and a total. Check the instructor's website for links to vendors of electronic supplies. For some items like PC board you may have to estimate a per-square-inch cost based on the price of another size of board (also the blue paper which costs $1.50 for a 8.5x11 sheet). Mention (but do not calculate a cost for) in-stock expendables like etching solution and solder.

    - All relevant diagrams/images/figures (schematics, board layout, maybe a picture of your finished product, etc).

Ethics

All work, including this report, is subject to institution policy on academic honesty. Any incidents of dishonest work will be handled in accordance with these rules, and reported to proper authorities. Any report that has any portion copied, without a reference to the source of this copied material, is considered plagiarism, as well as work copied from other students.