Report for Laboratory 1: Lab Summary

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Abstract. A BeagleBone Black (BBB) single-board open-source computer was implemented as a low-cost fully programmable pulse generator. The pulse generator makes use of the BBB Programmable Real-Time Unit (PRU) subsystem to achieve a deterministic temporal resolution of 5 ns, an RMS jitter of 290 ps and a timebase stability on the order of 10 ppm. A Python-based software framework has also been developed to simplify the usage of the pulse generator.

See the LaTeX tutorial below in Appendix A. You should delete Appendix A and the following filler text when using the template.

The suggested structure of the document is given. In the following sections, content is suggested by direct quotes from MIT's Guidelines for Writing a Lab Report. This text should obviously be deleted at some point.

1 Summary of Fedrizzi Article

In this article (, Fedrizzi2015) a BeagleBone Black single-board open source computer was used as a pulse generator in an effort to determine its overall accuracy and precision. The more expensive pulse generators are known to be both, but with the restrictions of budget this particular generator needed to be tested. This testing took the form of producing pulses at a set frequency with defined temporal offsets. Python is used to create parameters for the experiment and to measure and record the delays between the switching tasks of output timing pulses. The ability to use Python in this manner is another advantage that the BBB has over many commercial pulse generators.

The experiment found that, as expected, commercial competitors had an overall higher degree of precision and accuracy, they could not match the versatility offered by the BBB, which can receive the Python inputs. The price is also a factor that the commercial generators could not match. This means that the BeagleBone Black single-board open source computer can be effectively used by those in an academic setting as long as the accuracy is taken into account when collecting data for the experiment.

2 Materials and Methods

"This is like a cooking recipe. Include enough detail so that someone can repeat the experiment. It is important that the reader be able to interpret the results knowing the context in which they were obtained.

"The Materials and Methods section should be written in the past tense, since your experiments are completed at the time you are writing your paper."

Here are some things you don't want to do in this section.

1. Don't simply copy and paste material from my description.
2. Don't simply list the procedure in bullet points (although some lists are fine). I want a description in *your* words.
3. Don't use a figure from my description unless you properly cite it! A proper citation would be (**?**, p. 32).

3 Results

"To write the results section, use the figures and tables as a guide. Start by outlining, in point form, what you found, going slowly through each part of the figures. Then take the points and group them into paragraphs, and finally order the points within each paragraph. Present the data as fully as possible, including stuff that at the moment does not quite make sense.

"Verbs in the results section are usually in the past tense. Only established scientific knowledge is written about in the present tense, 'the world is round,' for example. You cannot presume that your own data are part of the body of established scientific knowledge, and so when you describe your own results, use the past tense, 'a band of 1.3 KB was seen,' for example. There are, however, exceptions to this general rule. It is acceptable to say, 'Table 3 shows the sizes of the DNA fragments in our preparation.' It is also acceptable to say, 'In a 1991 paper, Ebright and coworkers used PCR to mutagenize DNA.' ...

"Some readers begin by scanning the figures first. The figures, with the legends, should provide a self-explanatory overview of your data. Decide what the data show, then create figures which highlight the most important points of your paper.

"Tables are used to present repetitive data that is numerical. Graphs or illustrations, collectively called figures, are used to present numerical trends, raw data (like a picture of a gel), or a model that explains your work.

"When you prepare your figures and tables, keep in mind that it is significantly more expensive for journals to publish figures and tables than text, so try to present the data in a way that is worthy of such added expense."

4 Discussion

"This is the section of the paper for you to show off your understanding of the data. You should summarize what you found. Explain how this relates to what others have found. Explain the implications."

5 Author Contributions

You are required to describe each member's contributions to the laboratory exercise and report.

References

K. Ciesielski. *Set Theory for the Working Mathematician*. London Mathematical Society Student Texts. Cambridge University Press, 1997. ISBN 9780521594653.

Derek Rowell and David N. Wormley. *System Dynamics: An Introduction*. Prentice Hall, 1997.

A Appendix: LaTeX Tutorial

I'm going to teach you how to use LaTeX a little bit. Like how to cite a source, insert a graphic, and build tables. Follow along in the `report.tex` file.

Do not use this appendix as any sort of template for the report! Equations, figures, and tables should appear in the body of the report. Delete this appendix before submitting your report.

A.1 Citing a Source

Let's cite a source. The source must be already saved as a BibTeX file (`.bib`) in the same directory as the `.tex` document. I have already created a sample `report.bib` file. (If you want to add and remove sources to this file, you may use a reference manager like BibDesk on a Mac or JabRef on a PC.)

The next step is to cite the source, inline (Rowell and Wormley, 1997). And I can easily cite another reference (Ciesielski, 1997).

A.2 Equations

Equations should appear in the body of the report, especially in the Introduction (**??**), when describing your theoretical predictions. An equation should be part of a complete sentence.

Here are some examples.

We now see that

$$x = 1. \tag{1}$$

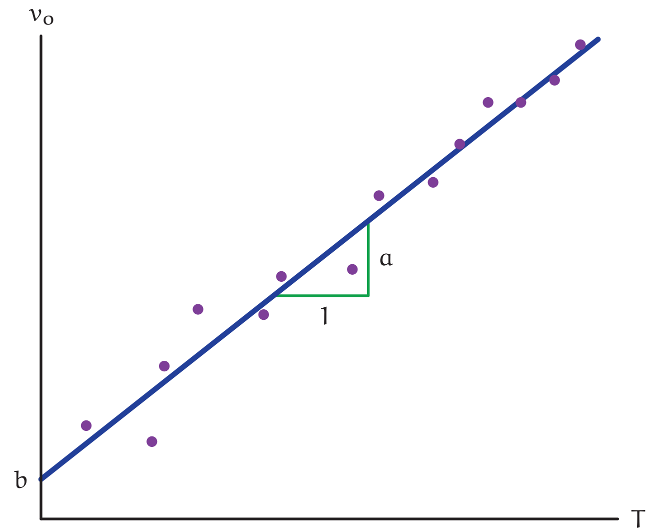

Figure 1: here's a caption.

Somehow, the following impossible equation hold:

$$\int_0^t x_2 \sin x \, dx = \begin{bmatrix} 1 & 0 & 8 \\ 0 & x^7 & \\ 7 & & \end{bmatrix}. \tag{2}$$

We now see that

$$\boldsymbol{x} = \boldsymbol{\alpha} \left(\left(\frac{2}{3} \right) + \frac{5}{6} \right), \tag{3}$$

where $\boldsymbol{\alpha}$ is the coefficient of stupidity.

And this works too: $\frac{\partial x}{\partial y}$.

$$\begin{aligned} x &= 2y && \text{(where } x > 2) \\ y &= 4x + 8 \end{aligned}$$

Later, you could refer to the equation Equation 2.

Or you could do it multiple times: Equation 2.

A.3 Figures

It is easy enough to add a figure. In the subdirectory `figures`, I placed a file `data.pdf`. If we want to include it in the document, we use the following commands.

We can easily reference the figure with its label, like Figure 1.

A.4 Tables

Tables can be a pain in LaTeX. Here's a simple table.

Notice (as in Table 1) that these things don't go where they're entered. Most of the time it's preferable to have a figure or table "float" such that it is at the top or bottom of a column.

	label 1	**label 2**
Interesting thing	5.1	603
Thing of interest	pigtails	x^3

Table 1: a table caption.