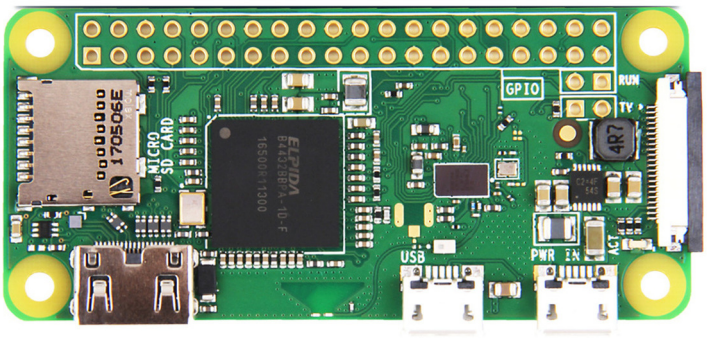
University of Cape Town



EEE3096S/EEE3095S

Embedded Systems II

Work Packages 2021

29 August 2021

Abstract

Welcome to the practicals for EEE3096S. These instruction are applicable to all practicals so please take note! It is critical to do the pre-practical/tutorial work. Tutors will not help you with questions with answers that would have been known had you done the pre-practical work. The UCT EE Wiki (wiki.ee.uct.ac.za) is a very useful point to find any additional learning resources you might need. Use the search functionality on the top right of the page.

Practical Instructions

- **Naming**
  All files submitted to Vula need to be in the format. Marks will be deducted if not.

```
pracnum_studnum1_studnum2.fileformat
```

- **Submission**
  - Work packages consist of a tutorial and a practical. Be sure you submit to the correct submission on Vula!
  - If working in a prac group, do only one submission to Vula for the team (i.e. by one of the team members). Ensure all files submitted to Vula are in the format: pracnum_studnum1_studnum2.fileformat (although if you are submitting a zip file, you do not need to have all the sub-files named according to the student numbers, but do please have the report filename containing student numbers to ensure the marker is aware that it is a team submission).
  - All text assignments must be submitted as pdf, and pdf only.
  - Code within PDFs should not be as a screenshot, but as text.
  - Where appropriate, each pdf should contain a link to your GitHub repository.
- **Groups**
  All practicals are to be completed in groups of 2. If a group of 2 can't be formed, permission will be needed to form a group of 3. You are to collaborate online with your partners. See more here.
- **Mark Deductions**
  Occasionally, marks will be deducted from practicals. These will be conveyed to you in the practical, but many will be consistent across practicals, such as incorrectly names submissions or including code as a screenshot instead of formatted text.
- **Late Penalties**
  Late penalties will be applied for all assignments submitted after the due date without a valid reason. They will work as 10% deduction per day, up to a maximum of 60%. After this, you will receive 0% and have the submission marked as incomplete.

Contents

Work Package 3

1 Tutorial - I2C, Debouncing and PWM

Submit a single PDF (named correctly with STUDNUM1_STUDNUM2_Tut3.pdf) answering the following questions. If you pull from any sources, be sure to correctly cite them.

1.1 I2C

I2C is a synchronous (a common clock signal is used to synchronise the data transfer) communication protocol. It requires only two bus line, SDA (data line) and SCL (Clock line). Each device connected on the bus is identified by its unique address.

1. Give the message structure for I2C protocol when master communicates with slave. [4]
2. Give 2 advantages of I2C over SPI? [2]
3. Describe the start and stop conditions for I2C. [2]
4. Draw a timing diagram showing a Master sending 0b11010101 to slave at address 0b1110000. [8]

1.2 PWM

The RPi doesn't have an on-board Digital to Analog Converter (DAC) and so cannot be used to generate analogue voltages of a particular value directly. However, the RPi does have a pulse width modulation (PWM) controller that can output 2 independent PWM signals (2 channels).

A PWM signal is a square wave for which the frequency and duty cycle can be adjusted by the controller. By adjusting the Frequency (the number of repeating cycles per second) and the duty cycle (the percentage of time that the square wave is high versus low), the resulting average voltage of the waveform can be adjusted. By changing the average voltage the controller is able to adjust the average power delivered to a load. This can be used to adjust the brightness of a LED, or the speed of a DC motor, or the position of a servo motor.

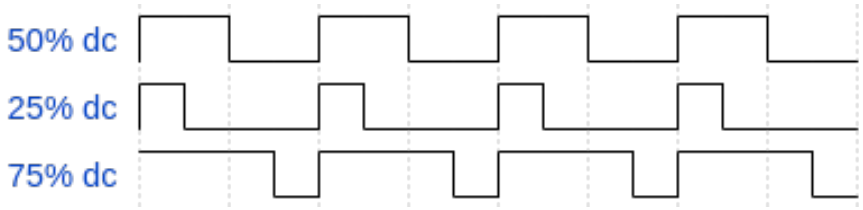


Figure 1.1: Fixed frequency, changing duty cycle PWM

1. Why is it, that PWM in software on the Raspberry Pi is particularly ineffective/does not work? Hint: Make reference back to Real Time systems and requirements, paying attention to the operating system used on the Raspberry Pi [2]
2. Explain the concept of persistence of vision, and why it can be useful in simplifying circuit designs. [2]
3. What is the difference between PWM frequency and the duty cycle? [1]
4. Which parameter should you change if you are trying to increase the brightness of an LED being driven by a PWM signal? [1]

!!!Marks will be deducted for not following instructions.!!!