# Breadboard Assignment Instructions

*EEE3088F 2024*

# General Instructions

This document contains the instruction sheets for both the power and sensing subsystems. Please read through this document carefully and make sure that you understand all the assignment requirements. There are two assessments linked to this assignment: the breadboard demonstration and a short report on your design. The demonstration is worth 15% of your mark and the report is worth 10% of your mark. A special note is that the assessment is **individual.**

## Group work

For this assignment and the remainder of the semester, you will be working in pairs of your choice (please remember to sign up). In your pairs, you must decide who will be responsible for each subsystem. Please note that you will be responsible for the subsystem throughout the entire semester for all assignments.

Although you are working in pairs, you will **each** be required to attend the lab demonstrations and submit your own report. You **will receive an individual mark.**

We encourage you to communicate and collaborate with your teammate throughout the course, it will likely take you farther than if you go alone.

## General Notes

1. One of the core skills of an engineer is the ability to ask questions and communicate with the client to ensure that you deliver the correct product. If you do not understand something, do some research and if you still do not understand then ask – suffering in silence is a mistake.
2. All changes to this document will be communicated via an announcement. Please keep track of these communications and download the latest version so that you do not miss out on key changes.
3. During the lab sessions tutors will be available to help you. However, you will need to do some work outside of these hours if you wish to make good use of the time with tutors.
4. **Adhere to the strict page limit on the report. You will be penalised for exceeding 8 pages.**
5. Again, this is an **individual** assessment. Each person will need to **submit an individual report** for the subsystem they have completed.
6. ***All reports must be written in LaTeX.***
7. ***Please name your PDF report submissions according to the following convention: EEE3088F 2024 Assignment 1 Report (Your Subsystem Name) Surname-Initial STUDENTNUMBER.pdf***

# Power Subsystem Assignment

## Project Description

You are required to design and build a circuit capable of driving a stepper motor using a high impedance logic (switching) signal. The solution must be capable of using a 3V3 logic input signal and draw a maximum of 1mA. Additionally, the solution must be capable of sustaining 1.5A at 12V on the output. You will likely use a DC power supply to obtain the 12V and a microcontroller to supply the logic signal for switching the motor on and off. The solution must fit on a single breadboard and consist of less than 20 components. All components must be sourced from White Lab.

## Materials Available

All components that you require to build a solution are available from White Lab.

## Testing the subsystem

### *Demo Expectations*

During the demonstration, the breadboard circuit will receive the required logic signal and will then be required to supply a 1.5A output current.

| Assessment | Requirement | Mark Allocated |
|---|---|---|
| Logic 1 | Switching ON/OFF | 1 |
| Logic 1a | ON at greater than 2.4V | 0.5 |
| Logic 1b | OFF at less than 0.5V | 0.5 |
| Power 1 | Current draw no more than 1mA on input stage | 1 |
| Power 2 | Circuit operates at 12V | 1 |
| Power 3 | Voltage across load is at least 11.5V at 1.5A | 2 |
| Power 4 | Switching speed ON-OFF / OFF-ON less than 1us | 1 |
| Design 1 | Less than 20 components used. | 1 |
| | Total | 7 |

### *Report Expectations*

In addition to the practical component, you are required to write a report detailing your design. This report must be written in LaTeX – a sample template and tutorial have been released on Amathuba.

| Report Structure | Description | Page limit |
|---|---|---|
| Introduction | Write a brief introduction about your subsystem. Include the following key information:<br>▪ A *design problem statement* (single sentence)<br>▪ Context Diagram (as discussed in class)<br>▪ High-level requirements diagram (as discussed in class)<br>▪ The specifications and requirements of the project.<br>▪ A discussion about the expected operation of your circuit and how you will test for this. | 2 pages |
| | Calculations and circuit schematic. | 2 pages |

| | | |
|---|---|---|
| Subsystem Design | Brief description of solution. | |
| System Integration Design | How would you integrate your circuit with a microcontroller to control a DC motor? Include any considerations you would need to make. | 2 pages |
| | Include a system interfacing diagram. | |
| Conclusion | Reflect on what specifications and requirements your solution met. Explain how you tested your system for each requirement and specification. Preferably use a table to show this.<br>*You will not lose marks for not meeting your specifications or requirements but rather you will be marked on your ability to test your system.* | 1 page |
| Extra Page | This extra page is given as a grace for formatting your report nicely. | 1 page |

***Please note that marks will be allocated to report presentation (grammar, formatting, use of space, etc.).***

# Sensing Subsystem Assignment

## Project Description

You are required to design and build a sensing system which can detect whether a wall is present in the sense direction. The system must be able to repeatably detect the presence of an external reflector from different physical locations on a testing rig, as shown in Figure 1. The system should take Infrared (IR) light as input and produce a signal-based output (an oscilloscope will be used to read the output). Additionally, the power source will be a 1S1P 18650 battery. All components used must be sourced from White Lab.

## Materials Available

All components that you require to build a solution are available from White Lab. There are potentially others, but the generally accepted ones are: [QRD1114, SFH205, TSAL6100, LDRs]

If you would like other components, you would need to look through the White Lab parts list here. You need to only build the sensing section of your sensor subsystem.

## Testing the subsystem

***Demo Expectations***

A testing rig with multiple predefined sensor positions will be used. At each location, your sensor will be rotated between +15 and –15 degrees along multiple small intervals from the original starting position. During this movement, the analog output will be measured and recorded using an oscilloscope. This testing procedure is visually shown in Figure 1.

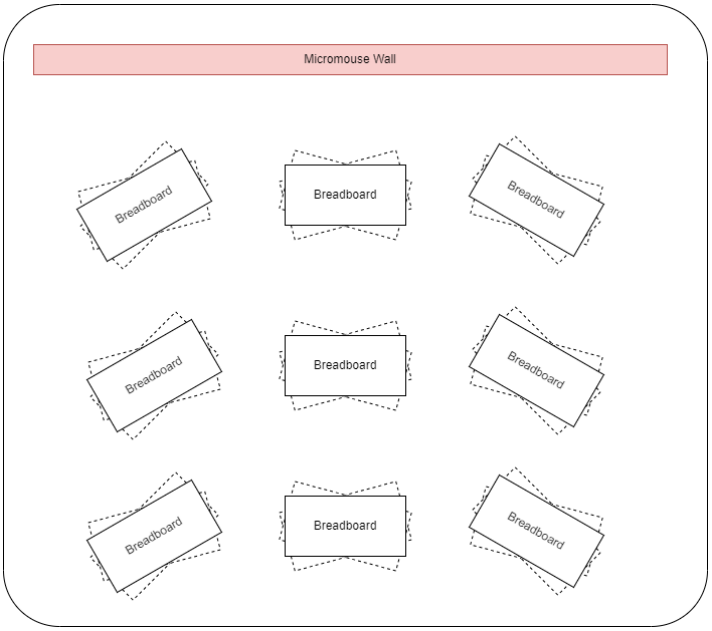


Figure 1: Testing Rig and procedure for testing the Analog Sensor

There should be a clear detectable difference between a far obstacle location and close location with preferably little difference between the *small* offset of angle to the wall. Additionally, your circuit will

be assessed based on how repeatable your outputs are e.g. if it is placed in position A then moved to position B and then back to A does the system respond the same way?

| Assessment | Requirement | Mark Allocated |
|---|---|---|
| Power 1 | Sensor operates on power supplied from a battery. | 1 |
| Sense 1 | Sensor's detection of the wall at different distances. | 3 |
| Sense 1a | Close - 60mm | 1 |
| Sense 1b | Mid - 180mm | 1 |
| Sense 1c | Far - 250mm | 1 |
| Sense 2 | Rotation Movement | 2 |
| Sense 2a | Justify the response of the sensor when rotated through an angle relative to the wall. | 1 |
| Sense 2b | Sensor does not respond to small changes in angle (what does jiggling the board do?) | 1 |
| Sense 3 | Repeatable outputs. | 1 |
| | **Total** | **7** |

### *Report Expectations*

In addition to the practical component, you are required to write a report detailing your design. This report must be written in LaTeX – a sample template and tutorial have been released on Amathuba.

| Report Structure | Description | Page limit |
|---|---|---|
| Introduction | Write a brief introduction about your subsystem. Include the following key information:<br>▪ A *design problem statement* (single sentence)<br>▪ Context Diagram (as discussed in class)<br>▪ High-level requirements diagram (as discussed in class)<br>▪ The specifications and requirements of the project.<br>▪ A discussion about the expected operation of your circuit and how you will test for this. | 2 pages |
| Subsystem Design | Calculations and circuit schematic. | 2 pages |
| | Brief description of solution. | |
| System Integration Design | Using screenshots of your sensor's outputs (taken from an oscilloscope), explain what additional circuitry you would need to integrate your circuit with a microcontroller.<br>*Pictures of the outputs taken from an external camera will be penalised, use the oscilloscope's onboard screenshot functionality.* | 2 pages |
| | Include a system interfacing diagram. | |
| | What is the effective resolution of your subsystem? | |
| Conclusion | Reflect on what specifications and requirements your solution met. Explain how you tested your system for each requirement and specification. Preferably use a table to show this.<br>*You will not lose marks for not meeting your specifications or requirements but rather you will be marked on your ability to test your system.* | 1 page |

| | | |
|---|---|---|
| Extra Page | This extra page is given as a grace for formatting your report nicely. | 1 page |

***Please note that marks will be allocated to report presentation (grammar, formatting, use of space, etc.).***