Chapter 1

Subsystem Design

1.1 Design Decisions

1.1.1 Final Design

The final design is centred around the working of two circuits; the IR-emitter circuit and the IR-receiver circuit, (in order to meet SP04.)
Various configurations were considered for the IR-receiver circuit, particularly configurations involving photo-diodes and photo-transistors. Their trade-offs were compared, and the photo-transistor configuration was chosen.

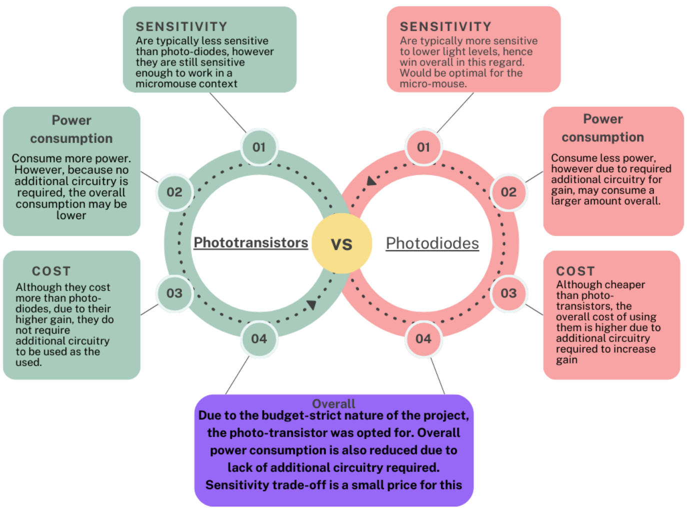


Figure 1.1: Comparison between phototransistor and photodiode

The choice was made to use the L-51ROPT1D1 phototransistor and OSRAM SFH-4544 IR-LED specifically was due to their spectral matching(940nm), which will ensures maximum signal strength, sensitivity and responsivity as both the receiver and the emitter will be operating at the same wavelengths.

In order to meet SP06 and UR02, the unique design decision to make use of a transistor to act as a switch within the IR-emitter circuit design was made.It will ensure that IR signals are only emitted once a command is given by the MCU, hence allowing for power saving functionality (through the use

of code), as well as greater overall control of the circuit.
The decision to use a MOSFET as opposed to the other types of transistors was made due to faster switching speeds, lower conduction losses, and simpler drive circuitry. The drawback was that they are more prone to damage caused by electrostatic charges.
To align with the budget-strict nature of the project, the AO3401A MOSFET P-CH SOT23-3L was chosen.

Capacitors were incorporated into the design in order to stabilize the supply voltage (remove noise) as well as to reduce the turn time on the IR-emitter circuit. These proved to be reasonable trade-offs for the increase in overall cost that they posed. Even then, cheaper capacitors were used to save money.

For saved cost, surface mount resistors were chosen instead of through hole resistors (which are more expensive). The trade off was that these types of resistors are harder to remove and replace from the PCB, which may make things harder to fix if values were miscalculated.

Resistor values were calculated in the figure below:

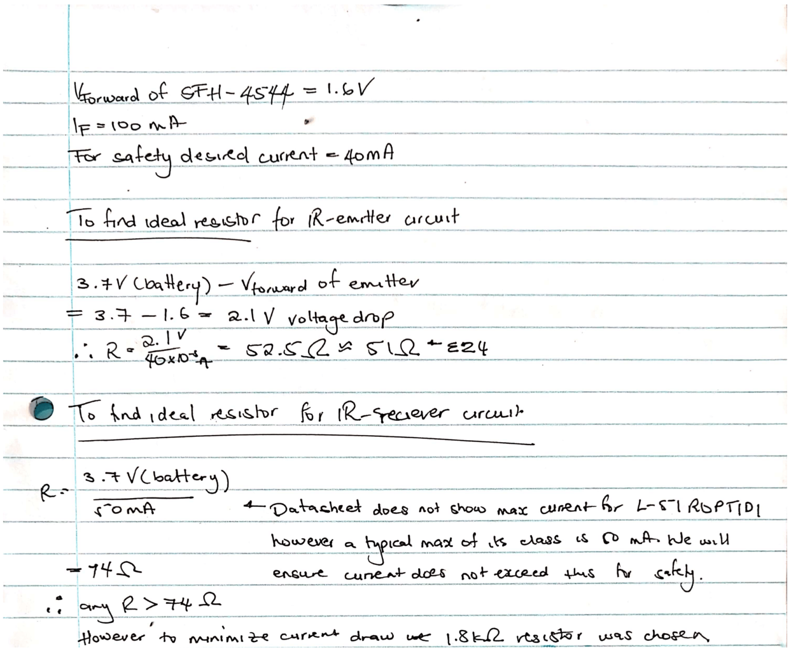


Figure 1.2: Resistor Value Calculations

If these resistor values are replaced with others, it may result in damage of components on one extreme (too low) or higher current draw on the other extreme, which may cause increased power consumption and hinder UR04.

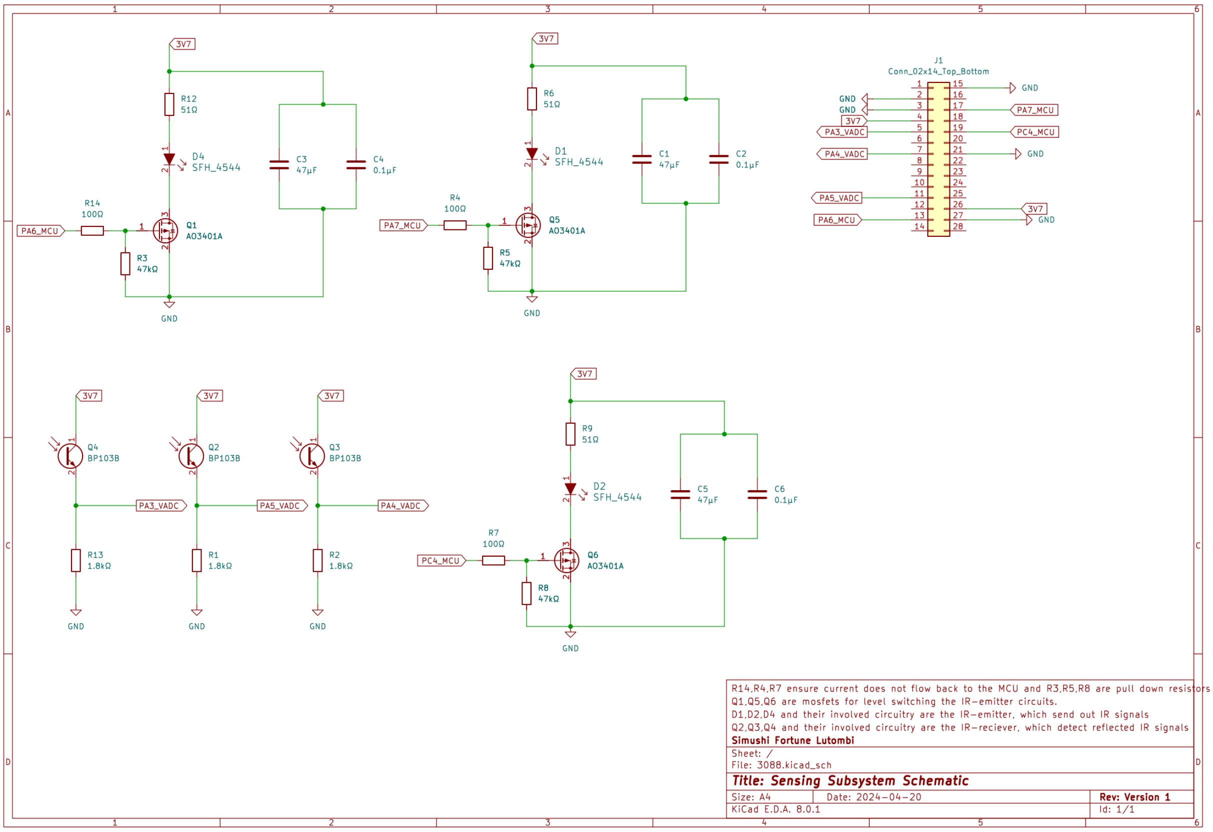
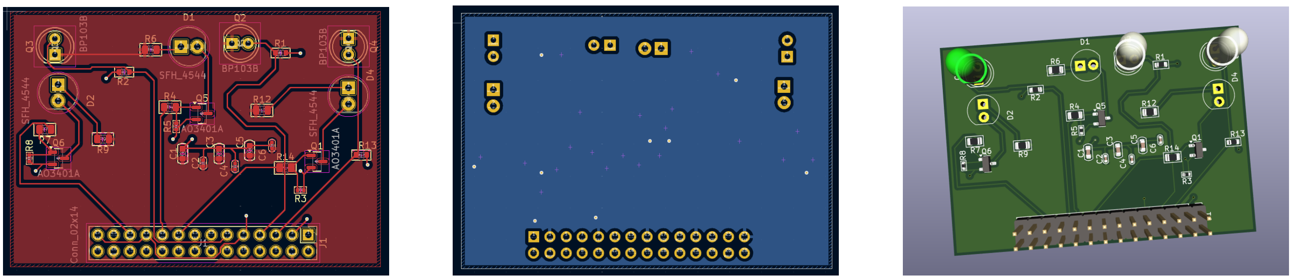


Figure 1.3: Schematic



(a) Front PCB

(b) Back PCB

(c) 3D PCB

Figure 1.4: PCB

1.2 Failure Management

Table 1.1: Failure Management Processes

Name	Description
Non-right angle traces	90° traces were generally avoided to reduce the formation of acid traps during
Protective resistors	Various resistors were used to mitigate excessive current from flowing to components
Simulation of electrical circuit	The working of the electrical logic of the PCB was tested using Ki-cads inbuilt ERC functions to ensure that there were no errors in this regard
Design logic testing	Ki-cads inbuilt Design Rule Checking functionality was used to ensure that there were no obvious design faults, such as short circuits

1.3 System Integration and Interfacing

To integrate the subsystem with the rest of the system ....

Table 1.2: Interfacing specifications

Interface	Description	Pins/Output
I001	Sensing Submodule to Microcontroller(MC) for data transfer	• Pin7 to MC-PA4(GPIO) • Pin11 to MC-PA5(GPIO) • Pin5 to MC-PA3(GPIO) • Pin13 to MC-PA6(GPIO) • Pin17 to MC-PA7 • Pin19 to MC-PC4 • Pin2 to MC-GND • Pin3 to MC-GND • Pin15 to MC-GND • Pin21 to MC-GND • Pin27 to MC-GND • Pin4 to MC-Battery • Pin26 to MC-Battery

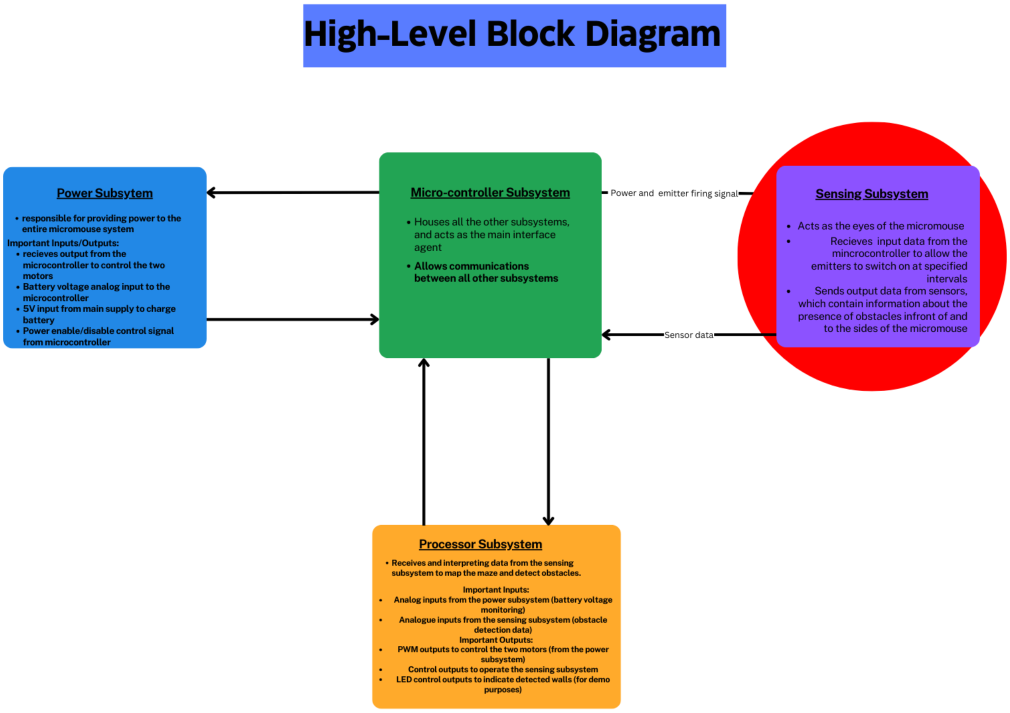


Figure 1.5: High-level Block Diagram

Bibliography