

Project Manual

Simulation Steering Wheel

ESCE 2010 - Fall 2025

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October 8, 2025

Project Resources

LTSpice Simulation File:

Github Link to .asc File

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1 Description

1.1 Complete Schematic and Block Diagram



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Figure 1: Complete circuit schematic - ALL major components must be clearly labeled



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Figure 2: Block diagram showing functional relationships between stages

1.2 High-Level Description of Operation and Intended Application

This project focuses on the design and fabrication of a custom simulation steering wheel, integrating load cells, buttons, and a servo to create a realistic driving experience for the user. The load cells measure precise grip force which is translated into throttle or braking; the buttons are timely triggered for insim actions; and the servo motor's rotational data is measured for steering functionality. All sensor data is then read and translated by the HID(Human Interface Device) format and relayed to a computer via a microcontroller - the microcontroller's only purpose is to read, not manipulate external data - which allows for seamless communication with a simulation software/application.

1.3 Description of Related Pre-Existing Applications

There are numerous existing sim wheel options from manufacturers such as LogitechG, Thrustmaster, and others. Entry-level models typically start around \$100, with midrange units costing up to \$300, and high-end versions—featuring force feedback, F1-style layouts, and other advanced features—reaching significantly higher prices. In contrast, this project aims to deliver similar functionality at a fraction of the cost, while maintaining high precision, simplicity, and ease of construction. However, unlike other commercial simulation wheels that rely heavily on microcon-

trollers to handle sensor inputs, this design focuses on hardware solutions while using as little power from a microcontroller, besides HID formatting, which has a combination of pros and cons.

2 Operation and Design

2.1 Input Block

2.1.1 Schematic



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Figure 3: Input block schematic with ALL components labeled

2.1.2 Design Equation

$$V_{out} = f(V_{in}) \quad (1)$$

where all variables are defined here or in the schematic.

2.1.3 Input/Output Plot



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Figure 4: I/O characteristic - from measurement, simulation, or datasheet (cite source!)

3 MS1 Building Block 1

3.1 Schematic

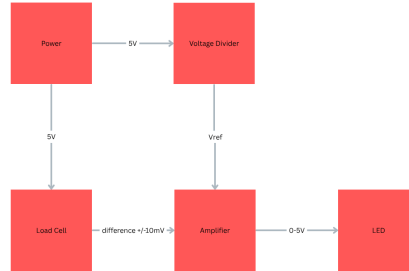


Figure 5: Building Block 1.1

3.2 Design Equation

Load Cell Output: *manufactures provide no internal resistances of wheatstone bridge besides output voltage*

$$V_{out} = \pm 10mV$$

Amplifier Gain:

$$G_m = 1 + \frac{49.4k\Omega}{R_G}$$

Voltage Divider:

$$V_{out} = V_{in} \times \frac{R_1}{R_1 + R_2}$$

Defined variables:

- G_m = gain multiplier
- R_G = resistor gain
- V_{out} = output to amplifier reference pin(6 recieving 2)
- R_1 & R_2 = resistors for voltage divider to get 2.5V output

3.3 Discussion of Component Choices

The loadcell has a 10mV output according to the manufacture(there is no information regarding the internal wheatstone bridge so cant provide a schematic for that). This means to get an LED lighting output, there needs to be a gain to 5V, which is approximately 500x multiplier. However, an input via a voltage divider supplies a baseline 2.5 volts, meaning there is only a required 50% gain, or 250x. Given the manufacture's gain of their AD8226 amp, it only requires a 200 ohm resistor to reach my threshold.

3.4 Input/Output Plot

3.5 Output Block

3.5.1 Schematic

Download

Figure 6: Input block schematic with ALL components labeled

3.5.2 Design Equation

$$V_{out} = f(V_{in}) \quad (2)$$

where all variables are defined here or in the schematic.

3.5.3 Input/Output Plot

Download

Figure 7: I/O characteristic - from measurement, simulation, or datasheet (cite source!)

4 Integration and Optimization

4.1 MS1

5 Operating Conditions

5.1 MS1

5.1.1 Limitations and Faults

A major limitation for this milestone is lack of complete data. The adafruit manufacturing team has provided poor documentation and schematics relating to their loadcell - only providing a Mandarin transcribed diagram with limited and inaccurate information(i.e. states range is 1-10kg but the one it is referencing is supposedly caps at 20kg load). Besides that

5.1.2 Tradeoffs Present in the Design

5.1.3 Circuit Improvements

6 ABET 3.2 Engineering Design Considerations

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7 References

References

Appendix