ECE437: Sensors and Instrumentation

Lab 5 – Capacitive Sensor

In this lab, you will get familiar with a capacitive sensor and you will learn how to communicate with the sensor using I2C serial protocol. The capacitive sensor is provided by Analog Devices. You will need to get familiar with the datasheet for the capacitive sensor. The datasheet contain all information regarding the capacitive sensor: technical specs and timing diagrams necessary to implement the I2C state machine. You will be implementing the write sequence of the I2C state machine.

The Capacitive Sensor

Before working with the sensor, you should become familiar with the sensor's specifications by browsing through the datasheet. The datasheet can be found at the following link:


Based on the datasheet, please answer the questions in Checkpoint 1.

Checkpoint 1 (40 pts)

Following the timing diagram provided on page 5 of the sensor’s data sheet, implement the read state machine in Verilog. Make sure that you can send the data from the FPGA to the PC using the necessary OplaKelly Verilog and Python code. Verify that you can read data from the data registers. You will need to read the data value from both input channels as well as their averaged values. Display the data in Python and present it to the TA.

Checkpoint 2 (30 pts)

Place your finger on the pads on the capacitive sensor. Press on the capacitance and demonstrate that it is inversely proportional with distance.

Checkpoint 3 (20 pts)

We will read only a single digital bit from the sensor that indicates an event when the sensed capacitance has exceeded a threshold value. You will program the sensor to use absolute or adaptive thresholds and you will also set the sensitivity of the thresholding operation. Note: the sensor outputs a single bit indicating that the capacitance has changed with respect to a threshold value. You will read this value from the sensor and display this information in Python.

You will need to write the Verilog code to write to the necessary registers to set the two different threshold modes as well as the sensitivity of the thresholding. Demonstrate these capabilities to the TA.
Questions (10 pts)
1. Describe how does a proximity capacitor sensor work?
2. You are using a capacitive sensor from Analog Devices, with part number AD7156. What kind of information does the “Status Register” provides in this sensor? What kind of information do bits 3 and 5 in the “Status Register” provide?
3. How are the date registers organized? Does the chip provide average data reading and if so how is the average data computed?
4. What does adaptive thresholding do on the data?
5. What does the Sensitivity Register do with respect to adaptive thresholding? Draw the necessary input and output diagram as well as equations necessary to understand how to set the desired sensitivity range.
6. What is the maximum capacitance that the sensor can detect?
7. For the three checkpoints, include a snapshot image demonstrating that you have completed the milestone. For each checklist, also elaborate on the results that you have observed during the experiment. What problems did you encounter and how did you solve them?
8. Include a printout of your Verilog code for each milestone.