

# **ECE 3829: Advanced Digital System Design with FPGAs**

## **A Term 2020**

### **Lab 4 - Oscilloscope**

#### **Report due Friday October 16<sup>th</sup> at noon**

Use the VGA controller and Light Sensor module to create a simple oscilloscope.

This project combines parts of Lab 2(VGA controller and seven segment display) and Lab 3 (light sensor). There are multiple parts to this project. To be successful will require a good design and debugging approach. Make simpler projects that you can test and debug separately and then combine them together.

This lab (and report) will be worth 25% of your course lab grade.

**Lab Signoff Deadline:** during a lab session by Thursday October 15<sup>th</sup> at 5pm.

#### ***Description***

##### **Part 1: Oscilloscope on VGA display**

- Use an MMCM to create a 25MHz output for the VGA display, and a 10MHz output for the light sensor interface and other sequential logic.
- Add your seven-segment display from your previous labs (no changes required)
- Create a blue border one-pixel wide, 512-pixels horizontal, by 256-pixels vertical, in the top left of the VGA display – this will be the oscilloscope window
- Move a one-pixel white block from left to right in the oscilloscope window at a rate of one second (i.e. moves 512-pixels in one second) – horizontal scan
- Create an SPI interface to be able to read the 8-bits of light sensor information from the PmodALS module provided.
  - Read the light sensor value at a rate of 10Hz
- Display the light sensor value in hexadecimal on two of the seven-segment displays (00 to approx. FF).
- As the oscilloscope pixel moves horizontally, use the light sensor value to move the oscilloscope pixel in the y-axis
  - 00 corresponds to a low voltage – bottom of oscilloscope window
  - FF corresponds to high voltage – top of oscilloscope window

##### **Part 2: Light sensor sample count**

- Use two of the seven segment displays to create a count in decimal from 00 to 99 (and repeating)
- The count should increment each time a new light sensor value is obtained (at 10Hz)

### Part 3: Text display

- To the right of the oscilloscope window, display the first three characters of your first name

### Extra credit

Up to 10% lab bonus points for any good improvements or enhancements to your design (must demo on board **and** describe in your report with pictures).

### **Notes:**

Your final design should combine parts 1, 2, and 3.

Write a **short** report including: a description of your design including a good block diagram of your overall design, pictures (especially of your text display), and a conclusion describing any problems or issues you had, and lessons learned.

## **Grading Guidelines**

- [60 pts] Implementation
  - [60 pts] Design works on board and meets requirements
- [20 pts] Source Code
  - Code style and comments (well-commented and tab-indented code!)
  - Use of *case* vs. *if*, spaghetti code vs. structured, etc.
  - Recognizable implementation of "standard" elements (state machines, counters, shift registers, clock dividers, decoders)
  - Good modular design
  - No latches or other synthesis problems
- [20 pts] Lab Report
  - [15 pts] Description of lab (including good block diagram and pictures of your display)
  - [5 pts] Conclusions
    - Problems faced in implementation
    - Solutions used to solve problems
    - Lessons learned from the project
    - Suggestions for further improvements and extensions
- [10 pts] Extra points
  - Possible extra points for good additional features or capabilities (need to demo on board and include description in report)

## **ECE 3829: Lab 4 sign-off sheet**

### **Part 1 (Oscilloscope)**

Oscilloscope trace show value of light sensor in real-time

(moves left to right and up/down)

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Light sensor value shown on seven segment displays (00 to FF)

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### **Part 2 (Light Sensor sample count)**

Seven segment display increments from 00 to 99

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### **Part 3 (Text display)**

VGA Display shows first three characters of first name

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### **All combined**

All parts are combined into one project

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### **Extra Credit (describe)**

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