

EECE 277

FPGA Design

Fall 2014, Dr. William H. Robinson

Laboratory Assignment Three

Due: *Monday, November 3, 2014 at the beginning of class*

OBJECTIVE

The purpose of the assignment is to incorporate display devices such as a VGA monitor and an LCD display into your project designs.

SAMPLE FILES

The software files related to the Altera DE2 Development and Education Board are available on OAK under “Labs – DE2-115 Board Information.” In addition, your Roth & John textbook has a CD that contains all the VHDL code from the textbook. There are also sample files related to this lab in the Laboratory Assignment #3 Folder on OAK.

COLLABORATION POLICY

Each team is responsible for completing the laboratory. Collaboration among teams is encouraged on the projects in this class, but only under the following conditions. Teams may discuss the laboratory assignment, the general approach taken to solve the problems, and compare results **without** comparing the entire solution. However, copying of code, results, or analyses of results is **NOT** allowed.

LABORATORY DESCRIPTION

You will need to read the following material from your textbook:

- CHAPTER 2 – Introduction to VHDL
- CHAPTER 8 – Additional Topics in VHDL

In addition, please refer to the documentation posted in the “DE2-115 Board Information” folder under the “Lab” section on OAK.

For each problem below, you should turn in the schematic or VHDL corresponding to the design as well as the simulation code and/or results that verify the design. Your VHDL code should include appropriate comments including the header file described in your lecture notes. In addition, you should answer any problem-specific questions (e.g., find the delay time). You will

also need to demonstrate your solutions to your instructor. Demonstrations should be as efficient as possible. Simulation results can be as simple as loading the wave log file (WLF) from ModelSim-Altera. DE2 demonstrations can be as simple as opening the Quartus II programmer and configuring the FPGA. **You will also need to upload all project-related files (including VHDL code) electronically to OAK for full credit.** Place each problem/project in a separate folder. Make a ZIP file of all the folders and upload it into the “file exchange” of your Team Page.

- **Problem 1:** Modify the color bar example to produce rows of colors on the VGA output.
- **Problem 2:** Modify the bouncing ball example to bounce and move in both the X and Y directions. You will need to add code for motion in two directions and check additional walls for a bounce condition.
- **Problem 3:** Modify the bouncing ball example from Problem 2 to move left, stop, or move right based upon input from three pushbuttons on the DE2 Board.
- **Problem 4:** Modify the VGA Sync Module to produce a resolution of 1024 x 768. You will need to change the count values (and possibly the bit precision) within the module using the guidelines within the file. You will also need to update the video PLL. Use the color bar example to test your design.
- **Problem 5:** Modify the VGA Sync Module to accept 8-bit inputs and produce 8-bit outputs for the RGB values. To test your module, use eight switches (SW7:SW0) as an input. Use three switches (SW17:SW15) to select whether the 8-bit input should correspond to the red, green, or blue input. The unselected color inputs should be grounded.
- **Problem 6:** Modify the LCD Display module to display four hexadecimal digits instead of two. Use switches to provide the input values, similar to the form in the LCD Test module.
- **Problem 7:** Create a scrolling marquee on the LCD Display that displays the following:

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The marquee should scroll from right-to-left. You likely will not be able to use the LCD Display in its current form, so use it as a basis to create your own display module.

- **Problem 8:** Create a smooth circle on a background color similar to the figure below:

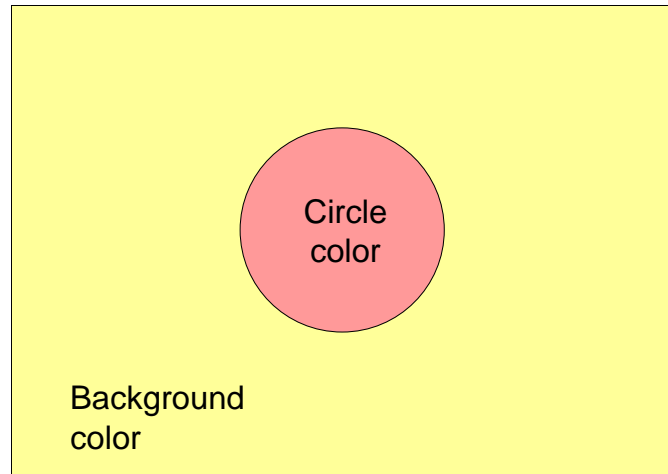


Figure 1: Sample VGA image for a smooth circle on a solid background

Use KEY0 to cycle through eight colors of the circle (refer to the VGA Test example for the color options). Use KEY1 to cycle through the eight colors of the background.

TEAM RESPONSIBILITY

This is a team assignment. Divide the assignment up such that each team member contributes equally to the problems described above. It is the team's responsibility to design and run adequate test cases. You may utilize the file exchange in OAK under "Groups." There should be only one (1) submission of the results/solutions for each team.

TEAM MEMBER EVALUATION

You will evaluate your teammate(s) on the quality and quantity of their contributions and cooperation. This team evaluation will comprise 10% of an individual's grade for the programming assignment. Each team member **MUST** complete the teammate evaluation form and submit it electronically before class. Use the link provided in **Session 33 - Monday, November 3, 2014** (under the "Lectures" menu item). **DO NOT USE THE FILE EXCHANGE FOR YOUR EVALUATION FORM!!!** Failure to submit your evaluation will result in a **10% penalty** for your individual grade.