UNIVERSITY OF CALIFORNIA, DAVIS

Department of Electrical and Computer Engineering

LAB 1: DE1-SOC System Development Tutorial and Exercises

This tutorial gives a review of using verilog HDL in Altera Quartus II to develop embedded systems implemented on FPGA's. You will be introduced to the DE1-SOC (System On Chip) Altera Development Board with the Cyclone V FPGA system. This board allows the use of both FPGA and programmable processor to function together, to provide extended capabilities.

Read and work through the Altera references below to obtain additional practice on the tool chain. This lab assumes you have a good working knowledge of Verilog HDL and FPGA programming experience. If you are rusty on these topics, review your EEC 180 material.

I. SETTING UP YOUR ENVIRONMENT

In the lab in Kemper 2107, log into one of the linux computers.

Open a terminal window and add the following lines to your ~/.cshrc file. (You have to do this only once. This sets up the environment permanently).

```
module load altera/modelsim
module load altera/quartus
```

In this course we use Quartus II 64-bit for designing systems, synthesizing and compiling our projects. On Linux machines you can start the program as follows.

```
quartus --64bit
```

• Notice that there is a space between quartus and **--64bit**.
After you start quartus, it opens a window similar to what is shown in Figure 1 and asks for license information. In this step choose the **last** option and then click on OK.
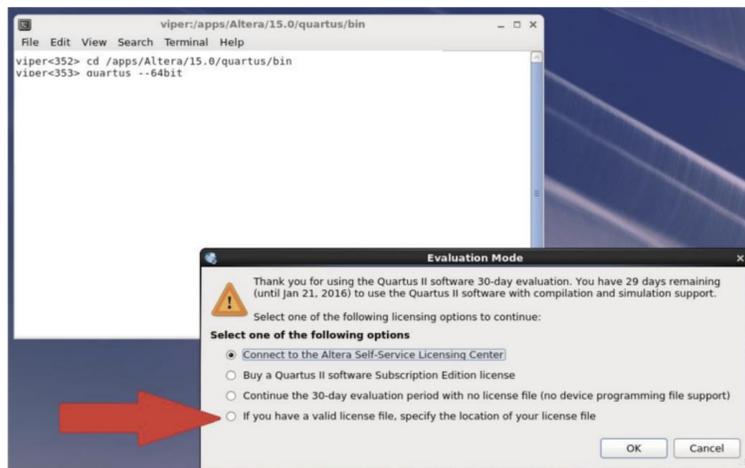
Figure 1. Setting the license server, step 1
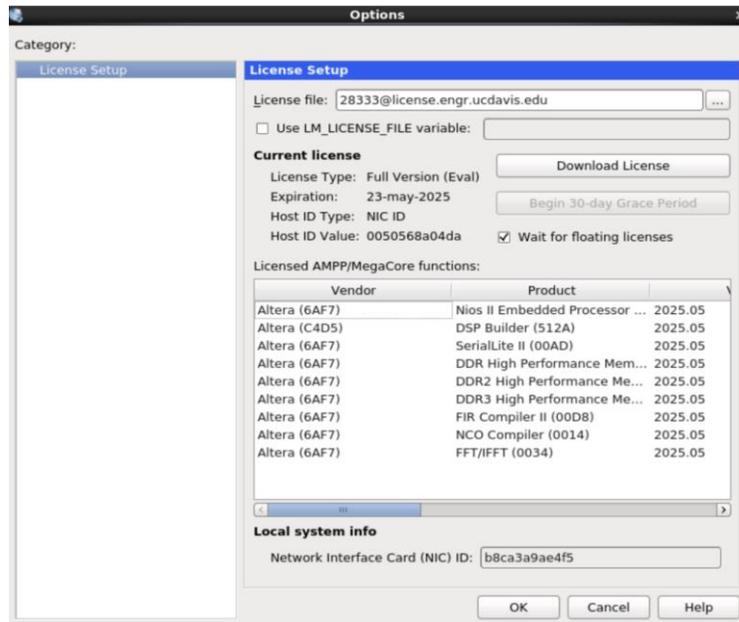
Figure 2. Setting up the license server, step 2

Then you will see the option window which is shown in Figure 2. In front of the license file, write the following address. Before clicking on OK, certify that you can see the list of supported products under "**Licensed AMPP/MegaCore functions**" as it is illustrated in Figure 2.
Click on OK. Quartus is ready to use.

```
28333@renoir.engr.ucdavis.edu
```

II. INTRODUCTION

Read the following documents posted on the course webpage:
- *Project Setup on the DE1-SoC*
- *Lights and Switches on the DE1-SoC*
- *Variable Frequency Clocking Hardware*

III. VERILOG HARDWARE DESIGN

The goal of this assignment is to give you practice writing Verilog. We will use the seven segment displays to display two custom light patterns, one at a time dependent on user input from the four (4) pushbuttons. For the switch input, once the user has decided which LED pattern to display on the seven segment display, the user will press a push button to load the pattern to the seven segment display. The seven segment display pattern should not update while the switches are toggling, but the user will be able to preview the switch pattern on the red LED's. You will also implement a horizontal text scrolling feature that we often see on LED banners and a LED rolling pattern. You can also choose the direction of the horizontal scrolling, Left -> Right or Right -> Left. For ambitious students, you can also change the scrolling direction from horizontal to vertical. There are many methods to do this and you are free to proceed with your preference.

Design the hardware to perform the following functions:

1. Display Patterns:

A. Design circuits so that the ten SW switches control the on/off state of the ten LED lights so that a switch in the "down" position makes the corresponding LED off and "up" makes it on. For example:

LED9-LED0:	ON	OFF	OFF	ON	ON	ON	OFF	OFF	OFF	OFF
SW9-SW0:	UP	DOWN	DOWN	UP	UP	UP	DOWN	DOWN	DOWN	DOWN
SW9-SW0:	SW9	SW8	SW7	SW6	SW5	SW4	SW3	SW2	SW1	SW0

B. Display your first name assigning LED elements on the 7-segment displays the best you can.

2. Scrolling Movement:

Implement a horizontal scroll movement and loop around so that the letters of your name scroll from right to left across the 7-segment displays, and then appear again at the right side. The nominal speed is one character change per 1.000 second. For example:
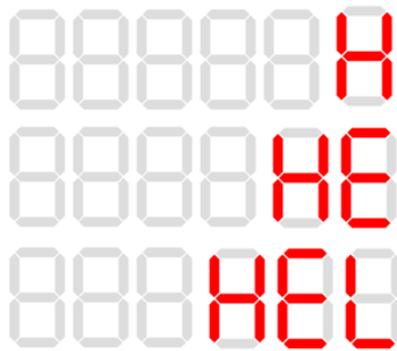
Example first three letters of the text "HELLO" scrolling from right to left.

3. Push button user input and display control on the Seven Segment Display. There are 4 push buttons on the DE1-SOC.
   a) One push button will reset the entire system.
   b) One push button will invert the patterns on both the LEDs and the 7-segment displays (on → off, off → on).
   c) One push button will speed up the horizontal scrolling movement displayed on the seven segment display. You choose how fast.
   d) One push button will pause the horizontal scrolling movement displayed on the seven segment display. Pushing the pause again will continue the scrolling movement. While in the pause state, other push buttons will have no effect on the seven segment display behavior. However, the user can still use the switches to change the red LED pattern at anytime.

IV. Download your system to the DE1-SoC board and demonstrate it to the TA