

# Practical Homework 1

(These problems should be done individually, not with project partner, although you may share the board)

## Instructions for submission

- 1) All answers are to be submitted in a **single** word/pdf file. This will be considered as the final submission. Project files should be submitted as a zip file.
- 2) Include Quartus Prime, Modelsim/Altera vwf and observation screenshots whenever possible with appropriate annotations for better presentation in your word/pdf file.  
**Do not** submit extra screenshots in the submission folder
- 3) Submit individual zipped folders for each project question as the method to submit Quartus Prime files.
- 4) Submit separate .sof files for each subsection and a zipped folder of latest project
- 5) Add an explanation of the new implementation in your word file
- 6) Naming Convention for submission  
LastName\_FirstName\_PracticalHWSet1.zip,  
LastName\_FirstName\_PracticalHWSet1.docx/  
LastName\_FirstName\_PracticalHWSet1.pdf
- 7) Do not submit a video of observations

**Due Date – as announced**

**Practical Questions:**

## Caution:

**Do not continue until you have read the following:**

The names that this document directs you to choose for files, components, and other objects in this exercise **must be spelled *exactly* as directed.**

### I. Setup and Test

- a) If you have not already done this, download and install [Quartus Prime](#) FPGA development software from Altera. Use the instructions from the videos in Homework 1.
- b) From Canvas, download the pdf document De10-Lite\_User\_Manual.pdf, and read chapter's 1-4.pdf. Recognize that Quartus II now means Quartus Prime.
- c) Download and unzip the DE10-Lite\_v.2.0.0\_SystemCD.zip.
- d) Download and unzip the DE10-ControlPanel\_v.1.0.2.zip.
- e) Remove your DE10-lite evaluation board and plug the USB cable into a computer. Describe how the device behaves – what do you see on the LED display and what is the light pattern?

The seven segment displays are counting from 0-F in hexadecimal. The LEDs are lighting up in an 101..., 010..., 111... pattern. If SW0 is flicked, the LEDs change to reflect the data from the accelerometer by acting like a bubble in a leveling tool. KEY0 acts as a reset button, which holds the LEDs and the displays fully on.

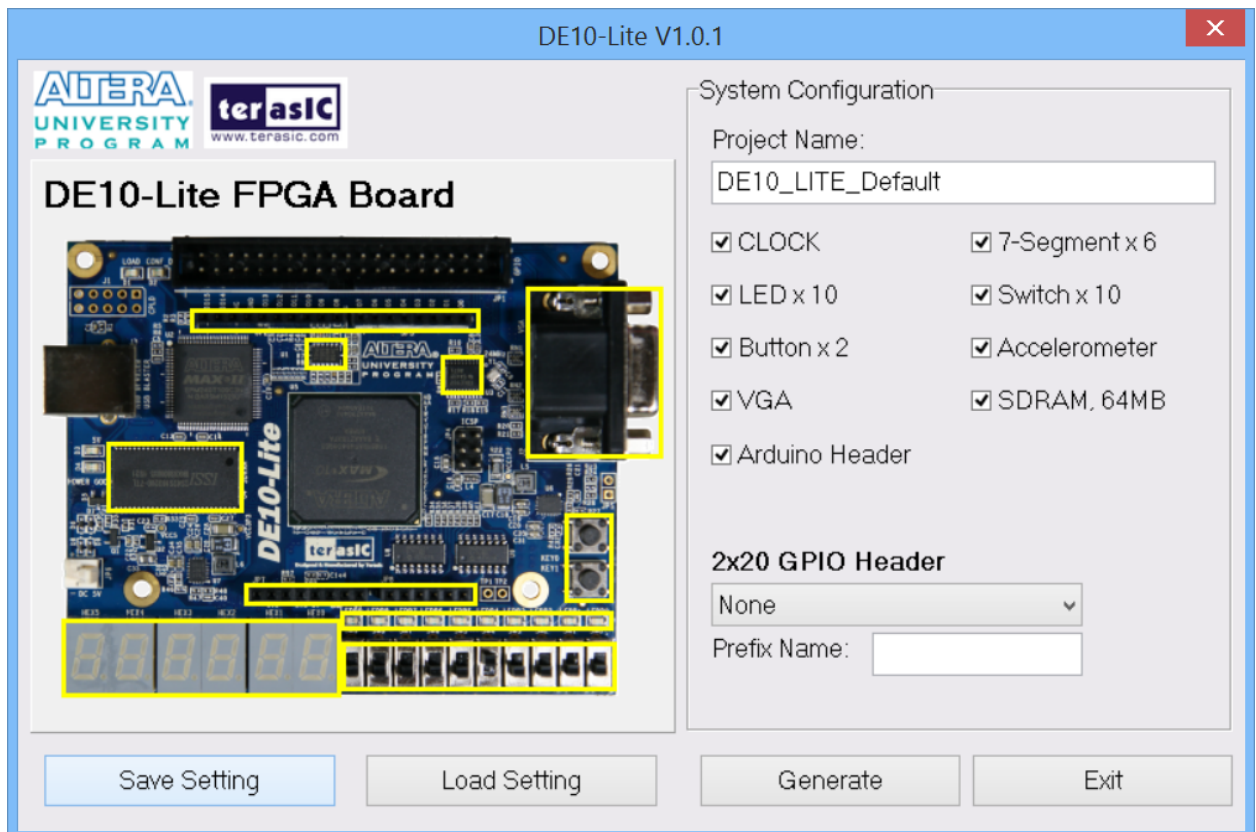
- f) Follow the instructions in Section 2 of the User Manual to Test the Control Panel Utility. Do sections 2.1 through 2.4 and record your results. \*If your board is not recognized, you may have

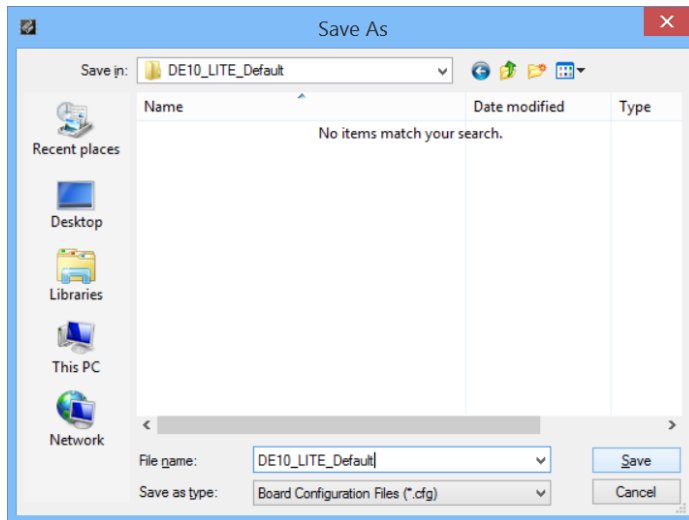
to do a workaround. See below for instructions. If you are using Linux as a development environment, email your instructor for specific directions.

All of the LEDs light up as expected, as do the seven segment displays. I was able to observe the switches and keys operate as expected. I wrote and read to the SDRAM and everything worked as expected.

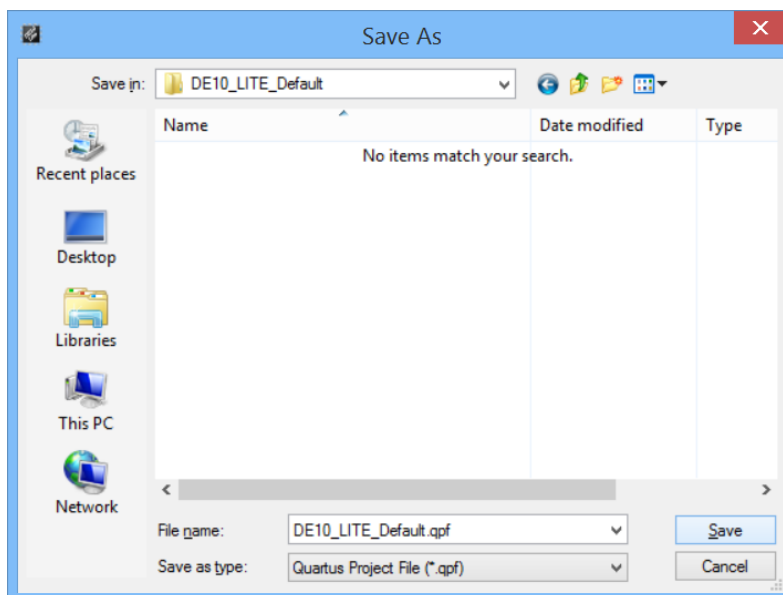
**II. Create a System using System Builder (SUBMIT ALL THE FOLLOWING QUESTION ANSWERS IN A SINGLE WORD DOCUMENT)**

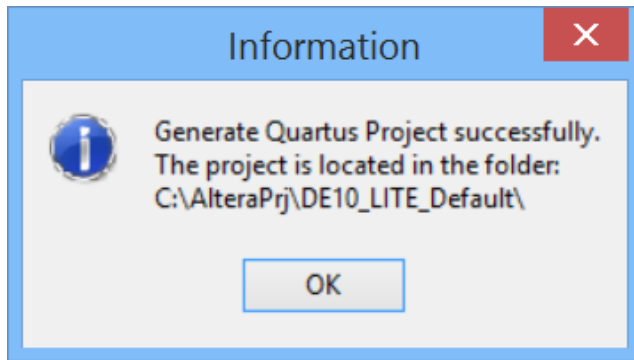
- In your main hard drive, typically C:\, create an AlteraPrj folder. Within this folder, create DE10\_LITE\_Default folder, and a DE10\_LITE\_Small folder.
- From the SystemCD.zip directory, extract, find (in the Tools directory) and run the System Builder utility.
- Change the Project Name to DE10\_LITE\_Default. Confirm all the checkboxes are checked, including Clock, LED, Button, VGA, Arduino, 7-segment, Switch, Accelerometer, and SDRAM. Click Save Settings, and navigate to the DE10\_LITE\_Default folder you just created and save the configuration file there.



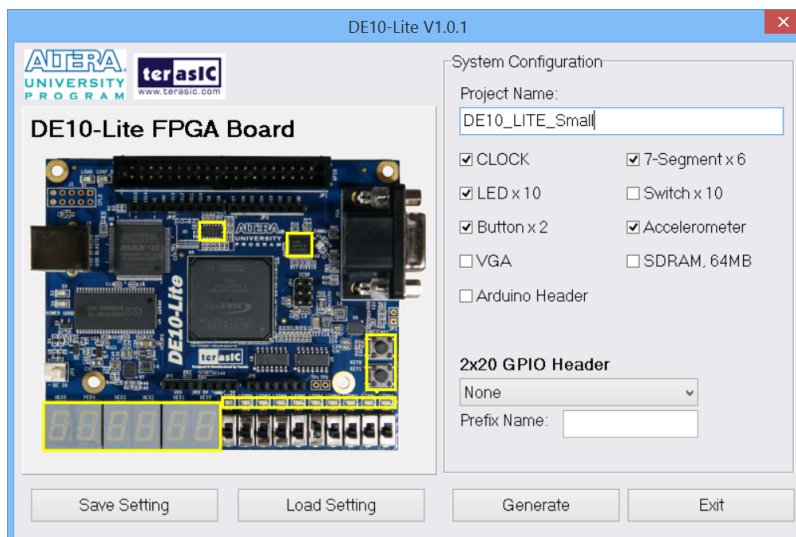


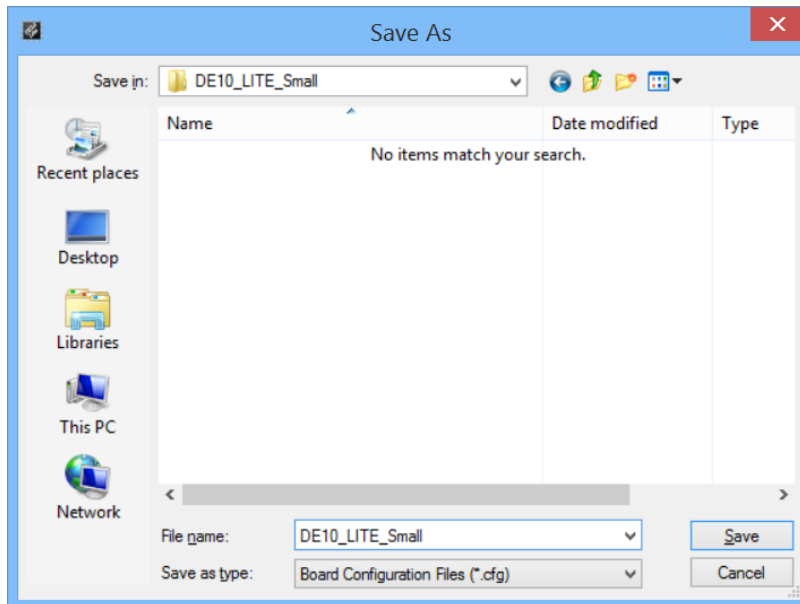
d) Press Generate, and save the project in the DE10\_LITE\_Default folder you just created.



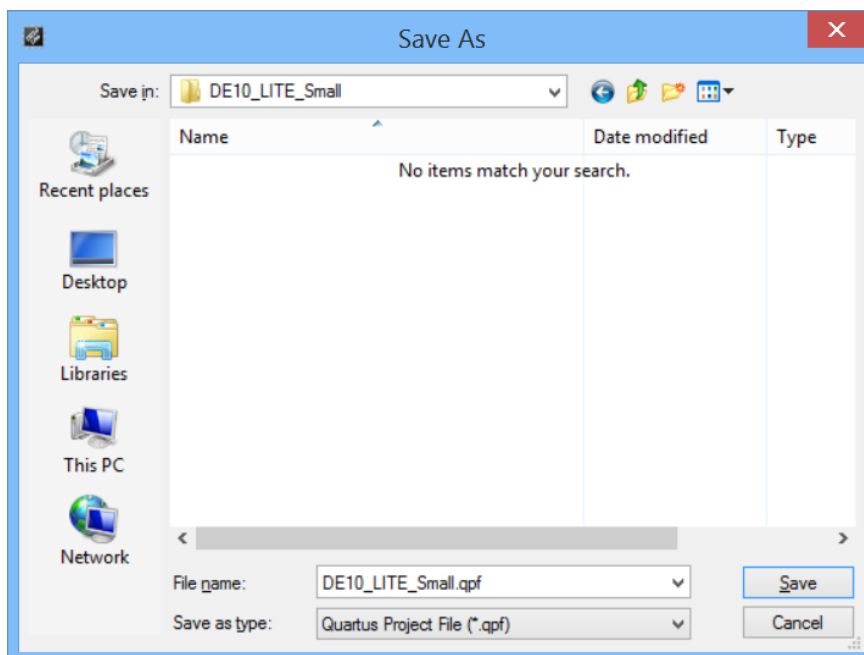


- e) Uncheck the boxes VGA, Arduino, SDRAM, and Switch. Change the project name to DE10\_LITE\_Small. Click Save Settings, and navigate to the DE10\_LITE\_Small folder you just created and save the configuration file there. Be sure to use the DE10\_LITE\_Small file name.

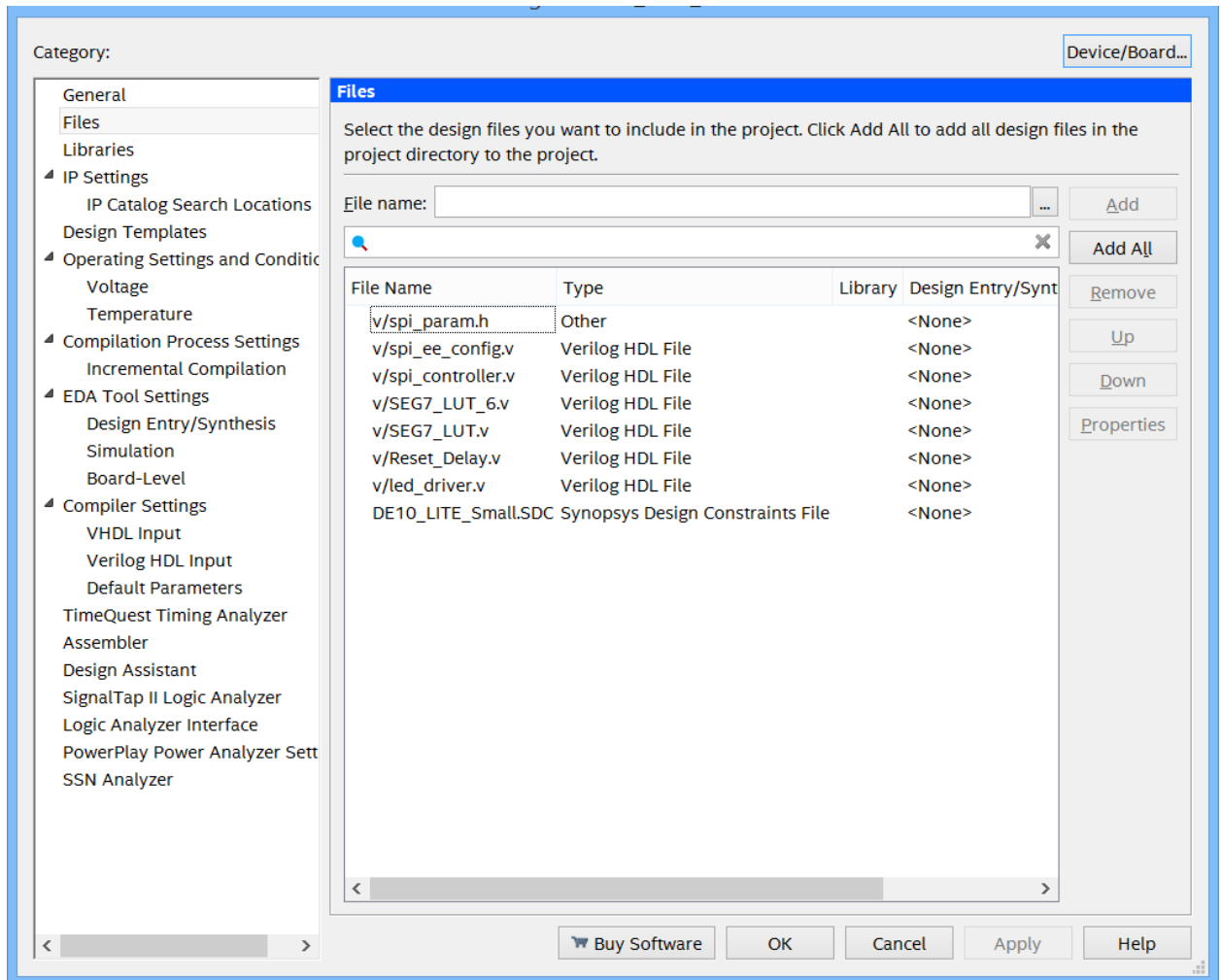




- f) Press Generate, and save the small project in the DE10\_LITE\_Small folder you just created. Be sure to navigate to this folder.



- g) From Canvas, get the DE10\_LITE\_Default.zip file and unzip it into the AlteraPrj/DE10\_LITE\_Default directory. Also copy DE10\_LITE\_Default.v to this directory, say OK to overwrite.
- h) From Canvas, get the DE10\_LITE\_Small.zip file and unzip it into the AlteraPrj/DE10\_LITE\_Small directory. Also copy DE10\_LITE\_Small.v to this directory, say OK to overwrite.
- i) Launch Quartus Prime, and open the small project you just created. Run full compilation on this project after using Projects-> Add/Remove files to get a file list like this:



- j) Using the instructions from the beginning of Chapter 3 of the user's manual, program the FPGA using the DE10\_LITE\_Small.sof programming file. If you see "No Hardware", you may have to update the USB Blaster Driver.

- g) From the Compiler Report in Quartus, estimate the Fmax and % utilization of FPGA logic.

Fmax = 253.29 MHz (clk1), 300.48 MHz (clk2)

% utilization = < 1% logic

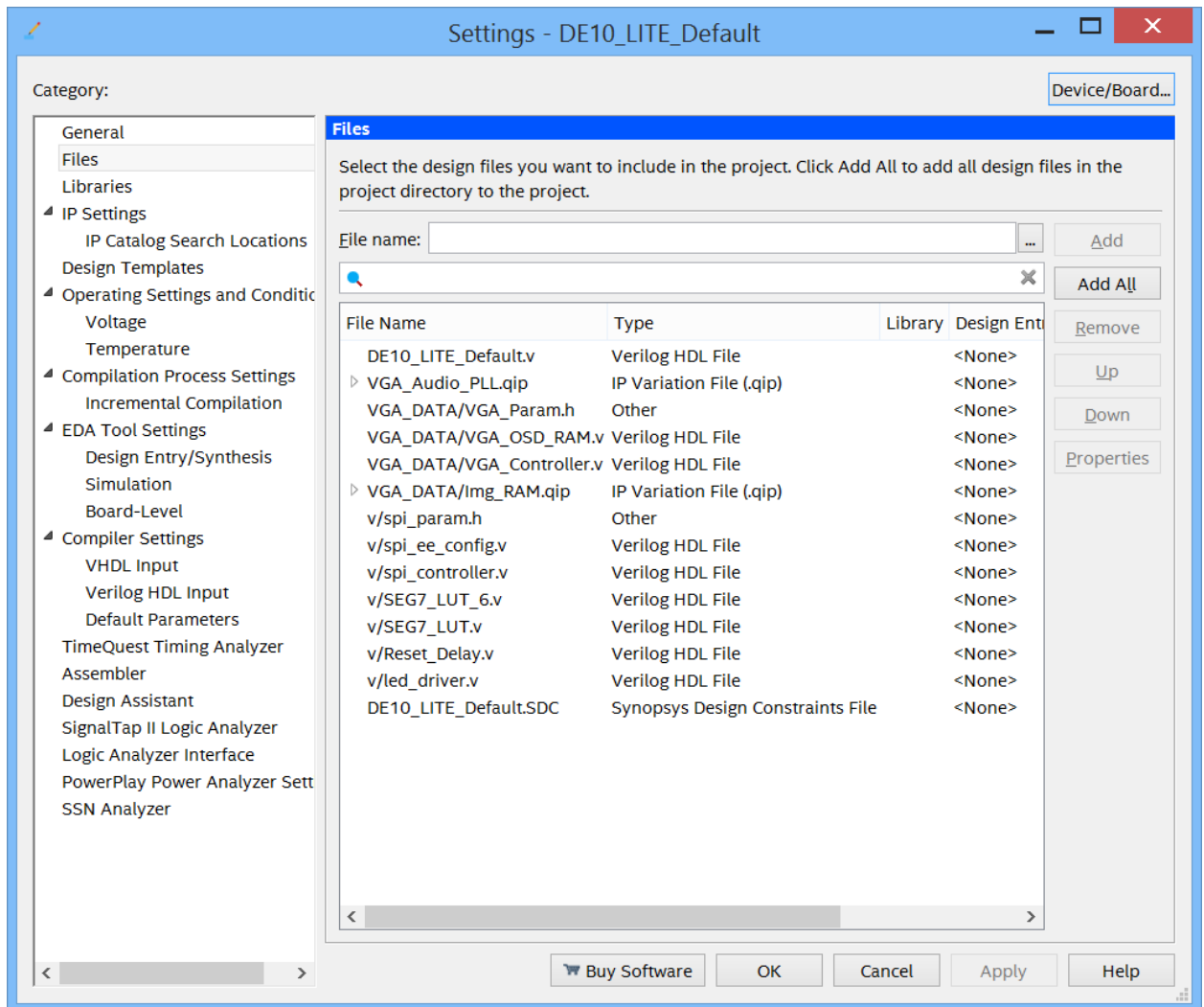
- k) Drill down into the blocks in the RTL Viewer. Estimate the number of Flip-flops used.

I counted 150 flip flops by looking at the list of primitives on the left side and adding the number of registers together.

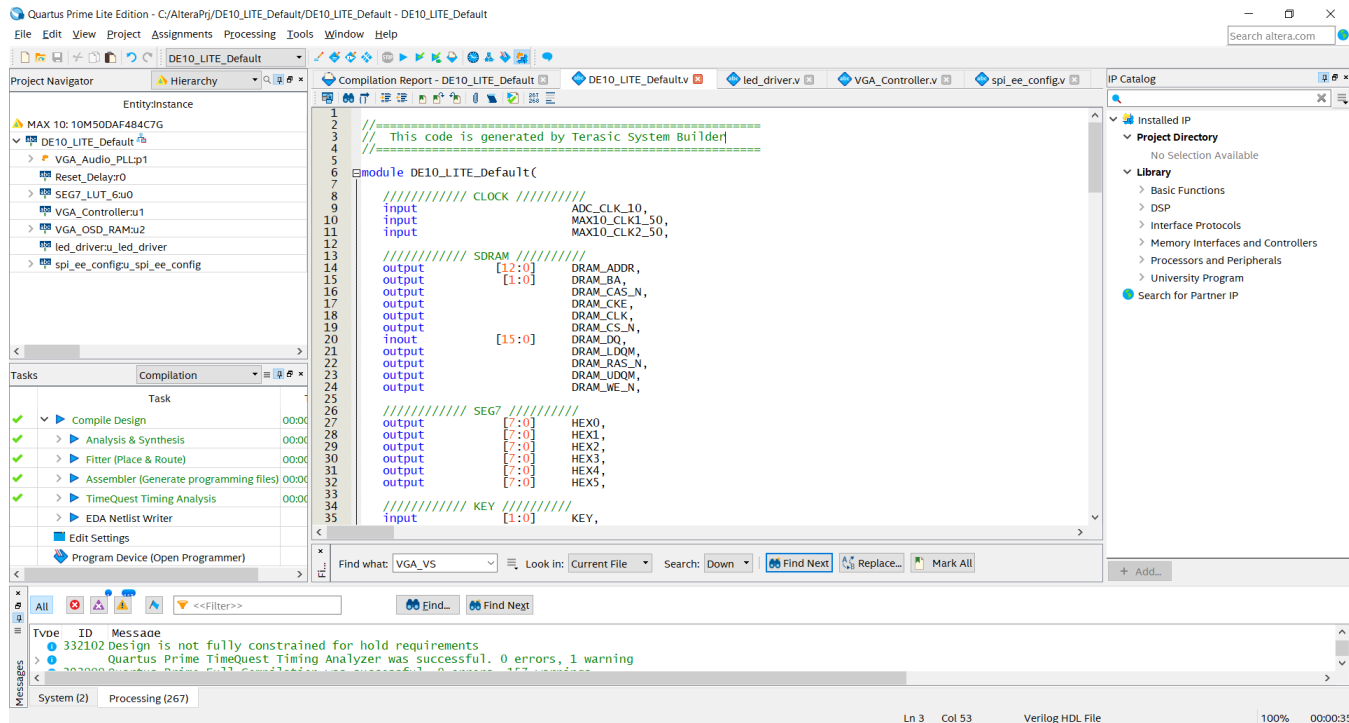
- l) Record your observations of the board behavior once the FPGA is programmed. Does it behave as you might expect?

No it doesn't operate as I would expect. Looking at the top level module, it seems that the LEDs should be driven based on the values read off of the G-sensor, but in operation, it doesn't. The LEDs are all dim except for the two in the center. Everything else works as expected, like the reset and KEY1 switching the LEDs to count mode. Since this is the DE10\_Lite\_Small config, I also wouldn't expect the switches to do anything, and they don't.

- m) Repeat i) through l) for the default project you created in c) and d). Again use Projects-> Add/Remove files, but this time use this list:



After compilation, you should see something like this:



Fmax: 98.15 MHz (p1|clk[0]), 212.36 MHz (MAX10\_CLK1\_50), 236.18 MHz (p1|clk[1]), 300.39 MHz (MAX10\_CLK2\_50)

% Utilization: 1% of logic, 18% of memory, 51% of pins

Number of flip flops: 285

The LEDs now behave as I expect, with them following the accelerometer. When I plugged the DE10-Lite into a VGA monitor (which required me to create a .pof file since I don't have a VGA monitor near my desk), I saw the Altera splash screen. However, I never heard any audio, so I don't know if the VGA\_Audio\_PLL module was supposed to create audio or not.

## Tips for success

If you see a request to upgrade IP in the Project Navigator window, ignore it for now.

If you see error about an undefined entity, then you may need to add another file to the project, the error message should give you some idea which one.

If you see errors in the full compilation relative to memory initialization, consider using Assignments->Device->Device and Pin Options->Configuration->Configuration mode to change the configuration mode to include memory initialization.

## CONGRATULATIONS!!

**You have completed the setup and test of the DE10-Lite!**

## Grading Rubric



1) - [20 points]

[6 points] Setup Questions and Results

[6 points] ea. Submission of completed projects: default, and small.

[4 points] Fmax, %Utilization

[2 points] Flip Flops (RTL Viewer)

[2 points] Board Implementation and Observations

*\* Commenting of code and presentation of material also carries weight*