

ECSE-323

Digital System Design

Lab #5 – *System Integration for the Base-100 Financial Calculator System*

Fall 2008

Introduction

In this lab you will put together all of the parts for the complete Base-100 Financial Calculator system and implement it on the Altera DE-1 board.

Learning Outcomes

After completing this lab you should know how to:

- Get a complete digital system working on the Altera board, and will have gained experience in implementing user interfaces.

Table of Contents

This lab consists of the following stages:

1. Integration of all the parts to form the complete system
2. Testing of the complete system on the Altera board
3. Writeup of the lab report

The Complete Base-100 Financial Calculator System

In this lab you will combine all of the parts you have developed in the previous labs and create the full Base-100 Financial Calculator system for your 100-fingered alien customers. Most of the work has been done in the previous labs, but in this lab you will combine everything and add a useful user interface.

The entire system will include a 4-digit LED display to show the computed results, and will use the switches and pushbuttons on the DE-1 board to provide the input. Once you have constructed the full system, it will be downloaded to the Altera board hardware and tested.

Specifications for the Complete Calculator

The functions to be computed by the calculator are all based on the following formula:

$$FV = PV(1 + i/100)^N$$

Where PV is the present value of an investment, FV is the future value of the investment after N years, and i is the annual interest rate (as a percentage).

The user interface should provide 3 different possible calculation modes:

1. **Future Value:** Given i , PV , and N , compute FV .
2. **Interest Rate** (to yield an M -fold increase in value in N years): Given $FV/PV=M$ (where M is an integer between 1 and 99) and N (between 1 and 63), find i .
3. **Doubling Time:** Given an interest rate i find the number of years N needed for the value to double (i.e. $FV/PV=2$).

Specifications for the Complete Calculator

Other specifications:

- Interest rate values should be between 1 and 99 percent
- Time (N) values should be between 1 and 63
- PV and FV values should be between 0 and 999999.99

Any out of range values should result in an error message being displayed (either flashing or scrolling).

The method of data entry is left unspecified and it is up to the designers to determine an effective approach. All values entered should be displayed on the 4 7-segment LEDs during data entry. The result of the computation must likewise be displayed on the 7-segment LEDs. The individual single LEDs can be used to indicate various conditions, such as which calculation mode is being used.

The Complete System Design (continued)

It is *up to you* to figure out how to use the resources on the Altera DE-1 board to *meet the given specifications*. Use all the tools and techniques that you have learned in this course (or even in other courses). If you are faced with a lack of information in the given specifications, make an executive decision on how to proceed. Be sure to indicate and justify your design decisions in the written report.

The complete system should be laid out using *schematic capture* in Quartus. This will basically involve wiring together the modules shown in the system diagram. Normally this would be done using VHDL with component instantiations, but using schematic capture makes it easy to print out a block diagram for your report.

Once you have laid out the complete system in Quartus show the schematic diagram to the TA.





TIME CHECK

You should be this far at the end of your *second* 2-hour lab period!

Testing of the Complete System on the Altera Board.

Compile the full system and download it to the Altera board.

Demonstrate the functioning of your system to the TA, showing operation in each of the three calculation modes. You should also demonstrate the error conditions.



NOTE: The last day for lab demonstrations is Friday, November 28. There will be NO lab sessions the week of December 1 (since Tuesday Dec 2 is the last day of classes, and actually follows the Monday schedule, and there are no lab sessions normally scheduled on Mondays).



TIME CHECK

You should be this far at the end of your *third* 2-hour lab period!

Writeup of the Lab Report

Write up a report for the complete *Base-100 Financial Calculator* system that you designed.

The report *must* include the following items:

- (1 mark) A report title page, giving the name of your system, your group number, and the names and student numbers of each group member.
- (1 mark) A description of the system's features (i.e. what it does, as in a product brochure).
- (1 mark) A block diagram of the entire system.
- (3 marks) A detailed description of how your system works, referring to the block diagram. This should include a description of an overall controller FSM if you used one. You do not need to describe the functioning of modules created in previous labs, but instead refer to the relevant lab reports.
- (1 mark) A description of the user interface (e.g. a users guide to operation).
- (1 mark) A discussion of how the complete system was tested, including description of the test case inputs used and the comparison of the results with predicted outputs.
- (1 mark) A summary of the FPGA resource utilization.
- (1 mark) A conclusion section discussing problems or significant issues that arose during the design process, as well as a discussion of possible enhancements or extensions that could be made to your system.

Some items to remember when preparing the report for lab #5:

- All diagrams, tables, and figures must have captions describing the contents of the figure and be given a figure number.
- All figures must be referred to in the text of the report. Do not just throw a figure into the report without referring to it. Figures should be used to augment the textual matter.
- If you include figures or text taken from other sources, be sure to cite these properly (including extracts from lab descriptions). **Avoid plagiarism!**
- Hand-drawn figures and diagrams are not acceptable!
- Turn off the grid in the Quartus schematics when making screenshots!
- Break large block diagrams into multiple smaller ones when inserting them into the report.
- Do not include long vhdl descriptions into the report. Instead, include the .vhd files in your report submission zip file.

Don't wait until the last day to start writing the report. Start writing it early on in the lab 5 period. Remember, it is due on the last day of classes, and not one week later!

The report should be done in html or pdf (preferred), or in Microsoft Word, and uploaded to the WebCT site using the lab #5 assignment submission icon.

The presentation of the report (grammar, spelling, and clarity of the diagrams) will also be graded. *Professor Clark will grade the final reports.*

Make sure that you have uploaded *all* of the design files (e.g. .bdf and .vhd files) used in your project. Also include the device programming file (.sof or .pof file) so that Prof. Clark can download your design to his Altera board.

The report is due at midnight on the last day of classes, *Tuesday, December 2.*

Late submissions will be accepted, but will be assessed a penalty of *1 mark per day*, (out of a possible maximum of 10) up to (and including) *Sunday December 7.* No submissions will be accepted after that date.



TIME CHECK

You should be this far (i.e. have completed the lab) at the end of your *fourth* 2-hour lab period!



Grade Sheet for Lab #5

Fall 2008.

Group Number: _____.

Group Member Name: _____ Student Number: _____.

Group Member Name: _____ Student Number: _____.

Marks

1.	<u>Schematic for the complete system</u>	_____.
2.	<u>Demonstration of calculator mode 1 on the Altera board</u>	_____.
3.	<u>Demonstration of calculator mode 2 on the Altera board</u>	_____.
4.	<u>Demonstration of calculator mode 3 on the Altera board</u>	_____.
5.	<u>Demonstration of the error condition display</u>	_____.
TA Signatures		

Each part should be demonstrated to one of the TAs who will then give a grade and sign the grade sheet. Grades for each part will be either 0, 1, or 2. A mark of 2 will be given if everything is done correctly. A grade of 1 will be given if there are significant problems, but an attempt was made. A grade of 0 will be given for parts that were not done at all, or for which there is no TA signature.