University of Toronto, Department of Electrical and Computer Engineering

ECE241F - Digital Systems - Lab 2

Altera Software Introduction and Use

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1.0 Purpose

The purpose of this lab is to learn the basics of the Altera design software: design entry, simulation and compilation. It will also introduce a large-scale programmable logic device, and show you how to download a circuit into the device.

2.0 Preparation

1. Do Tutorial #1 and as much of Tutorial #2 as possible before the lab.

2. Design, enter and simulate a circuit, using VHDL as the primary entry method, that implements the following logic function:

   You are to design two functions, f1 and f2, with four inputs named x1, x0, y1, and y0. Consider X = x1 x0 to be a number. The four possible patterns of x1 x0, namely 00, 01, 10, and 11 represent the four numbers 0, 1, 2, and 3, respectively (we will learn about representing numbers in this way later). Similarly, consider Y = y1 y0 to be another number with the same four possible values. The function f1 should be 1 when the two numbers represented by X and Y are equal (i.e., X = Y). Otherwise, f1 should be 0. The function f2 should be 1 when the number represented by X is greater than the number represented by Y (i.e., X > Y).

   Show truth tables for functions f1 and f2. Derive a Boolean expression in canonical form for each function. Use algebraic manipulation to simplify the Boolean expressions. Enter the simplified Boolean expressions into **maxplus2** in two different ways:

   i. Draw a schematic that includes the logic gates for both f1 and f2.

   ii. Write VHDL code that represents both f1 and f2 with Boolean equations.

   Your <u>preparation</u>, to be marked, should consist of the VHDL code, the schematic and the simulator output all circuits, including that from Tutorial #1.

3. Be sure to place all your design files on your home directory on the ECE ugsparcs. Your login name and password for ECE ugsparcs is the same as your ECF account. If you don't have either an ECF account or an ECE account, request one from ECF (in GB 154) and then send a request to tim@eecg to make sure one is created on ECE ugsparcs. The ECE ugsparc machines are named ugsparc1.eecg.toronto.edu up to ugsparc48.eecg.toronto.edu, and are located at the south-west corner of the Galbraith building, second floor, roob GB 251. You can also bring files from home on a floppy disk, and use them directly on the PCs in the lab.

3.0 In the Lab

You will need the information contained in Section 4.0, below.

1. Download and test the circuit of Tutorial #1, as described in Tutorial #2 and Section 4.0 below. You should be sure to choose pins on the 7128 device that are available in Table 1 below. Demonstrate that your circuit works to a TA.

2. Download and test your circuit from part 2 of the preparation, and demonstrate it to a TA.

4.0 PC Set-Up Information for the Machines in GB 144/150 and Running Maxplus2

The PCs in the lab are new, and we have only just got the networking functioning. I'm afraid that there are a few weird things you'll have to do at the moment, to make it all work. Hopefully, this will be smoothed out soon.

1. **Logging in to get your ECE ugsparc files attached to this machine.** The PC should be showing you a login prompt. If not, reboot it using the **Start** menu in the lower left hand corner, by selecting the "shutdown" menu item. Log in using your password for the ECE ugsparcs. Do this by clicking the mouse in the appropriate dialog box with your login name and password. **Don't type return until you've put in both the name and password!** (If the login doesn't succeed, you'll have to shutdown the machine as described above)**.**

2. **Mapping your ECE ugsparc files to a specific drive on the PC, setting up an Initialization file and Starting Maxplus2.** Unfortunatley, to set up the initialization file properly, we have to open a DOS command window: (**don't double click on the maxplus2 icon to start it, this won't work properly).** Do the following:

   i. Click on the Windows 95 **Start** button in the lower left hand corner of the screen and select the **Run** menu item. In the dialog box type: **command** (if it isn't there already) and select OK. This will bring up a DOS window.

   ii. Type the following command replacing the **your_login_name** below with your ECE ugsparc login name.

      `max` **your_login_name**

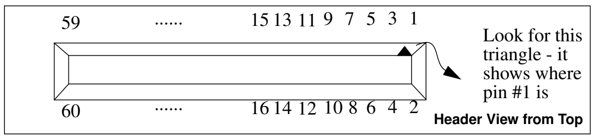
      This command installs a copy of the file maxplus2.ini in the directory **max2work**, (it creates this directory if you haven't done this already) and sets an environment variable that tells maxplus2 to look for the maxplus2.ini file at that location, and then starts the maxplus2 software running. This is ugly, but it is the only solution we have at the moment.

      This is the way you should start **maxplus2** until further notice.

3. With maxplus2 running, you can open your project and compile your design as described in Tutorials #1 and #2. **Before downloading, go to step 4 below.** You will need to specify which pins to use for your inputs and outputs, to make sure that the pins used are available from the connector (some of the pins are hard-wired to devices on the board, and are not connected to the header). Table 1 lists which pins are available on the header.

4. Before downloading your designs into the board, connect a 60-pin cable from the board into a protoboard - A TA will demonstrate this. **Be sure to use the header that is closest to the MAX 7128 device, not the one at the other end of the board**.

   Notice that the cable can only plug into the header one particular way, because the headers have “keys” which prevent incorrect insertion. The header itself is numbered as follows, as viewed from the top:



   Be sure that the power to the Altera board is off and the power to protoboard is off. Using diagram above and Table 1 do the following:

   i. Make a common ground between the board by connecting pin #2 of the header to the ground of the protoboard. (Otherwise the signals won’t have a common reference point, and the voltages seen by either side will be wrong).

   ii. Connect your input signals from the digital board switches to the correct input pins for your circuit on the protoboard header - i.e to those pins that correspond to the pins you selected on the MAX 7128S chip. You have to check Table 1 below to see the correspondence between the MAX 7128 chip pins and header pins. Connect your outputs to digital board lights in a similar way.

   iii. Turn on the power to the altera board and protoboard.

   iv. Download and test your circuit, using the instructions from Tutorial #2.

Protoboard Header - Max 7128 Pin Correspondence

Protoboard Header #	MAX 7128 Pin (or board signal)	Protoboard Header #	MAX 7128 Pin (or board signal)
1	Raw (beware! don’t use)	2	Ground
3	Vcc	4	Ground
5	Vcc	6	Ground
7	No Connect	8	No Connect
9	No Connect	10	No Connect
11	No Connect	12	GCLRn/1
13	OE1/84	14	OE2/GCLK2/2
15	4	16	5
17	6	18	8
19	9	20	10
21	11	22	12
23	15	24	16
25	17	26	18
27	20	28	21
29	22	30	24
31	25	32	27
33	28	34	29
35	30	36	31
37	33	38	34
39	35	40	36
41	37	42	39
43	40	44	41
45	44	46	45
47	46	48	48
49	49	50	50
51	51	52	52
53	54	54	55
55	56	56	57
57	Vcc	58	Ground
59	Vcc	60	Ground

Table 1: *Proto-Board Header - MAX 7128 Pin Correspondence*