University of Toronto, Department of Electrical and Computer Engineering

ECE241F - Digital Systems - Lab 2

Altera Software Tutorial 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 automatic synthesis. 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 from appendix B of the textbook and Tutorial #2 from Appendeix C; SKIP Section C.2) before the lab. Sections C.3 and C.4 are to be done in the lab period itself. You can use maxplus2 on the EECG UGSPARC system in GB251 or use your home computer as indicated in the **SOFTWARE** handout.

2. Design, enter **and simulate** a circuit, using both schematic entry and VHDL as the design 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. 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 less than the number represented by Y (i.e., X < Y).

   Show truth tables for functions f1 and f2. Derive a Boolean expression in canonical sum-of-products (i.e. sum of min-terms only) form for each function. Use algebraic manipulation to simplify the 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 schematic, the VHDL code, and the simulator output for all circuits, including that from Tutorial #1. YOUR PREPARATION MUST BE PRINTED BEFORE THE LAB BEGINS.

3. Be sure to place all your design files on your home directory on the ECE ugsparcs. Your login name for the ECE ugsparcs is the same as your ECF account. The password is your student number. 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 ugsparc74.eecg.toronto.edu. Use the faster machines which are numbers 1-26 and 50-74. The machines are located in the south corridor of the Galbraith building, second floor, rooms GB 243 and 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 show it to a TA.

4.0 PC Information for the Machines in GB 144/150 and SF 2201 for Maxplus2

This section tells you how to access the files you have placed on the ECE ugsparc machines from the PCs in the labs in Rooms GB 144/150 and SF 2201.

1. **Logging in to get your ECE ugsparc files attached to the PC. Turn on the PC and monitor.** 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 (this appears to be necessary even though there is a "Start Menu" item that says it will let you log in as a new user).

2. **In order to make your ECE ugsparc files visible on the PC, and do some initialization that Maxplus2 needs, open a DOS command window as follows:**

   i. Click on the Windows 95 **Start** button in the lower left hand corner of the screen and select the **Program** menu and then "MS-DOS Prompt." 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**

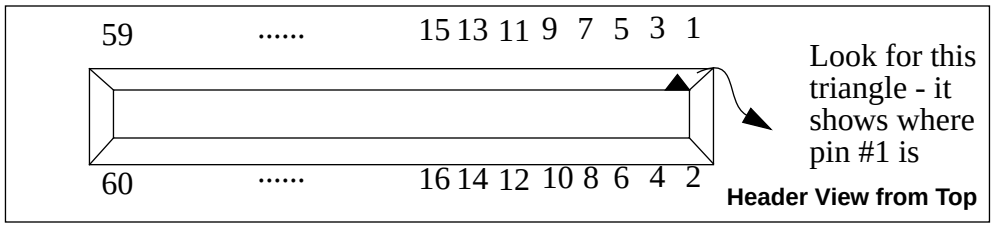
   You will be prompted to answer a question asking which year you are in (which is likely 2nd year). The **max** command installs a copy of the file maxplus2.ini in the directory **max2work**, (and it creates this directory if you haven't done so already) and sets an environment variable that tells maxplus2 to look for the maxplus2.ini file at that location, and then starts the maxplus2 software running. You only have to do this once; after that,

you can run it from the Program menu or icon.

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 UP1 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 Altera UP1 board into the protoboard - a TA will demonstrate this. **Be sure to use the header that is closest to the MAX 7128 device**.

   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 supply is switched off.

   i. Connect the power supply to the Altera UP1 board using the special cable that has a white plastic connector on one end and a power plug that matches the power-in of the Altera UP-1 board.

   ii. Connect the power supply to the protoboard as you did in lab #1 using the cable that has the logic probe attached to it. To Do this, you plug one end into the power supply connector, and the "banana" plugs into the proto board. You'll be connecting the ground to the header in the next step.

   iii. Using diagram above and Table 1 do the following: first, In order to make sure there is a good solid common ground between the proto board and the UP1 board, connecting pin #2 of the header to the ground of the protoboard. This ensures that the grounds are at the same potential, and so the switch board and UP1 board have a common reference point.

   iv. Connect your input signals from the digital switch board to the correct input pins for your circuit on the protoboard header. You have to check Table 1 below to see the correspondence between the MAX 7128 chip pins and the header pins. Connect your outputs to digital board lights in a similar way.

   v. Turn on the power supply. 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	25
31	24	32	27
33	29	34	28
35	31	36	30
37	33	38	34
39	35	40	36
41	37	42	40
43	39	44	41
45	44	46	46
47	45	48	48
49	50	50	49
51	52	52	51
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*