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Instructions for Programming Altera DE1 Boards
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Overview

These instructions are for using *Quartus II* to download a precompiled circuit design into your DE1 board. The circuit design is stored in a file with the extension **.pof** or **.sof**. There are two ways of programming your DE1 board: *temporary* and *persistent*. The main chip on the board, an Altera Cyclone II FPGA, stores its programming data in its internal SRAM. However SRAM is volatile, meaning it forgets the data each time the chip is turned off. The persistent way stores the programming into a tiny non-volatile Flash memory chip on the DE1 board (it is labeled U16 on my board). This Flash memory copied the FPGA's internal SRAM each time it is turned on.

A. Download and Install the Altera Software

The bare minimum you need to program your board is installation of *Quartus II* and the *USB-Blaster Cable* device driver. However, you will need the other tools later, so you might as well install everything.

> http://courses.ece.ubc.ca/259/homework/installing.htm

B. Programming the DE1

Overview. First, you have to set up the *Quartus II* software so that it uses the USB-Blaster Cable. Since there are many types of programming hardware, you have to tell it which one to use. After that, you can program your board with either the **.pof (persistent)** or **.sof (temporary)** files we provide on the course website.

B1. Software Setup

1) Start Quartus II:

   Start → Programs → Altera → Quartus II 9.1sp2 Web Edition→ Quartus II 9.1sp2 Web Edition

2) Start the **Programmer** feature by choosing **Tools → Programmer**. Alternatively, there is a shortcut icon below the menu bar – it appears as a cyan diamond a wavy squiggle on top, representing a chip with a cable coming out of it.

3) Choose **Hardware Setup** at the top-left of the main programmer window.

4) In the hardware setup window, beside **Currently Selected Hardware,** select **USB-Blaster**, then close the hardware setup window. If the **USB-Blaster** option is missing, check that:

a) the DE1 is plugged directly into the computer (not a hub) and is turned on, and b) the USB-Blaster device driver was installed.

B2. Programming the EPROM (Persistent)

5) In this section, you will be downloading a **.pof** file into a programmable EPROM memory chip on the board. On power-up, the contents of this EPROM automatically loaded into the FPGA. This gives you a way to automatically program the FPGA each time you power-up the board.

6) On the left side of the DE1 board there is a toggle switch with **PROG** and **RUN** positions. **Turn OFF the board**, put the switch in the **PROG** position, and turn it ON again. The LEDs will appear to be dimly lit; this is normal.

7) Back in the main programmer window, beside the **Hardware Setup** (which should now say **USB-Blaster**), there is a **Mode** selection box where currently **JTAG** is selected. Change **JTAG** to **Active Serial Programming.**

8) Choose **Add File** from the buttons down the left side of the main programmer window.

9) Select the **.pof** file you would like to program into your board. The default programming files for your DE1 board are located here:
   http://courses.ece.ubc.ca/259/homework/files/default

10) Check the boxes under **Program/Configure**, so it will actually program your board.

11) Select **Start**, and the programmer will start downloading the design to your DE1 board. This method is slower than the temporary method, taking on the order of 10 seconds or more.

12) After the download is complete, power off the board and change the **PROG** / **RUN** switch back to **RUN.**

13) Power the board back on. Your design will be loaded immediately.

B3. Programming the FPGA (Temporary)

14) In this section, you will be downloading a **.sof** file directly into the FPGA chip. When you turn off the board, the FPGA loses this programming information. The next time it is turned on, it will reload the last **.pof** that was stored in the programmable EPROM on the board.

15) Make sure the **PROG** / **RUN** switch on the left side of the DE1 is in the **RUN** position. (Yes, **RUN**, not **PROG.** For temporarily programming, keep this switch on **RUN**.)

16) Back in the main programmer window, beside the **Hardware Setup** (which should say **USB-Blaster**), make sure the **Mode** selection box is on **JTAG**

17) Choose **Add File** from the buttons down the left side of the main programmer window.

18) Select the **.sof** file you would like to program into your board.

19) Check the boxes under **Program/Configure**, so it will actually program your board.

20) Select **Start** and the programmer will begin the process of downloading the design to your DE1 board. This normally takes 1 or 2 seconds. When complete, the design will automatically become active.

C. Testing Your DE1 Board

21) The manufacturer of the DE1 board is Terasic. They have a DE1 web page with the latest PDFs and CDROM files:

http://www.terasic.com.tw/cgi-bin/page/archive.pl?Language=English&CategoryNo=39&No=83

22) If you want to test your DE1 board, use the "DE1 Control Panel" application. It is located on the DE1 CDROM.

23) To use the Control Panel application:

a) Program your board with the **DE1_USB_API.pof** file in persistent mode and exit the Quartus II programmer.

b) Keep your DE1 board plugged into the USB port.

c) Next, run the **DE1_Control_Panel.exe** program and go to **Open → Open USB Port 0** so it can use the **USB-Blaster**.

d) Change the 7-segment displays to 8888 and check all the LED options, then press **Set**. Your board should light up all of the red, green, and 7-segment LEDs.

e) If you have a spare keyboard from a PC that uses the PS2 port, connect it to the PS2 port on your board and test it out.

f) You can select the other tabs to test other parts of the board. There are 3 different memories: SRAM, SDRAM, and Flash. Also, you can test the VGA out by connecting your DE1 board to a VGA monitor.

g) Go to the **Tools** tab and press **Board Test**. You can check all the tests (but do not bother with the LCD test, since you don't have an LCD) and press **Start Test**. After each test, a dialog box should pop up to say it passed.

h) When you are done, select **Open → Close USB port** and exit.