V. Configuring the Cyclone IV E FPGA on the Terasic DE2-115 Rapid Prototyping Platform

It is often desirable to actually implement the design in programmable logic. The Terasic DE2-115 Rapid Prototyping Board contains a Field Programmable Gate Array, FPGA, that will can be used to implement digital designs that range in size from a few gates to designs that are as complex as a system of embedded microprocessors. To illustrate this let us consider again the **comb_logic** example.

In this example, the inputs to the design can be driven, using external switches, and the output can be made to drive a single discrete LED. The DE2-115 board documentation specifies the pin numbers of the Cyclone IV E FPGA that are connected to the switches and the LEDs. A valid configuration for the **comb_logic** example might be to bind design pins **I0** through **I5** to Switch 0 through Switch 5 (*SW0* -- *SW5*) of the DE2-115 board and connect the output, *O*, to the green LED number 8 (LEDG8).

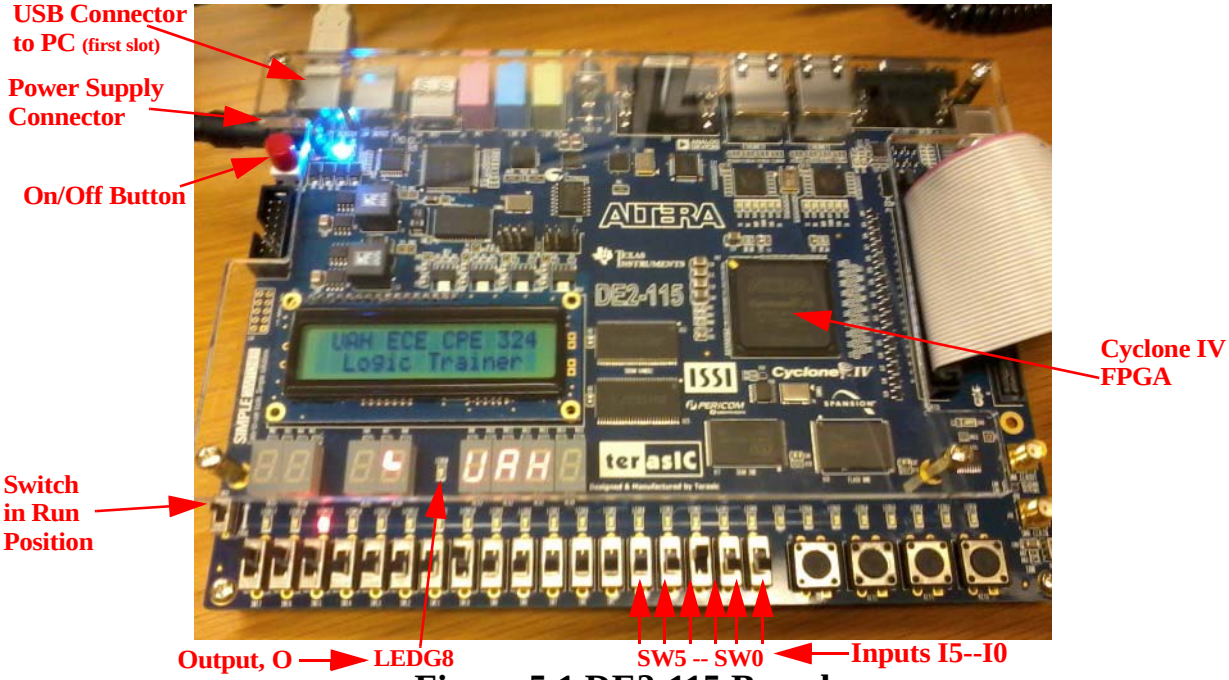

Figure 5.1 DE2-115 Board

1 To enable such a configuration of the DE2-115 board, one must first plug in its power supply cable, and plug in the USB cable to the port marked in Figure 5.1 (the other end of the cable must be inserted into the USB port of the computer that is running the Quartus Prime software). It is also important to make sure that the *On/Off* button is in the *On* position and that the *Run/Prog* switch is in the *Run* position.

Before the design can be downloaded into the Cyclone IV E FPGA on the DE2-115, you must assign the logical names of the inputs and output in your design to the corresponding FPGA pins that are connected to the switches and the LED. The DE2-115 manual has a complete listing of all of the pin connections that have been made between the Cyclone IV E FPGA and the other peripherals that are present on the DE2-115 board. This information should be present under the CPE 324 Info folder that is on the desktop of the laboratory computers.

2 As part of the project setup at the beginning of this document, you entered the specific Cyclone IV E FPGA device that is present on the DE2-115. The next step is to enter the specific pin numbers on this FPGA which you want to associate the logical I/O pins in your design. To accomplish this, first select *Pin Planner*, from the *Assignments* menu as shown in Figure 5.2.

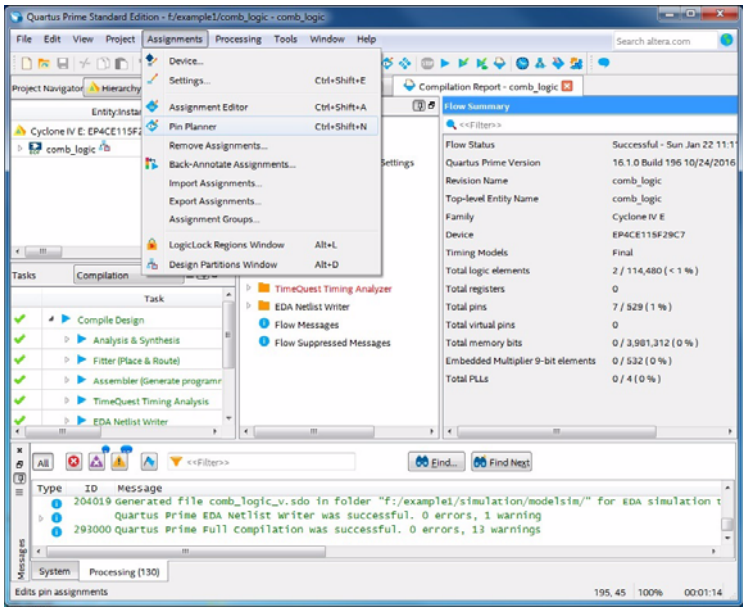

Figure 5.2

3 This will launch the *Planner Window* as shown in Figure 5.3. The *Node Name* fields at the bottom of this window will contain the name that was assigned by you when naming the INPUTS and OUPUT connector components of your design. The *Location* field will be empty. This is where the user is allowed to place a specific external pin number of the FPGA that is to be associated with the logical input/output of the design. If the user does not enter a pin number, then the Quartus Prime software will select the pin numbers itself which is often undesirable.

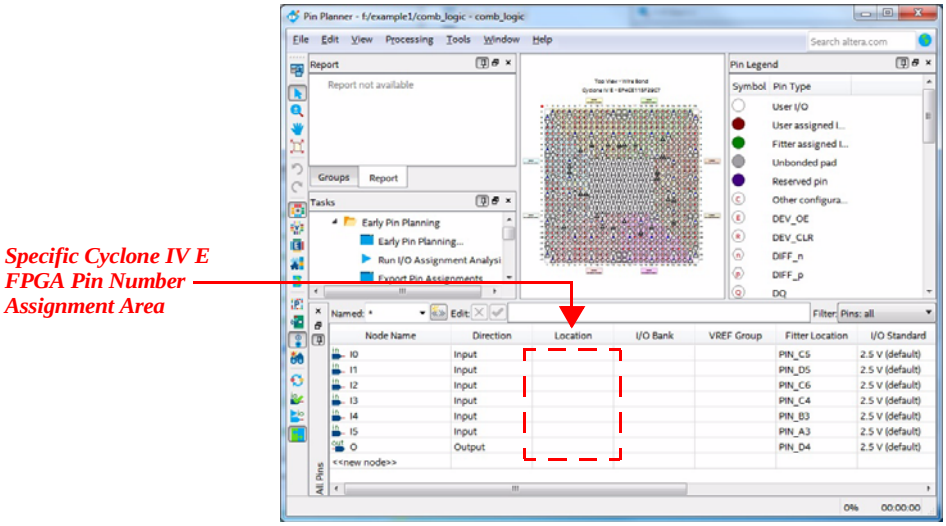

Figure 5.3 Pin Planner Window

4 In this example the pin numbers that correspond to the six switches, and the single LED are shown in Figure 5.4 after the correct FPGA pin numbers have entered on the *Pin Planner Window.* After entering these numbers you should then go back to the main Quartus Prime window and recompile the project.

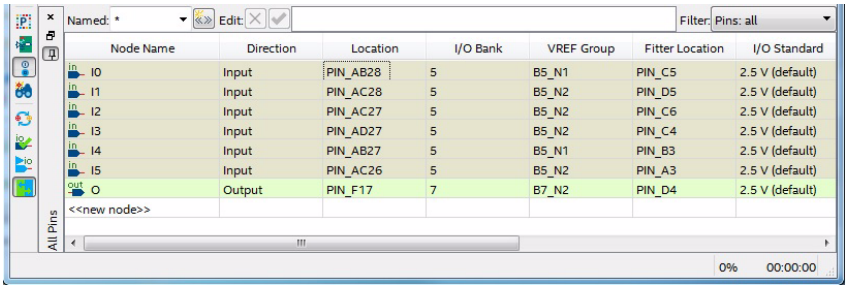

Figure 5.4 Pin Planner Window

5 To re-compile your project, left-click on the Icon or select the *Start Compilation* which can be found under the *Processing* menu. The compilation proceeds in the same manner as it did when the project was initially compiled. After the compilation has completed, the DE2-115 Cyclone IV E device can now be configured.

6 To configure the DE2-115 board with the example design, click on the Icon as shown in Figure 5.5, or select the *Programmer* option from the *Tools* menu.

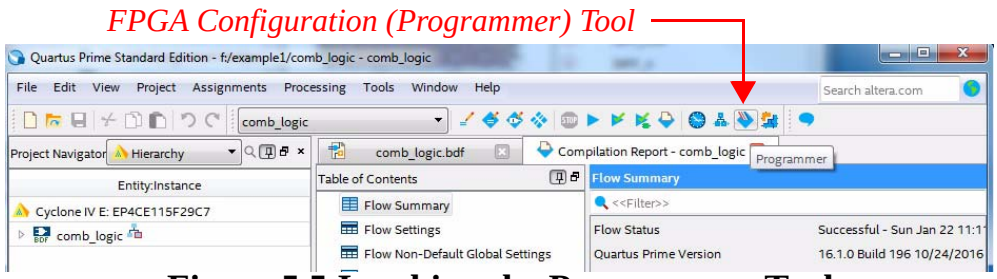

Figure 5.5 Invoking the Programmer Tool

This will launch a *Programmer Window* as shown in Figure 5.6.

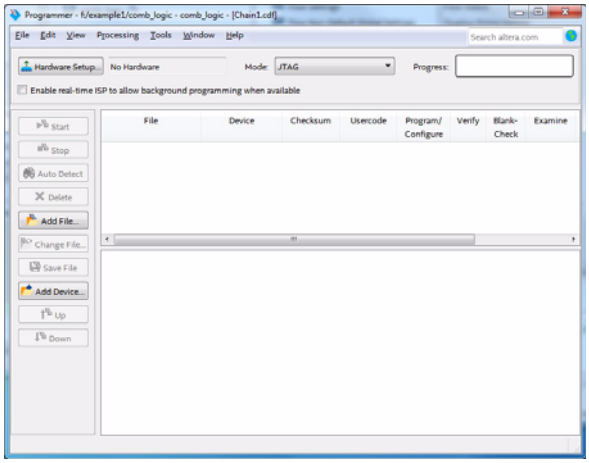

Figure 5.6 Programmer Window when no programming hardware is enabled

7 This window has a *File* field that should show the top-level file name of your project (but with a .sof extension). It also has a *Device* field that should match the EP4CE115F29 Cyclone IV E device that you have selected when you set up the project. There is also a *Program/Configure* box that should be checked. At the top of the window is a *Hardware Setup* button on the upper left-hand corner of the window. If the field next to it does not read *USB-Blaster,* then you will have to click on the *Hardware Setup* button before the DE2-115 can be programmed. (If the text next to the *Hardware Setup* button reads *USB-Blaster*, then the programming driver is already set up and does not need to be setup again. In this case, simply skip to step 9 and proceed).

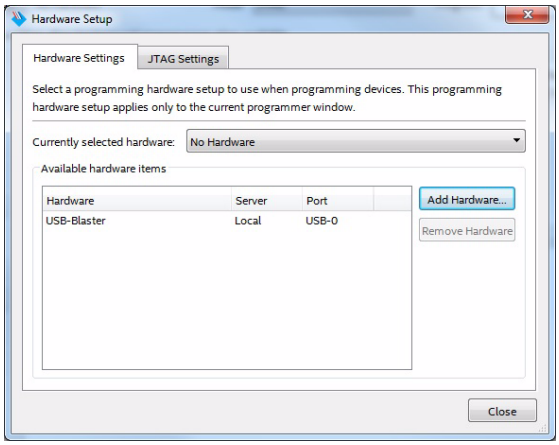

Figure 5.7 Hardware Setup Window

8 From the *Hardware Setup* window, choose, *USB-Blaster*, from the *Currently selected hardware:* list as shown in Figure 5.8. Then click on the *Close* button. This should result in the *Programmer* window now be displayed again.

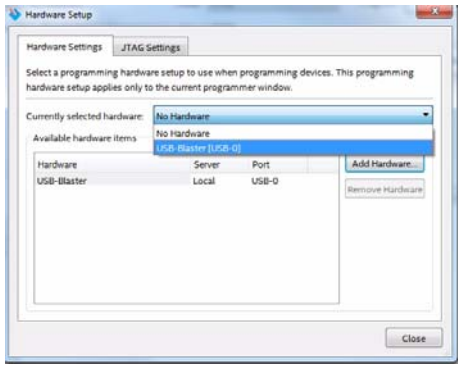

Figure 5.8 Selection of USB-Blaster

9 The *Programmer* window should now recognize the *USB-Blaster* and should have its *Start* button enabled. Make sure that the *Program/Configure* box is checked as shown in Figure 5.9 and that the DE2-115 board is turned on and properly connected to the PC through the USB cable as mentioned previously. Then click on the *Start* button to configure the DE2-115. The LEDs on the DE2-115 Board will flicker and after a few seconds the device should be configured. If there are problems with the configuration, error messages will appear in the status area at the bottom of the man Quartus Prime window. In this example, the design should now reside in the DE2-115's Cyclone IV E device, switches SW5-SW0 should control the design causing, LEDG8 to light up in the manner dictated by the Boolean function.

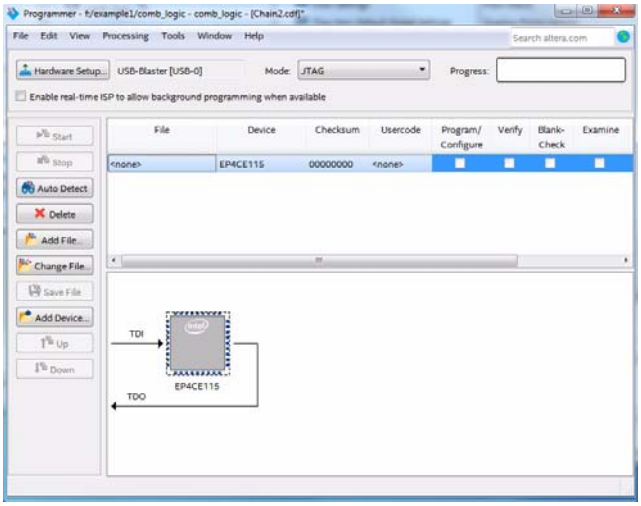

Figure 5.9 Programmer Window with USB-Blaster Enabled and successful DE2-115 Download