Introduction to the Altera DE2-115 Based HW/SW Platform with Environment Setup

In the logic design laboratories students will be working with hardware (Altera DE2-115 Development and Education Board) and software (Altera Quartus II programmable logic device development software).

Part I – Overview of the Altera DE2-115 Development and Education Board.

A photograph of the DE2-115 board is shown in Figure 1. It depicts the layout of the board and indicates the location of the connectors and only key components that will be employed in this lab; for more details please refer to "DE2-115 User Manual"[1].

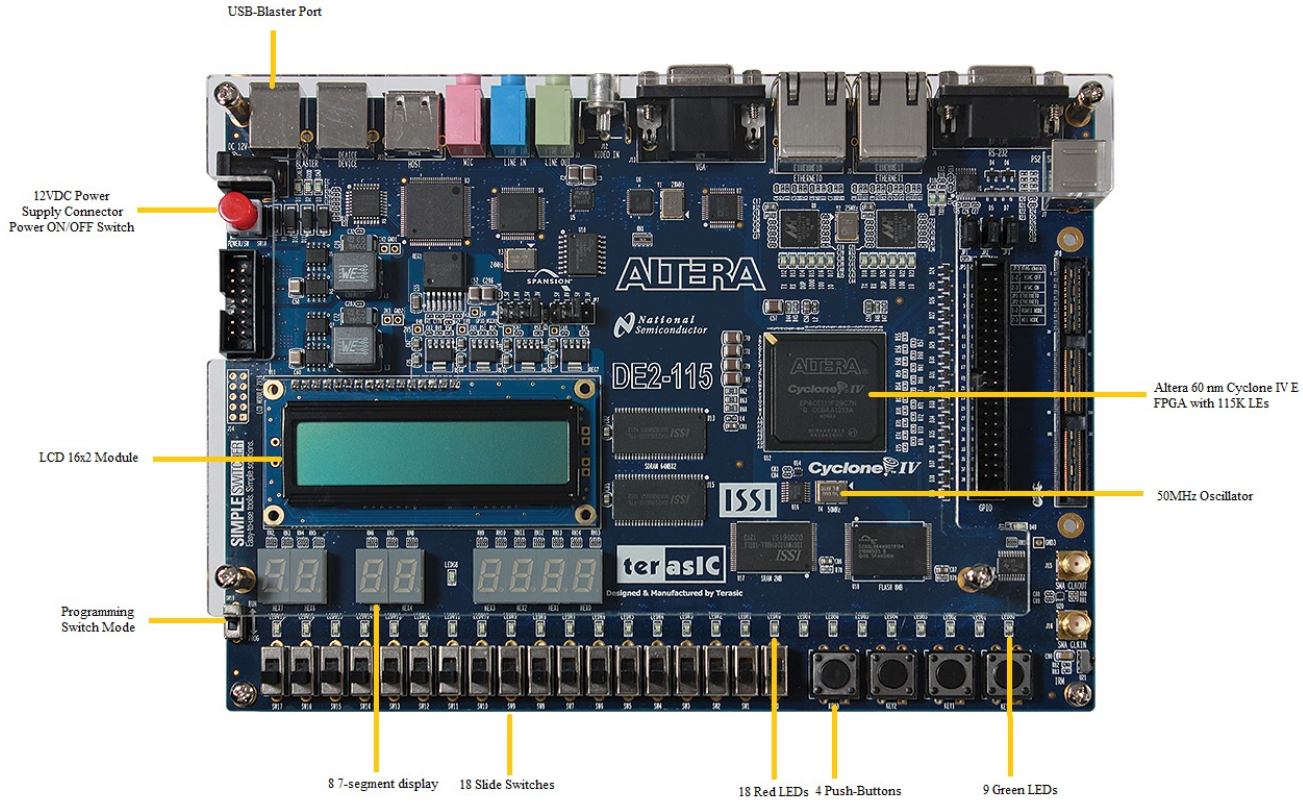

Figure 1: The DE2-115 board

The following hardware provided on the DE2-115 board will be employed in the lab experiments:

- Altera Cyclone® IV 4CE115 FPGA device
- Altera Serial Configuration device-EPCS64
- USB-Blaster (on board) for programming; both JTAG and Active Serial (AS) programming modes are supported
- 4 Push-buttons
- 18 Slide switches
- 18 Red user LEDs

[1] http://www.terasic.com.tw/cgi-bin/page/archive_download.pl?Language=English&No=502&FID=cd9c7c1feaa2467c58c9aa4cc02131af

- 9 Green user LEDs
- 50 MHz oscillator for clock sources
- USB Host/Slave Controller with USB type A and type B connectors
- 16x2 LCD module

All logic circuits in the following lab experiments will be implemented on the FPGA (Field Programmable Gate Array) device of the board (Altera Cyclone® IV 4CE115). An FPGA is an array of configurable logic elements (LE), memories or multipliers which can be connected between them or to FPGA's pins through programmable connections; each LE (or groups of LE's) can implement any logic function, and it can be connected to any FPGA pin (I/O) or to any other LE.

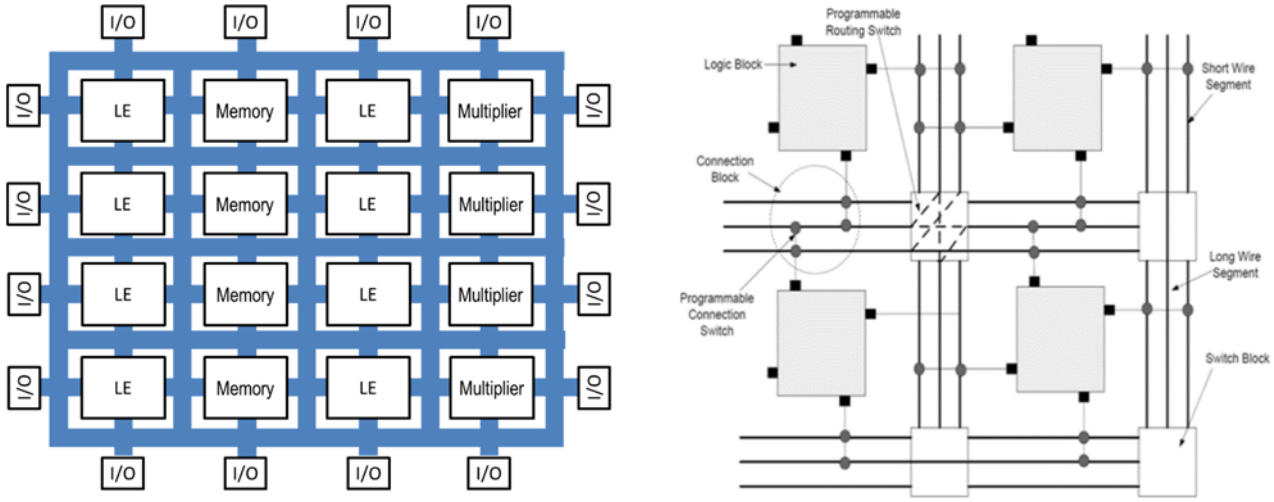

Figure 2: FPGA block diagram

Altera Cyclone IV FPGA (EP4CE115F29) is the core of DE2-115 board, as it shown in the following block diagram:

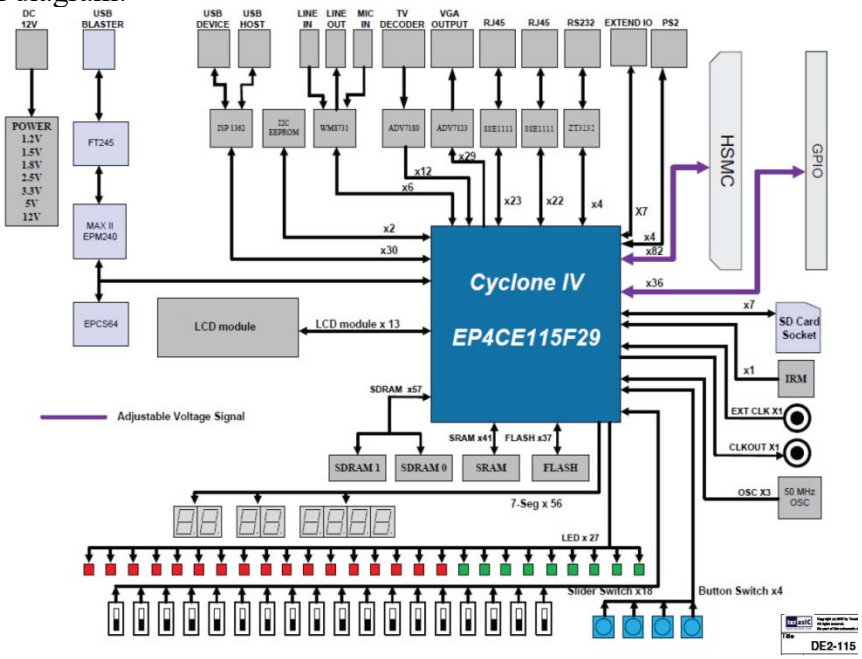

Figure 3: Altera Cyclone IV FPGA (EP4CE115F29) block diagram

Part II – DE2-115 pin connections details

On our DE2-115 board all external components to the Altera Cyclone IV FPGA are hardwired connected to the FPGA's pins through the PCB (Printed Circuit Board), and, as such, the assignments of the FPGA pins have to respect these connections. In other words, one cannot connect link a given component to other pin than the one to which is already corrected!

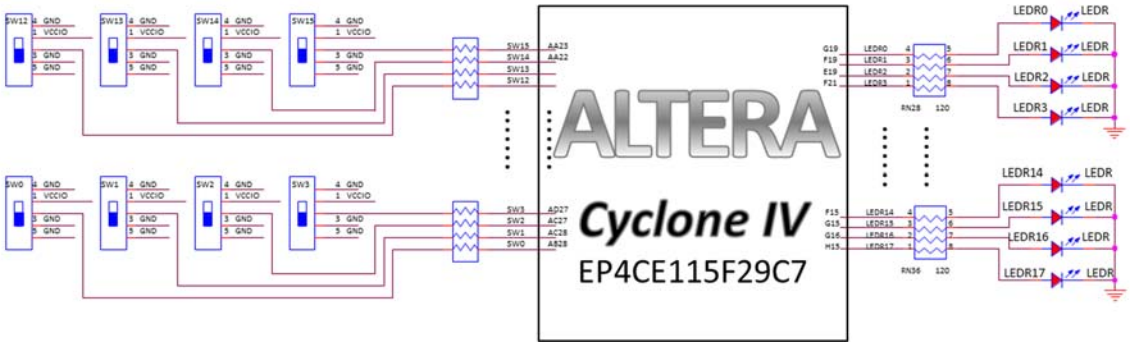

Figure 4: LED and SW connection

Schematics of subset of slide-switches and LED's that will be employed for experimental static verification of the logic circuits implemented on the Altera Cyclone IV FPGA.

Figure 5: Connections between the LEDs and Cyclone IV E FPGA

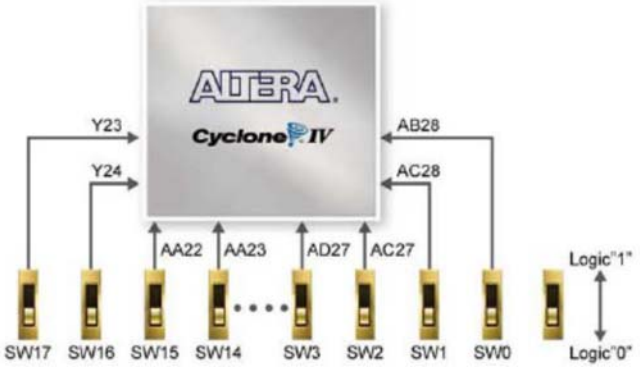

Figure 6: Connections between the slide switches and Cyclone IV E FPGA

Part III – Overview of Altera Quartus II SW/HW interaction

Altera Quartus II is a PLD (programmable logic device) development software that allows analysis and synthesis of logic circuit designs. Quartus enables the developer to capture their designs into logic diagrams, compile them for the FPGA that will implement the logic circuit, perform timing analysis, simulate a design answer to different stimuli, and configure the target FPGA device with the programmer. Except the last step, all the previous phases can be performed without the DE2-115 board. This means that once you have installed Quartus II on your computer, you may be able to design, simulate and debug your logic circuit, such that when you will deploy your project onto the DE2-115 board in the lab, you should perform only the practical verification of your design.

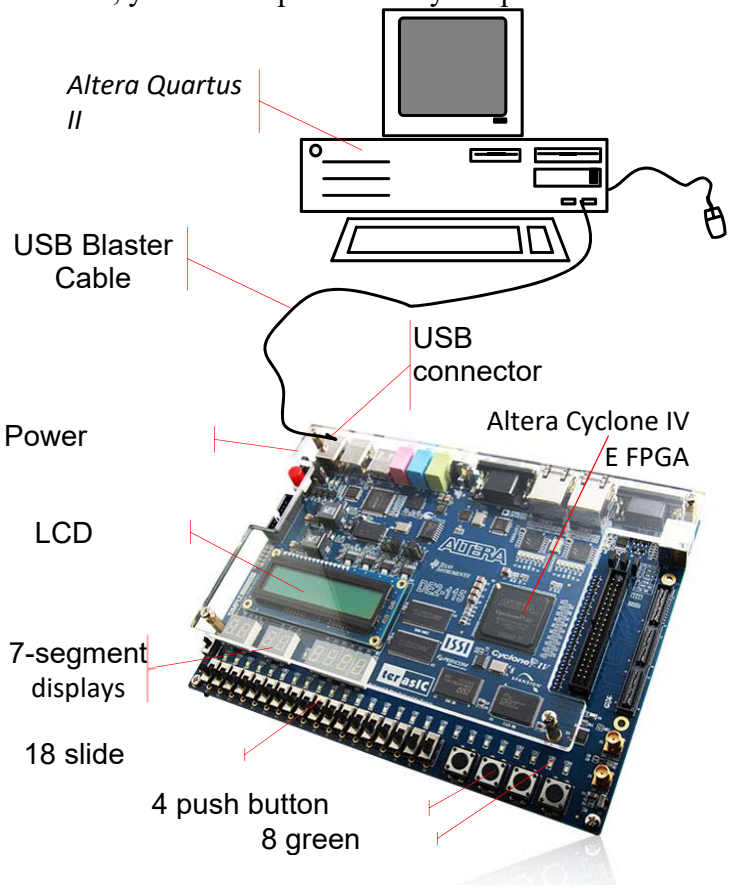

Figure 7: The Altera DE2-115 Based HW/SW Platform

Part IV – Environment configuration:

Personal environment:

Quartus II software package can be found at http://dl.altera.com/13.0sp1/?edition=web. This link will give you the possibility to download a free version (Web Edition) of the design tool software needed to design your digital circuits.

You will need to create a free account in order to download the product. To download the Quartus II Web Edition 13.0 sp1, select the OS installed on your laptop or PC.

NOTE: It is simpler to perform the Quartus II installation in Windows than in Linux.

Here's a link listing the OS compatible with Quartus II 13.0 sp1:

https://www.altera.com/support/support-resources/download/os-support.html

- Quartus II cannot be installed on a Mac OS laptop. Workaround for this issue is to create a virtual machine running either Linux or Windows OS

Select the **Combined Files** tab to download all the required software modules to run the Quartus II. You will need a significant amount of disk space (about 15 GB) in order to install Quartus II. However, you can delete the downloaded files and the decompressed files once installation is complete. For Linux users, if you are running the Bitdefender antivirus software, you should temporarily disable the software during the Quartus II software download and installation process. Once the download is finished, extract the *.tar file.

NOTE: You can install WINRAR or 7-Zip or other unpacking SW to extract the *.tar file.

NOTE: The names of folders or files cannot contain spaces!

Browse to the location where you have saved the downloaded files and run the setup.bat (Windows) or setup.sh (Linux) file. The installation wizard window will appear. When selecting the components, select the same components as shown in the figure below. Wait for the installation to be complete. Once completed, you can delete the downloaded and decompressed files.

NOTE: If you have a 64-bit Linux OS, you will need to install the 32-bit libraries: glibc.i386 libXext.i386 libX11.i386 libXau.i386 libXdmcp.i386 freetype.i386 fontconfig.i386 expat.i386

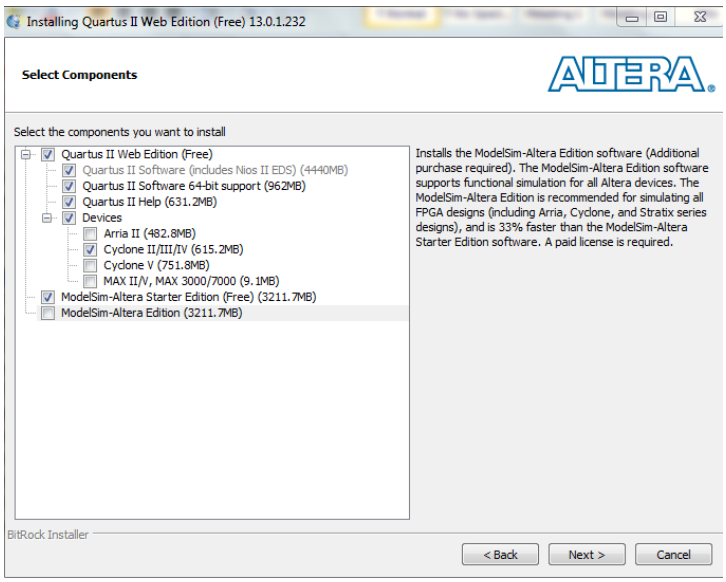

Figure 8: Selected components

To finish the installation, open Quartus II 13.0sp1 (xx-bit) where xx is 32 or 64 depending on the laptop/PC OS architecture and go to **Tools → Install Devices** and install the Altera device, i.e. Cyclone II/III/IV (*.qdz file under …/Quartus-web-13.0.1.232-windows/components in the folder where the unpacked downloaded *Quartus-web-13.0.1.232-windows* is located… in case it was not already automatically installed).

UOttawa Environment:

Everything is already setup to use Quartus II. Only thing to note is when launching the Quartus II software it is possible that you will be asked about the license option, select “Run the Quartus II

software". To access the program, go to Start → All Programs → Software Development and open the QUARTUS II 13.0 sp1 (64-bit).

For extra information, you can visit the link below for Quartus II on installation:
https://dl.altera.com/static/quick_start_guide/quick_start_guide_13.0_en.pdf
https://www.altera.com/downloads/software/faq/dnl-v130-download-installation-faq.html