Contents

Lab 2: Introduction to VHDL and Xilinx ISE

Objectives

The purpose of this laboratory exercise is to become familiar with the Xilinx ISE development environment, next with basic VHDL syntax, and input/output devices.

Materials

You will use push buttons on the CoolRunner-II CPLD starter board (XC2C256-TQ144, manual, schematic) as inputs and light emitting diodes (LEDs) as output devices.

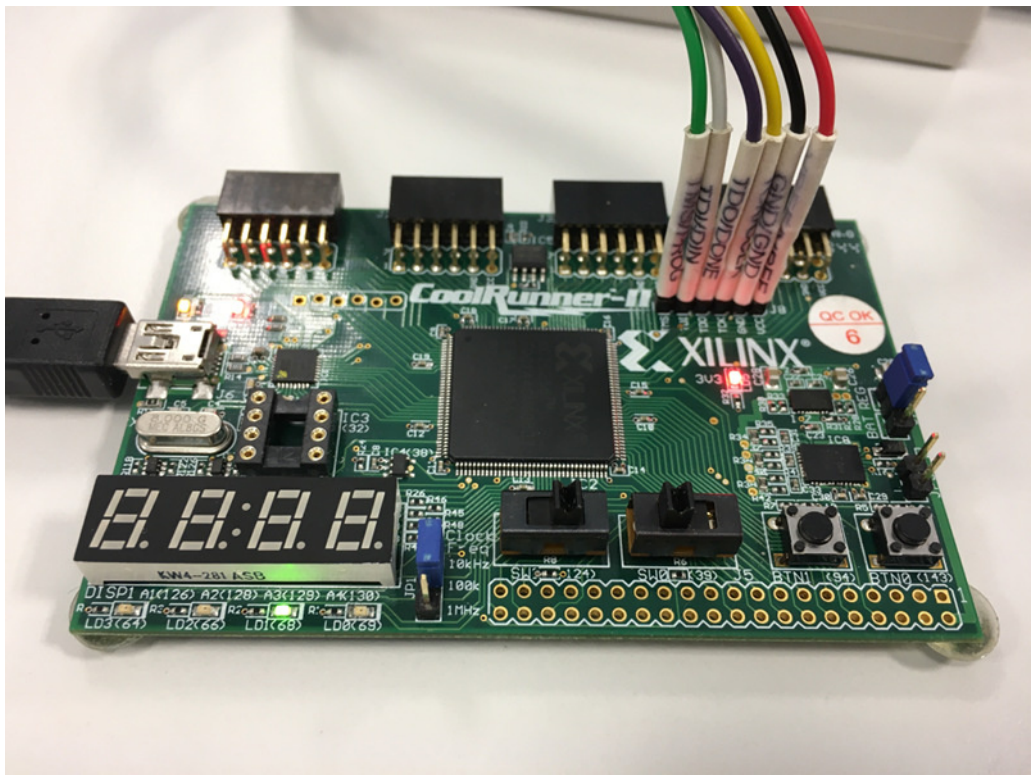


Figure 1: CoolRunner-II CPLD starter board

1 Preparation tasks (done before the lab at home)

1. Digital or Binary comparator compares the digital signals A, B presented at input terminal and produce outputs depending upon the condition of those inputs. Complete the truth table for 1-bit Identity comparator (A equals B), and two Magnitude comparators (A greater than B, A less than B). Note, '1' represents true, '0' represents false.

A	B	A greater than B	A equals B	A less than B
0	0	0	1	0
0	1			
1	0			
1	1			

According to the truth table, create canonical SoP (Sum of Products) or PoS (Product of Sums) forms as follows:

$$f(b,a)^{SoP}_{greater} =$$

Figure 2: Greater than

$$f(b,a)^{SoP}_{equals} =$$

Figure 3: Equals

$$f(b,a)^{PoS}_{less} =$$

Figure 4: Less than

Create K-maps for all three functions.

Use the K-map to create the simplified PoS form of the function.

$$f(b,a)^{PoS}_{less,\ Simple} =$$

Figure 5: Simplified PoS form

Equations and symbols were generated by Online LaTeX Equation Editor.

2 Synchronize Git and create a new folder

1. Open a Linux terminal, use `cd` commands to change path to your Digital-electronics-1 working directory, and synchronize the contents with GitHub.

```
$ pwd
/home/lab661
$ cd Documents/your-name/Digital-electronics-1/
$ pwd
/home/lab661/Documents/your-name/Digital-electronics-1
$ git pull
```

2. Create a new folder `Labs/02-ise`

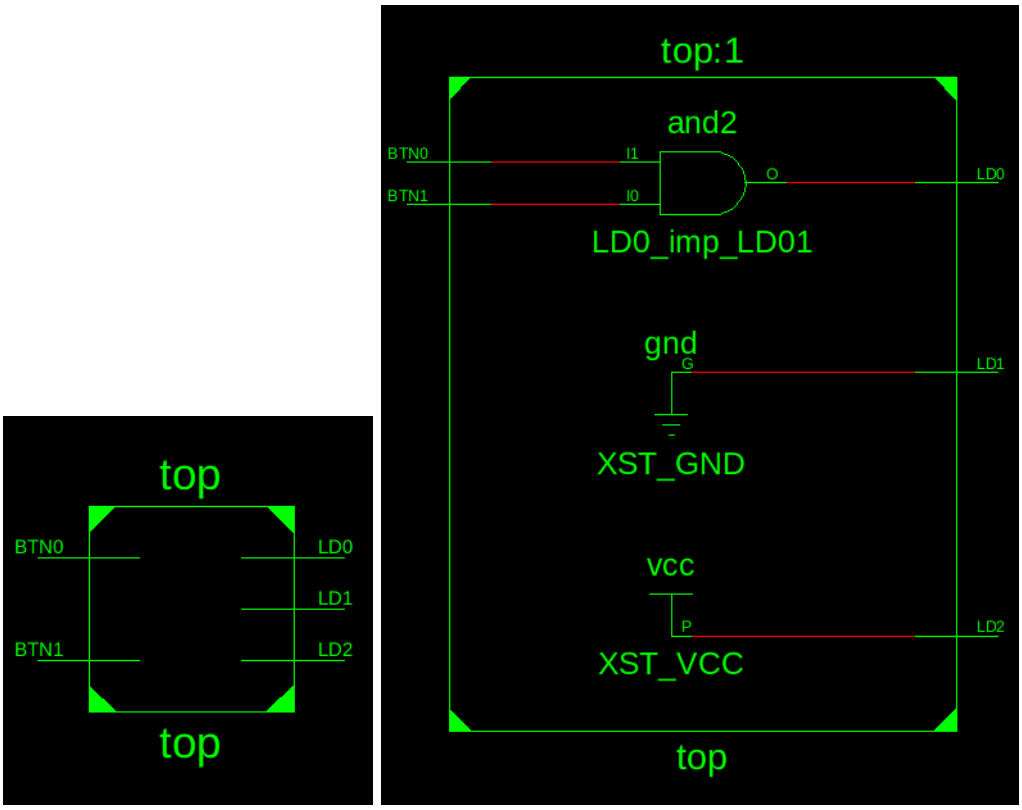
```
$ cd Labs/
$ mkdir 02-ise
$ cd 02-ise/
$ touch README.md
$ ls
README.md
```

3 Digital circuits in VHDL language

1. Follow instructions from wiki and create a new project in ISE. Make sure the project location is `/home/lab661/Documents/your-name/Digital-electronics-1/Labs/02-ise` , ie in your local folder.
2. Using VHDL operators, define the architecture for 1-bit digital comparator. Most common VHDL operators are shown in the table.

Operator	Description
`<=`	Value assignment
`and`	Logical AND
`nand`	Logical AND with negated output
`or`	Logical OR
`nor`	Logical OR with negated output
`not`	Nagation
`xor`	Exclusive OR
`xnor`	Exclusive OR with negated output
`-- comment`	Comments

3. Follow instructions from wiki, create a test bench with all input combinations, and simulate your design in ISim simulator.
4. See schematic or reference manual of the board and find out the connection of LD0, LD1, LD2 LEDs and BTN0, BTN1 push buttons. Follow instructions from wiki, create a constraints file, and implement your design to CoolRunner-II CPLD starter board. Modify the internal architecture of your design so that a pressed button represents log. 1 and a LED is turn off for log. 0.
5. In menu Tools > Schematic Viewer > RTL... select Start with a schematic of top-level block and check the hierarchical structure of the module.



6. In menu Project > Design Summary/Reports check CPLD Fitter Report (Text) for implemented functions in section `********** Mapped Logic **********` .

4 Clean project and synchronize git

1. In Xilinx ISE, clean up all generated files in menu Project > Cleanup Project Files... and close the project using File > Close Project.

   Warning: In any file manager, make sure the project folder does not contain any large (gigabyte) files. These can be caused by incorrect simulation in ISim. Delete such files.

2. Use `cd ..` command in Linux terminal and change working directory to `Digital-electronics-1`. Then use git commands to add, commit, and push all local changes to your remote repository. Check the repository at GitHub web page for changes.

```
$ pwd
/home/lab661/Documents/your-name/Digital-electronics-1/Labs/02-ise

$ cd ..
$ cd ..
$ pwd
/home/lab661/Documents/your-name/Digital-electronics-1

$ git status
$ git add <your-modified-files>
$ git status
$ git commit -m "[LAB] Adding 02-ise lab"
$ git status
$ git push
$ git status
```

Experiments on your own

1. Follow the Linux or Windows instructions and install ISE 14.7 on your computer.
2. Create a new project, define, and simulate a 2-to-4 decoder in VHDL (its structure was mentioned in Lab 1).
3. Complete your `README.md` file with screenshot from the simulation(s).