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Learning digital frequency dividers through practical laboratory activities

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Abstract

This paper present a group of useful practical activities in electronics vocational education for teaching digital frequency dividers by completing three successive stages: simulate electronic circuits with dedicated software; implement and test circuits on breadboard using general purpose logic integrated circuits; implement logic circuits using reconfigurable circuits. At the end, students will be able to implement other projects with the same level of complexity; they will have a better understanding of sequential logic circuits and good skills in working with reconfigurable circuits and handling laboratory equipment, which are essential requirements for a well-trained technician in electronic field.

Introduction

•To increase the flexibility, the quality, efficiency and attractiveness of Vocational Education and Training (VET), the Bruges Communiqué establish eleven strategic objectives for the period 2011-2020.

•Project "*one2one - One Teacher and One Students working with ProjectX* ",, aims to develop practical activities that can be done in any VET school, using a tool that was called ***ProjectX***.

•***ProjectX*** is "a methodological guide for the student to carry out a concrete activity, one to one with a teacher, in which theory and practice are both perfectly integrated and is related to the real workplace**. Each ProjectX will be developed on the basis of Learning Outcomes, which means we will also create a tool based in the ECVET credit system that will allow mobility of students"** (ProjectX, 2014).

Project description (1/2)

Aims of our *ProjectX:*

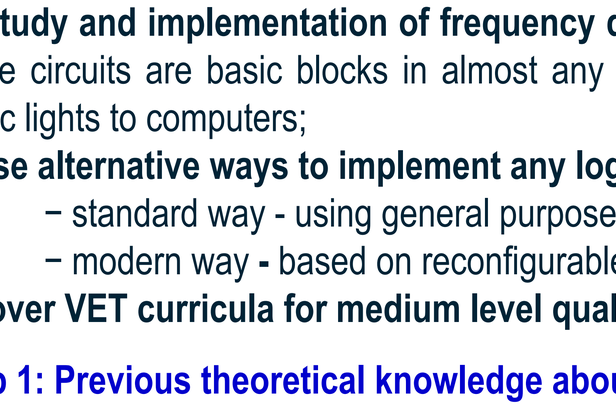
- **study and implementation of frequency dividers** taking into account that these circuits are basic blocks in almost any modern digital equipment, from traffic lights to computers;
- **use alternative ways to implement any logic circuit**
  - − standard way - using general purpose logic integrated circuits ;
  - − modern way **-** based on reconfigurable logic IC such as FPGA
- **cover VET curricula for medium level qualifications.**

Step 1: Previous theoretical knowledge about flip-flops and counters:

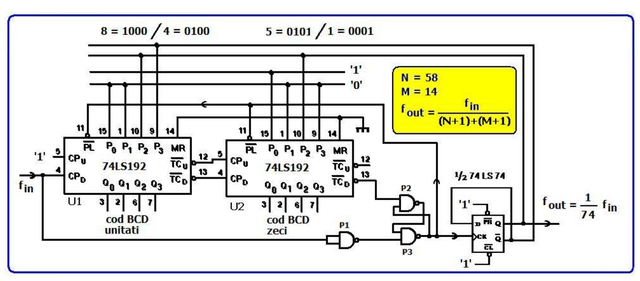
- − ensured by well selected tutorials and exercises;
- − all support materials are focused more on how to use these circuits and less on how they are made inside.

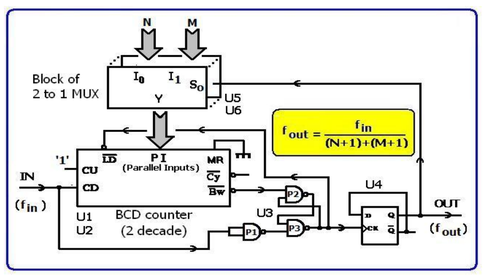
Step 2: Frequency dividers design techniques: we selected two types of representative dividers:

• frequency dividers with fixed dividing factor, implemented with asynchronous counters



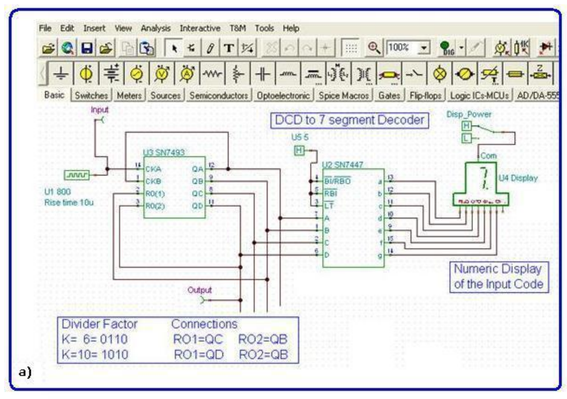
• programmable frequency dividers implemented with synchronous counters





Project description (2/2)

Step 3: Simulation and implementation with general purpose logic IC



Step 4: Implementation with FPGA

To implement a logic circuit in FPGA students must perform the following steps: description of the logic function; compile the logic function to obtain configuration file; circuit configuration; testing the application; in case of mistake students must fix the logic function, re-compile and re-download it.

Learning outcomes of the projects

To be easily integrated in VET system of different countries, each *ProjectX* must present a list of skills and abilities acquired after project completion.

If these learning outcomes are attractive and are in compliance with the requirements for a particular qualification, we have a chance to increase the degree of mobility in VET systems.

Table 3. Skills related to implementation of logic circuit with FPGA .

Circuit design with FPGA	***Testing circuits implemented in FPGA***
– make new project, add new sources, draw the schematic of the divider; *– make constrains file (specify the input/output FPGA pins);* *– generate configuration file;*	*− download the configuration file into FPGA;* *− make connection to the signal generator and power supply;* *− make tests to verify the functionality of the circuit;* *−use oscilloscope to display the input/output electrical signals.*

Conclusion

All these practical activities are designed to bring the following benefits to students who completed this project:

- ➢ a better understanding of sequential logic circuits:
- ➢ design different type of frequency dividers based on counters;
- ➢ use computer programs to simulate any small/medium digital circuit;
- ➢ use breadboard and general purpose logic IC to implement and test any small/medium logic circuit;
- ➢ use state of the art logic IC such as FPGA to implement logic circuit;
- ➢ improve personal skills in handling laboratory equipment.

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References

Bruges Communiqué (2011). Supporting vocational education and training in Europe: the Bruges Communiqué, ProjectX (2014). Guidelines for making ProjectX, *Lifelong Learning Programm "One teacher and one student working with ProjectX",* project code 2013-1-ES1-LEO01-66485, acronym "One2one", http://projectxone2one.eu. Floyd, T.(2006). *Digital Fundamentals* (9th edition), Pearson Education International, ISBN 0-13-197255-3.

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