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FPGA Implementation of Frequency Dividers in Vocational Education

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Abstract

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"***.**

This paper present a part of one ProjectX for teaching digital frequency dividers in VET school, by completing three successive stages: simulate electronic circuits with dedicated software; implement and test circuits on breadboard using general purpose logic integrated circuits; implement and test logic circuits using FPGA.

Introduction

A long period of time general and higher education played a major role in the European education and vocational education and training (VET) only a minor role – the thinking being that it offered less good job and even less promotion opportunities.

The growing importance of VET it is recognized in various documents elaborated by European Centre for the Development of Vocational Training.

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

Each *ProjectX* was developed on the basis of Learning Outcomes and ECVET credit system in order to increase the mobility of students and teachers between different institutions.

Project description (1/2)

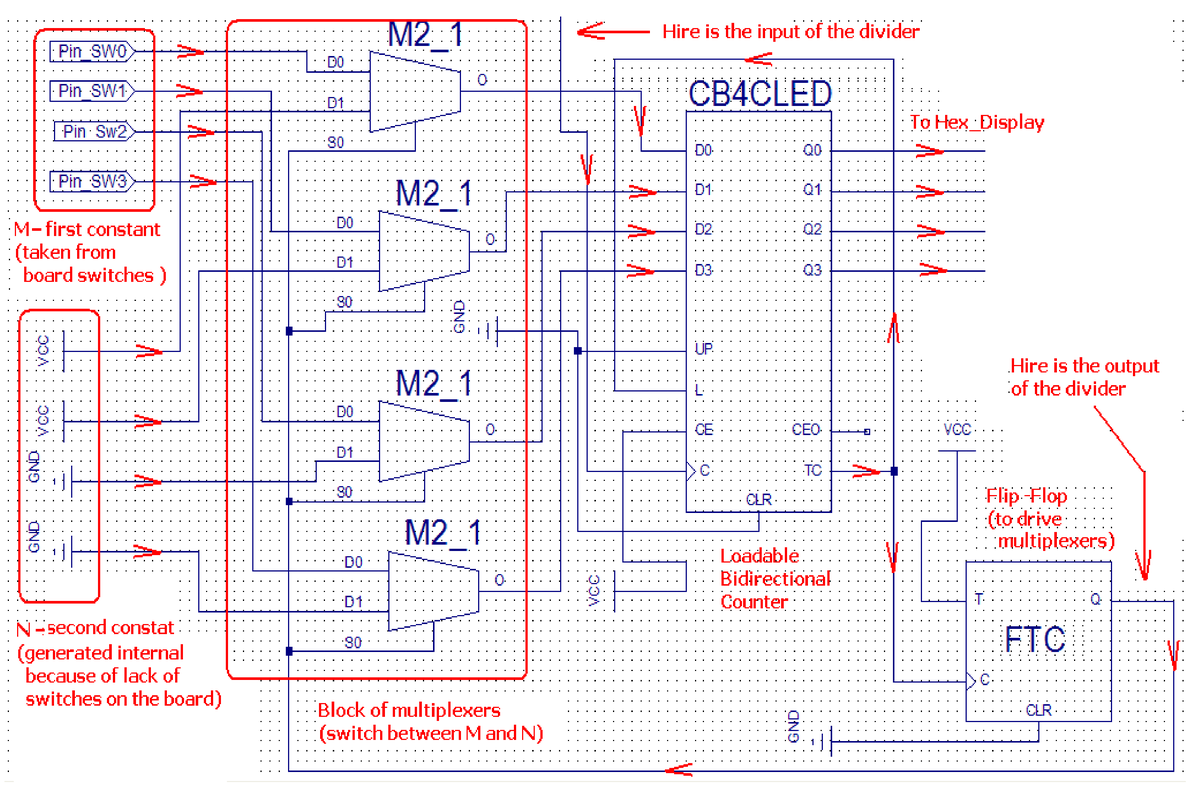
Aims of the ProjectX "Implementation of digital frequency dividers"

- **study and implementation of frequency dividers** taking into account that these circuits are basic blocks in almost any modern digital equipment;
- **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.**

Applayed ProjectX in Teaching Frequency Dividers

After an initial theoretical documentation regarding flip-flops, counters and frequency dividers implementation techniques, each student are going to perform three groups of practical activities:

- **simulate** different counters and frequency divider using dedicated software programs;
- **implement** and test different counters and frequency divider, **on breadboard**, using general purpose logic integrated circuits;
- **implement** and test different counters and frequency divider using modern digital circuits such as **FPGA**.



Project description (2/2)

Working with FPGA is not an easy task but is the most attractive and flexible modality of implement digital circuits. Generally speaking, for each FPGA application it is mandatory to make a project in which to specify the target circuit, its logic function and how external devices are connected to the FPGA. To make things easier, all applications will start from a *Project_Template* in which the student will place their application in well delimited area. In this template there are already implemented some useful tools in order to access the resources of the board or in order to see the state of the counter:

- a programmable signal generator;
- one BCD to 7segment decoder in order to display the state of the counter in decimal format,
- one driver in order to display the state of the counter in binary format on *Basys 2* LED's.

All experiments will be implemented in *ISE Project Navigator* software and will be tested on *Basys2* board.

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.

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

Students who tested this *ProjectX*, at the end of all practical activities were able to simulate, design and implement counters and frequency dividers or other logic circuits with same complexity level. They learn to implement and test logic circuits in two different technologies:

- using general purpose logic IC;
- using most recently logic IC such as FPGA.

A good understanding of these circuits and ability to work with FPGA as well as working with general purpose logic IC are essential skills for a well-trained technician in electronic field.

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References

[1] CEDEFOP; [2] Bruges Communiqué (2011); [3] 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.; [4] I. Bostan, R. Beloiu, and N. Bizon, "Learning Digital Frequency Dividers Through Practical Laboratory Activities", Procedia - Social and Behavioral Sciences, vol. 180, 5 May 2015, pp. 1014-1021;

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