Lab04 – Introduction to the project: getting started with the Basys 3

The goal of this lab is to get familiar with the Basys 3 FPGA board. The reference manual of the Basys3 can be found here.

1 Introductory exercise: LED ON/OFF

Implement a module such that LED0 is ON when the right button is pressed then synthesise it and program your FPGA. **Refer yourself to the slides available on the UV to get started with this exercise.**

2 Binary to hexadecimal converter

Write a module which allows to convert a binary number given by the position of the switches to its hexadecimal representation. The obtained hexadecimal value should be displayed on the 7-segment. An example of the expected behaviour is shown in Figure 1.
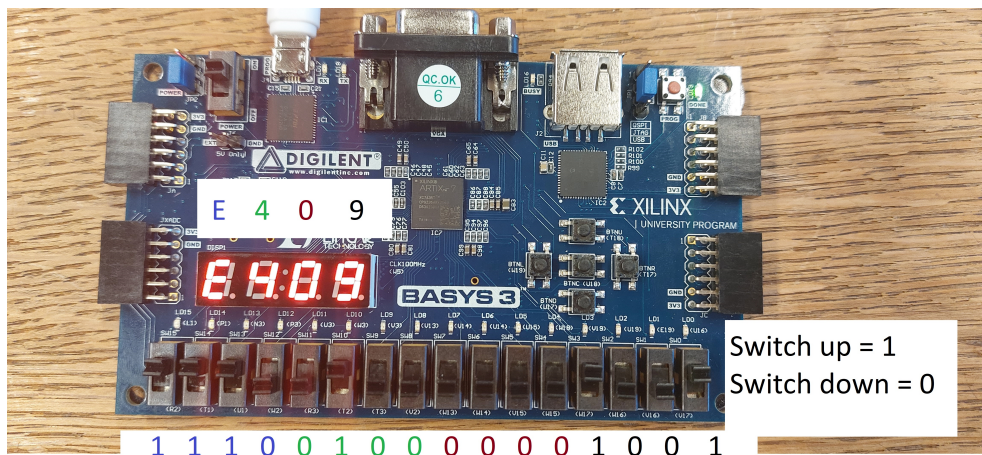

Figure 1: Example of expected results

What is the 7-segment display?
As explained in the reference manual, the Basys3 board contains a four-digit common anode seven-segment LED display module. Each of the four digits within the module is composed of seven segments that can be individually illuminated.

How does the 7-segment display work?
The segments are controlled using 4 anode input signals (AN0 to AN3) and 8 cathode input signals (CA to CG and DP) as shown in Figure 2. The signals CA to CG correspond to each of the 7 segments and the signal DP corresponds to the dot. **The cathode signals are common to all digits but they can only illuminate the segments of the digit whose corresponding anode input signal is made active**. Both anodes and cathodes signals are made active when **driven-low** (= when set to '0').
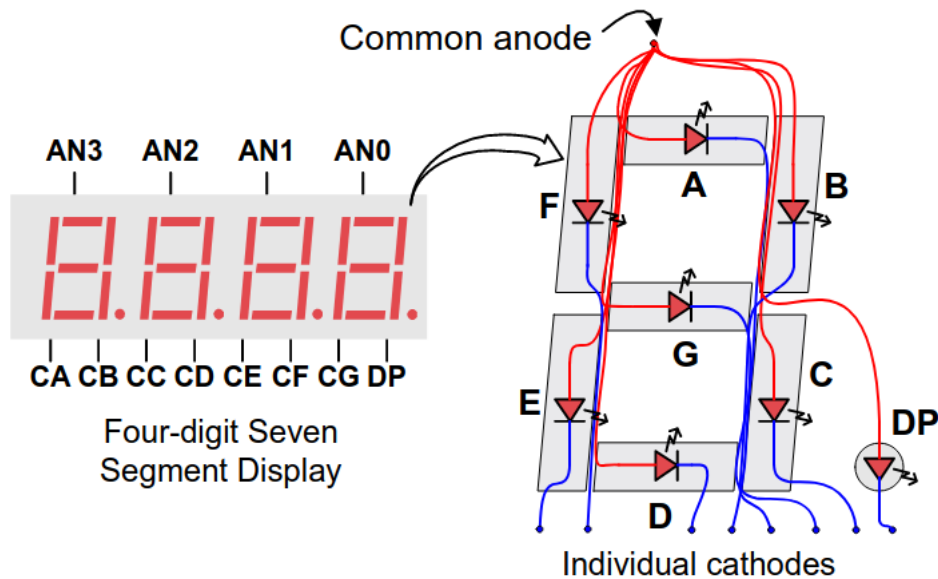
Figure 2: 7-segment display anode and cathode input signals

How to display 4 different digits on the 7-segment display?
To display 4 different digits you should implement a module that drives the anode signals and corresponding cathode patterns of each digit in a repeating, continuous succession **at an update rate that is faster than the human eye can detect**. By doing so, each digit will be illuminated just one-fourth of the time, but because the eye cannot perceive the darkening of a digit before it is illuminated again, the digit appears continuously illuminated. For example, if AN0 is driven while CB and CC are driven, then a "1" will be displayed in digit position 1. Then, if AN1 is driven while CA, CB, and CC are driven, a "7" will be displayed in digit position 2. If AN0, CB, and CC are driven for 4ms, and then AN1, CA, CB, and CC are driven for 4ms successively and endlessly, the display will show "71" in the first two digits. An example timing diagram for a four-digit controller module is shown in Figure 3.
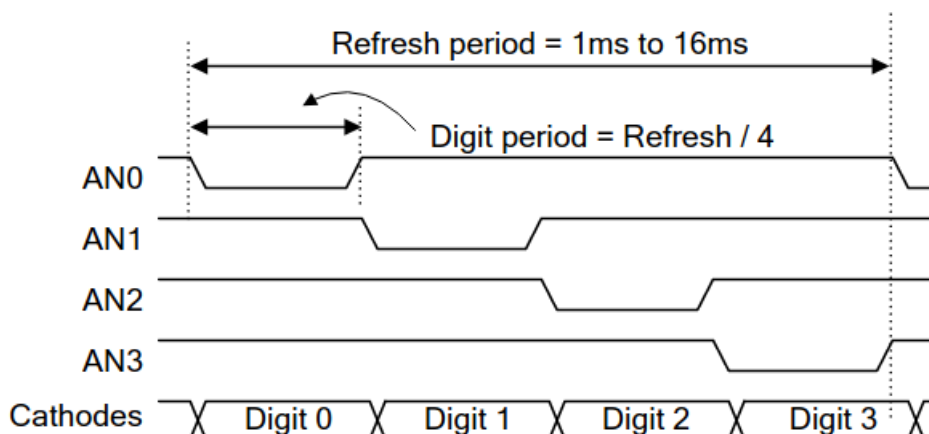

Figure 3: Example timing diagram for a 4-digit controller module