



Digital Oscilloscope

Objective: Implement a digital oscilloscope with trigger, memory, VGA display and data communications with a PC.

The aim of this assignment is to implement a digital oscilloscope by integrating the several modules developed in the previous laboratory assignments. This work will be evaluated in the standard grade scale from 0 to 20.

A digital oscilloscope has several components and subsystems that need to be implemented.

Data acquisition subsystem.

This subsystem is based in an ADC, the MAX153, that is able to convert analog voltages to digital values with a resolution of 8 bits at a maximum frequency of 1 MHz. This ADC in particular was chosen for its DIP package and because it has a parallel data output. The ADC is mounted in a small PCB to interface the GPIO and to provide power (through the 5V pin of the GPIO) and Ground to the ADC. Digital lines from the GPIO go to the control lines of the ADC and the ADC data lines are connected to GPIO digital lines. The analog input of the ADC can be the output of a voltage divider (for testing) or an external line. The documentation both for the board and for the ADC can be found in the webpage.

The first step is to make sure that data from the ADC is read correctly. For this, connect the DE2 to the ADC and show some acquired data¹. The ADC can be easily used by choosing the pipe-line mode with a relatively slow clock (e.g. 200 kHz) when compared with the maximum acquisition frequency.

Pin MAX 153	Pin connector	GPIO	Function	Pin MAX 153	Pin Connector	GPIO	Function
2	40			18	2		
3	38			17	4		
4	36			16	6		
5	34			15	8		
6	32			14	10		
7	28			13	14		
8	26						
9	24						

Trigger subsystem

The oscilloscope must be able to identify voltage pulses with a width of 100 microseconds and 3 V of amplitude. The rising edge should be recorded in the middle of the recorded data, i.e., there should be data recorded before the rising edge and data recorded after the rising edge.

¹ The method to show the acquired values is not suggested on purpose.

Control subsystem

The oscilloscope must have a set of controls that allow to make a reset, start an acquisition and make a trigger. It can have as a user input a command to show the data and/or transmit data to a computer.

Display subsystem

The acquired data should be shown in a VGA display. The minimum requirement is to show 256 acquisition points. Beside this, leds and 7-segment displays can (and should) be used to show the oscilloscope state and additional information.

Communication subsystem

The oscilloscope should be able to be read by a PC, at least in a rudimentary way. This means that it should be possible to visualize the data in a PC even if it is necessary to make several steps². The ability to program a data display in the PC will not be evaluated, only the ability to implement a data communication system between the DE2 and the PC.

² The data could be, for instance, acquired in a terminal, copied to a text file, reformatted, copied to an excel file and then plotted.