Description of digital hardware and connections

This document presents a description of the connections used in the digital hardware of the wave speed meter project. This hardware is used to determine the travel time of the acoustic wave, to calculate the propagation speed, the mean and the standard deviation, controlling and displaying the results. In the following, the connections of the components (FPGA, Arduino and LCD display), are shown and explained. The VHDL and the arduino files used are in the compacted in the “Experiment.zip” file.

First, as a starting point, consider the signal from the circuit that converts the analog signal to a TTL level (see Figure 8 of the article). This signal is called J1 and enters the FPGA by pin 132.
Obs. The active time duration of this signal (“high-level”), corresponds to the travel time of the acoustic wave between the transmitter and receiver transducers.

The FPGA project has only one programmed file, "Experimento.vhd". This program performs the counting of the clock pulses while the J1 signal is active (high-level).
Obs.The clock frequency is 50MHz.

After counting, the FPGA transfer the obtained value to the Arduino, using a parallel bus with 7 data bits, 2 control and 1 enabling.

Figure 1 shows the described connections used in the project.

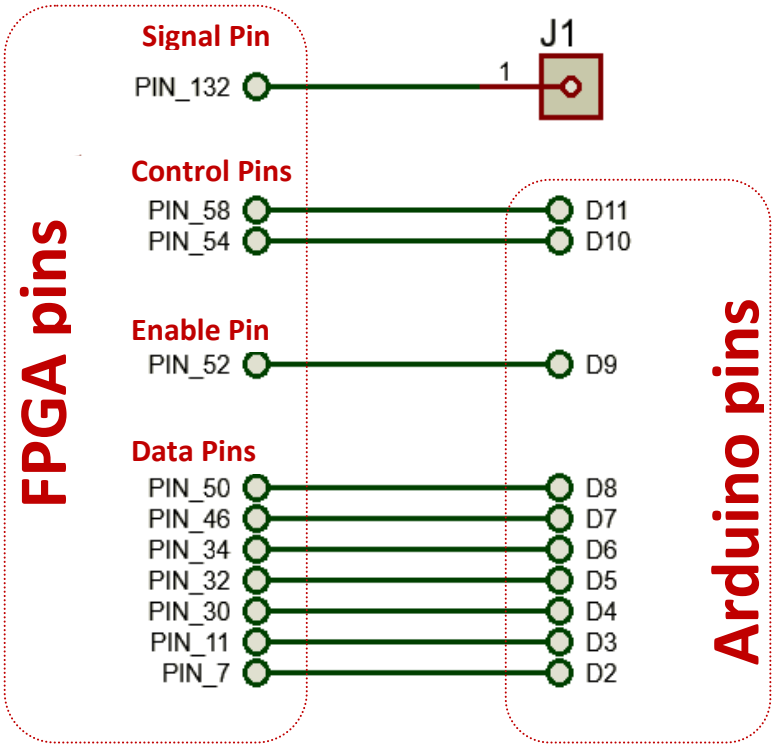

Fig1. Pin connection

The program stored in Arduino is called “Experimento.ino”. This program calculates the mean and standard deviation values for the travel time of the pulses and for the speeds of wave propagation.

Figure 2 shows the Arduino the connections: to FPGA (D2-D11), to control buttons (A0-A3), to LCD (A4-A5).

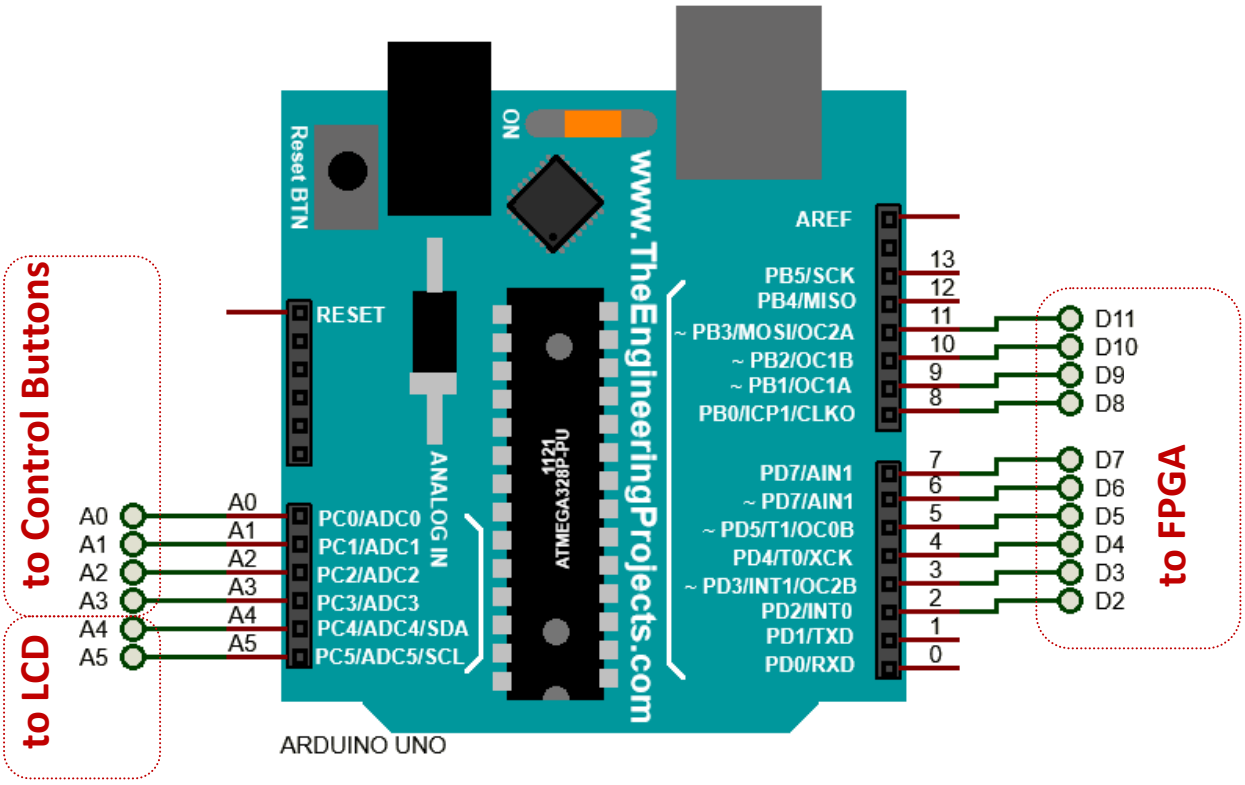

Fig2. Arduino pin connection

Figure 3 shows the schematic of the four control buttons connected to Arduino. The four buttons are connected via pull-down configuration. The first two buttons, “Navigation1” and “Navigation2” (A0 and A1), are responsible for navigating between the collected data. That is, it is possible to navigate through all the samples, one by one, to view them individually. The first (Navigation1) advances to the next sample, and the second (Navigation2) moves back to the previous one. Each sample is displayed on the LCD. The second button, “Reset” (A2), is responsible for obtaining new data (new cycle of data acquisition), causing previous data to be deleted. Finally, the "Change" button (A3) is responsible for displaying the mean and standard deviation values for time and speed interchangeably.

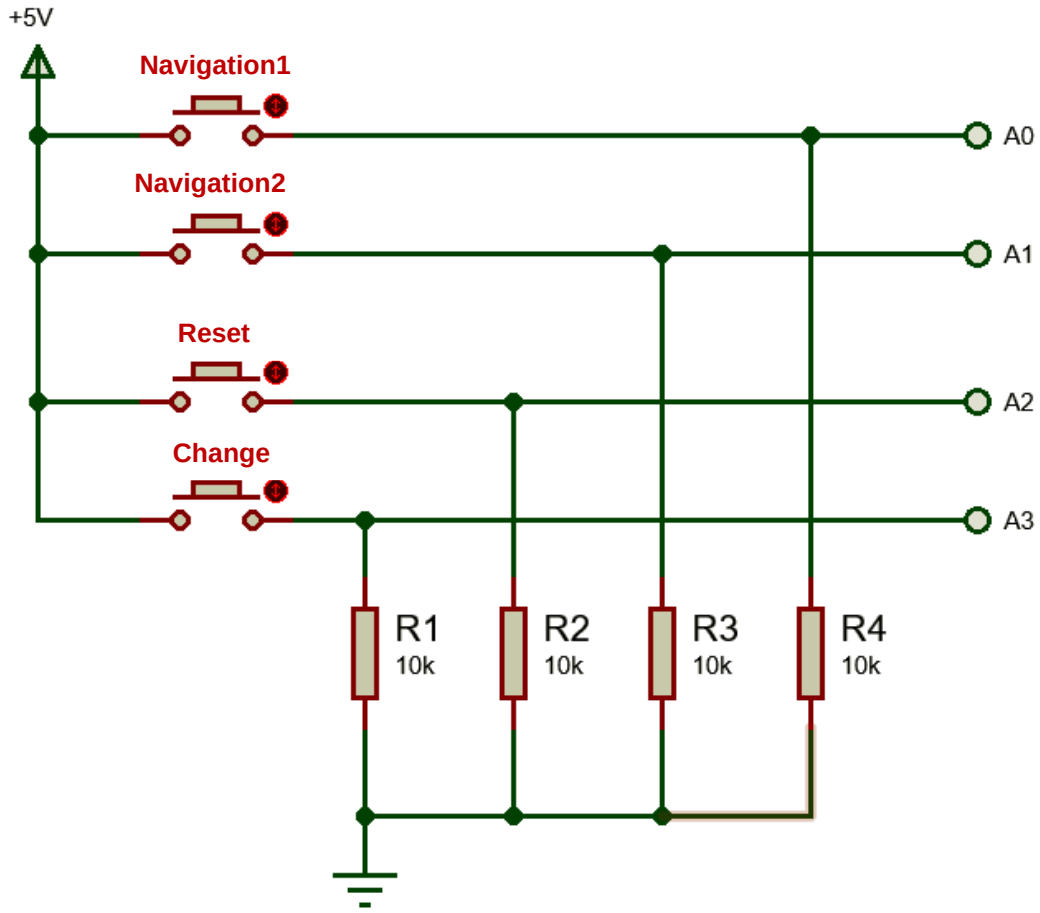

Figure 3 - Schematic representation of the control buttons

A 16x2 LCD display was used to present the results. In order to use a smaller number of pins, Arduino uses an I2C interface to communicate with the LCD. The schematic of the display with the I2C is shown in Figure 4. The VDD and VSS pins are connected to a 5V source and to the ground, respectively. The SCL and DAS communication pins are connected directly to the Arduino (A4-A5).

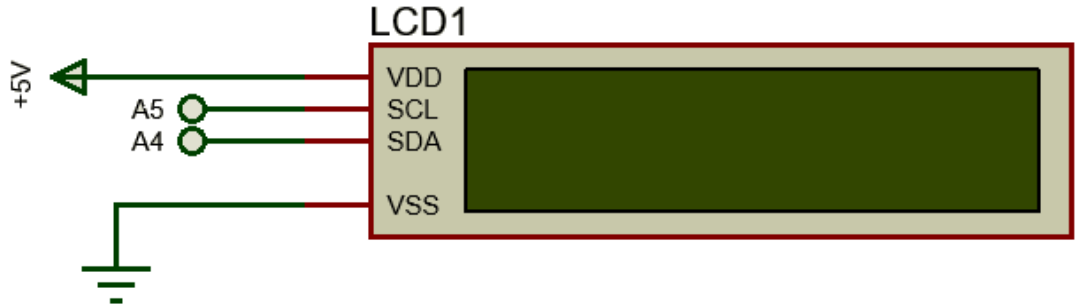

Figure 4 - Schematic representation of the LCD display