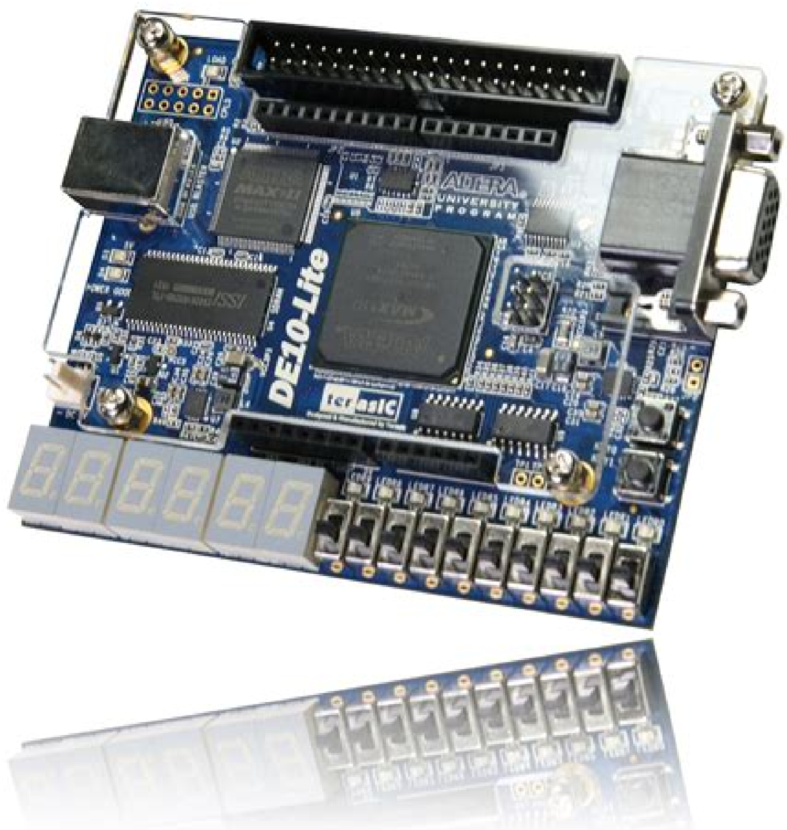
isep
École d'ingénieurs du numérique

BE Digital
T0-Group



TEAM 30
Nahle Rawad
Toledano Chloe
Terisse Arthur
Vizzavona Hector

BE- Digital sound meter

Objectives:

This lecture's objective is to design a simple digital sound level meter. This will be made up with the analog sound level meter and the Altera DE10 digital card, to take care of the digital and the processing part. We will be able to do this by applying and developing basic knowledge, seen during our previous lectures.

Introduction

Today, we applied what we learned previously on sequential logic using Quartus software and a DE-10 card. Our goal was to visualize the outputs on the LEDs of the card when we modified the input using the different switches. But today we are going to apply a new variable: we want to display the sound levels on the LED

Presentation of the DE-10-Lite card, the FPGA circuit:

The DE10-Lite presents a robust hardware design platform built around the Altera MAX 10 FPGA. The MAX 10 FPGA is well equipped to provide cost-effective, single-chip solutions in the control plane or data path applications and industry-leading programmable logic for ultimate design flexibility.

BE- Digital sound meter

B. Display sound levels on LEDs.

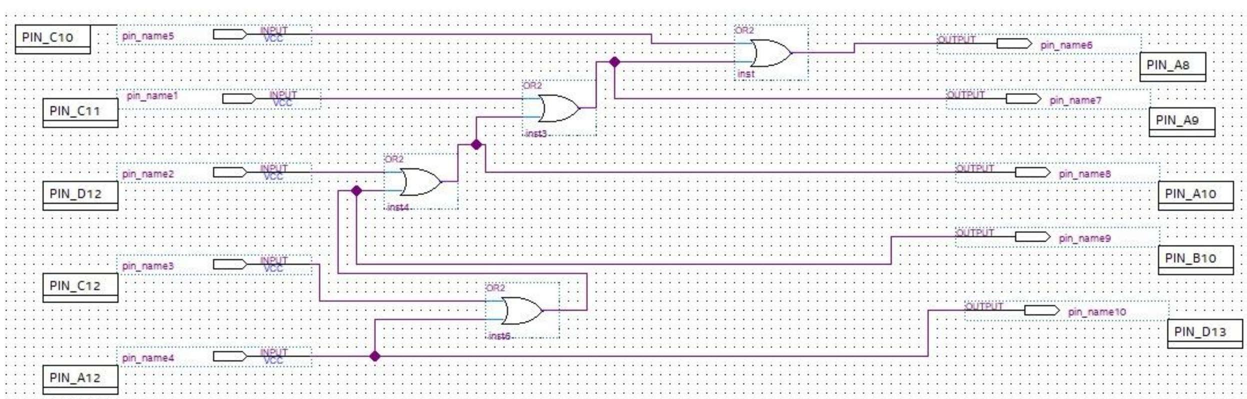
Brief explanation :

The objective of this part is to design a diagram allowing us to turn all the LEDs up to the selected switch. For example, if we switch on input 3, all first three LEDs would turn on. That can be done using a simple **or method**.

Inputs and outputs:

Here we consider the switches as our inputs and the LED as the outputs.
Using the table of the Datasheet from the User’s manual we assigned each input and output pins with the numbers of the table.

Logic circuit diagram :



Calculations :

- Truth table :

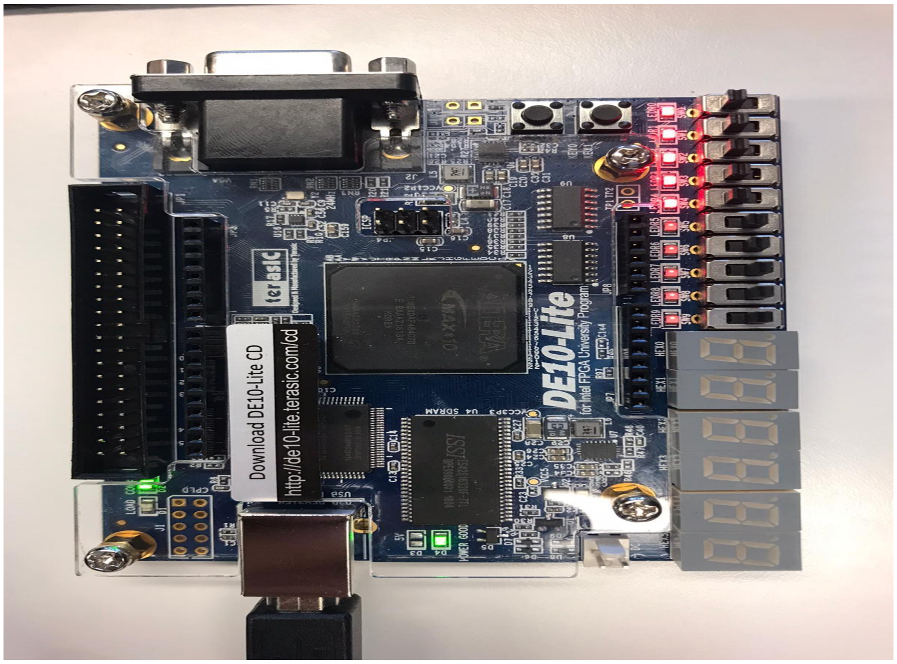
Input	Output	
0	0	0
0	1	0
1	0	0
1	1	1

Logical equations simplified :
 Y = A+B

BE- Digital sound meter

DE10 card :

All 5 switches turned on, so all 5 LEDs turned on.



C. Display the sound levels on a 7-segment display. If there is no sound level, the display shows 0.

Brief explanation:

The goal here is to display the highest value input on the seven-segment display. The difficulty is switching the right LEDs at the correct time to display the right number.

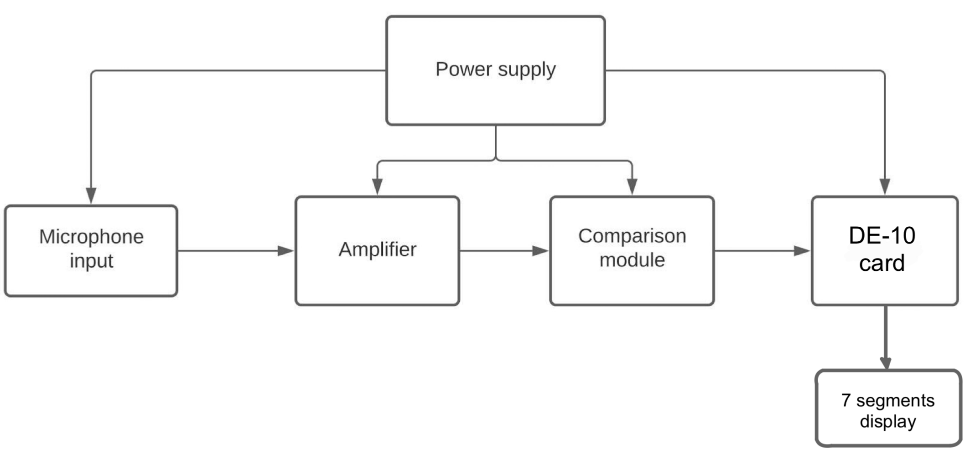
BE- Digital sound meter

To do that, the easiest way was to use a truth table. Here is the one used:

1	2	3	4	5	0	1	2	3	4	5	6
0	0	0	0	1	0	1	1	0	0	0	0
0	0	0	1	1	1	1	0	1	1	0	1
0	0	1	1	1	1	1	1	1	0	0	1
0	1	1	1	1	1	0	1	0	0	1	1
1	1	1	1	1	1	0	1	1	0	1	1

This facilitates the design of the diagram on Quartus prime. Here’s an example, to display 1, we have to turn on segments 1 and 2 only. For 2, we need to display segments 0, 1, 3, 4, and 6, and so forth.

<u>Functional diagram of the system :</u>



BE- Digital sound meter

Inputs and outputs :

Inputs are the switches and the 2nd 7-segments display is the output. Using the table of the Datasheet from the User's manual we assigned each input and output pins with the numbers of the table. There are 5 switches, so we've got 5 inputs. We've got 7 outputs, each output corresponding to one segment (segment 00 to segment 06). To obtain our 5 different digits, we need to activate a specific combination of these segments when a switch is turned on.

Calculations :

Inputs					Outputs						
I5	I4	I3	I2	I1	00	01	02	03	04	05	06
1	0	0	0	0	1	0	1	1	0	1	1
0	1	0	0	0	0	1	1	0	0	1	1
0	0	1	0	0	1	1	1	1	0	0	1
0	0	0	1	0	1	1	0	1	1	0	1
0	0	0	0	1	0	1	1	0	0	0	0

Let's consider the columns

- 00 → I5 I4 I3 I2 I1

I5	I4	I3	I2	I1	00
1					1
	1				0
		1			1
			1		1
				1	0

$$00 = (\overline{I1} + I2 + I3)\cdot \overline{I4} + I5$$

- 01 → I5 I4 I3 I2 I1

I5	I4	I3	I2	I1	01
1					0
	1				1
		1			1
			1		1
				1	1

$$01 = (I1 + I2 + I3 + I4)\cdot \overline{I5}$$

- 02 → I5 I4 I3 I2 I1

I5	I4	I3	I2	I1	02
1					1
	1				1
		1			1
			1		0
				1	1

$$02 = (I1 \cdot \overline{I2}) + I3 + I4 + I5$$

- 03 → I5 I4 I3 I2 I1

I5	I4	I3	I2	I1	03
1					1
	1				0
		1			1
			1		1
				1	1

$$03 = (I1 + I2 + I3)\cdot \overline{I4} + I5$$

BE- Digital sound meter

- O4 →

I5	I4	I3	I2	I1	O4
1					0
	1				0
		1			0
			1		1
				1	0

$$O4 = (\overline{I1} + I2)\cdot \overline{I3}\cdot \overline{I4}\cdot \overline{I5}$$

- O5 →

I5	I4	I3	I2	I1	O5
1					1
	1				1
		1			0
			1		0
				1	0

$$O5 = (\overline{I1}\cdot \overline{I2}\cdot \overline{I3}) + I4 + I5$$

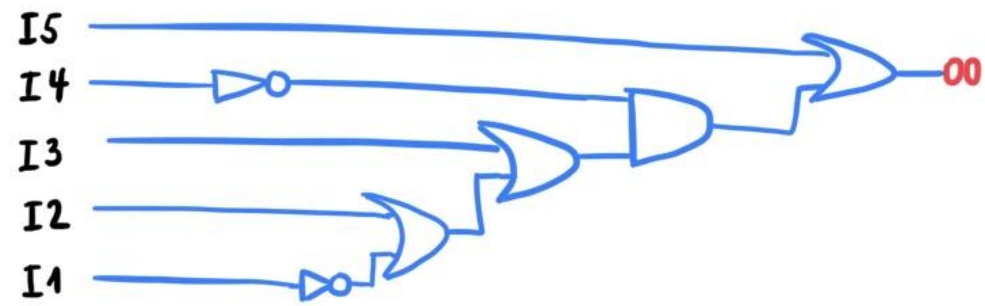
- O6 →

I5	I4	I3	I2	I1	O6
1					1
	1				1
		1			1
			1		1
				1	0

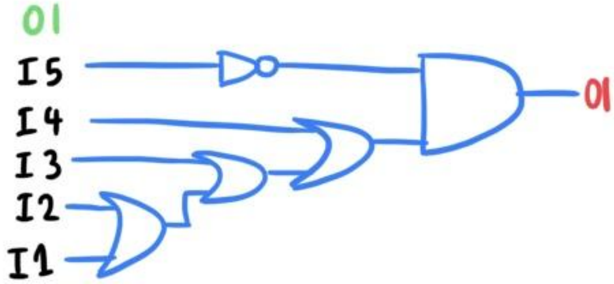
$$O6 = \overline{I1} + I2 + I3 + I4 + I5$$

Implementations:

O0

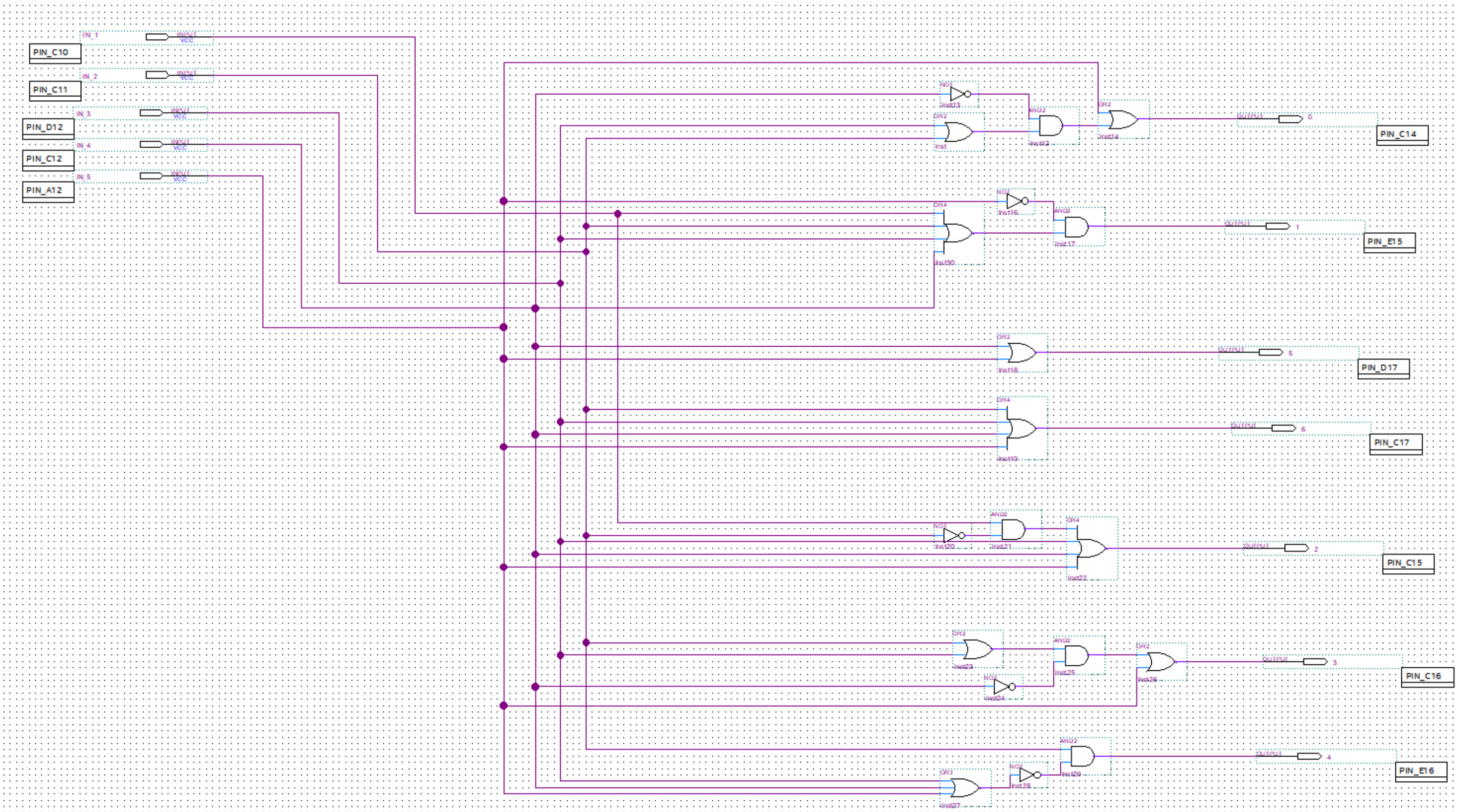


O1

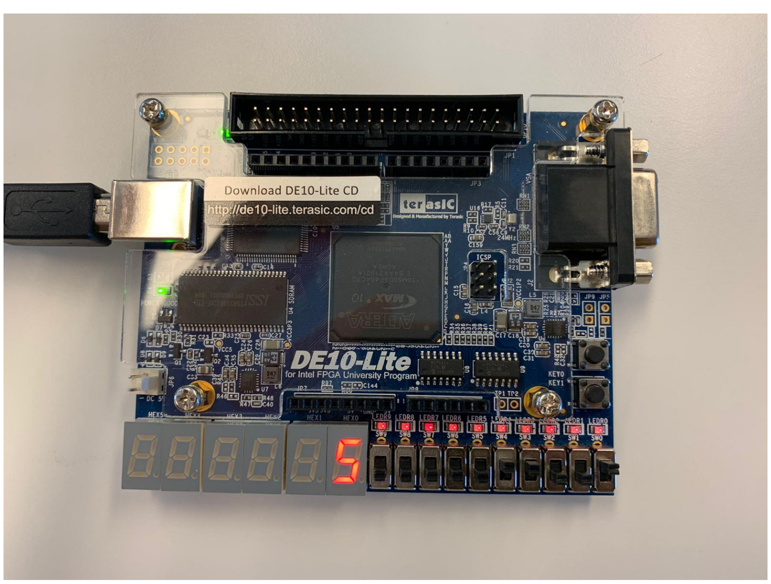


BE- Digital sound meter

Logic diagram :



DE10 card :



D. Display the H (3,4,5) and L (1,2) levels on a 2nd 7-segments display. If there is no sound level, the display shows L.

Brief explanation :

In this part, the objective is to display an H when inputs 3 to 5 are pushed and an L when inputs 1 to 2 are pushed. The highest level gets the priority, which means that if we push 3 and 2, we will be able to observe an H on the 2nd 7-segment display. When nothing is pushed, and L should be seen.

Functional diagram of the system :

Cf. page 5, the only difference is the display, it is on the 2nd 7-segment.

Inputs and Outputs :

This works the same way as in part C but with 2 letters instead of 5 digits.

Calculations :

$\overbrace{I5 \quad I4 \quad I3}^{H}$ → 1 $\qquad$ $\overbrace{I2 \quad I1}^{L}$ → 1

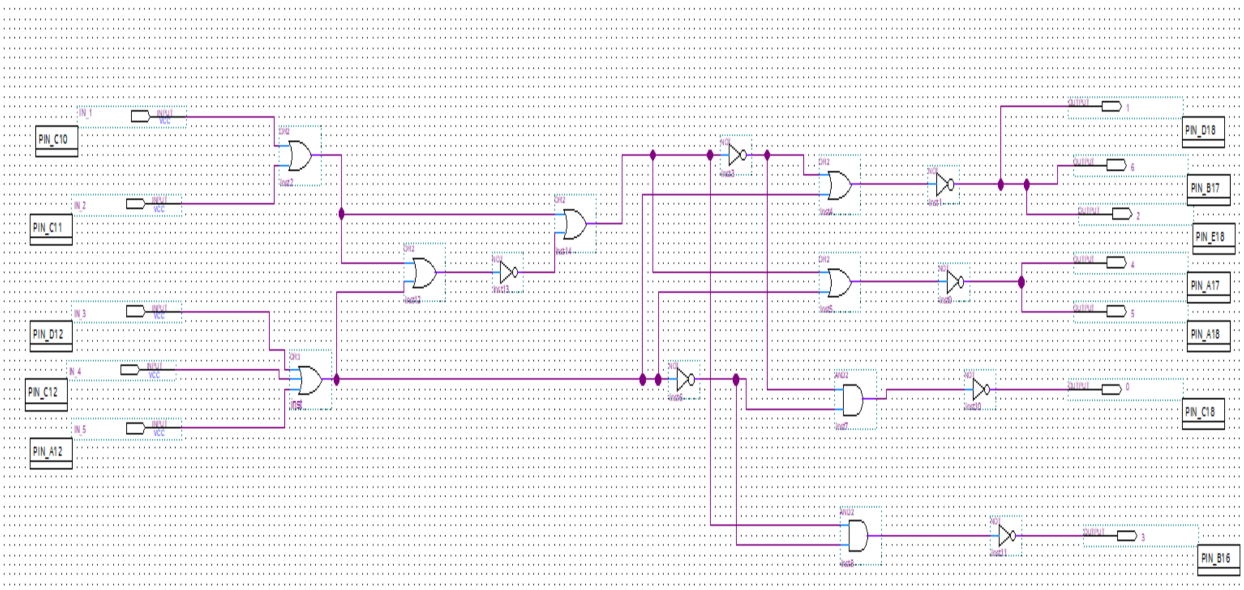
O0	O1	O2	O3	O4	O5	O6
0	1	1	0	1	1	1
0	0	0	1	1	1	0

$O0 = \overline{H}\,\overline{L}$
$O1 = \overline{L} + H$
$O2 = \overline{L} + H$
$O3 = L \times \overline{H}$
$O4 = L + H$
$O5 = L + H$
$O6 = \overline{L} + H$

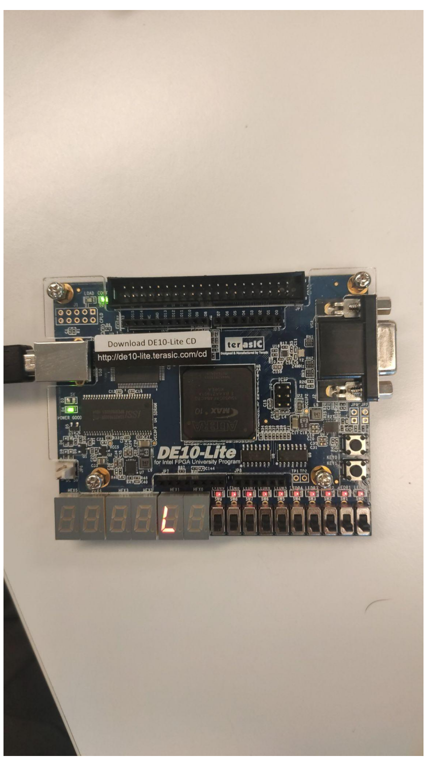
We have 5 inputs and 7 outputs.

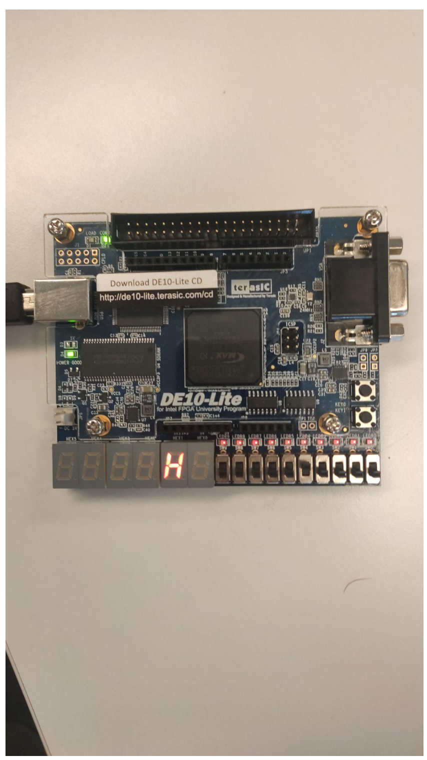
BE- Digital sound meter

Logic circuit :



DE10 card :





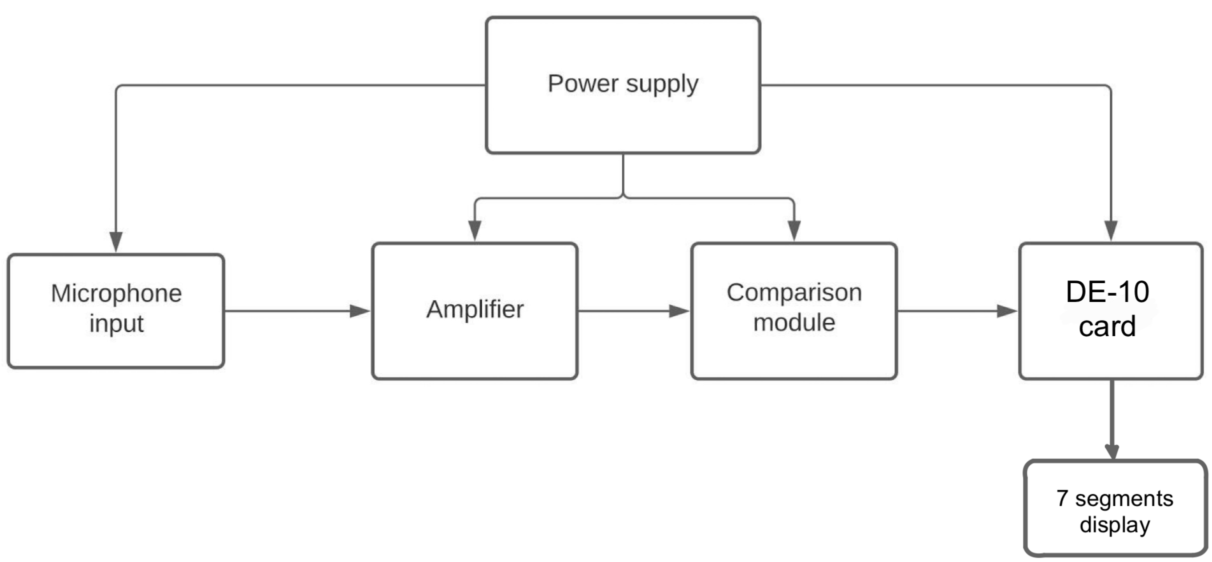
BE- Digital sound meter

E. Display the number of times level H is reached, on a 3rd 7-segment display. It is a transcoder between a counter and a display.

Brief explanation :

This time we were asked to produce a counter using our 3rd, 4th and 5th switch as our inputs and to display the numbers on the 3rd 7-segment display. At the beginning our display shows 0, then by turning the 3rd switch on it displays number 1. Then the same process for the first 4th switch, it displays now number 2, then when switch 5 is on, number 3 is shown. After that the number 4 is shown by turning off the 5th switch, then number 5 is shown by turning the 4th switch off, and so on till it reaches number 7 on the 3rd segment display.

Functional diagram (block diagram) of the system:



it's on the 3rd segment display

BE- Digital sound meter

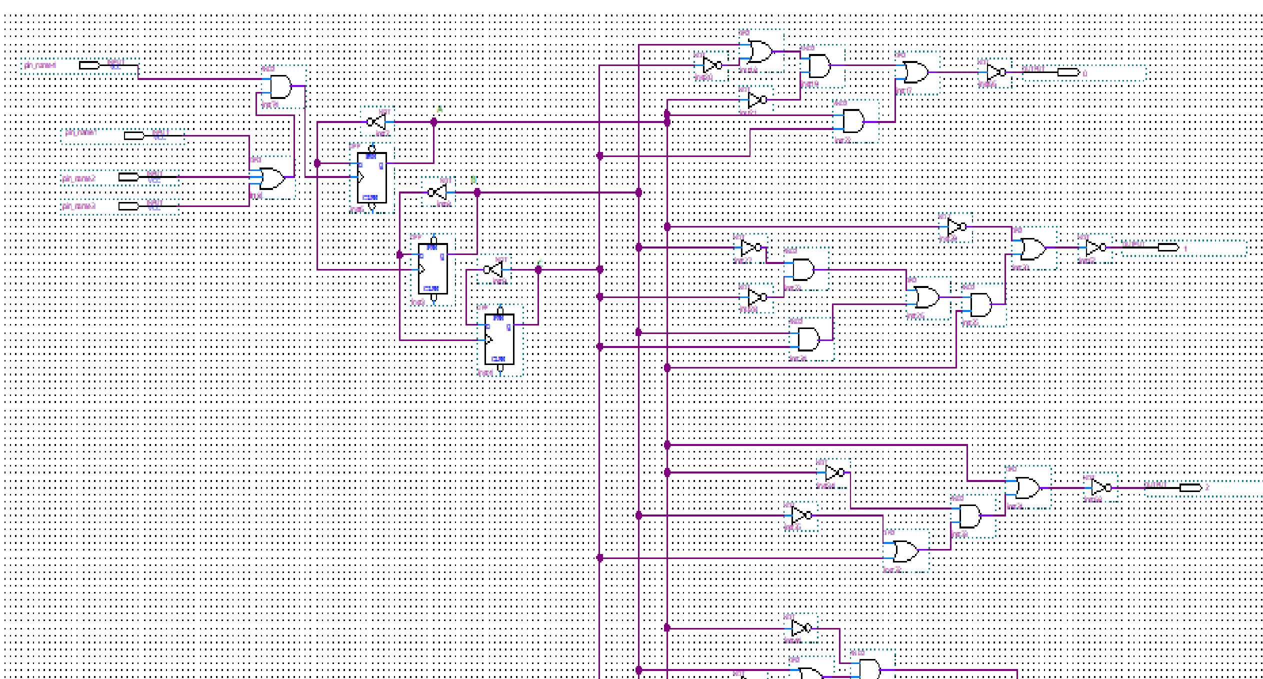
Identify inputs and outputs :

Here we have 3 inputs (switch 3,4,5) and we will have as outputs our seven seven segment numbers (7 numbers) which are displayed on the 3rd of the “7 segment display”.

Calculations:

A	B	C	00	01	02	03	04	05	06
0	0	0	1	1	1	1	1	1	0
0	0	1	0	1	1	0	0	0	0
0	1	0	1	1	0	1	1	0	1
0	1	1	1	1	1	1	0	0	1
1	0	0	0	1	1	0	0	1	1
1	0	1	1	0	1	1	0	1	1
1	1	0	0	0	1	1	1	1	1
1	1	1	1	1	1	0	0	0	0

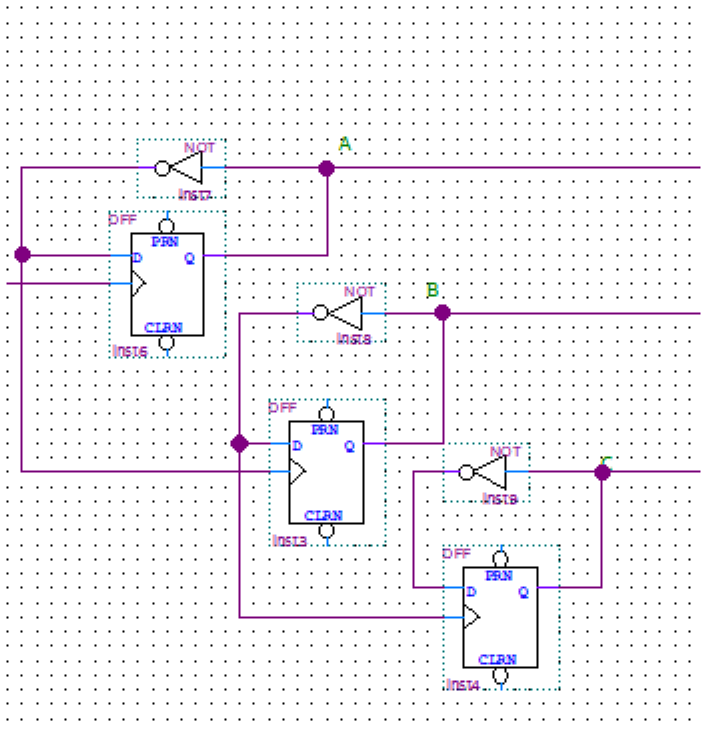
§Logic circuit diagram :



BE- Digital sound meter

Amplifiers :

BE- Digital sound meter



<u>Conclusion</u>:

BE- Digital sound meter

The goal of this project was to get a practical approach to sequential logic. We were able to apply theory on tangible materials and develop real world applications. With the help of Quartus Prime software, and an intel card, the DE-10 Lite, we realised a number of tasks ranging from simple counters, to comparing inputs in order to display certain things such as sound levels.
Using critical thinking, and some guidance from our teacher, we were able to put up complex diagrams. An interesting point was the recurring method that needs to be applied when dealing with sequential logic projects. Applying strictly the method made working on the project easier, and smoother. All in all, this was a new topic to us, that was fascinating, and that could be taken even more in-depth.