

Hardware Software Platforms Project Presentation

Servomotor Control with DE1-SoC

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- Context and Objectives
- Software and Hardware installation
 - Software to install
 - Board installation
- Tests with the board and LabView
 - Creating a new project
 - Servo-motor
 - Board Control
 - Simulations
 - Results
- Software operation

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Context and Objectives

- ❑ This project is part of the course Hardware/Software Platforms for students in first master in Electrical Engineering at the Faculty of Engineering of Mons
- ❑ Objectives:
 - To handle an entire electronical project
 - To familiar us with processors De-SoC
 - To control a Servomotor
 - To understand the VHDL coding language
 - To create a tutorial for other users

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Software to install

- Quartus II
 - <http://fpgasoftware.intel.com/?edition=lite>
 - To install the software, you'll need both the Quartus software tarfile, and the CycloneV qdz file.
 - Save these both to the same directory.
- ModelSim
 - Select also the "ModelSim-Altera Starter Edition".
 - ModelSim is a HDL Simulator and will be used to simulate signals before using the board.

Hardware to install

□ DE1-SoC

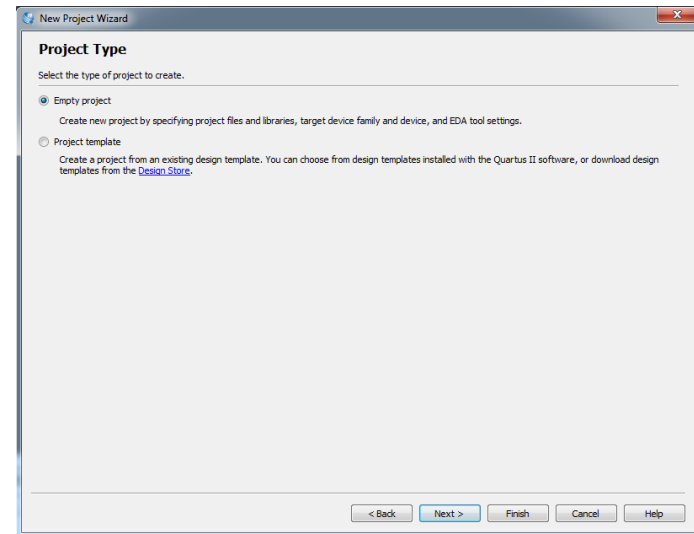
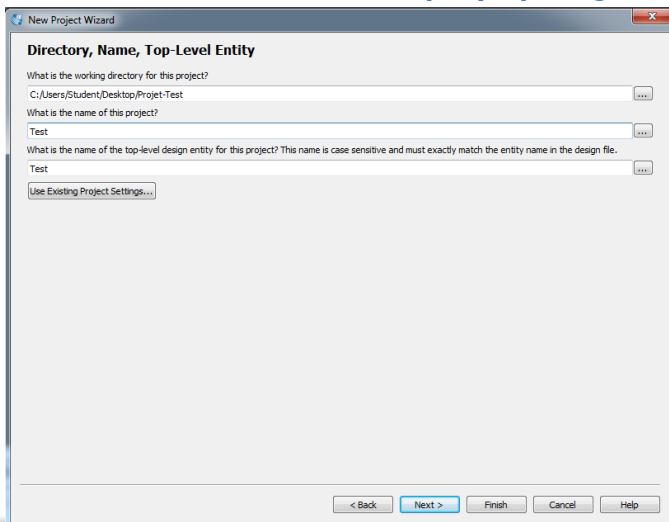
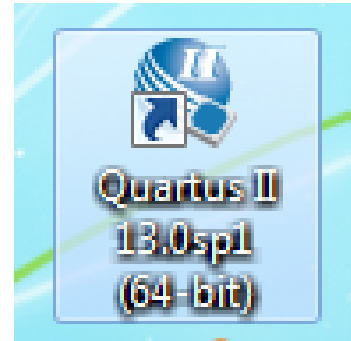
- <https://www.terasic.com.tw/cgi-bin/page/archive.pl?Language=English&No=836>
- In the package, you can find the cable to supply the FPGA and an other one to connect to the computer

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Create a new project on Quartus

- Open Quartus II
- Click on "Create a new project"
- A new window will open
 - Select the folder and the title of your project
 - Next
 - Click on "empty project"



Create a new project on Quartus

- A window "Family & Device Settings" will open
 - Select the right family of your component and then "next"

Family & Device Settings

Select the family and device you want to target for compilation.
You can install additional device support with the Install Devices command on the Tools menu.

To determine the version of the Quartus II software in which your target device is supported, refer to the [Device Support List](#) webpage.

Device family

Family: Cyclone V (E/GX/GT/SX/SE/ST)

Device: Cyclone IV E, Cyclone IV GX, Cyclone V (E/GX/GT/SX/SE/ST)

Target device: MAX 10 (DA/DF/DC/SA/SF/SC), MAX II, MAX V

☐ Auto
☒ Specific device selected in 'Available devices' list
☐ Other: n/a

Show in 'Available devices' list

Package: Any

Pin count: Any

Core Speed grade: Any

Name filter:

☒ Show advanced devices

Available devices:

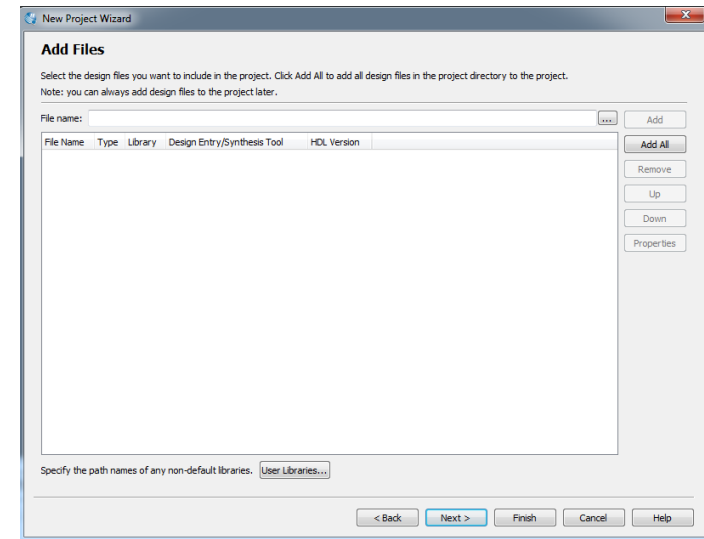
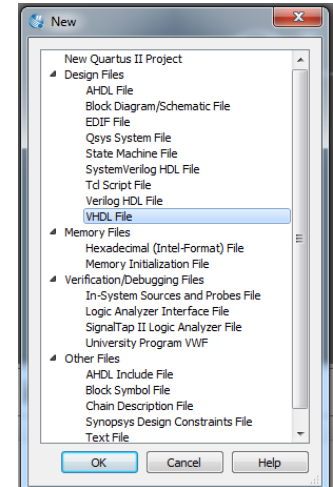
Name	Core Voltage	ALMs	Total I/Os	GPIOs	GXB Channel PMA	GXB Channel PCS	PCIe I
5CGXFC7C6F23C6	1.1V	56480	268	240	6	6	1
5CGXFC7C6F23C7	1.1V	56480	268	240	6	6	1
5CGXFC7C6F23I7	1.1V	56480	268	240	6	6	1
5CGXFC7C6U19A7	1.1V	56480	268	240	6	6	1
5CGXFC7C6U19C6	1.1V	56480	268	240	6	6	1
5CGXFC7C6U19C7	1.1V	56480	268	240	6	6	1
5CGXFC7C6U19I7	1.1V	56480	268	240	6	6	1
5CGXFC7C7F23C8	1.1V	56480	268	240	6	6	1
5CGXFC7C7U19C8	1.1V	56480	268	240	6	6	1

< Back Next > Finish Cancel Help

Here, it is a Cyclone V
5CSEMA5F31C6N

Create a new project on Quartus

- Create new file
- Create a new file at your project and select the VHDL Type File
- You can also add an existing file at your project



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Servomotor

- **What is a servomotor ?**

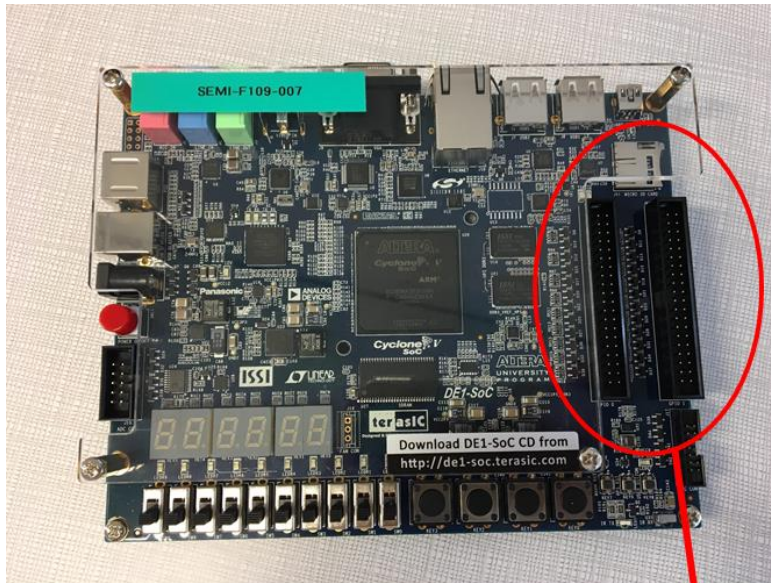
Electrical device, that rotate a part of its body with high efficiency and great precision to a particular angle between 0 and 180°)



- **How to connect a servomotor?**

- Three cables
- The yellow wire connected to the pin of the board: GPIO1(1)
- The red wire connected to 5V on the board GPIO1(10)
- The brown (or black) wire connected to the ground on the board GPIO1(11)

Servomotor

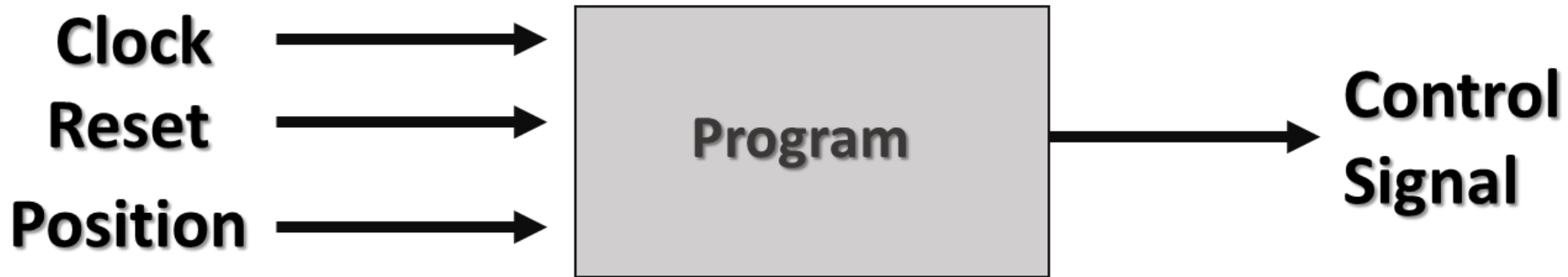


GPIO 0 (JP1)			
PIN_V12	GPIO_0[0]	1	2 GPIO_0[1] PIN_E8
PIN_W12	GPIO_0[2]	3	4 GPIO_0[3] PIN_D11
PIN_D8	GPIO_0[4]	5	6 GPIO_0[5] PIN_AH13
PIN_AF7	GPIO_0[6]	7	8 GPIO_0[7] PIN_AH14
PIN_AF4	GPIO_0[8]	9	10 GPIO_0[9] PIN_AH3
5V		11	12 GND
PIN_AD5	GPIO_0[10]	13	14 GPIO_0[11] PIN_AG14
PIN_AE23	GPIO_0[12]	15	16 GPIO_0[13] PIN_AE6
PIN_AD23	GPIO_0[14]	17	18 GPIO_0[15] PIN_AE24
PIN_D12	GPIO_0[16]	19	20 GPIO_0[17] PIN_AD20
PIN_C12	GPIO_0[18]	21	22 GPIO_0[19] PIN_AD17
PIN_AC23	GPIO_0[20]	23	24 GPIO_0[21] PIN_AC22
PIN_Y19	GPIO_0[22]	25	26 GPIO_0[23] PIN_AB23
PIN_AA19	GPIO_0[24]	27	28 GPIO_0[25] PIN_W11
3.3V		29	30 GND
PIN_AA18	GPIO_0[26]	31	32 GPIO_0[27] PIN_W14
PIN_Y18	GPIO_0[28]	33	34 GPIO_0[29] PIN_Y17
PIN_AB25	GPIO_0[30]	35	36 GPIO_0[31] PIN_AB26
PIN_Y11	GPIO_0[32]	37	38 GPIO_0[33] PIN_AA26
PIN_AA13	GPIO_0[34]	39	40 GPIO_0[35] PIN_AA11

GPIO 1 (JP7)			
PIN_Y15	GPIO_1[0]	1	2 GPIO_1[1] PIN_AC24
PIN_AA15	GPIO_1[2]	3	4 GPIO_1[3] PIN_AD26
PIN_AG28	GPIO_1[4]	5	6 GPIO_1[5] PIN_AF28
PIN_AE25	GPIO_1[6]	7	8 GPIO_1[7] PIN_AF27
PIN_AG26	GPIO_1[8]	9	10 GPIO_1[9] PIN_AH27
5V		11	12 GND
PIN_AG25	GPIO_1[10]	13	14 GPIO_1[11] PIN_AH26
PIN_AH24	GPIO_1[12]	15	16 GPIO_1[13] PIN_AH25
PIN_AG23	GPIO_1[14]	17	18 GPIO_1[15] PIN_AH23
PIN_AG24	GPIO_1[16]	19	20 GPIO_1[17] PIN_AH22
PIN_AH21	GPIO_1[18]	21	22 GPIO_1[19] PIN_AG21
PIN_AH23	GPIO_1[20]	23	24 GPIO_1[21] PIN_AA20
PIN_AF22	GPIO_1[22]	25	26 GPIO_1[23] PIN_AE22
PIN_AG20	GPIO_1[24]	27	28 GPIO_1[25] PIN_AF21
3.3V		29	30 GND
PIN_AG19	GPIO_1[26]	31	32 GPIO_1[27] PIN_AH19
PIN_AG18	GPIO_1[28]	33	34 GPIO_1[29] PIN_AH18
PIN_AF18	GPIO_1[30]	35	36 GPIO_1[31] PIN_AF20
PIN_AG15	GPIO_1[32]	37	38 GPIO_1[33] PIN_AE20
PIN_AE19	GPIO_1[34]	39	40 GPIO_1[35] PIN_AE17

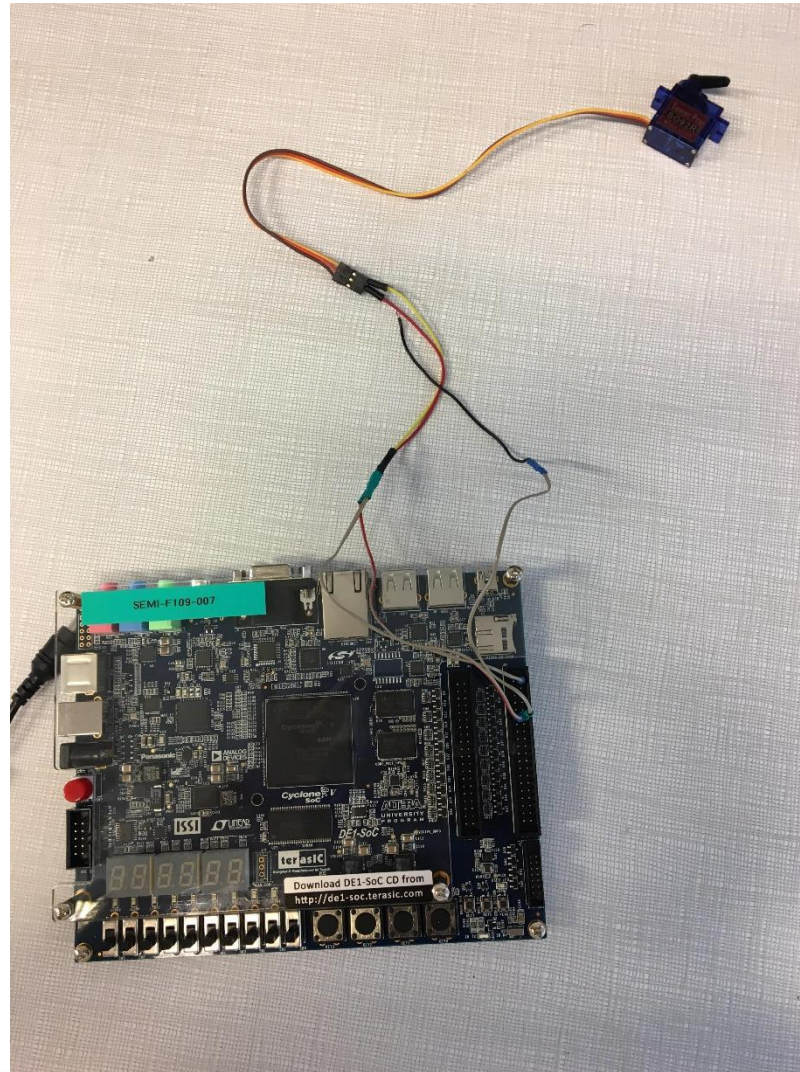


Bloc Diagram to Control a Servomotor



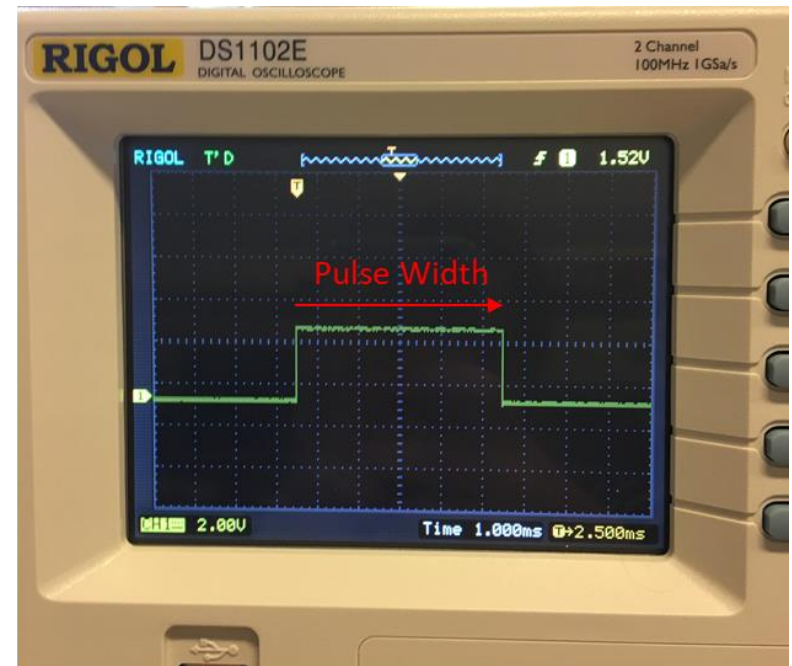
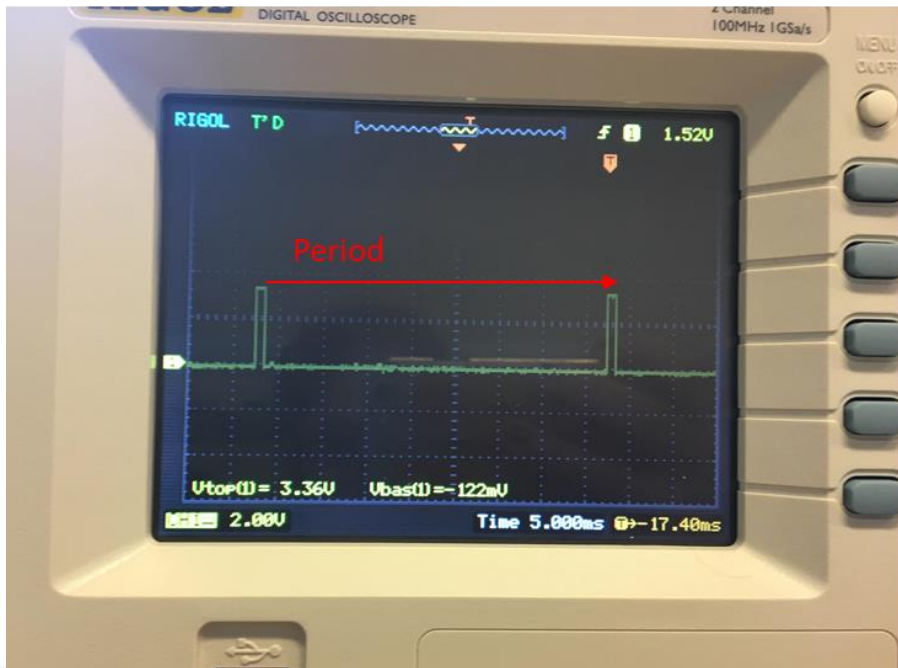
- The values of the position came from the Switch of the board
- The control signal goes to the GPIO1(1) pin and then directly to the servomotor

Connection between the board and the motor



Servomotor

- How it works?
- Coding a square wave of different pulse width
- Period of 20 ms
- Minimal value of 0,5ms and maximal value 2,5ms

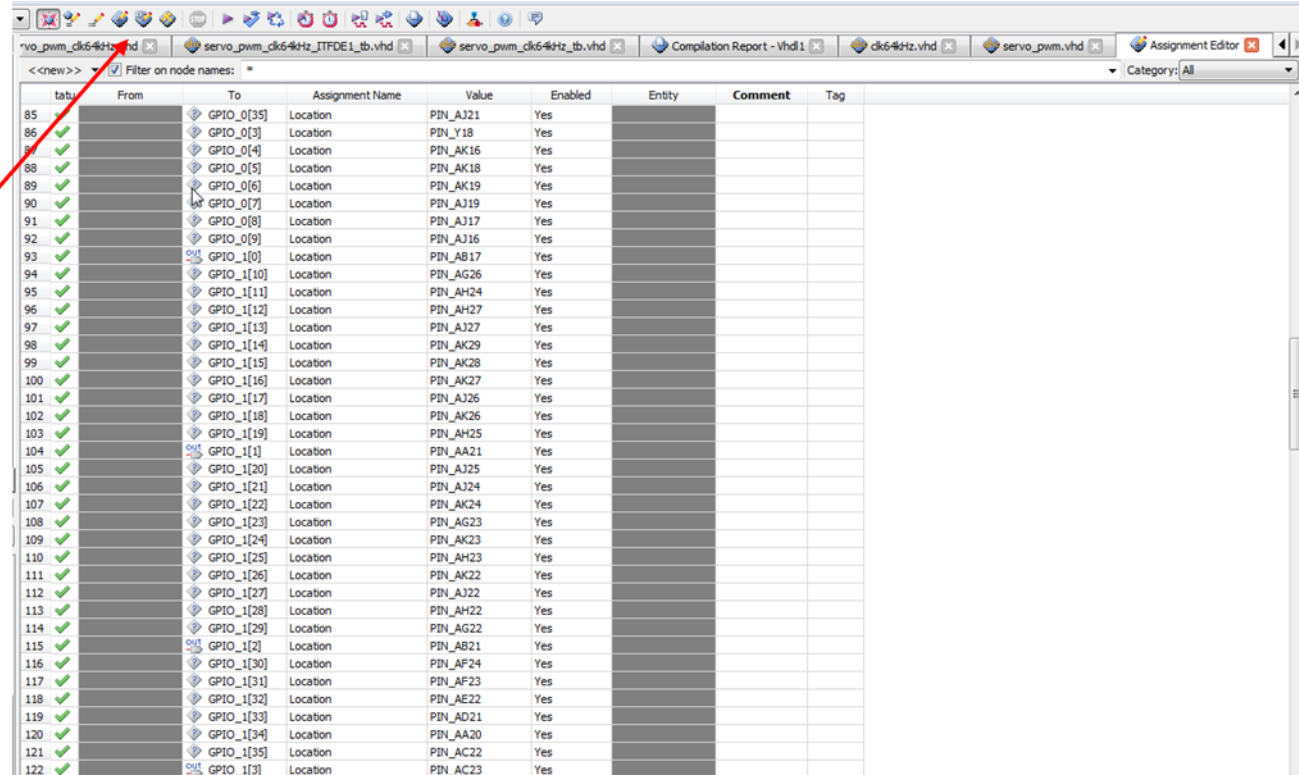


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Board Control

- **How to link the hardware and the software?**
- Connect the board to the computer
- Create a file to connect the signals with the pins of the board
- To have a look at all the pins of your board you can click on this icon

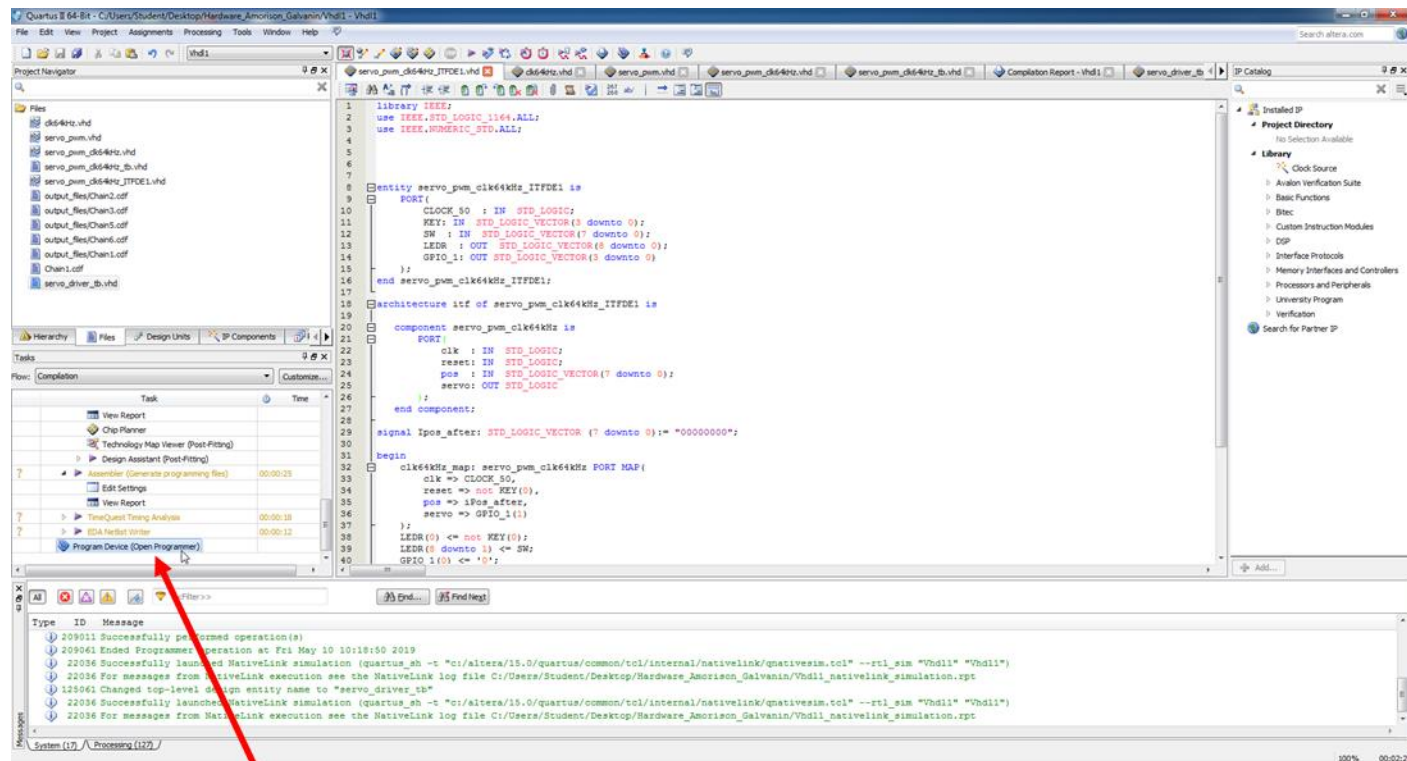


The screenshot shows a software window with a table of GPIO pins. The table has columns: 'From', 'To', 'Assignment Name', 'Value', 'Enabled', 'Entity', 'Comment', and 'Tag'. The 'From' column is highlighted with a red arrow. The table lists pins from 85 to 122, each with a checkmark in the 'From' column and a pin number in the 'To' column. The 'Assignment Name' column contains pin names like PBN_AJ21, PBN_Y18, etc. The 'Value' column contains 'Location'. The 'Enabled' column contains 'Yes'. The 'Entity' column is empty. The 'Comment' and 'Tag' columns are also empty.

From	To	Assignment Name	Value	Enabled	Entity	Comment	Tag
85	GPIO_0[35]	Location	PBN_AJ21	Yes			
86	GPIO_0[3]	Location	PBN_Y18	Yes			
87	GPIO_0[4]	Location	PBN_AK16	Yes			
88	GPIO_0[5]	Location	PBN_AK18	Yes			
89	GPIO_0[6]	Location	PBN_AK19	Yes			
90	GPIO_0[7]	Location	PBN_AJ19	Yes			
91	GPIO_0[8]	Location	PBN_AJ17	Yes			
92	GPIO_0[9]	Location	PBN_AJ16	Yes			
93	GPIO_1[0]	Location	PBN_AB17	Yes			
94	GPIO_1[10]	Location	PBN_AG26	Yes			
95	GPIO_1[11]	Location	PBN_AH24	Yes			
96	GPIO_1[12]	Location	PBN_AH27	Yes			
97	GPIO_1[13]	Location	PBN_AJ27	Yes			
98	GPIO_1[14]	Location	PBN_AK29	Yes			
99	GPIO_1[15]	Location	PBN_AK28	Yes			
100	GPIO_1[16]	Location	PBN_AK27	Yes			
101	GPIO_1[17]	Location	PBN_AJ26	Yes			
102	GPIO_1[18]	Location	PBN_AK26	Yes			
103	GPIO_1[19]	Location	PBN_AH25	Yes			
104	GPIO_1[1]	Location	PBN_AA21	Yes			
105	GPIO_1[20]	Location	PBN_AJ25	Yes			
106	GPIO_1[21]	Location	PBN_AJ24	Yes			
107	GPIO_1[22]	Location	PBN_AK24	Yes			
108	GPIO_1[23]	Location	PBN_AG23	Yes			
109	GPIO_1[24]	Location	PBN_AK23	Yes			
110	GPIO_1[25]	Location	PBN_AH23	Yes			
111	GPIO_1[26]	Location	PBN_AK22	Yes			
112	GPIO_1[27]	Location	PBN_AJ22	Yes			
113	GPIO_1[28]	Location	PBN_AH22	Yes			
114	GPIO_1[29]	Location	PBN_AG22	Yes			
115	GPIO_1[2]	Location	PBN_AB21	Yes			
116	GPIO_1[30]	Location	PBN_AF24	Yes			
117	GPIO_1[31]	Location	PBN_AF23	Yes			
118	GPIO_1[32]	Location	PBN_AE22	Yes			
119	GPIO_1[33]	Location	PBN_AD21	Yes			
120	GPIO_1[34]	Location	PBN_AA20	Yes			
121	GPIO_1[35]	Location	PBN_AC22	Yes			
122	GPIO_1[3]	Location	PBN_AC23	Yes			

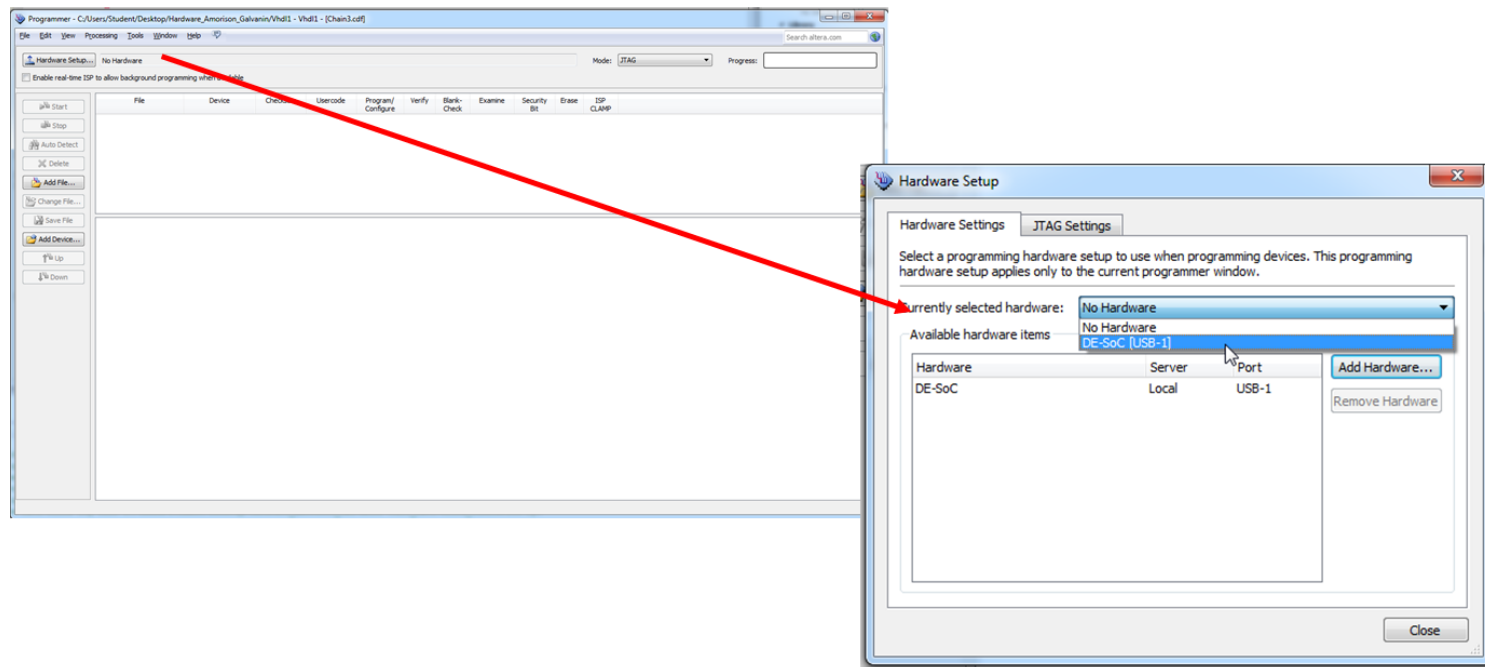
Board Control

- How to put the code on the processor?
- Click on the Program Device



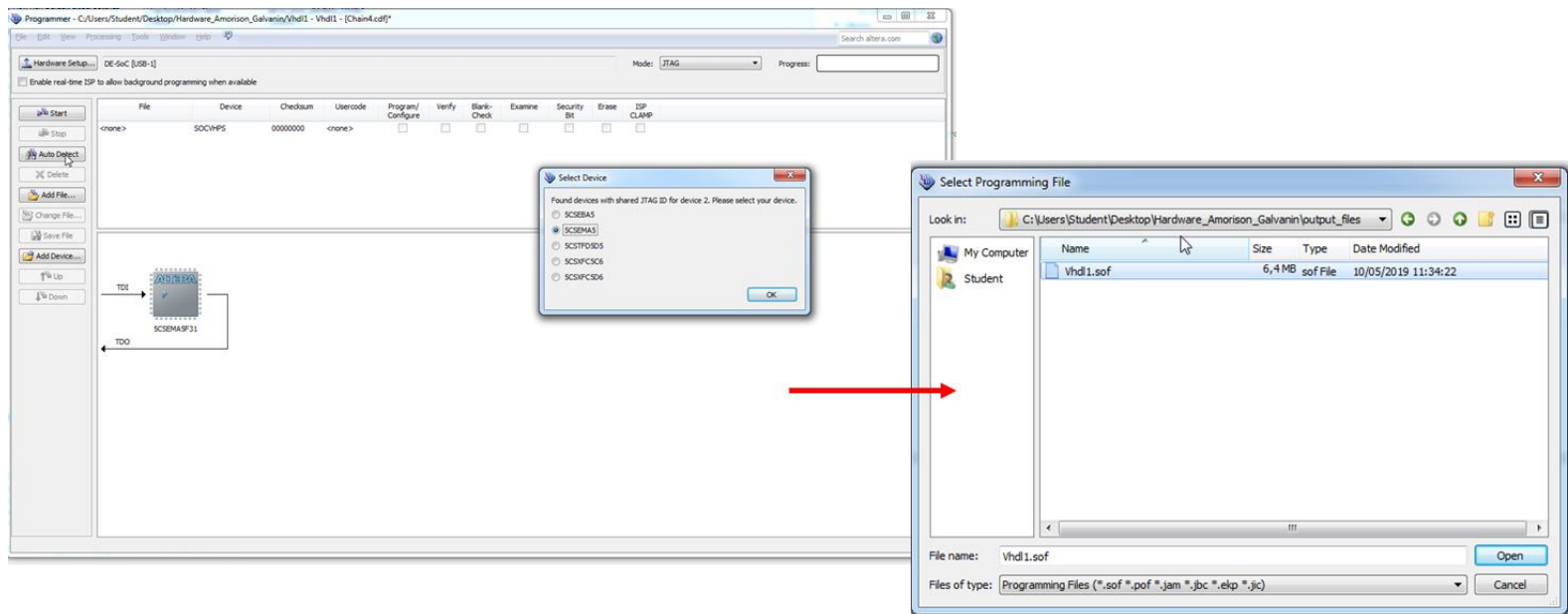
Board Control

- **How to put the code on the processor?**
- A window will open
- Click on “Hardware Setup” and choose your hardware



Board Control

- **How to put the code on the processor?**
- Click on "Auto Detect" and choose your correct device
- Then on "Add File" and select your own file



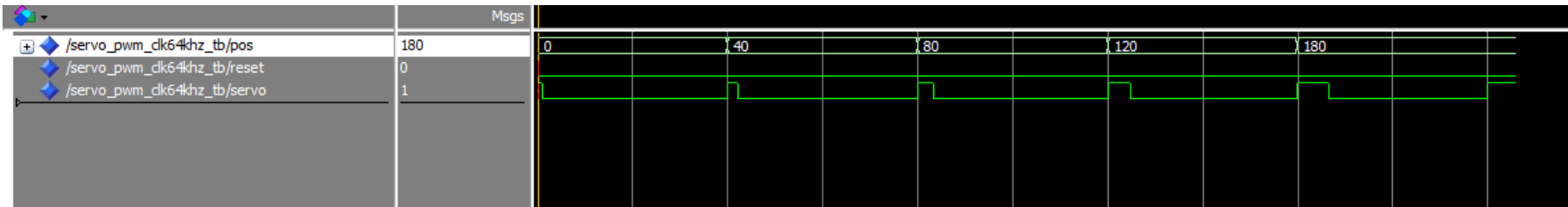
- Finally, click on "Start" and wait for the loading of your code

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Simulations

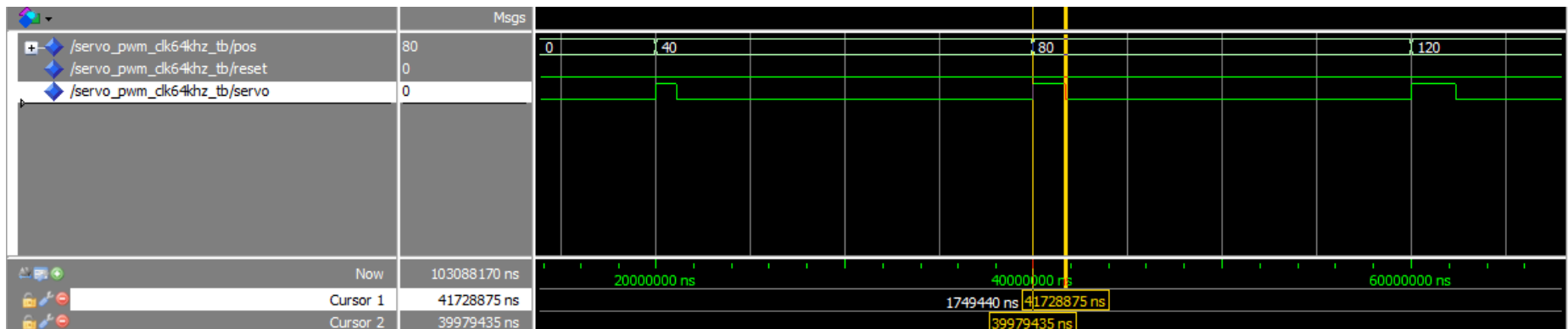
- Driver Simulation



For the simulation, we define some values for the variable « pos ».

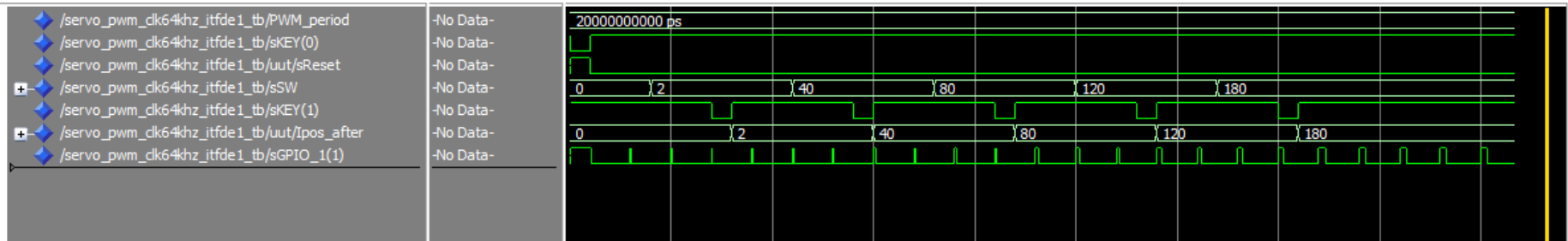
We can see the control signal becoming bigger and bigger.

We can zoom to see the value of PWM and so, the PWM value for an 80° angle is 1749440 ns.



Simulations

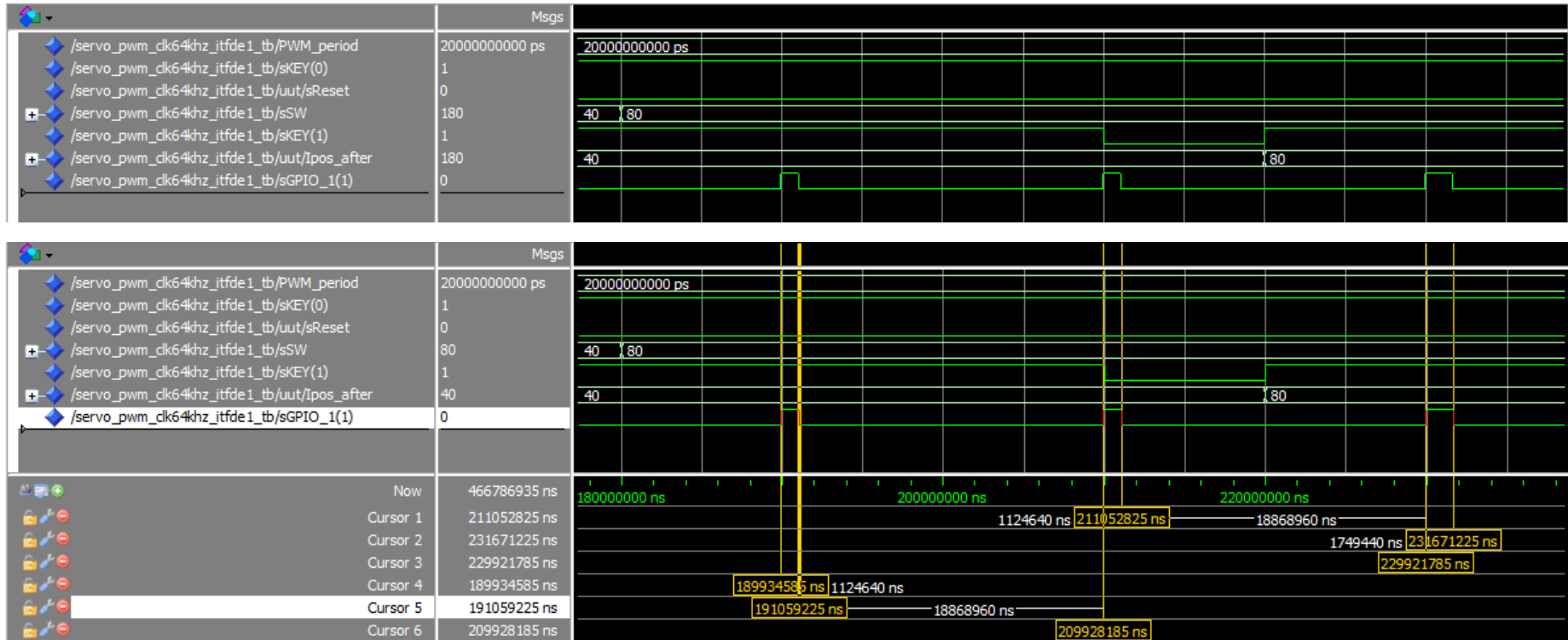
- Driver+Application Simulation



- We change the values of switches and therefore pos after 3 PWM half period = $3 \times 10\text{ms}$
- We wait for 3 additional PWM half period before pressing the button.
- We wait for 1 additional PWM half period before releasing the button.
- When the button is released -> switches values go to lpos_after.
- PWM value is then modified from the next impulse.
- We notice that the PWM value increases according to the angle.

Simulations

• Driver+Application Simulation



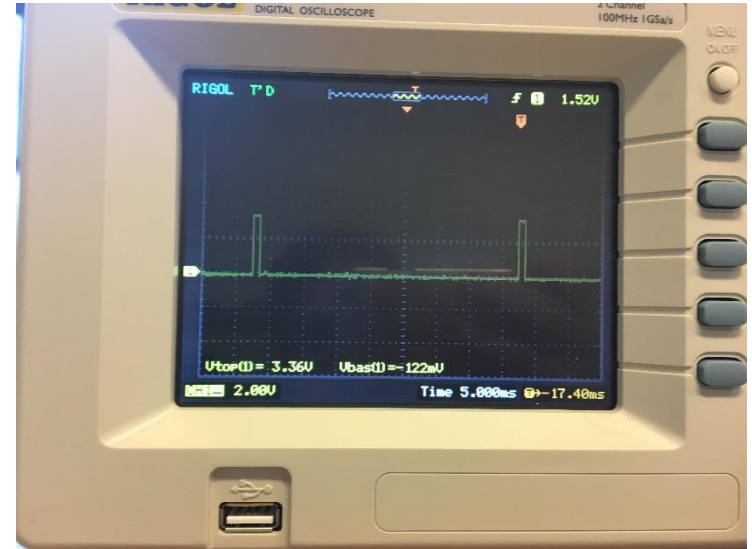
- We make a zoom to measure PWM values and check that the values are growing proportionally with the angle.
- We can see that the PWM value for an 40° angle is 1 124 640ns and for an 80° angle is 1 749 440ns (which is equal to our previous value.)

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Results

- **Results on an oscillator**



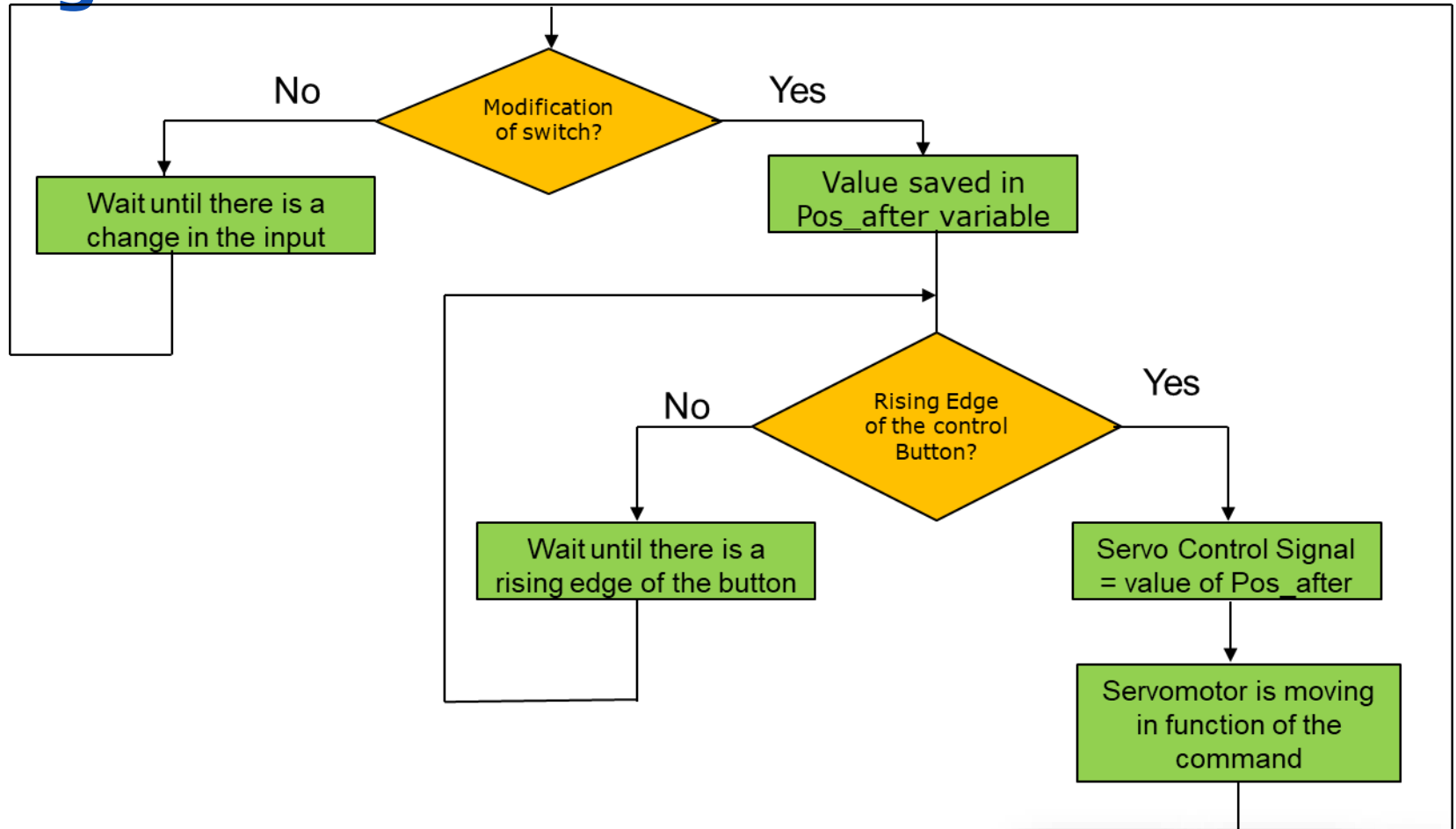
- **Results on the servomotor**
 - See the video

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Software Operation

Diagram block of the behaviour of our program



Conclusion



Congrats !



You can now drive a servo-motor
with a new processor!

Useful links

□ Github:

<https://github.com/cleliagal/Control-of-Servo-motor-with-DE1-SoC>

□ Youtube Video:

<https://www.youtube.com/watch?v=H VyE35rkSaQ>