UNIVERSIDAD SAN FRANCISCO DE QUITO USFQ

Colegio de Ciencias e Ingenierias

A proposal for teaching automation laboratory using a sorting festo machine

.

Robert Steven Regalado Tamayo

Ingeniería en Electrónica y Automatización

Trabajo de fin de carrera presentado como requisito para
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UNIVERSIDAD SAN FRANCISCO DE QUITO USFQ

Colegio de Ciencias e Ingeniería

HOJA DE CALIFICACIÓN
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A proposal for teaching automation laboratory using a sorting festo machine

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Quito, 07 de febrero de 2024

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RESUMEN

Este trabajo presenta una propuesta de laboratorio de automatización utilizando un módulo FESTO de clasificación. La práctica de laboratorio funcionará como introducción a las aplicaciones en el campo industrial mediante el desarrollo de una Interfaz Hombre-Máquina en el software Labview. El usuario tiene la posibilidad de manejar todos los sensores y actuadores de la máquina clasificadora. Finalmente, el usuario puede elegir entre Easyport o PLC Siemens, para controlar la máquina con la lógica programable que el usuario desee.

Palabras clave: Clasificación, HMI, sensor, interactivo, educación, electrónico.

ABSTRACT

This paper presents a proposal for an automation laboratory using a sorting FESTO module. The laboratory practice will work as an introduction into the applications in the industrial field by developing a Human-Machine Interface in the software Labview. The user has the possibility to manage all the sensors and actuators of the sorting machine. Finally, the user can choose between Easyport or Siemens PLC, to control the machine with the programable logic that the user desires.

Key words: Sorting, HMI, sensor, interactive, education, electronic.

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A proposal for teaching automation laboratory using a sorting festo machine

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***Abstract*—This paper presents a proposal for an automation laboratory using a sorting FESTO module. The laboratory practice will work as an introduction into the applications in the industrial field by developing a Human-Machine Interface in the software Labview. The user has the possibility to manage all the sensors and actuators of the sorting machine. Finally, the user can choose between Easyport or Siemens PLC, to control the machine with the programable logic that the user desires.**

***keywords*—Sorting, HMI, sensor, interactive, education, electronic.**

I. Introduction

Nowadays, students can investigate scientific phenomena using tools like data collection techniques, models, and theories of science in physical laboratories that support interactions with the material world or in virtual laboratories that take advantage of simulations [1]. Finding ways for students to have a more active development through practice is fundamental in learning electronics and automation. [2]. Considering a lot of students retire from Electronics Engineering in the earliest of the career, is crucial to incentive them by showing how they could applied all the knowledge acquires in the first two years of the career.

For the development of the practice we will have an initial vision of the operation of LabVIEW and the interface of a SIEMENS PLC.

LabVIEW works as a graphical environment for programming, using a block method that allows interconnecting inputs and outputs in an intuitive way [3]. These blocks function as a flowchart, in which many of them are a library that helps to simplify the student's work [4].

The Festo Sorting Machine consists of a modular machine that provides various inputs (actuators) and outputs (sensors) for the manipulation and control of a cap sorting system. [5]

This paper is organized in the following manner: First, Section II describes the hole identification of the elements of the Festo Sorting Machine. Section III describes in a brief way how to connect with the software Labview by using EasyPort. Section IV, describes also in a brief way how to communicate by PLC SIEMENS - TIAPORTAL. Later, in Section V an example of how the interface and the programmable logic will work. Results and discussion about the impact of the laboratory proposal are given in Section VI. Finally, our concluding remarks are given in Section VII.

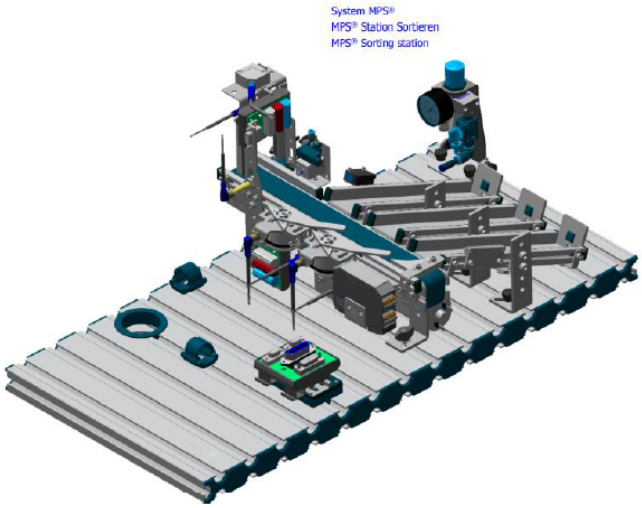

Fig. 1: Festo Sorting Machine.

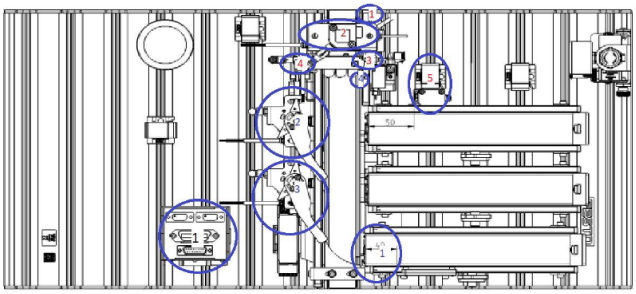

Fig. 2: Festo Sorting Machine upper diagram view.

II. Festo Sorting Machine

The first step is to know the Festo sorting module, this one will be represented by the figure 1.

Then, we must know where all the sensors and actuators are, them are shown in figure 2.

All sensors and actuators are summarized in Table 1.

TABLE I: Inputs

Number	Type	Function
1	Optical Sensor	Detect any kind of material in the band
2	Fork Light Barrier	Detect any kind of material which enters the detection module
3	Diffuse Light Sensor	Detects the red and the metallic work pieces
4	Inductive Proximity Sensor	Detects the metallic work piece
5	Retro-Reflective Sensor	To know if the chutes are full

Now we can identify them in the real Machine that we have in Lab. The sensors are identified by numbers in the figure 3.

Finally the outputs are described on the Table 2.

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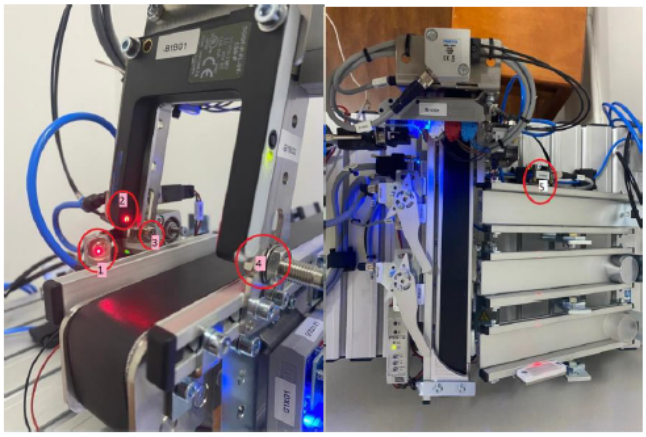

Fig. 3: Inputs in the Festo Machine.

TABLE II: Outputs

Number	Type	Function
1	Conveyor Belt Motor	Moves the belt of the system
2	Section 1 Motor	Ejects to the first chute
3	Section 2 Motor	Ejects to the second chute
4	Pneumatic Piston	Stop the piece to start the process

III. LabVIEW Interface and EasyPort Connection

In order to use Easy Port for communicate the Festo Sorting Machine, The students will be using Labview Software and the extension of ActiveX, so it is necessary to have ActiveX controller installed on Labview.

The detail description on how to connect to LabVIEW using EasyPort are described on appendix. On resume we have to:

1) Add the ActiveX Container
2) Chose Insert ActiveX object, by making a right click on the ActiveX Container
3) Then look for Festo Controller
4) On the programming side, we add the communication protocol by looking for Connectivity -¿ ActiveX -¿ Automation Open Invoke Node
5) Then, we must add three invokes nodes Connectivity -¿ ActiveX -¿ Invoke Node
6) The Automation Open, is to set the protocol of the communication between Labview and the sorting machine, and the two invokes nodes are to see the correct module of the Easyport side, and set an automation send of data.
7) Then we finally make a while structure and the end of the communication protocol.
8) To send or get the information, we must add the Invoke Nodes of SetOutputWord and GetDigitalInput
9) After making the blocks, we put the system in function to identify all the sensors.
10) After we identify the sensors(inputs), we must identify the actuators(outputs).
11) After identifying the whole system, we can proceed to program the Labview part.

IV. PLC SIEMENS - TIAPORTAL

Now, in order to connect to a PLC, it is necessary to have TIAPORTAL which is the software to program the PLC SIEMENS. Also the detail description on how to connect to LabVIEW using EasyPort are described on appendix. On resume we have to:

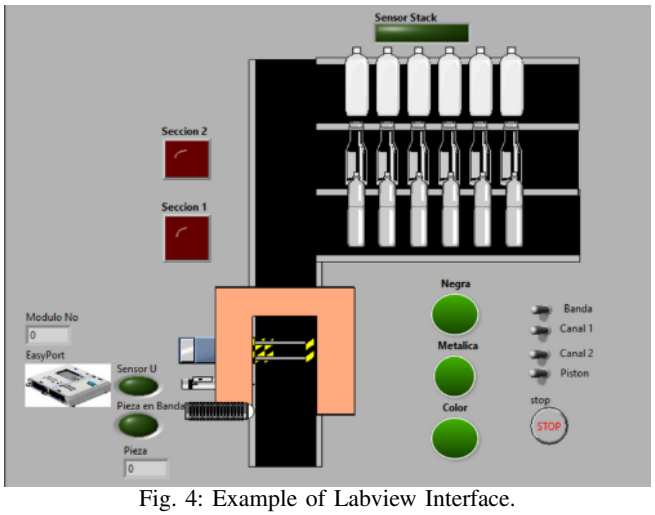

Fig. 4: Example of Labview Interface.

- Connect the PLC with the computer through the Ethernet port. Open TiaPortal icon.
- Create a new project.
- Choose a new device
- Add new device and choose CPU of your PLC, in this case is: CPU 1215C DC/DC/DC, 6ES7 215 -1AG40-0XB0, V4.4
- We need to deactivate all of protections, so we must choose the following options.
- Program In Labview.

V. Students Survey

In order to know if the proposal has an impact on the perspective of students about the career; A survey has been conducted to ten engineering students of third semester of different careers of San Francisco University (USFQ). The statements shown in the questionnaire are:

1) Which engineering are you studing?
2) Semester that you are taking?
3) The manual has enough information to make a successful communication between LabVIEW and the Festo Machine?
4) The manual was difficult to understand or the manual skips steps to make the machine works?
5) The laboratory practice elevates my desire in the applications of electronic engineer in the industry?
6) Does the system proposed in the manual allow to control all sensors and actuators of the machine?
7) Do you consider it necessary to have COMPLETE programming knowledge to be able to carry out the practice proposed in the manual?
8) In which semester do you think it is possible to carry out the practice proposed by the manual?

The survey presents multiple choice answers that are shown in the Results.

VI. Results

This section describes how will look an interface made by students in the laboratory proposed by the paper and also shows the results of the survey made to engineering students

A. Practice Results

The Labview interface results are shown in the figure 4:

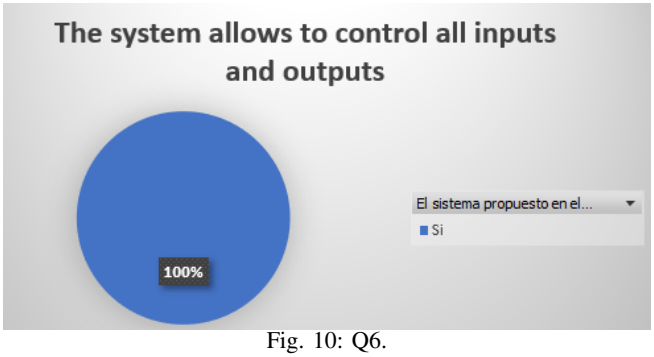

Fig. 10: Q6.

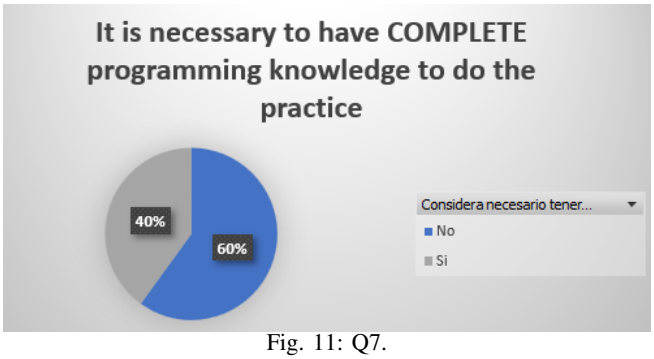

Fig. 11: Q7.

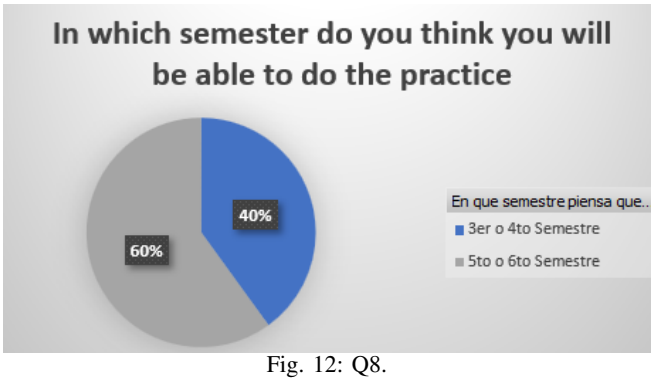

Fig. 12: Q8.

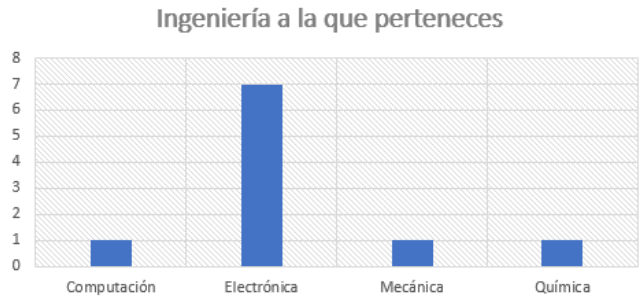

Fig. 5: Q1.

Fig. 6: Q2.

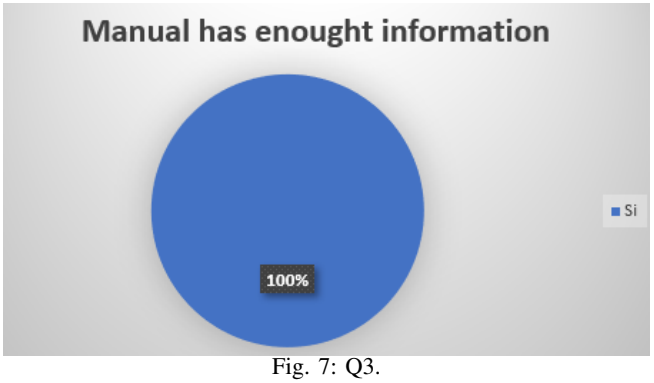

Fig. 7: Q3.

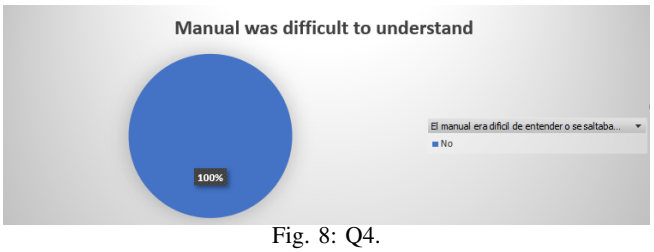

Fig. 8: Q4.

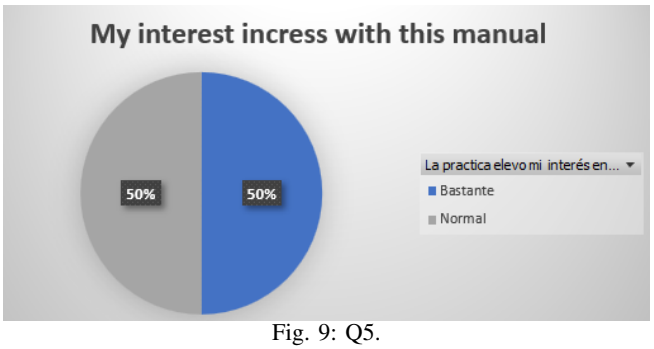

Fig. 9: Q5.

B. Survey Results

The results of the survey in general provides positive feedback

VII. Conclusion

This work represents an easy way to give a simple example of industrial applications to students that are starting their career on Electronic and Automation engineering. Therefore, it helps students increase their desire to learn electronic engineering, using interactive tools and modular machines such as the FESTO sorter machine.. The LabVIEW interface meets all these characteristics of learning to give a clear view about the programming side and the Human Machine Interface, based on simplicity's and functionality. There is several ways to make an interactive laboratory for young students of the career, this work is a good example on how to get to more students even outside the career.

References

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Appendix 1

UNIVERSIDAD SAN FRANCISCO

MANUAL DE LABORATORIO

FESTO SORTING MACHINE

Automatismos Industriales

WORK OF A SORTING FESTO MACHINE

ABSTRACT:

The following document presents a laboratory practice to learn about an industrial automation process. The systems consist of a Festo sorting module which will take 4 different types of caps that will enter on a band to be identified later, and then get classified into 3 different chutes depending on the material of the cap.

The practice can be divided into parts, the first one consists of only the communication of the Festo sorting module with the software Labview by using an Easyport module or by using a PLC siemens. The second part will be the programing in Labview or a PLC.

PRACTIC DEVELOPMENT

The first step is to know the Festo sorting module, this one will be represented by the figure.

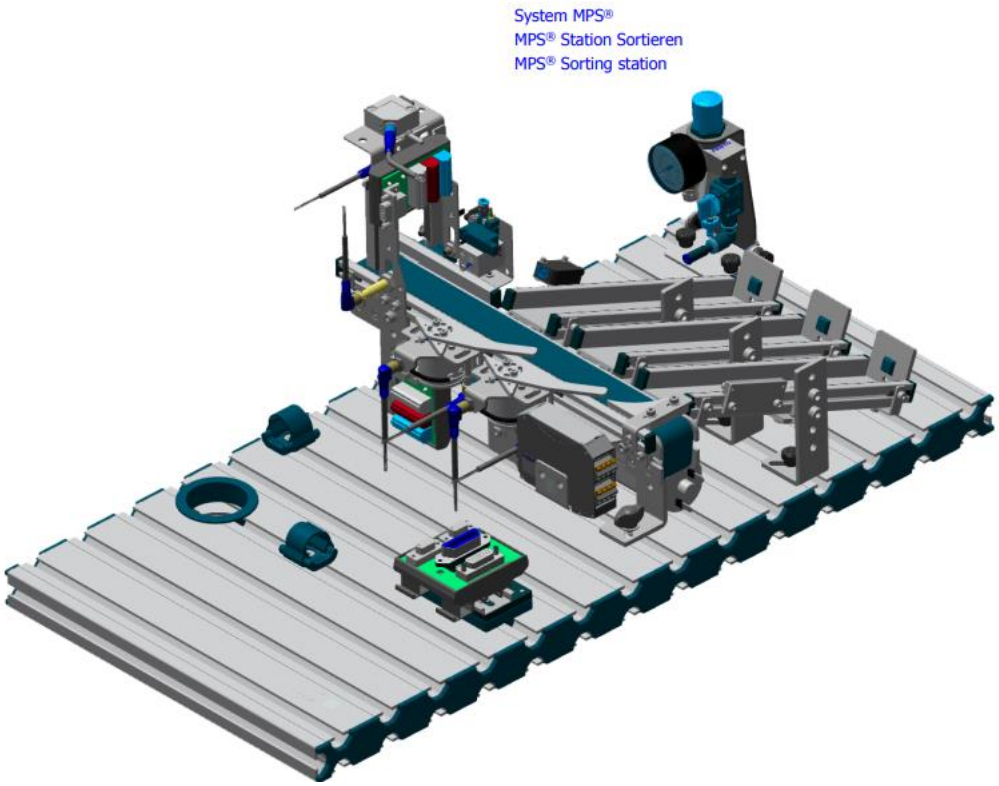


Figure 1.

Then, we must know where all the sensors and actuators are:

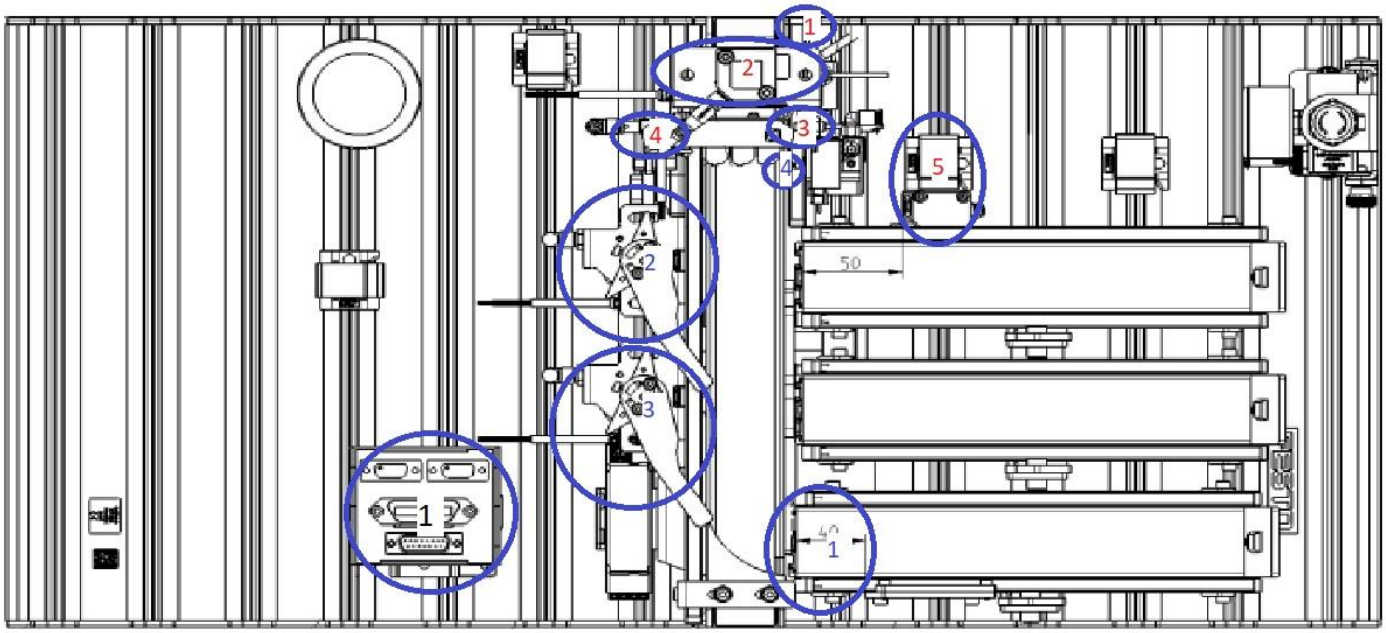


Figure 2.

INPUTS		
Number	**Type**	**Function**
1	Optical Sensor	Detect any kind of material in the band
2	Fork Light Barrier	Detect any kind of material which enters the detection module
3	Diffuse Light Sensor	The diffuse light sensor detects the red and the metallic workpieces
4	Inductive Proximity Sensor	Detects the metallic workpiece
5	Retro-Reflective Sensor	To know if the chutes are full

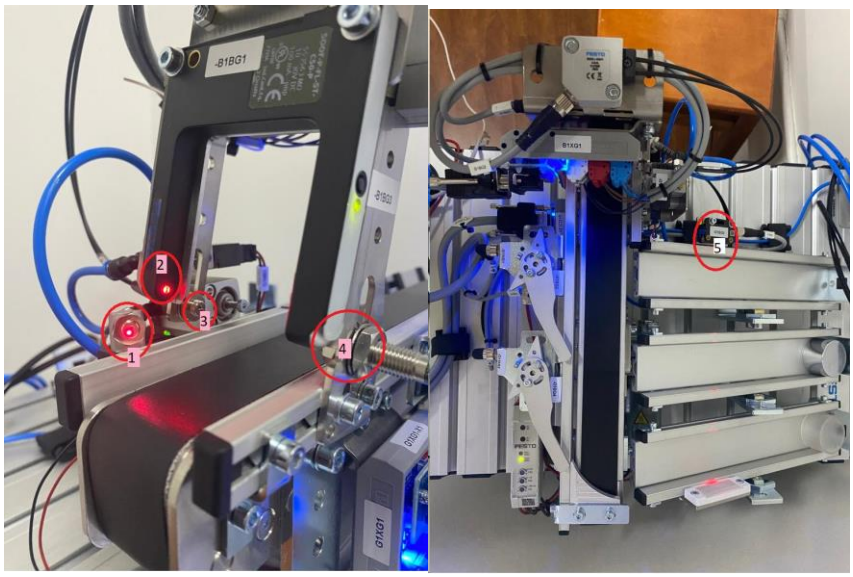


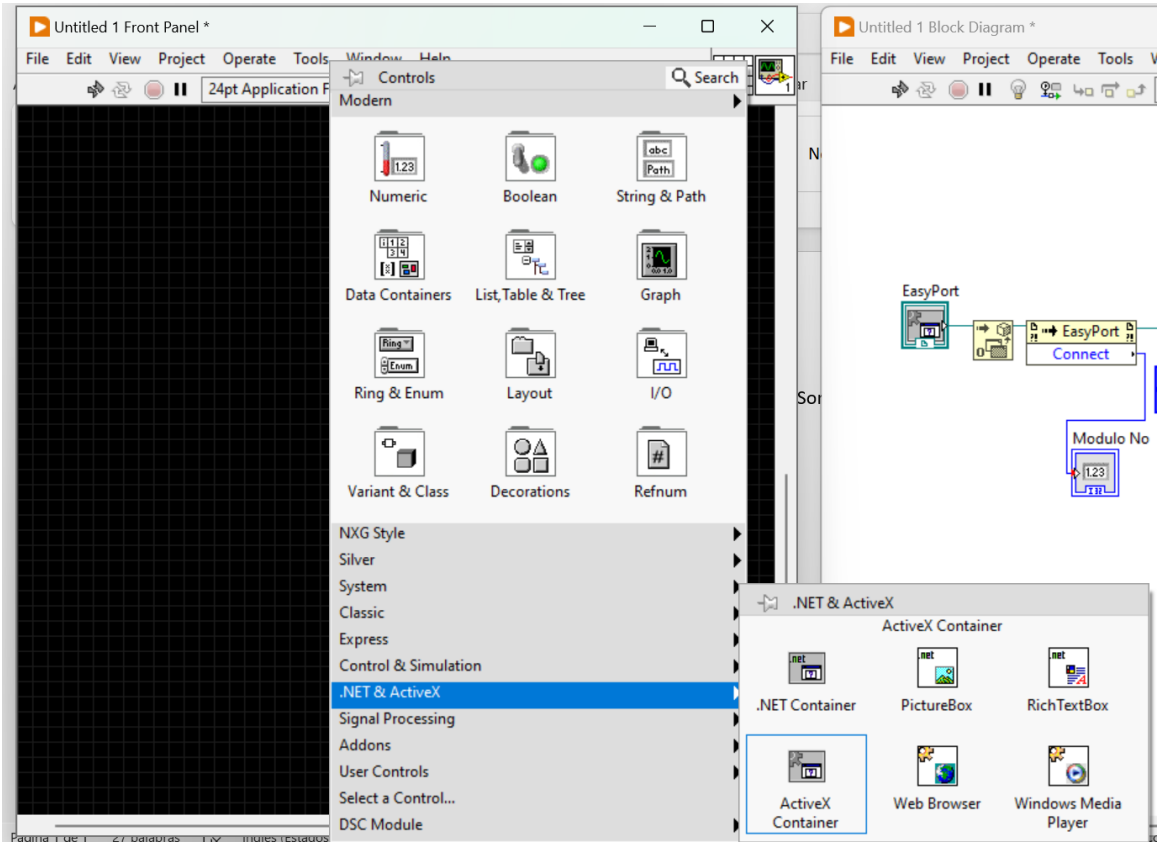
Figure 3.

OUTPUTS		
Number	**Type**	**Function**
1	Conveyor Belt Motor	To move the belt
2	Section 1 Motor	Ejects to the first chute
3	Section 2 Motor	Ejects to the second chute
4	Inductive Proximity Sensor	Pneumatic piston to stop the piece

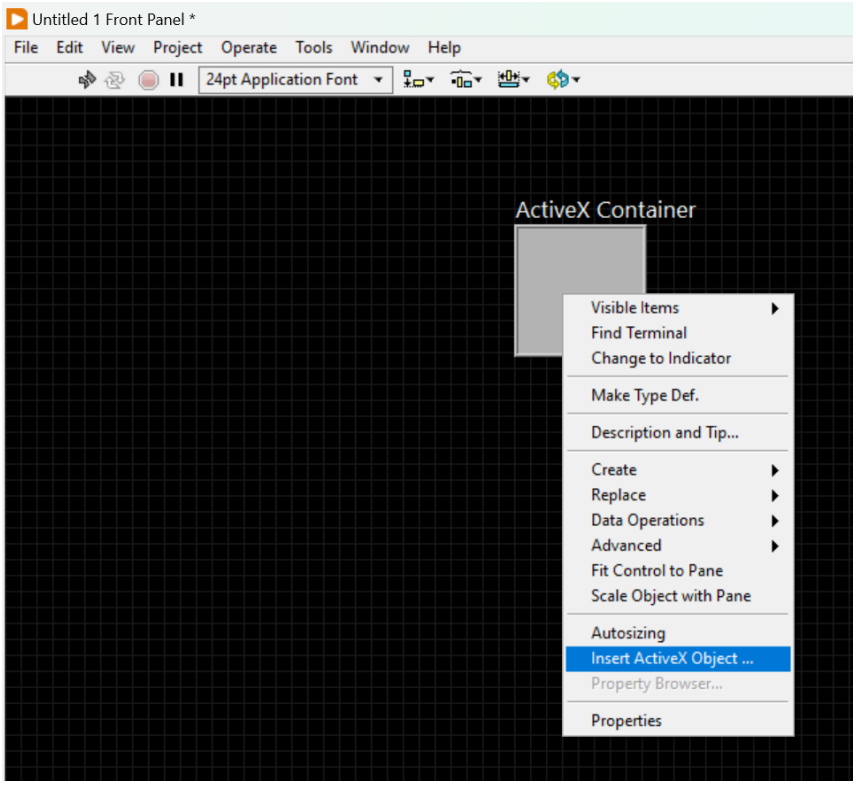
COMMUNICATE BY EASYPORT

In order to use Easy Port for communicate the Festo Sorting Machine, The students will be using Labview Software and the extension of ActiveX, so it's necessary to have ActiveX controller installed on Labview.

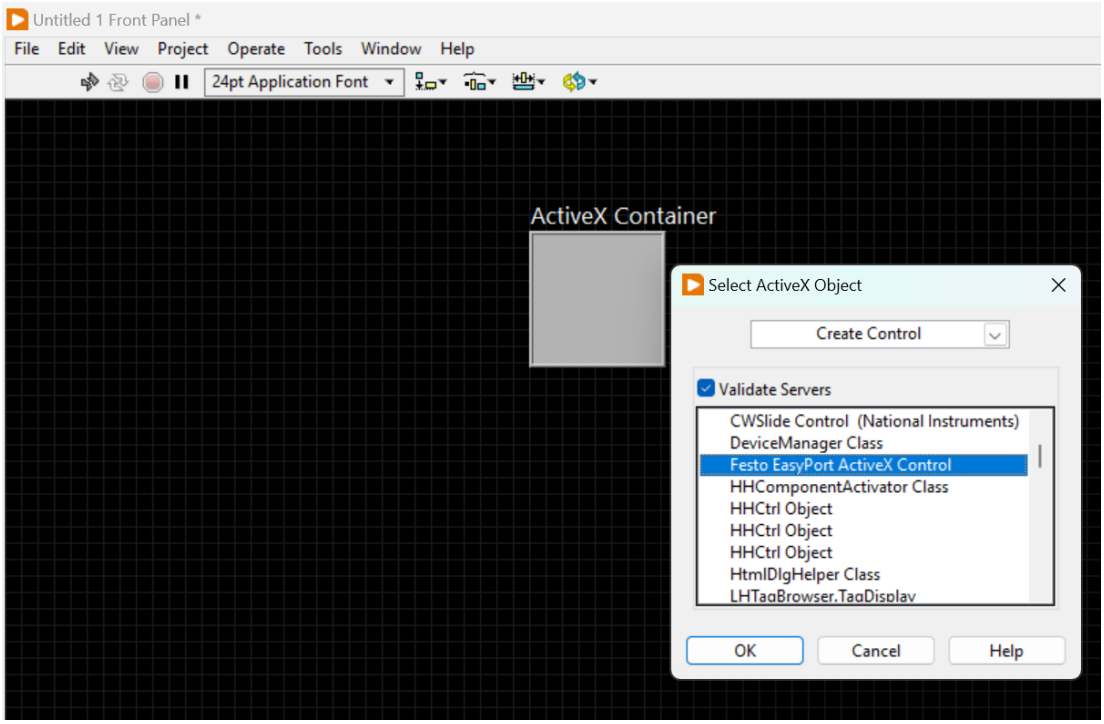
1. Add the ActiveX Container.



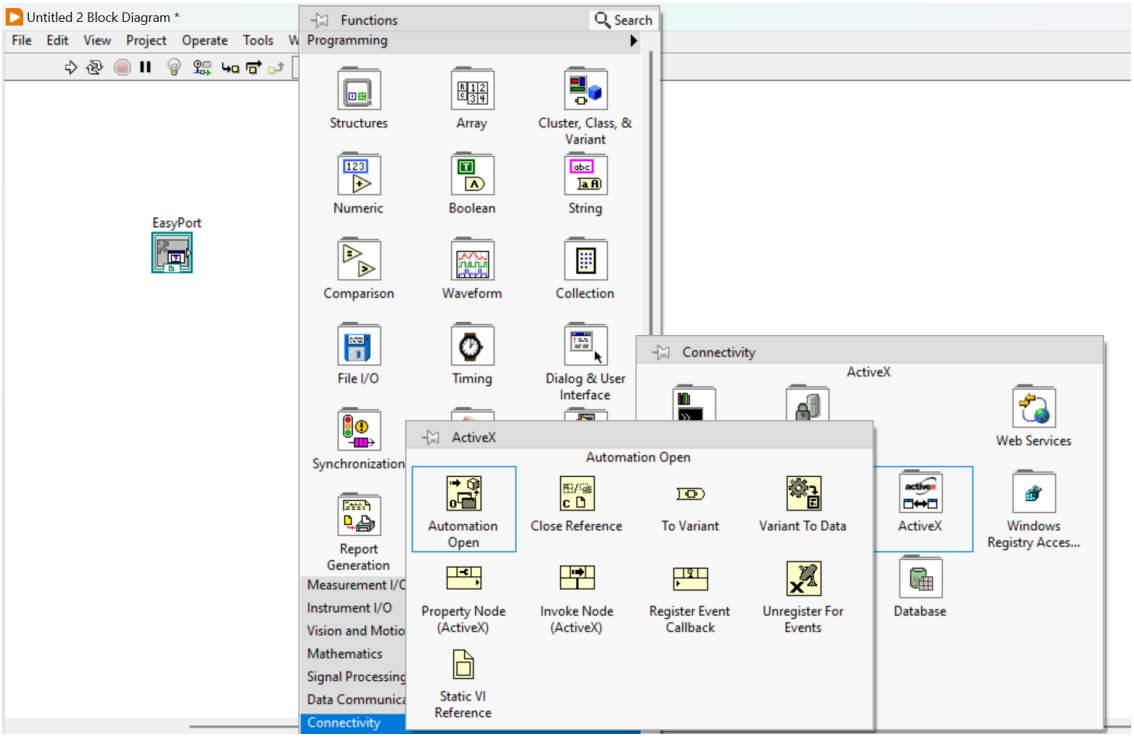
2. Chose Insert ActiveX object, by making a right click on the ActiveX Container



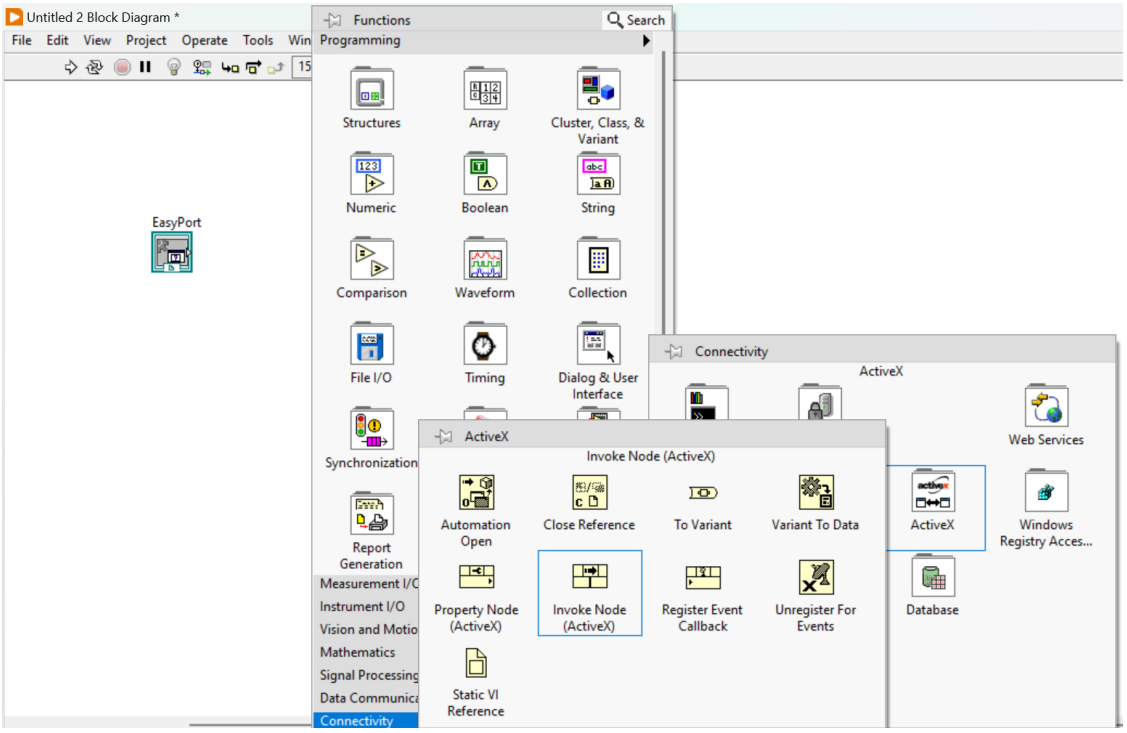
3. Then look for Festo Controller



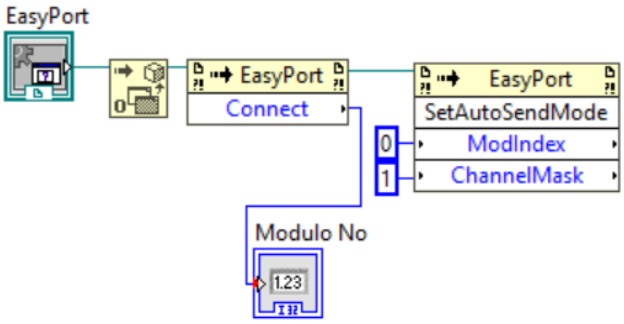
4. On the programming side, we add the communication protocol by looking for Connectivity -> ActiveX -> Automation Open Invoke Node



5. Then, we must add three invokes nodes Connectivity -> ActiveX -> Invoke Node

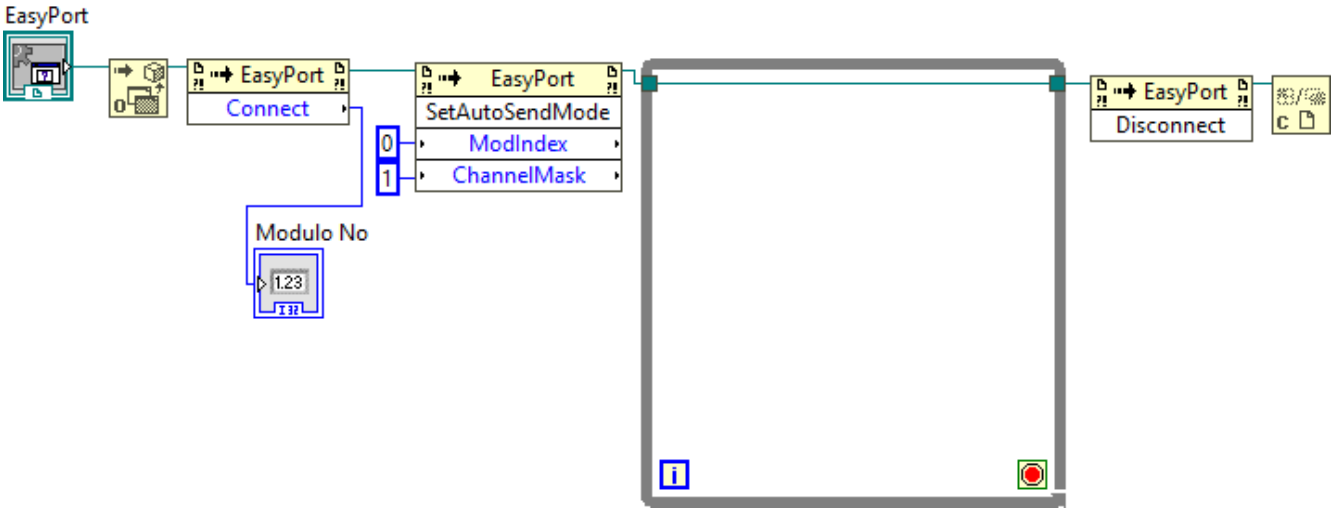


6. The Automation Open, is to set the protocol of the communication between Labview and the sorting machine, and the two invokes nodes are to see the correct module of the Easyport side, and set an automation send of data.

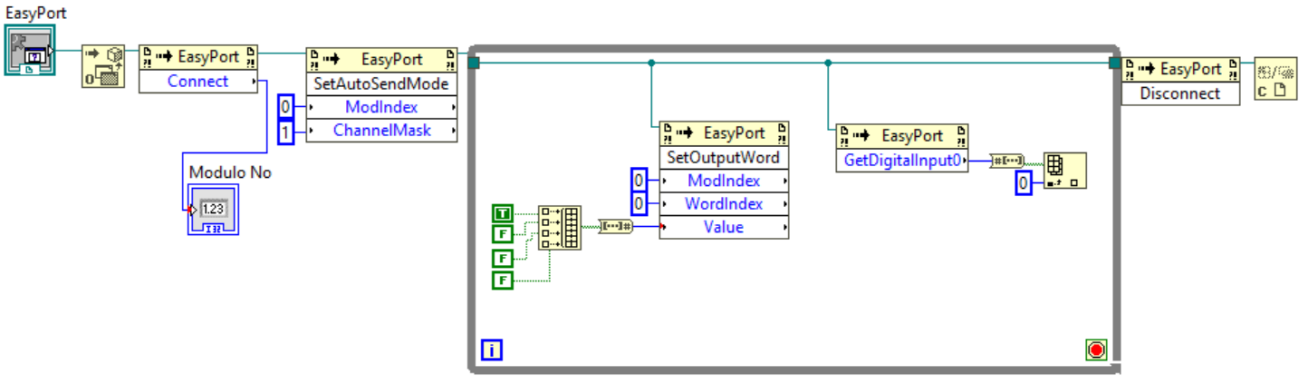


In this step, is necessary to connect the blocks to the EasyPort to appear.

7. Then we finally make a while structure and the end of the communication protocol.



8. To send or get the information, we must add the Invoke Nodes of SetOutputWord and GetDigitalInput

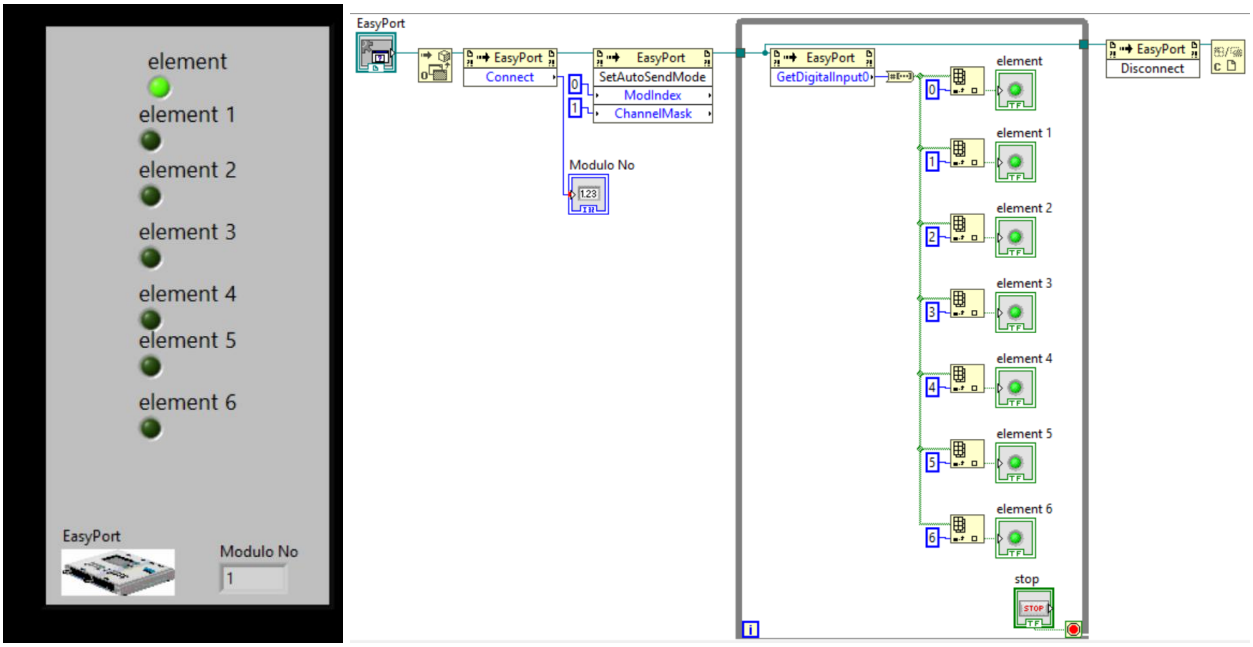


Depending on how we want to manage the data, we will transform to Boolean data or work it like a constant value.

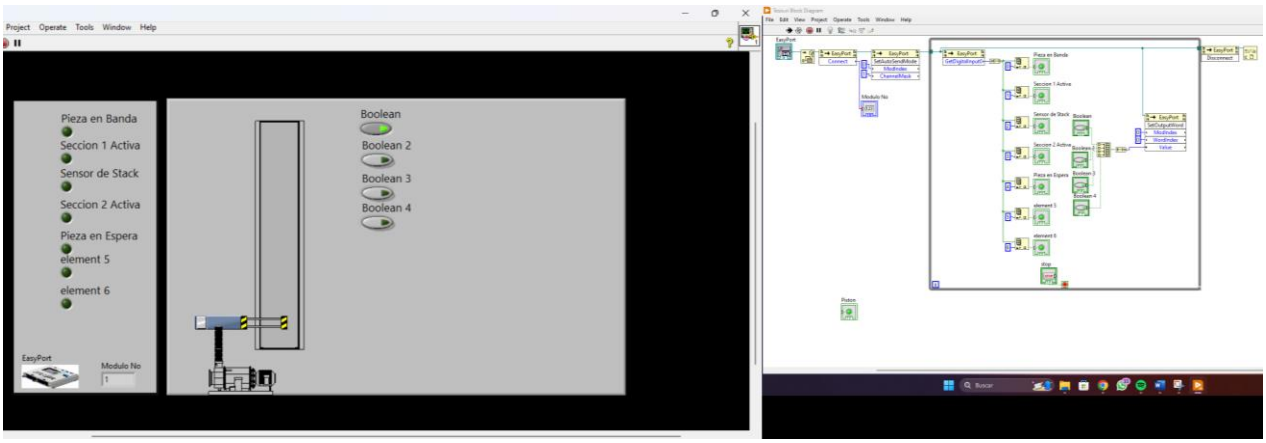
Inputs and Outputs

Due to, we need to have the data from each sensor, we must transform the constant value to an array of Boolean information, where each element will be each sensor.

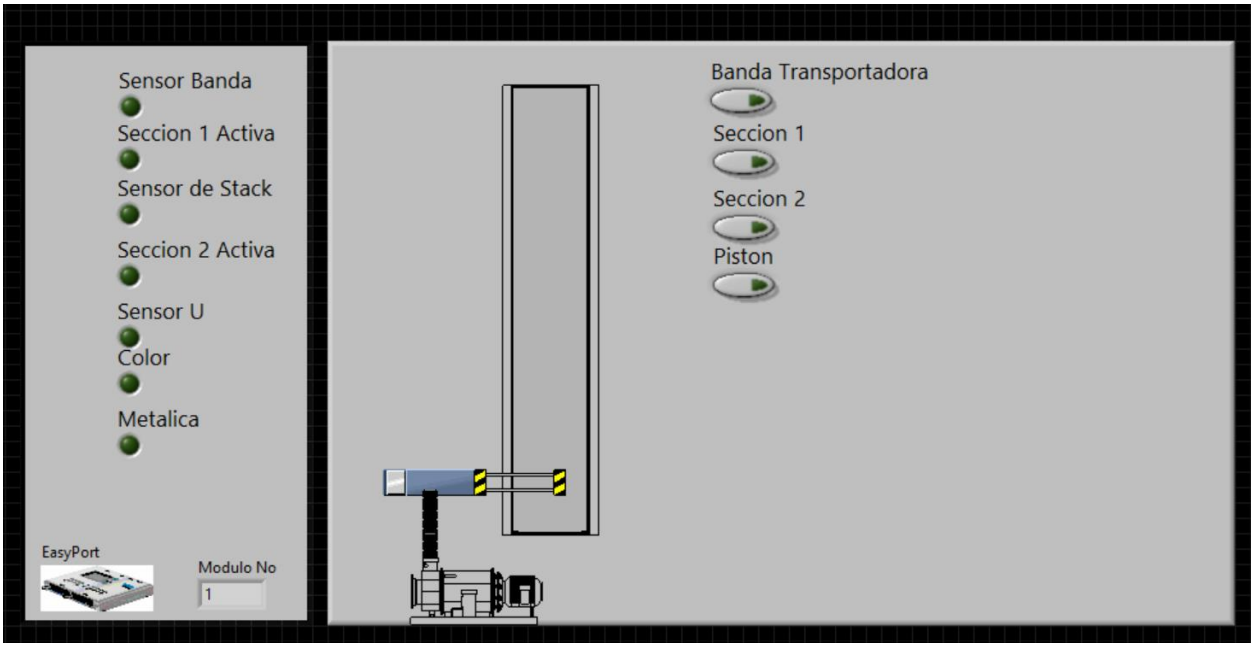
9. After making the blocks, we put the system in function to identify all the sensors.

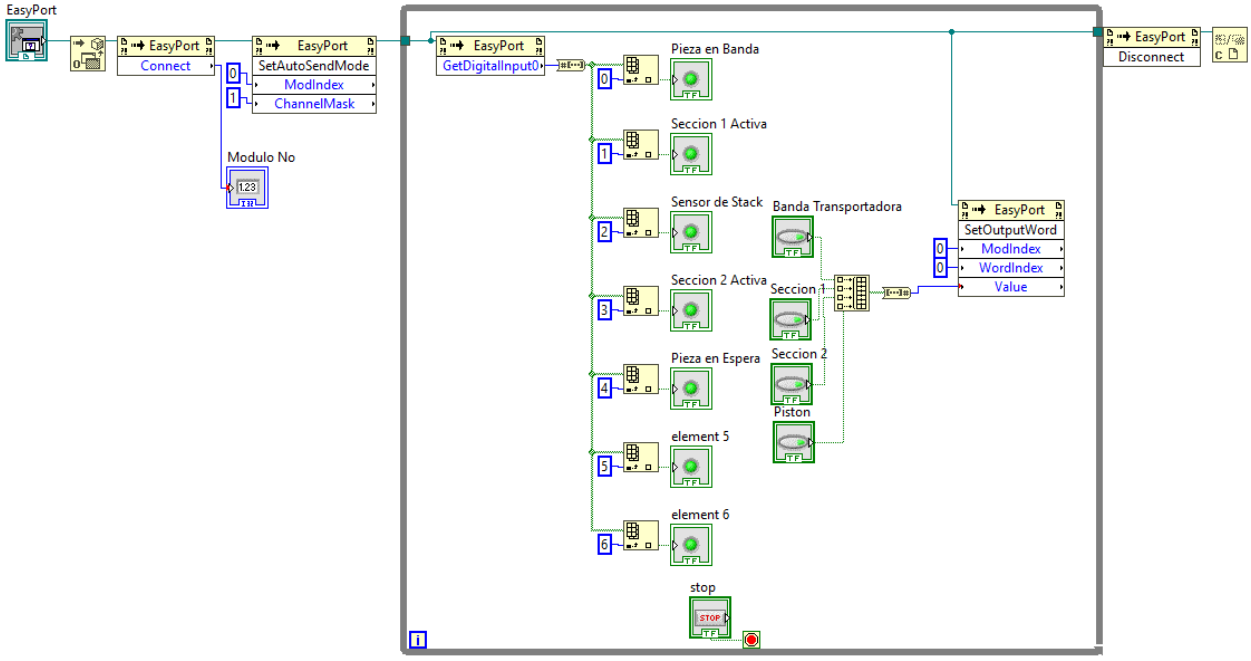


10. After we identify the sensors(inputs), we must identify the actuators(outputs).



11. After identifying the whole system, we can proceed to program the Labview part.

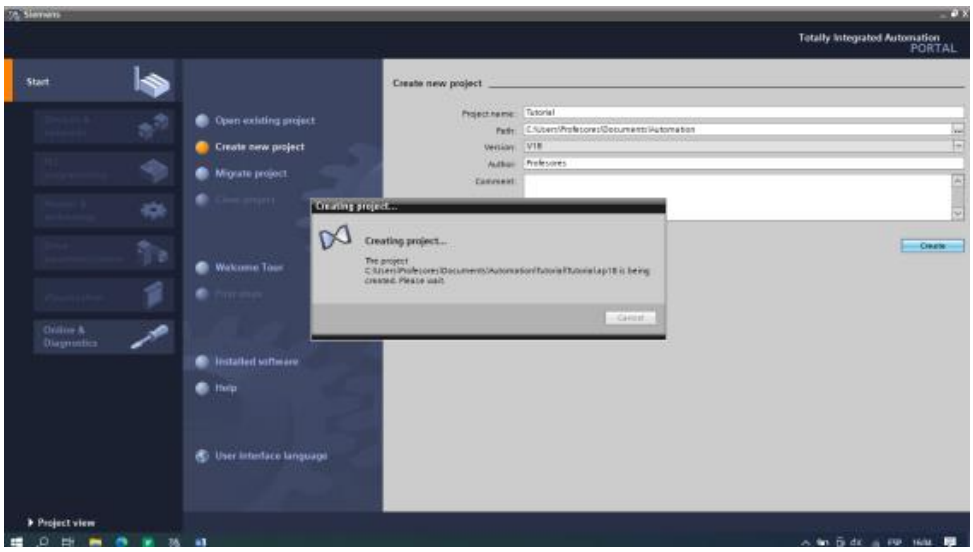




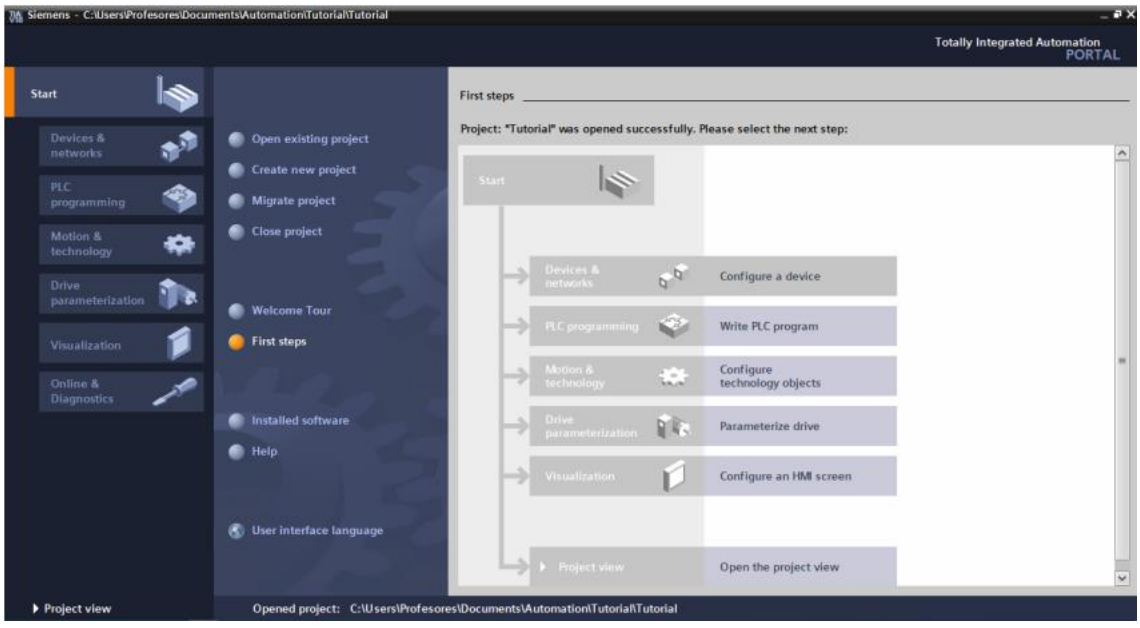
COMMUNICATE BY PLC SIEMENS - TIAPORTAL

1. Connect the PLC with the computer through the Ethernet port. Open TiaPortal icon.

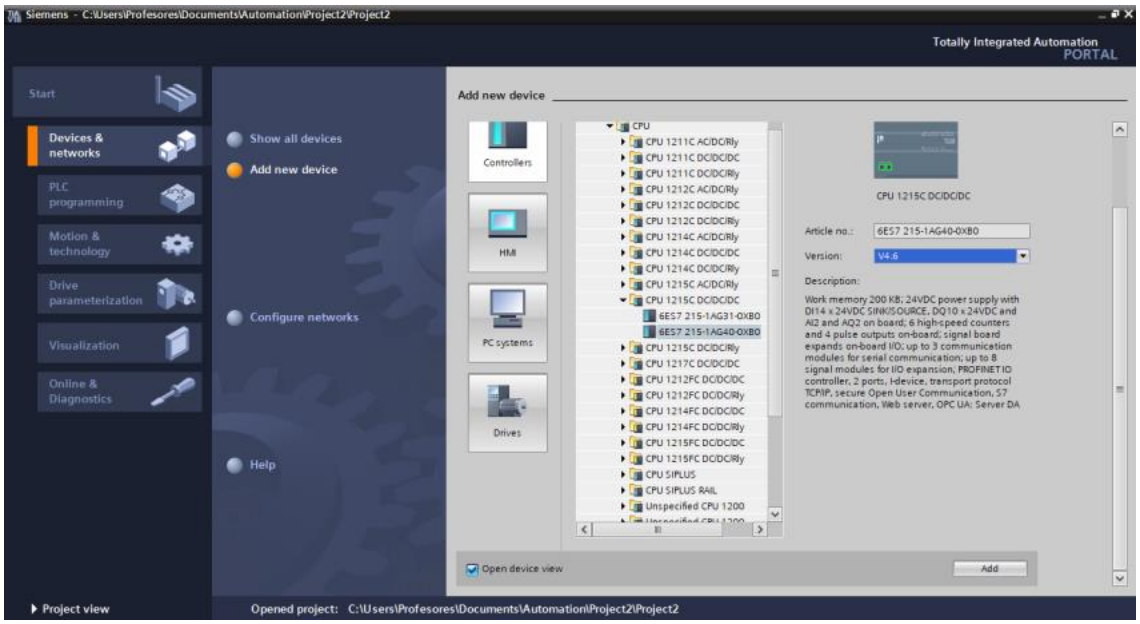
2. Create a new project.



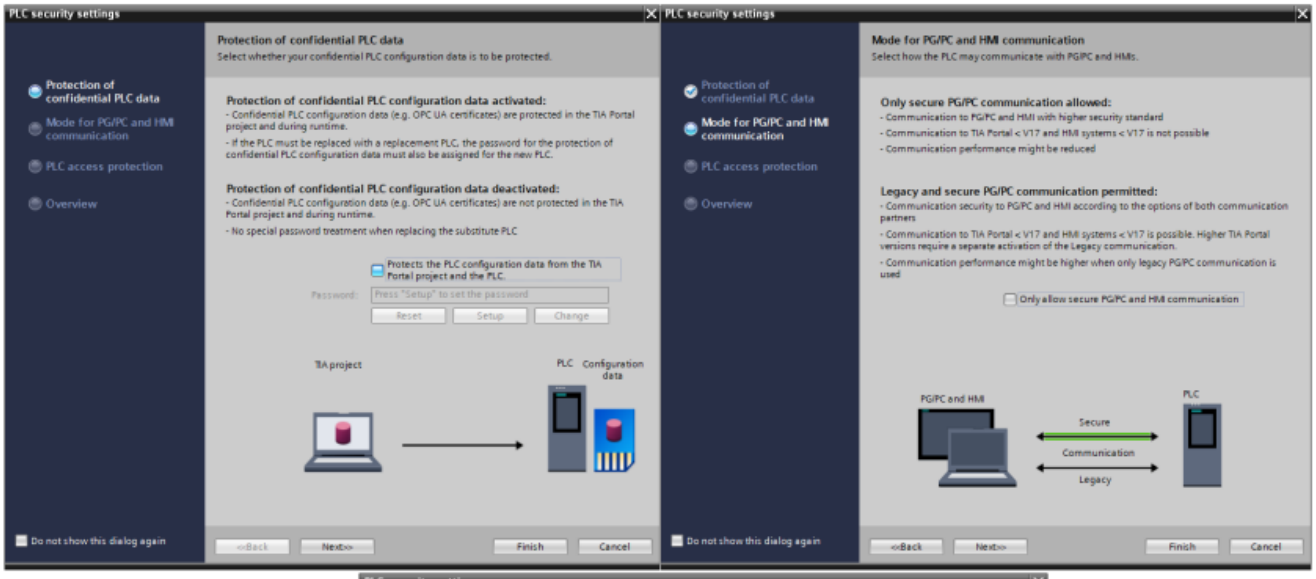
3. Choose new device.

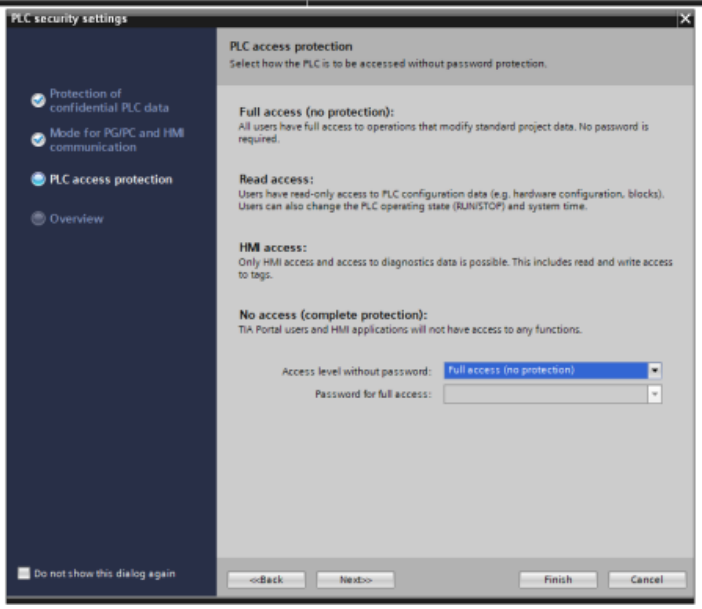


4. "Add new device" and choose CPU of your PLC, in this case is: CPU 1215C DC/DC/DC, 6ES7 215 -1AG40-0XB0, V4.4

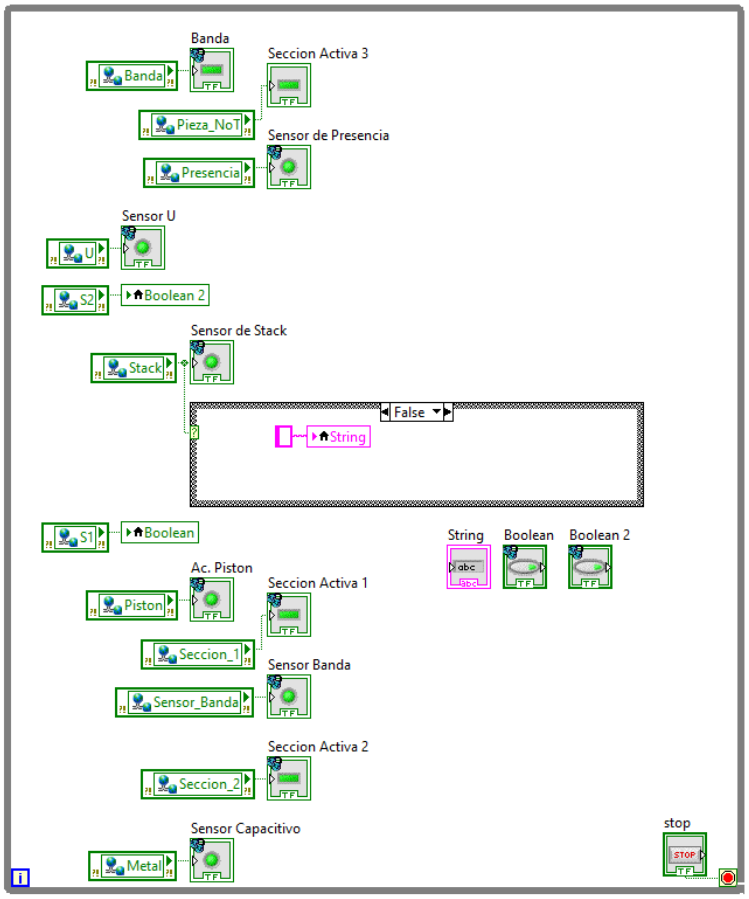


5. We need to deactivate all of protections, so we must choose the following options.





6. Program In Labview



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