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Automation and supervision system of a mixer and cooler by PLC (S7-300) and HMI

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Dedication

I dedicate this modest work to my dear parents who have encouraged and supported me a lot throughout their lives to these days and for these precious tips as well as these recommendations.

To my very dear brother and my dear sister.

To all my family, big and small without exception.

All my friends

May the master thesis be the expression of my deep respect and my great love them.

ZAKARIA

Thanks

first, we would like to thank ALLAH the almighty and merciful, who has given us the strength and the patience to do this modest work.

Secondly, we would like to thank our supervisor

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Our warm thanks also go to the members of the jury for the interest they took in our research by agreeing to examine our work and enrich it with their proposals.

Finally, we would also like to thank all the people who have participated directly or indirectly in carrying out this work.

ملخص:

يهدف هذا المشروع إلى تطوير آلة الخلط والتبريد بنظام أوتوماتيكي سهل الاستخدام مع سهولة الصيانة. للقيام بذلك ، قمنا بتوصيل الجهاز بنظام (تحكم آلي) و (شاشة مستخدم) ، علاوة على ذلك ، أضفنا اللغة العربية وحددنا إعدادات المستخدم لتسهيل التحكم وتجنب الأخطاء .باستخدام برنامجي STEP7 و WINCC

الكلمات المفتاحية: تحكم تلقائى, أتمتة, وحدة تحكم قابلة للبرمجة, STEP7 , WINCC.

Résumé

Ce projet vise à développer la machine de mélange et de refroidissement avec un système automatique qui est facile à utiliser avec une facilité de maintenance. Pour cela, nous avons connecté la machine avec un système (API) et (écran utilisateur) Par ailleurs, nous avons ajouté la langue arabe et spécifié les paramètres de l'opérateur pour faciliter le contrôle et éviter les erreurs par l'utilisation des programmes STEP 7 et WINCC.

Mots clés : Contrôle Automatique, Automatisation, Automate programmable industriel (API), STEP7, WINCC

Abstract

This project aims to develop the mixer and cooler machine with an automatic system that is easy to use with simple maintenance. To do this, we connected the machine with a system (PLC) and (user screen). Furthermore, we added the Arabic language and specified the user settings to facilitate control and to avoid faults using STEP 7 and WINCC programs.

Keywords: Automatic control, Automating, programmable logic controller (PLC), STEP7, WINCC

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Symbols and acronyms:

AC: Alternating Current.

AI: analogic input.

AO: analogic output.

BS1: Emergency safety reset.

BS2: Heating mixer cover safety reset.

BS3: Horizontal cooling mixer safety reset.

CMX: Cooler mixer.

CPU: Central Processing Unit.

CS: Cycle Start.

DC: Direct Current.

DCE: Data Communications Equipment.

DI: Digital input.

DO: digital output.

DTE: Data Terminal Equipment.

FBD: Function Block Diagrams.

HMI: Human Machine Interface.

I / O: input and output.

IG: main switch.

GPIB: General-Purpose Instrument Bus.

LAD: Ladder.

LED: light-emitting diode.

MAP: manufacturing automation protocol.

MPI: Multi Point Interface.

OB: Organization Block.

PEM: Emergency push button.

PLC: Programable Logic controller.

PS: Power Supply.

RAM: Random Access Memory.

ROM: Read-Only Memory.

RS232: Recommended standard 232

S: Cycle Stop.

STL: Statement List.

TMX: Turbo mixer.

TS: Touch screen.

USB: Universal Serial Bus.

GENERAL INTRODUCTION

General Introduction

The huge development of automation techniques allowed the transition from the manual machine to the automated machine, which manages the energy supply and provides also a better quality of products for the security and flexibility of processes, but that caused an increase in needs, particular controlling a lot of variables and real communication flows.

By definition, we know that automation is the automatic and continuous way of production, which improves the work conditions, so a programmable logic controller (PLC) and Human Machine Interface (HMI) are devices specialized on the control of a machine or an industrial process, composed of electronic components that contain a programmable memory. In other words, a PLC and HMI are logic computers, or computers with a deliberately reduced instruction set, intended for real-time control and monitoring industrial processes.

The problem that was posed to us in the PVC windows and doors system of the '' Belaid and his sons SNC'' group is that the mixer and cooler work in manual mode, this latter causing delays in the production.

Our presented work in this project is essentially based on the use of a programmable controller from the SIEMENS family. We have carried out automation and supervision on manufacturing through two essential stages; mixing and cooling. The process management of process data is carried out by a PLC S7-300 controller and Touch screen TP 177B 6 mono DP.

This work consists of the following chapters presented sequentially:

General Introduction.

Preamble: Company presentation.

Chapter I: Process description.

Chapter II: PLC control.

Chapter III: Programming in STEP 7.

Chapter IV: Supervision of the control of the mixer and cooler.

General Conclusion.

PREAMBLE:

COMPANY PRESENTATION

1 Company presentation

‘’ Belaid and his Sons SNC’’ is a private economic company incorporated in August 2015 in "Ksar el Boukhari Medea", a leader in the field of aluminum and PVC joinery and construction planning and it provides a chance of work with private companies and to individuals. ‘’ Belaid and his Sons’’ has the fourth level qualification certificate.

‘’Belaid and his Sons SNC’’ is committed to a new PVC project with European quality and technology. With modern techniques of production, manufacturing, and organization, with an efficient team that ensures the study of the project, guidance of customers as well as the establishment of quotes as soon as possible and in a professional way.



Figure 1: Belaid and his Sons SNC Company

2 List of activities

Manufacture and installation of all aluminum work for industrial, professional or domestic use. tailored interior decoration that specific in:

- Manufacturing of aluminum and PVC doors and windows.
- All types of the wall (VEP, VEC, and traditional).
- Exterior coating (composite panels, PVC panels).
- Interior covering and ceiling (PVC, MDF, BA13, plasterboard, and aluminum).
- Stair trunk and railing in aluminum and stainless steel.

- Glass roof and verandas in aluminum and PVC with frosted glass and polycarbonate.
- Separation of offices in aluminum and PVC.
- Roller shutter in aluminum and PVC.
- Removable aluminum partitions.



Figure 2: Some of Belaid and his Sons SNC's products

3 Identification card

Company name / Trade name: SNC Belaid and his Sons

Registration number: 07B0342945

Registration date: 08/19/2015

Nationality: ALGERIAN (001)

Legal form: COMPANY IN COLLECTIVE NAME

Legal regime: PRIVATE SECTOR

Capital: 40,120,000.00DA

Municipality / Registration Wilaya: Boghar / Medea. [1]

4 Current factory capabilities

‘’SNC Belaid and his Sons’’ actually has 3 lines. The first concern of the aluminum profile.

For this, it has acquired very modern lines. added with another line that manufactures the metal reinforcements necessary for the design and collecting of PVC windows. Third, it has double glazing system manufacturing unit.

Currently, the company manages to produce 120 windows/day. they were able to increase their capacities from 100 tons per month in 2016 to 300 tons for the current year (2020).

This all goes to an investment of 4 million euros that they made in 2015.

It acquired a second production line. This allowed them to work in 3x8 h. The factory does therefore never stop. 4 groups of 76 employees keep it running at full speed. To operate a company of this magnitude, you need a skilled workforce. [1]

5 Company's plans

Their immediate project is to reduce the import of the aluminum profile. And there are real possibilities for Algeria to be a leader in the field. It’s strange that our country importer of this petroleum-derived product while it is a producer of hydrocarbons. [1]

6 Business situations

Its business is evolving. it has obtained contracts with public companies working in the building sector. it is one of the 4 biggest Algerian companies’ leaders in the local market.

7 SNC Belaid and his Sons in Numbers:

- 76: This is the number of employees that the company has.
- 300: This is the capacity, in tons, of PVC profiles that the company currently manufactures each month.
- Evolution of 300% compared to 2016.
- 197: This is the turnover in million DA of the family business recorded in 2016.
- The number is expected to grow.
- 120: This is the number of PVC windows the company produces per day.
- 4 million euros is the latest investment made by the company to double its production capacity.

CHAPTER I:

PROCESS DESCRIPTION

1.1 Introduction

Aluminum contains many types and Each manufacturing sector has different requirements. Its manufacture goes through several stages, but it all starts from one principle (mixing) based on two main machines HEATING MIXER and HORIZONTAL COOLING MIXER



Figure 1.1: Aluminum types

1.2 Definition of heating mixer

The TMX 'turbo mixers' are used for both rigid and soft PVC and have shown themselves to be extremely efficient in the thermoplastic materials transformation industry.

when good quality material must be combined with high hourly throughput, this turbo-mixer is the ideal solution.

in our situation, we have Heating Mixer TMX 400/VS. [2]

1.3 Features:

1.3.1 Mixing vessel

- Internal surfaces in contact with the material are made of stainless steel.
- Double or triple insulated jacket for the circulation of water or oil.

1.3.2 Mixing tool

- Made of stainless steel, with axial and radial mixing effect, designed to optimize the distribution of the hot material on the cooling surfaces.

1.3.3 Emptying

- Openable discharge outlet
- Double discharge outlet

1.3.4 Lid

- It can be supplied in various configurations; it can be opened vertically by a pneumatic cylinder operated lifting system.
- Mechanical safe opening system of lead type or automatic motor.
- The safety device only allows the lid to be opened after the mixer has stopped moving.

1.3.5 Temperature control

- Through a thermocouple located at the side of the mixing vessel to control operating and safety temperatures. [3]

1.4 Heating mixer TMX 400/VS

Machine suitable for mixing of PVC Dry-Blend loaded either manually in the mixing chamber.

- Total Volume: 500 lt.
- Useful Volume: 420 lt.
- Electric Motor: 110 kW – 400 V – 50 Hz

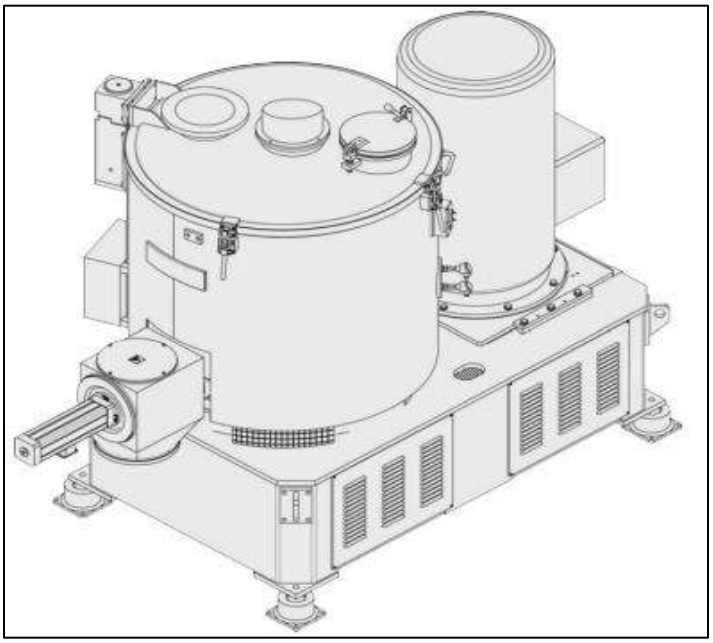


Figure 1.2: Heating Mixer TMX 400/VS

1.5 Heating mixer type TMX-400/VS comprising:

- Base
- Container
- Lid
- Discharge Outlet
- Mixing Device (Blades)
- Transmission
- Motor
- Cylinder
- Filter

1.5.1 Base

The transmission pulleys (A) and (B) with relative belts (C) and the tensioning devices (D) are included in the welded steel base (1)

Aeration and inspection panels (E) are positioned on the side securely fixed to the structure with screws.

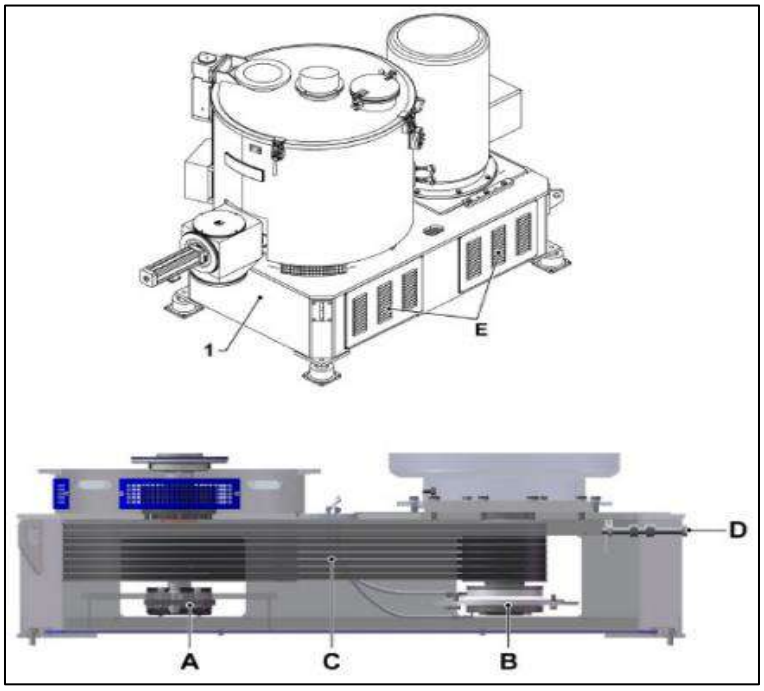


Figure 1.3: base of the heating mixer

1.5.2 Mixing vessel

The recipient (1) is insulated to double-walled.

The interspace can contain a thermal isolator, cooling water, or diathermic oil used to heat the mixture.

The internal surfaces in stainless steel with a fine satin finish are in contact with the PVC DRY-BLEND.

The series of product mixing blades (2), directly operated by the transmission group, are positioned inside the vessel. [3]

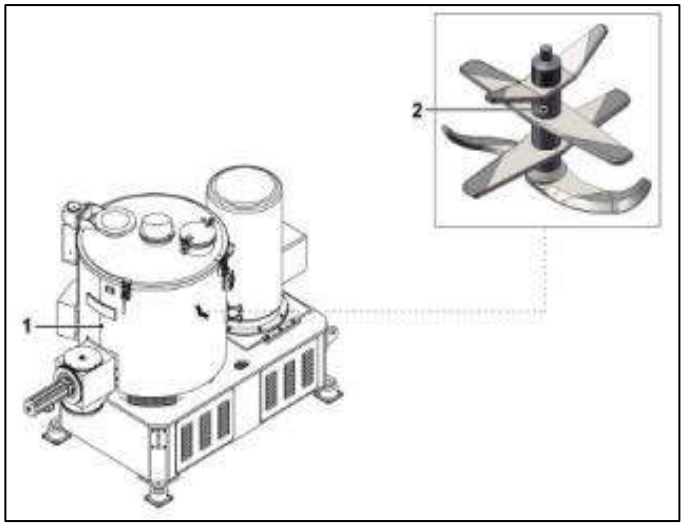


Figure 1.4: Product mixing vessel

On its side are the thermocouples (3) for product temperature control and safety, the connector block (4) for connection to the cutout box, the pneumatic box (5) and the push-button panel with the commands:

A- CLOSE/OPEN cover.

B- CLOSE/OPEN heating mixer discharge.

C- EMERGENCY button.

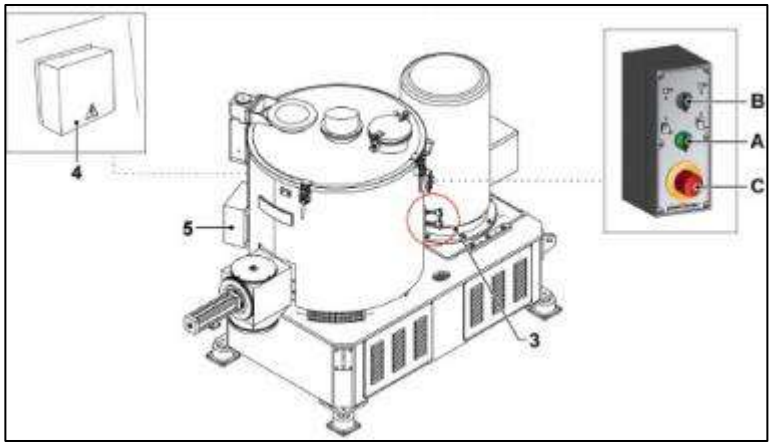


Figure 1.5: mixing vessel

1.5.3 Mixing vessel cover

Operated vertically by the pneumatic cylinder (2) or by a hydraulic system that keeps it either pressed onto the vessel or raised to allow for manual opening.

The cover is closed using a handle (3).

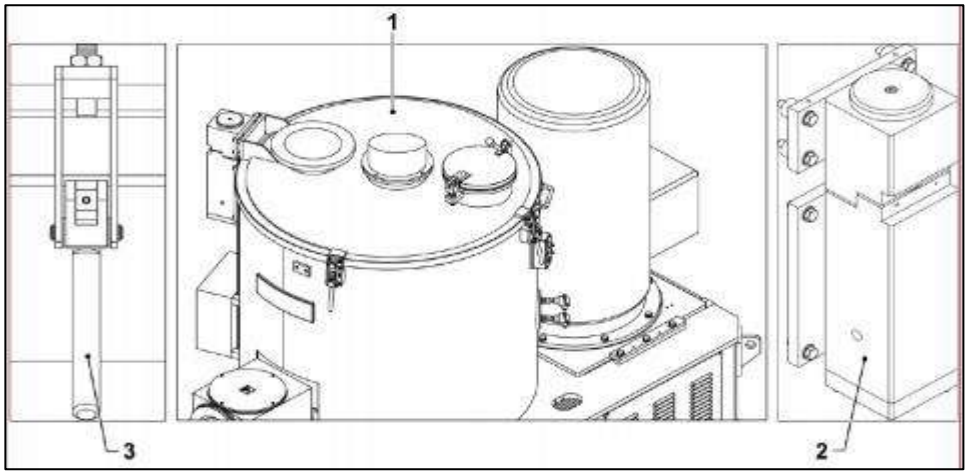


Figure 1.6: Mixing vessel cover 1

The cover is used for the following purposes:

4) Inspection porthole with manual opening.

5) Connection for air vent or connection to self-cleaning filter.

6) Connection for powder loading, with or without a valve.

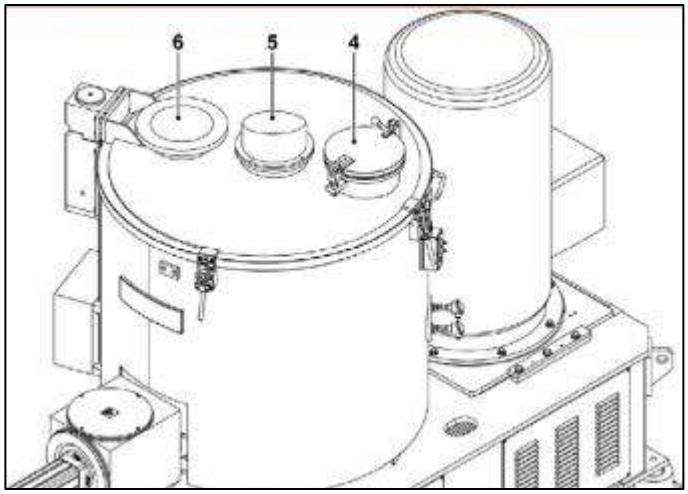


Figure 1.7: Mixing vessel cover 2

1.5.4 Transmission group

The group is composed of:

A- Motor;

B- Driving pulley;

C- Driven pulley;

D- Transmission belt (they transmit the movement directly to the shaft of the mixing blades);

E- A sealing system for the mixing shaft (grease or air).

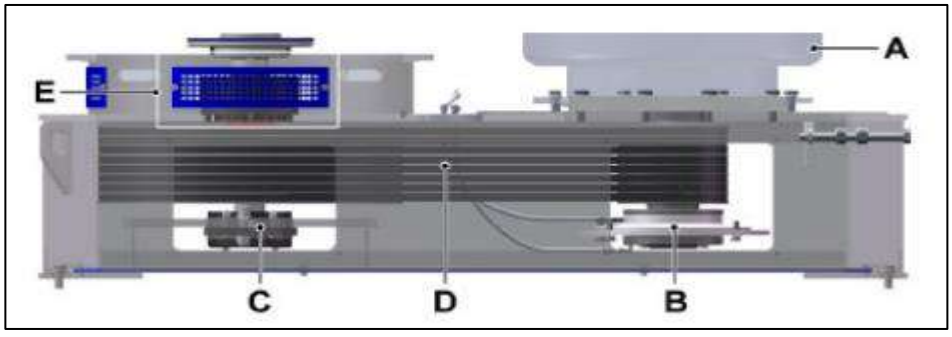


Figure 1.8: Transmission group

1.5.5 Discharge group

The product is discharged using the pneumatic cylinder (1) that operates the watertight plug positioned on the group's outlet, (A) standard port.

The plug can be operated automatically during the work cycle or manually by the operator, using the button (B) found on the push-button panel on board the machine.

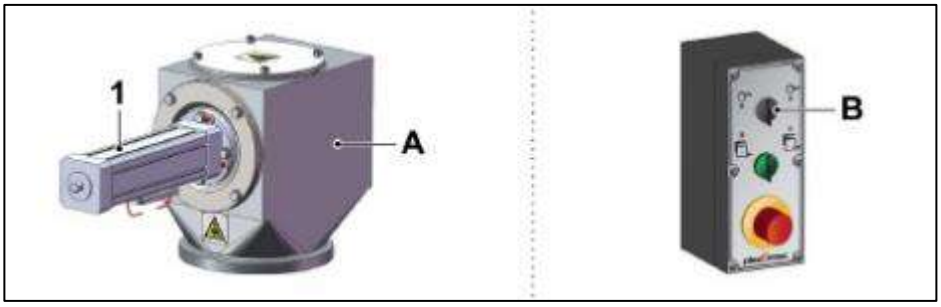


Figure 1.9: discharge group

1.5.6 Electric motor

It connects the ground cable from the support foot to the ground terminal of the motor terminal box and connects the electric power supply cables to the terminal box of the motor.

- Electric Motor: 110 kW – 400 V – 50 Hz. [3]

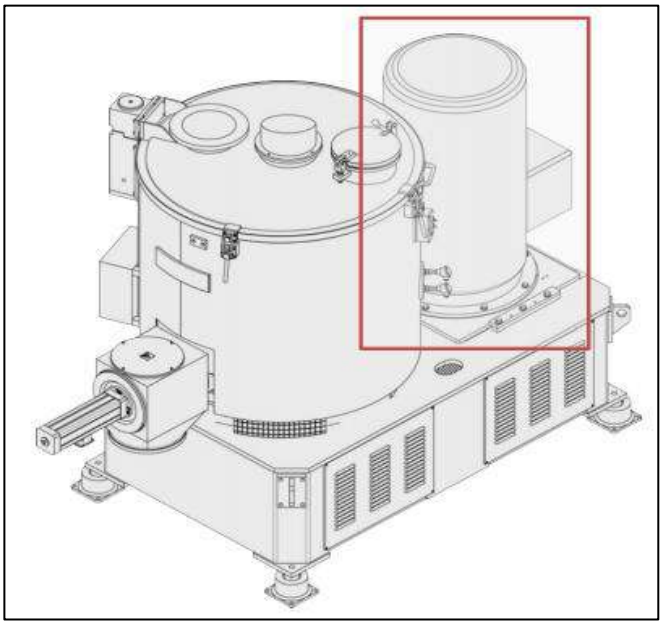


Figure 1.10: Electric motor

Table 1.1: Technical data for the mixer

Mixing vessel total capacity:	**500 Liters**
Mixing vessel useful capacity:	**420 Liters**
Parts in contact with the product:	**AISI 304 Stainless Steel**
Degree of finishing internal surfaces of the mixing vessel:	**300 Emery**
Max. charge per each batch of rigid PVC (density 0.5 kg/dm^3):	**7 batch/hour at 120" C**
A.C. motor power:	**110 kW**
Type of mixing tool:	**4 Stages**
The peripheral speed of the mixing tool:	**16:32 mt/sec**
Feeding pressure of compressed air:	**7 Bar**

1.6 Definition of horizontal cooling mixer

The CMX range of coolers used for this combination can be applied to any type of turbo mixer TMX and this is the ideal solution for all manufacturing needs in the field of rigid or plasticized PVC dry-blend. This equipment is built entirely of stainless steel concerning the parts in contact with the material and double or triple jacket for the circulation of cooling water.

in our situation, we have Horizontal Cooling Mixer CMX-1200. [4]

1.7 Features:

1.7.1 Temperature control

- Using thermocouples located on the side of the mixing bowl to control operating and protective temperatures.

1.7.2 Cap

- Opens along the entire length of the cooler, equipped with a double “jacket” for water circulation.

Internal safe opening system with mechanical or automatic type screw lift.

- A safety device that allows you to open the lid only after the mixer has completely stopped.
- Safety switch with the engine stopped when opening.

1.7.3 Horizontal cooling cup

- The internal surfaces of the parts of the cooler in contact with the material are made of stainless steel.

The cooler is equipped with a double/triple "jacket" for circulating cooling water.

1.7.4 Blades

- Made of stainless steel, with axial and radial mixing effect, designed for optimum distribution of hot material on cooling surfaces. [5]

1.8 Horizontal cooling mixer CMX-1200

Machine suitable for mixing PVC Dry-Blend, loading is performed automatically from the Heating Mixer TMX-400/VS.

- Total Volume: 1500 lt.
- Useful Volume: 1000 lt.
- Electric Motor: 11 kW – 400 V – 50 Hz.

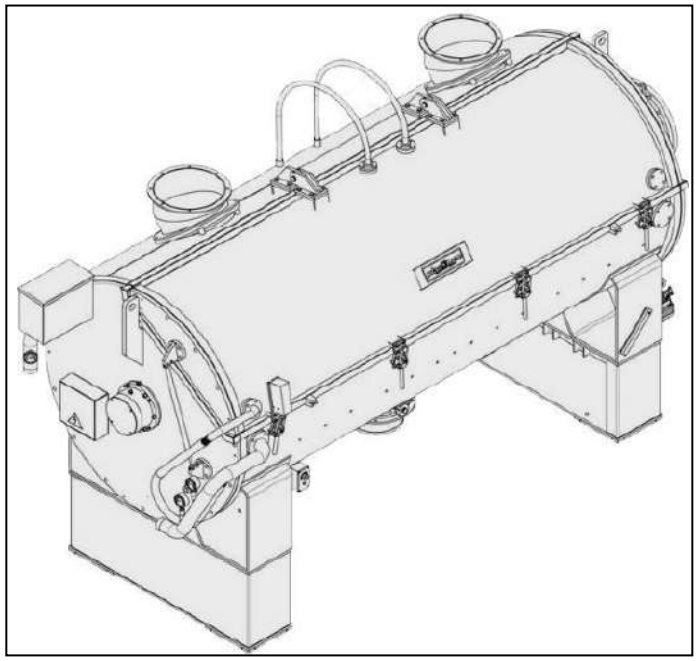


Figure 1.11: Horizontal Cooling Mixer CMX-1200

1.9 Horizontal cooling mixer type CMX-1200 comprising:

- Base
- Container
- Lid
- Discharge Outlet
- Mixing Device (Blades)
- Transmission
- Electric Motor
- Cylinder

1.9.1 Cooling Vessel

The cylindrical product cooling vessel is composed of an inner body in stainless steel and an outer shell in painted steel.

The product cooling liquid circulates in the interspace created between the body and the shell.

The ends of the vessel are closed by two metallic flanks that can be equipped with an interspace for the circulation of cooling liquid.

The opening where the cover unit (1) is housed is in the upper part of the vessel, as are the material loading inlets (2), the air vent (3), with or without a valve.

The cooled product is discharged from the discharge outlet (4).

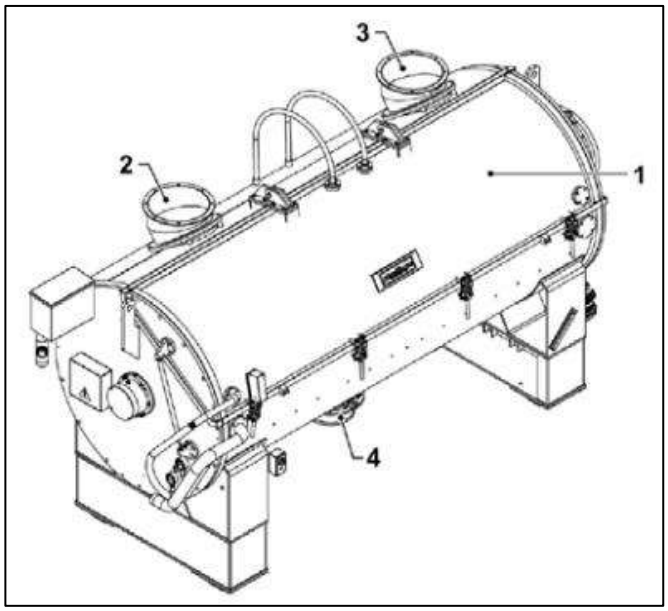


Figure 1.12: Cooling Vessel 1

The following are installed on the vessel flanks:

- The water connections (5).
- The hoisting devices and cover guide (6) and (7).
- The transmission group (8).
- The gasket sets (A).

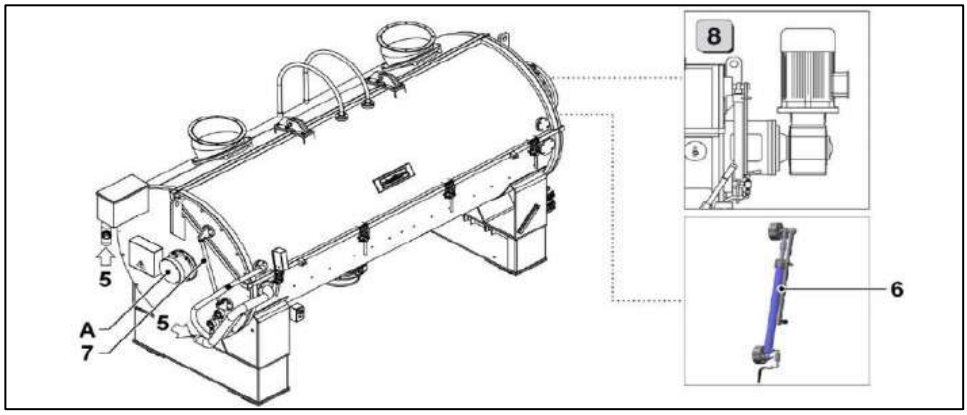


Figure 1.13: Cooling Vessel 2

1.9.2 Vessel cover

The cover, made with an interspace as for the vessel, is hinged on one side and opens vertically.

The opening is controlled by a manually operated oleo pump (1) and an actuator (2) assisted by the device (3).

The seal between the cover and the vessel is guaranteed by the gaskets (4).

The cover can be locked in the closed position using the appropriate handles (A) and (B).

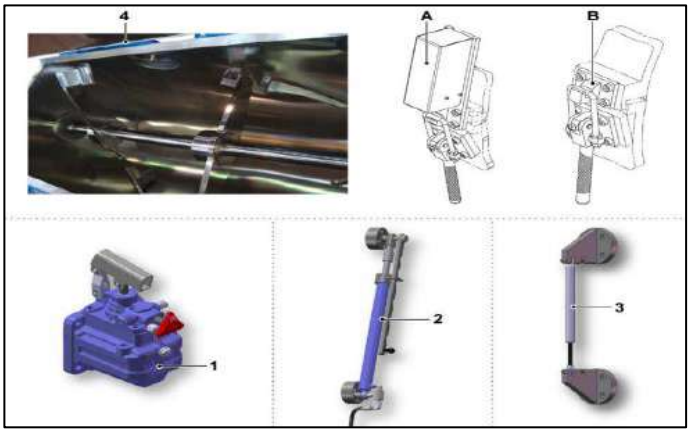


Figure 1.14: Vessel Cover

1.9.3 Stirrer and transmission unit

The stirrer (1) is installed inside the cooling vessel and is composed of a central rotation shaft and radial arms with product mixing blades mounted at the ends.

The stirrer is operated by the transmission group composed of the motor (2) and the gear (3).

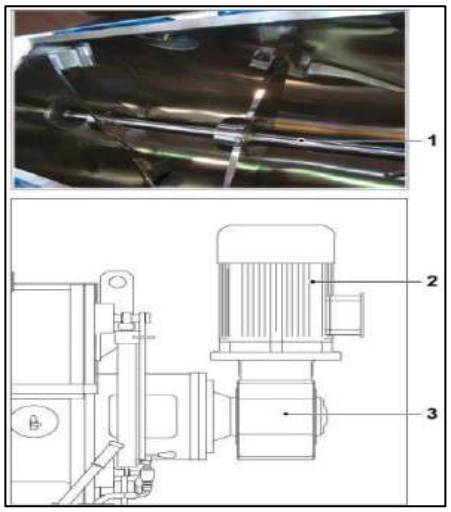


Figure 1.15: Stirrer and transmission unit

1.9.4 Discharge group

Cooled material in the vessel is discharged from the discharge outlet (1), which can be single or multiple.

The product is discharged using the pneumatic actuator (2) that operates the watertight plug positioned on the group's outlet port.

The plug can be operated automatically during the work cycle or manually by the operator, using the button (A) found on the push-button panel (3) onboard the machine

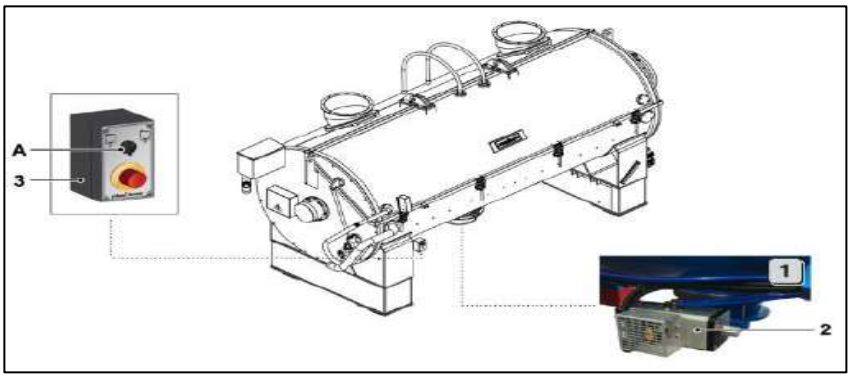


Figure 1.16: Discharge group

1.9.5 Electric motors

It connects the ground cable from the support foot to the ground terminal of the motor terminal box.

It connects the electric power supply cables to the terminal box of the motor.

Electric Motor: 11 kW – 400 V – 50 Hz. [5]

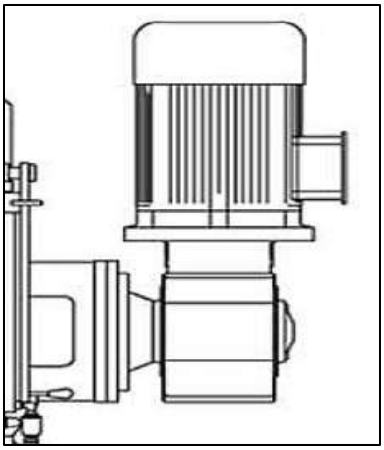


Figure 1.17: Electric motors

Table 1.2: Technical data for the cooler

Mixing vessel total capacity:	**1500 Liters**
Mixing vessel useful capacity:	**1000 Liters**
Parts in contact with the product:	**AISI 304 Stainless Steel**
Degree of finishing internal surfaces of the mixing vessel:	**300 Emery**
Max. pressure admitted in the circulation space of the cooling water with outlet free:	**0,5 bar**
Cooling temperature of rigid PVC Dry-Blend:	**50°C**
Cooling water max. temperature:	**15°C max**
Cooling water min. flow rate (water inlet temperature: 15°C)	**9,9 m^3/h**
Compressed air feeding pressure:	**7 Bar**
Compressed air consumption:	**29000 NI/hour**
Motor power alternating current:	**11 kW**

1.10 Electrical control panel

The distribution of the three-phase power is 400 Vac – 50Hz, with earth and neutral wires. The total installed power is 120 kW with an automatic protection switch.

The electrical system consists of:

- Main electrical power board/auxiliaries;
- Control station with adjustment and control devices and the operator panel;
- Boxes, connections, sensors on-board the machine;
- Emergency push-buttons.



Figure 1.18: Electrical system on-board the machine

- ❖ All the controls acted by the operator are found on the electric board to execute the operation modes: the user's interface (TOUCH SCREEN).
- ❖ All the sensors and measuring devices that are necessary for machine operation and control are supplied.
- ❖ Inside the main electrical board, there are two transformers for providing the following voltages:
- ❖ 220 V for supplying power to the PLC, the electrical board conditioning system, and the auxiliary device's connection.
- ❖ 24 Vdc for supplying power to the auxiliaries, the emergency circuit, the input, and output analog units and the interface units.
- ❖ The operating logic of the machine cycle uses a programmable logic controller (PLC). [5]

1.11 Outside electrical panel

TS= Touch screen

IG= main switch

BS1=Emergency safety reset

BS2=Heating mixer cover safety reset

BS3=Horizontal cooling mixer safety reset

S=Cycle Stop

CS=Cycle Start

PEM=Emergency push button

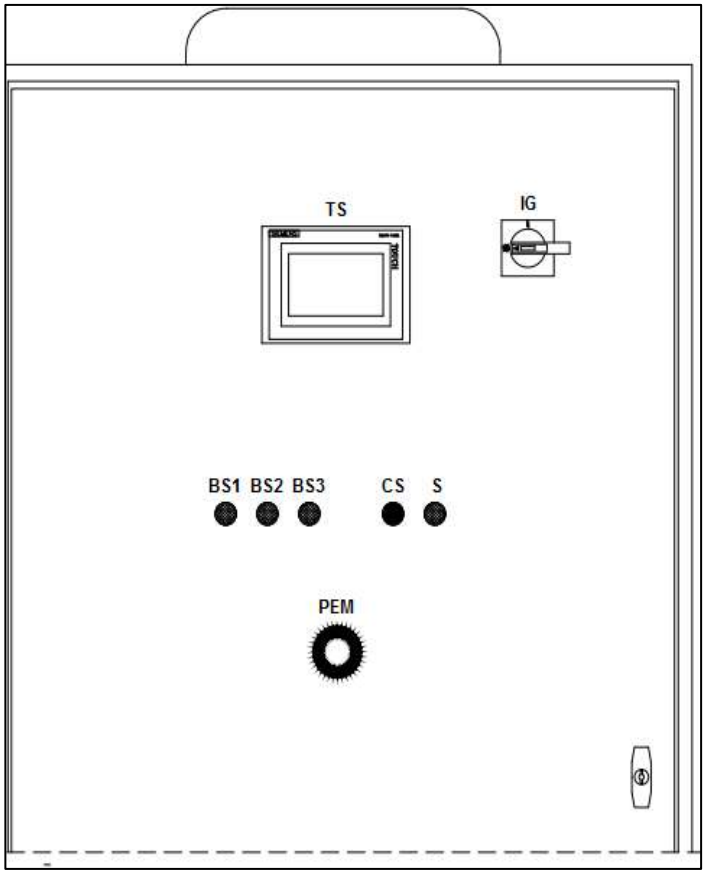


Figure 1.19: Outside electrical panel

1.12 devices connection

A horizontal cooler combination is the combination of the heating mixer TMX and the high-efficiency horizontal cooler CMX.

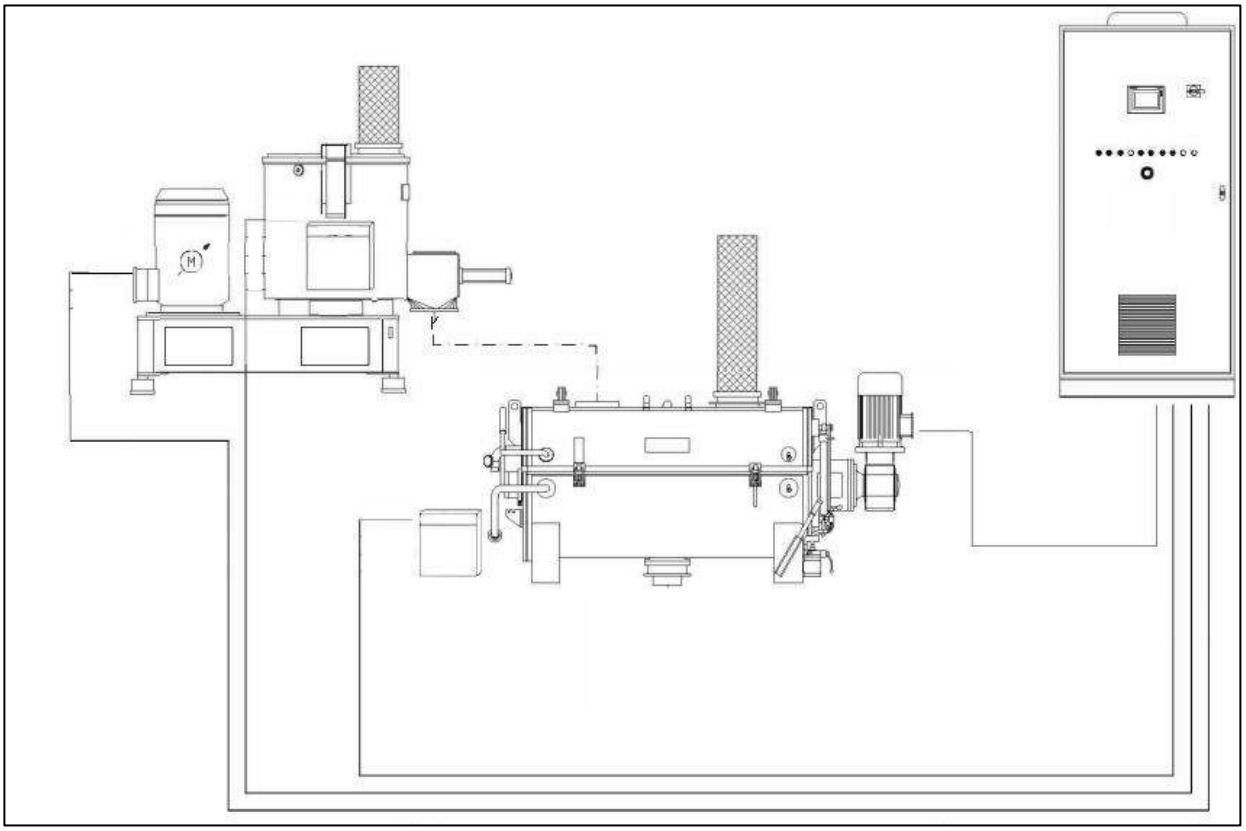


Figure 1.20: devices connection

1.13 Conclusion

In this chapter, we have reviewed the sequences of start, stop, and protection of the machine as well as these electrical organs, which allowed us to understand its operation.

The description of the sequences will allow us to best design an automated solution for the correct operation of the machine.

CHAPTER II:

PLC CONTROL

2.1 Introduction

Automation of many different processes, to control certain processes in industries like PVC, it's done by using small computers called programmable logic controllers (PLC).

Today PLC is the most widely used component for automating. It is found in virtually all sectors of the industry because it helps the adaptation and flexibility in a large number of operations.

So, this chapter is an introduction to the programmable logic controller and its general function.

2.2 History of PLC

PLC development began in 1968 in response to a request from a US car manufacturer (GE). The first PLCs were installed in the industry in 1969.

Communications abilities began to appear in approximately 1973. They could also be used in the '70s to send and receive varying voltages to allow them to enter the analog world.

The '80s saw an attempt to:

standardize communications with manufacturing automation protocol (MAP), reduce the size of the PLC, and making them software programmable through symbolic programming on personal computers instead of dedicated programming terminals or handheld programmers.

The '90s have seen a gradual reduction in the introduction of new protocols, and the modernization of the physical layers of some of the more popular protocols that survived the 1980's.

The latest standard "IEC 1131-3" has tried to merge plc programming languages under one international standard. We now have PLCs that are programmable in function block diagrams, instruction lists, C, and structured text all at the same time. [6]

2.3 Definition

Programmable Logic Controller (PLC) is an industrial computer that monitors inputs, makes decisions based on its program, and controls outputs to automate a process or machine.

PLC defined as:

“A digitally operating electronic apparatus which uses a programmable memory for the internal storage of instructions by implementing specific functions such as logic sequencing, timing, counting, and arithmetic to control, through digital or analog input/output modules, various types of machines or processes”.

*In the automated system, the PLC controller is usually the central part of a process control system.

*To run more complex processes, it is possible to connect more PLC controllers to a central computer.[7]

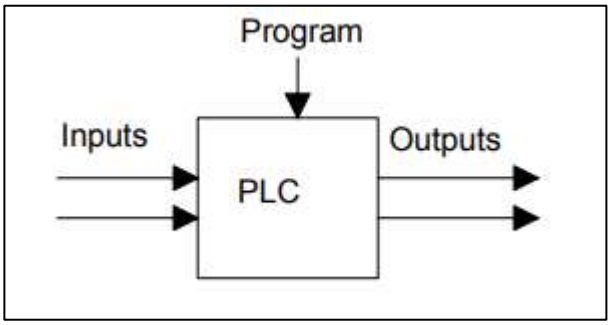


Figure 2.1: A programmable logic controller

2.4 Types of PLC:

There are two common types of mechanical design for PLC systems a single box and the modular/rack types. The single-box type (or, as it's sometimes called, a brick) is commonly used for small programmable controllers and its supplied as an integral compact package complete with power supply, processor, memory, and input/output units.

2.4.1 Single box type

We will distinguish the programming modules (LOGO from Siemens, ZELIO from Schneider…) from micro PLCs.

It integrates the processor, the power supply, the inputs, and the outputs. Depending on the models and manufacturers, it may perform certain additional functions (rapid counting, I / O analog…) and receive extensions.

These simple functioning automata are generally intended for the control of small automatisms.



Figure 2.2: LOGO from Siemens

2.4.2 Modular type

The processor, the power supply, and the input/output interfaces reside in separate units (modules) are fixed on one or more racks containing " the backplane " (bus plus connectors). These automata are integrated into complex or power automation, processing capacity and flexibility are required. [8]



Figure 2.3: Siemens S7-300 plc

2.5 PLC hardware:

Hardware components of a PLC System: Processor unit (CPU), Memory, Input/Output, Power supply unit, Programming device, and other devices.

2.5.1 Power Supply

Most PLC controllers work either at 24 VDC or 220 VAC. Some PLC controllers have electrical supply as a separate module, while small and medium series already contain the supply module.

2.5.2 Central Processing Unit (CPU)

CPU – Microprocessor-based, may allow arithmetic operations, logic operators, block memory moves, computer interface, local area network, functions, etc.

CPU makes a great number of check-ups of the PLC controller itself so eventual errors would be discovered early.

2.5.3 System Busses

The internal paths along which the digital signals flow within the PLC are called busses.

The system has four busses:

– The CPU uses the data bus for sending data between the different elements.

– The address bus to send the addresses of locations for accessing stored data.

– The control bus for signals relating to internal control actions.

– The system bus is used for communications between the I/O ports and the I/O unit.

2.5.4 Memory

System (ROM) to give permanent storage for the operating system and the fixed data used by the CPU.

RAM for data, this is where information is stored on the status of input and output devices and the values of timers and counters and other internal devices. EPROM for ROM's that can be programmed and then the program made permanent.

2.5.5 I/O Sections

Inputs monitor field devices, such as switches and sensors.

Outputs control other devices, such as motors, pumps, solenoid valves, and lights.

2.5.6 Programming Device

The programming device is used to enter the required program into the memory of the processor.

The program is developed in the programming device and then transferred to the memory unit of the PLC. [7]

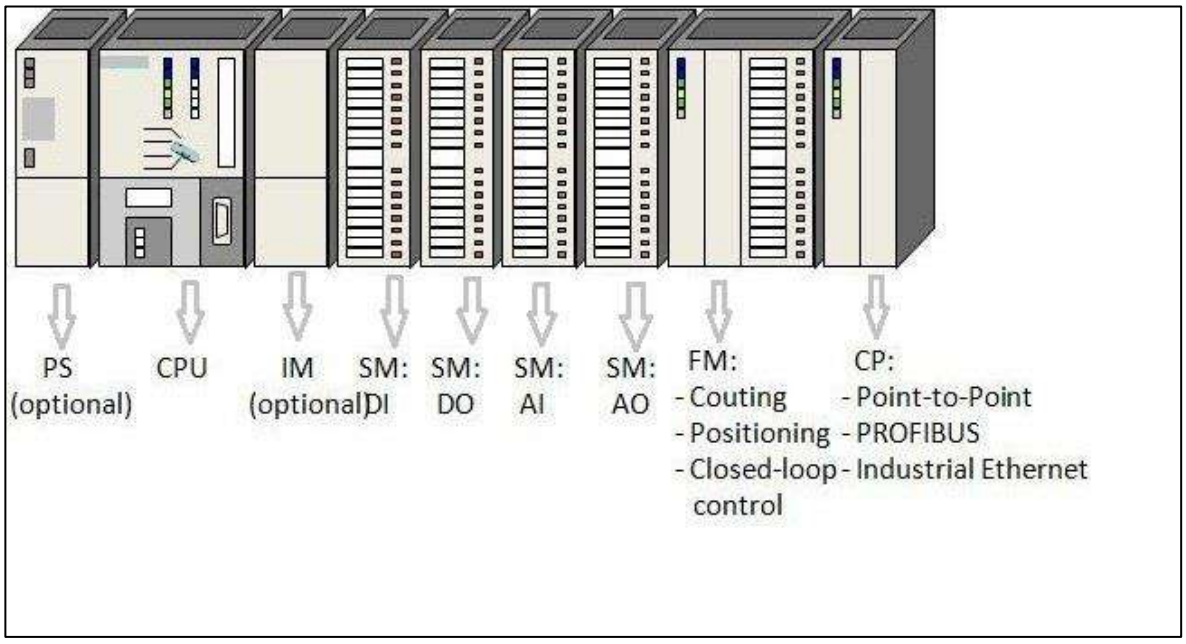


Figure 2.4: PLC Hardware

2.6 The PLC system

Typically, a PLC system has the basic functional components of processor unit, memory, power supply unit, input/output interface section, communications interface, and the programming device. (**Figure 2.5)** shows the basic arrangement.

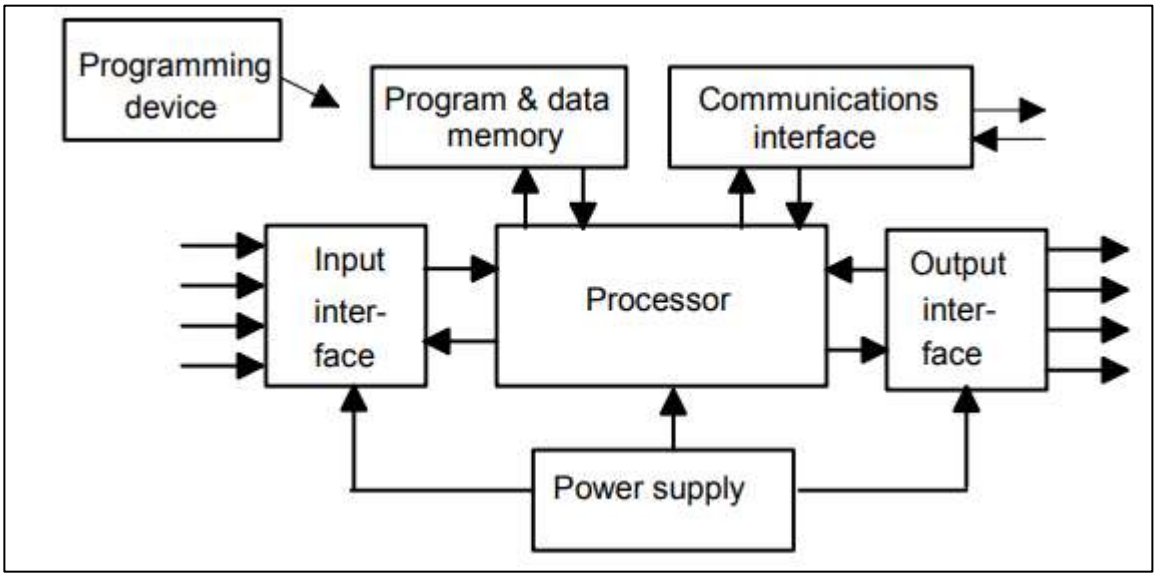


Figure 2.5: The PLC system

- The processor unit or central processing unit (CPU) is the unit containing the microprocessor and this interprets the input signals and carries out the control actions, according to the program stored in its memory, communicating the decisions as action signals to the outputs.
- The power supply unit is needed to convert the mains A.C. voltage to the low D.C. voltage (5 V) necessary for the processor and the circuits in the input and output interface modules.
- The programming device is used to enter the required program into the memory of the processor. The program is developed in the device and then transferred to the memory unit of the PLC.
- The memory unit is where the program is stored that is to be used for the control actions to be exercised by the microprocessor and data stored from the input for processing and for the output for outputting.

- The input and output sections are where the processor receives information from external devices and communicates information to external devices. The inputs might thus be from switches or sensors.

Input and output devices can be classified as giving signals which are discrete, digital, or analog. Devices giving discrete or digital signals are ones where the signals are either off or on. Thus, a switch is a device giving a discrete signal, either no voltage or a voltage. Digital devices can be considered to be essentially discrete devices which give a sequence of on−off signals. Analog devices give signals whose size is proportional to the size of the variable being monitored. For example, a temperature sensor may give a voltage proportional to the temperature.

- The communications interface is used to receive and transmit data on communication networks from or to other remote PLCs (**Figure 2.6)**. It is concerned with such actions as device verification, data acquisition, synchronization between user applications, and connection management. [7]

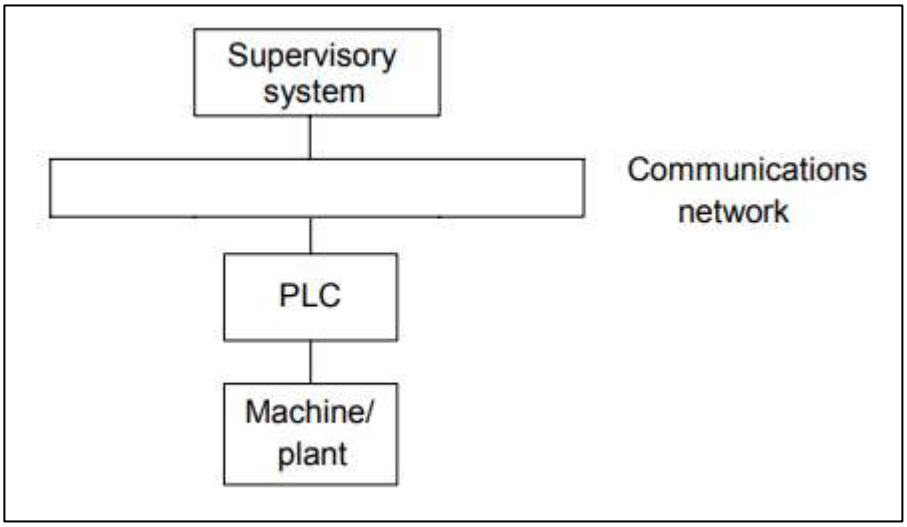


Figure 2.6: Basic communications model

2.7 PLC communications:

2.7.1 Extension modules

PLC I/O number can be increased through certain additional modules by system extension through extension lines. Each module can contain an extension of both of the input and output lines.

Extension modules can have inputs and outputs of a different nature from those on the PLC controller. When there are many I/O located considerable distances away from the PLC an economic solution is to use I/O modules and use cables to connect these, over the long distances, to the PLC.

2.7.2 Remote I/O connections

When there are many I/O located considerable distances away from the PLC economic solution is to use I/O modules and use cables to connect these, over the long distances, to the PLC.

2.7.3 Remote PLC

In some situations, several PLCs may be linked together with a master PLC unit sending and receiving I/O data from the other units.

2.7.4 Cables

Twisted-pair cabling often routed through steel conduit. The coaxial cable enables higher data rates to be transmitted and does not require the shielding of the steel conduit. Fiber-optic cabling has the advantage of resistance to noise, small size, and flexibility.

2.7.5 Parallel communication

Parallel communication is when all the constituent bits of a word are simultaneously transmitted along with parallel cables. This allows data to be transmitted over short distances at high speeds. Might be used when connecting laboratory instruments to the system.

2.7.6 Parallel standards

The standard interface most commonly used for parallel communication is IEEE-488 and now termed as General-Purpose Instrument Bus (GPIB).

Parallel data communications can take place between listeners, talkers, and controllers.

2.7.7 Serial communication

Serial communication is when data is transmitted one bit at a time. a data word has to be separated into its constituent bits for transmission and then reassembled into the word when

received. Serial communication is used for transmitting data over long distances. Might be used for the connection between a computer and a PLC.

2.7.8 Serial standards

RS-232 communications are the most popular method of PLC to external device communications. RS 232 is a communication interface included that is similar to RS232 although they permit higher transmission rates and longer cable distances.

There are 2 types of RS-232 devices:

- DTE – Data Terminal Equipment and a common example is a computer.
- DCE – Data Communications Equipment and a common example is a modem.

PLC may be either a DTE or DCE device. [7]

2.8 Advantages of PLC control

- Rugged and designed to withstand vibrations, temperature, humidity, and noise.
- Have interfacing for inputs and outputs already inside the controller.
- Easily programmed and have an easily understood programming language.

2.9 Disadvantages of PLC control

- Difficulty with changes or replacements. Difficulty in finding errors; requiring skillful workforce.
- When a problem occurs, hold-up time is indefinite, usually long.

2.10 Choice of PLC

The choice of programmable logic controller is made after establishing the specifications of the system, considering several important criteria**:**

• The processor capacity (speed, data, operation, real-time, etc.).

• The type and number of inputs/outputs.

• The cost of the PLC.

• The simplicity and ease of use of the configuration software.

• The quality of after-sales service.

2.11 Technological study

Our installation has actuators (cylinders) and electrical sensors the S7-300 controller offers a wide variety of all or nothing I / O that has the particularity of being perfectly adapted to the

industrial environment where generally works the controller to ensure the reliability of information exchange.

2.12 Economic study

The economic criterion is a determining factor in the choice of a solution. Indeed, the choice of the latter depends not only on technical requirements but also different costs of study, development of maintenance. The availability of equipment (PLC) to the Algerian market, the existence of documentation, and the know-how of the personnel of the company on the material contributed perfectly to the choice of a SIEMENS S7-300 PLC.

2.13 PLC Siemens S7-300

We have two types of PLC; the first one **CPU 313C** we used that in **the company** for real practice and the second **CPU 312** in **the university of Medea** to exam our work.

- PLC of the company, ‘’PVC’’ It has five parts:
    - 1 CPU 313C firmware V1.0
    - 2 DI Digital input [0 2]
    - 3 DO digital output [4 5]
    - 4 AI analogic input [288 297]
    - 5 AO analogic output [288 291]

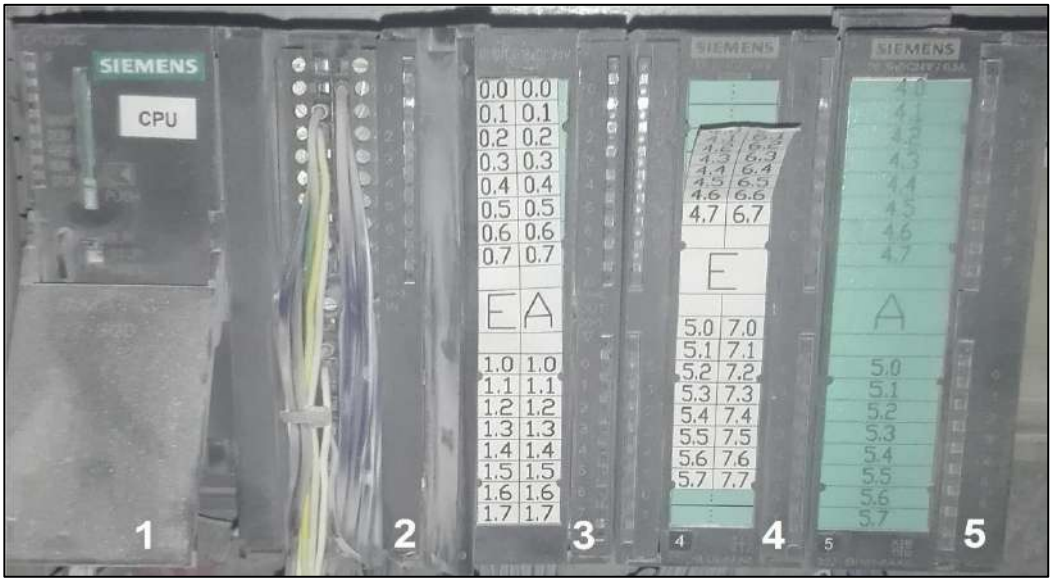


Figure 2.7: PLC of Company

- PLC of Medea University It has five parts:
    - 1 CPU 312 firmware V2.0
    - 2 DI Digital input [0 3]
    - 3 DO digital output [4 7]
    - 4 AI analogic input [288 295] AND AO analogic output [288 291]



Figure 2.8: PLC of University

2.14 Conclusion

PLC is the most common tool in industry processes. use of S7-300 software is essential for simulating programs and concepts of automated controls before being implemented in a real system.

In this project, we used two PLC, the first one for the real part in PVC company and the second in the lab of Medea university just for more explaining, also they have the same station but each one has different CPU and modules, and the second PLC is to see what is applied in the company and that can be applied in the university as a simulation without changing anything hardware just we changed some addresses in software part from Step 7.

CHAPTER III:

PROGRAMMING IN STEP 7

3.1 Introduction

The S7-300 family of controllers consist of a range of PLCs, covering a span of requirements from simple to very complex. Though differences in size and overall capabilities, these controllers are alike in operational characteristics, memory organization, data structure, addressing, programming languages, and instruction sets, they share the STEP 7 programming facilities.

3.2 Definition the STEP 7 Project Management System

Step 7 is the basic software that allows the configuration and programming of SIMATIC automation systems, it is comprised of many components that make it the basis for the development, management, and maintenance of SIMATIC automation systems. These systems include PLCs, HMIs, numerical controllers, electric drives, networks, and others. Furthermore, STEP 7 provides many standards and optional tools including program development languages. utilities for program conversion, monitoring, and diagnostics, hardware configuration, network configuration, remote access service, and many other operations. [9]

3.3 Getting Started with STEP 7:

create a new STEP 7 project. we will create a new project that will contain an S7-300 based on our selection. The new station will contain the CPU of our choice, a STEP 7 program with the main organization block (OB), and any other organization blocks we select. we will also be able to set the default language (STL) for creating program blocks.

3.3.1 Create a project in step 7

1- Double-click on the SIMATIC MANAGER icon  located in the official launch of the SIMATIC MANAGER and close any open projects.

If the new project wizard did not start automatically, from the menu, we select File >>New Project Wizard.



Figure 3.1: STEP 7 Wizard

2- By clicking the next button to continue the new project procedure, the window that will appear allowing us to choose the CPU with what we want to work. select from the CPU type list, the s7-300 CPU to use.

In our project, we change the default name of the CPU, displayed in the CPU name field (In our case we choose the CPU 313C first).

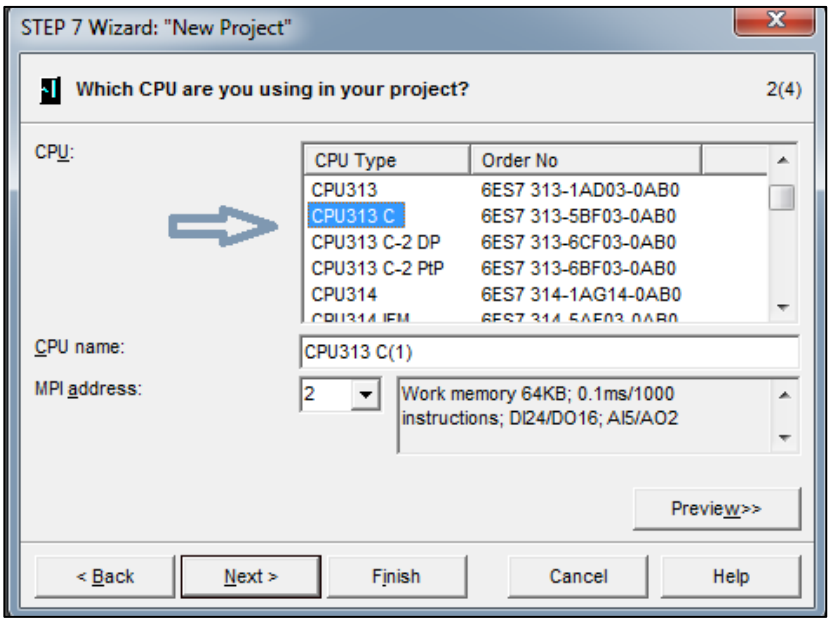


Figure 3.2: CPU choosing

3- After choosing the CPU that suits us, we select, from the Blocks window, organization blocks we wish generated for our program. We Leave OB1 (the main cyclical block of a STEP 7 program) checked.

we select the language representation (LAD, Ladder). (STL, Statement List), or (FBD. Function Block Diagrams) we wish to use for creating the OB you selected.

In our case, we have chosen the OB1 block (organization block) and the contact language (STL) as the programming language.

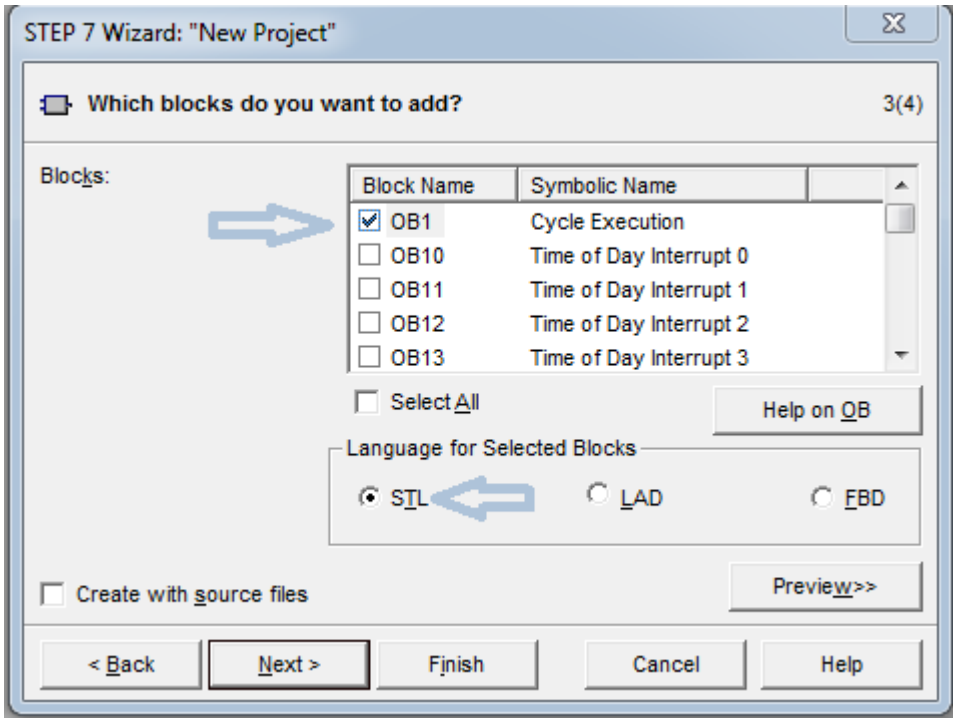


Figure 3.3: block choosing to insert and the programming used language

4- In the final dialog, we type a name for our project. Names longer than eight characters are used by the STEP 7 software but will be shortened to eight characters in Windows.

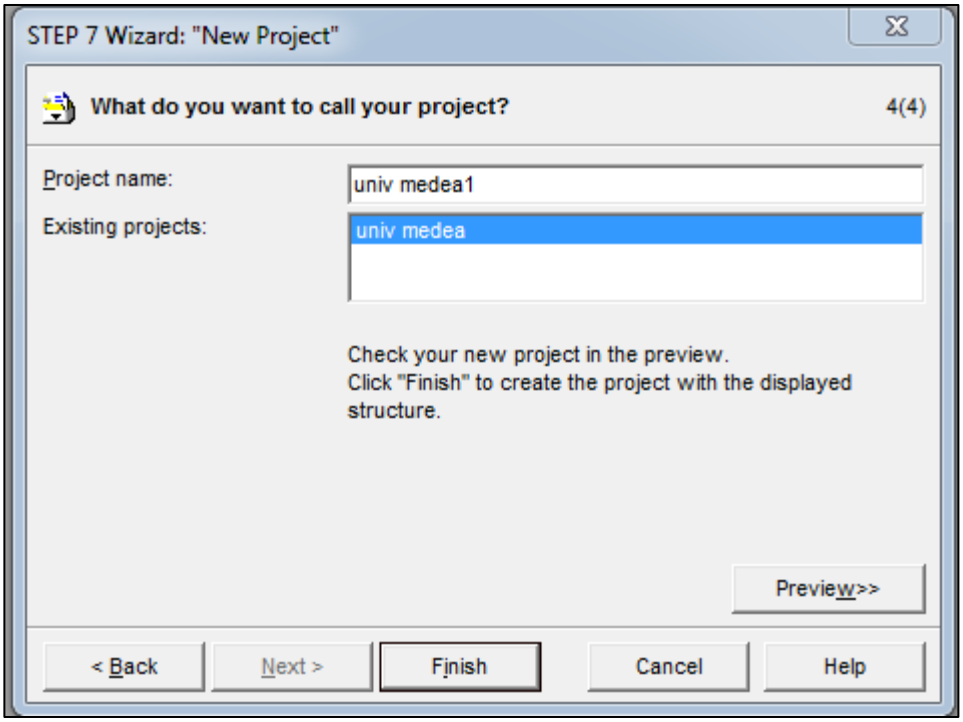


Figure 3.4: name choosing and project creation

5- By Clicking the Finish button to generate the project, otherwise you may press **the Back button** to back up and make changes or **Cancel** to abort the project.

- ❖ After that, we want to create a new station because we want to implement it, on two stations as we see in the picture below.

3.4 Adding a New Station to Project

Once we have generated a project, manually or using the project wizard, we additional new station within the project add using the Insert Station command of the SIMATIC Manager. A station must be inserted before we can create its hardware configuration using the hardware configuration utility.

From the SIMATIC Manager, **right-click on the project folder**, we select **Insert** > **New Object** and select a station type.

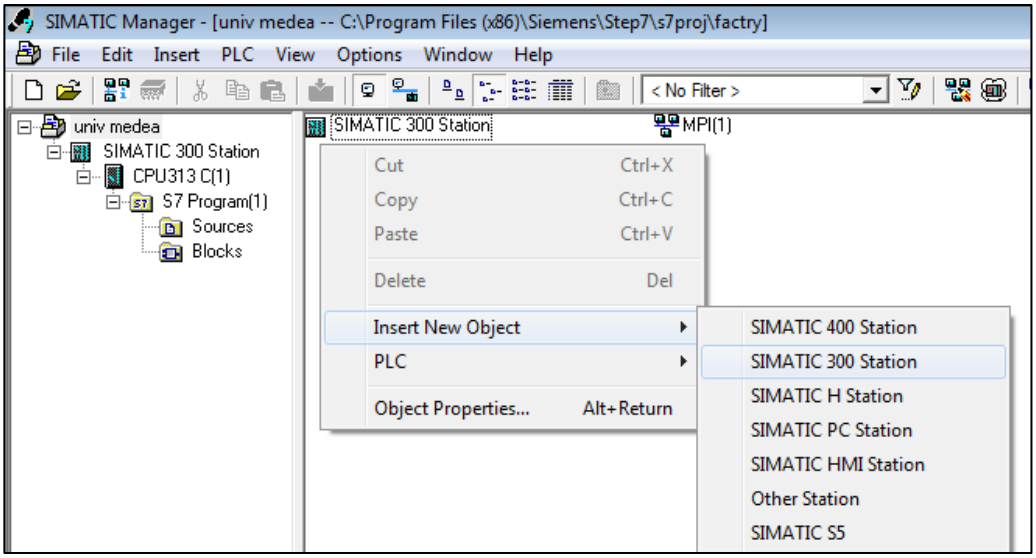


Figure 3.5: Adding a New Station to Project

3.5 Hardware configuration:

The creation of the hardware configuration requires the Hardware Configuration Tool, which is started by the SIMATIC Manager. After a station is created, the configuration tool is launched by opening the Station folder and then double-clicking on **the hardware object**. With the hardware configuration tool, an object model of our actual hardware arrangement is developed, with each component of our hardware installation having a matching object in the hardware configuration. Once developed, a configuration may be copied to other STEP 7 projects, modifying it as required.

3.5.1 First station

1- by clicking on Hardware will find everything in it, after following steps but we must change the address (just to take one program with integrated addresses).

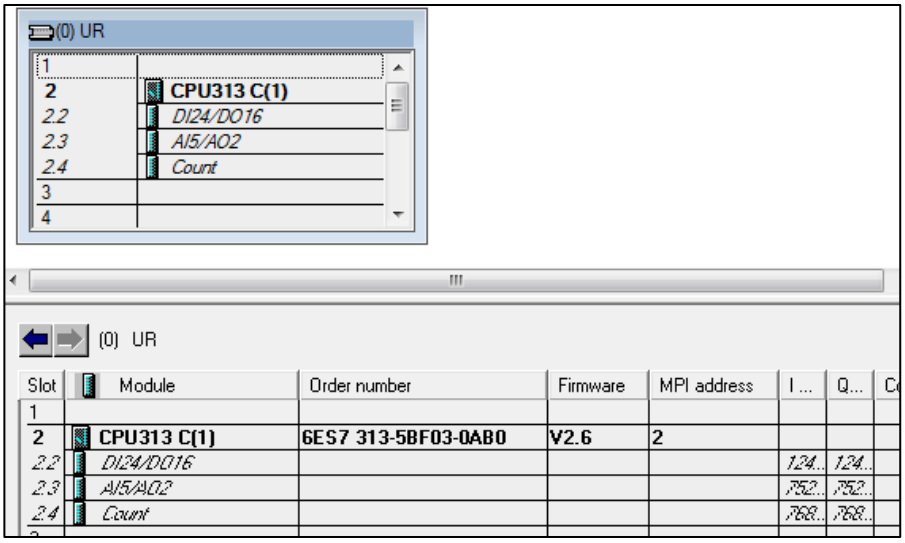


Figure 3.6: First station configuration

2- Double-click on any address and then selected **address** from properties, after that remove the **checkmark** on system default.

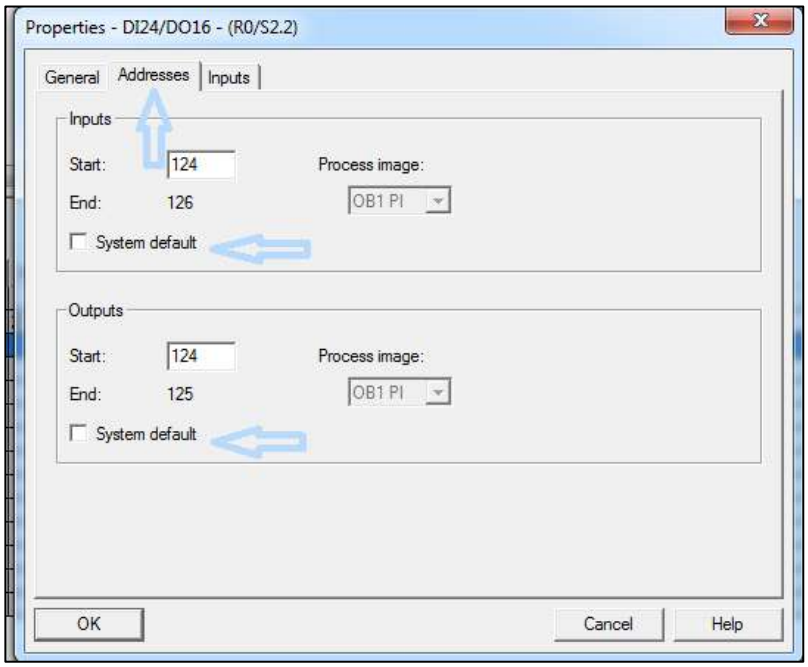


Figure 3.7: change addresses

3- we change all addresses

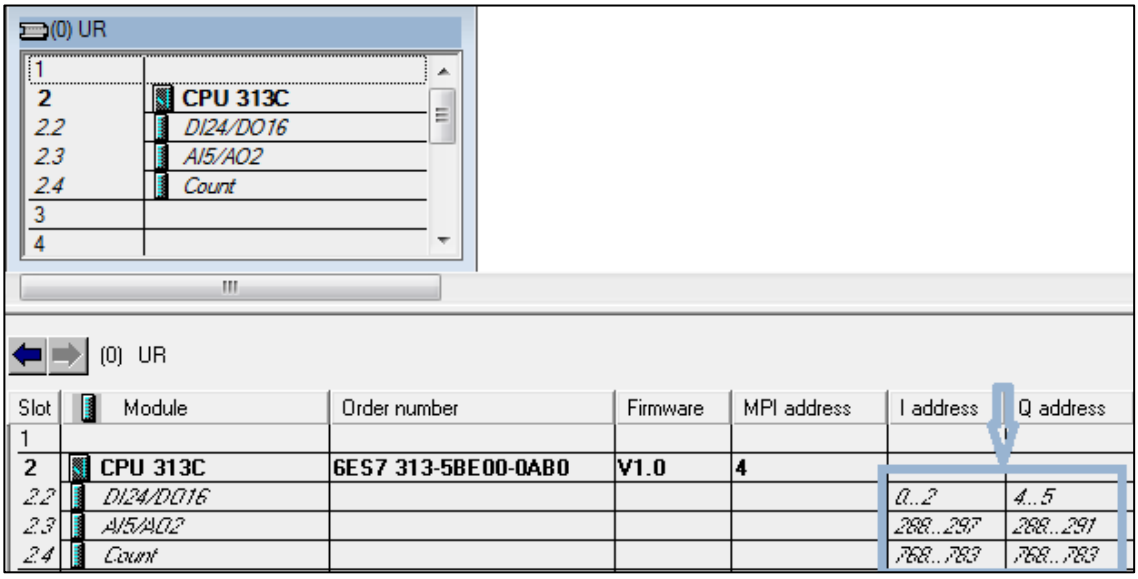


Figure 3.8: After change addresses

3.5.2 Second station

1- Double-click on Hardware. From the hardware catalog, click on the plus sign (+) of the SIMATIC 300 object to access its component folders and parts.

Some folders, as the CP-300, will have more than one level of subfolders to further categorize the components. CP folders include subfolders for Profibus, Industrial Ethernet, and Point-to-point communications processors.

When Selecting any folder or subfolder displays a brief description of its contents in the bottom pane of the catalog window.

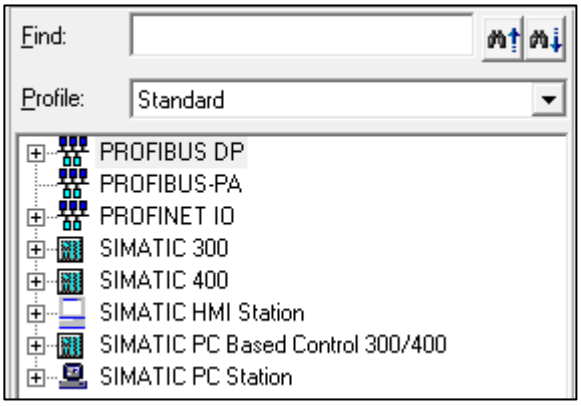


Figure 3.9: hardware catalog

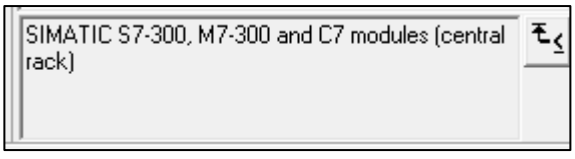


Figure 3.10: brief description

2- we take the Rack-300 folder, to view and select module racks. The S7-300 has a single rack type. UR, for universal racks (usable as central or expansion rack).

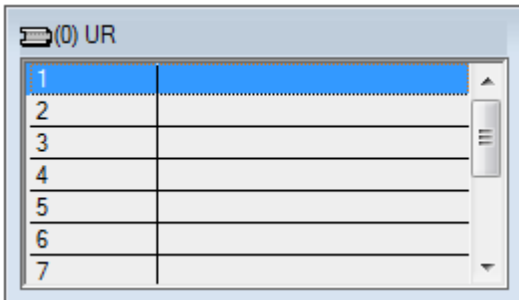


Figure 3.11: Rack

3- we Open the CPU-300 folder and subfolders, to view and select CPU.

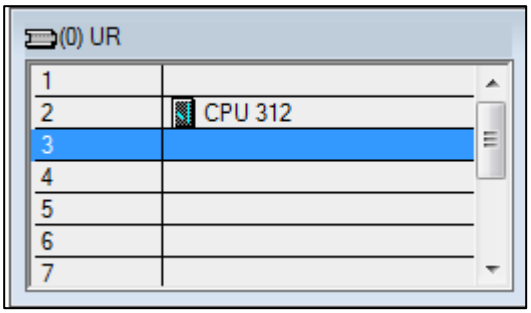


Figure 3.12: Add the CPU

4- we view and select signal modules in the SM-300 folder. include subfolder for digital input (D1), digital output (DO), analog input (Al), and analog output (AO). The S7-300 also contains folders for digital input/output (DI/DO) and analog input/output (AI/AO) modules.

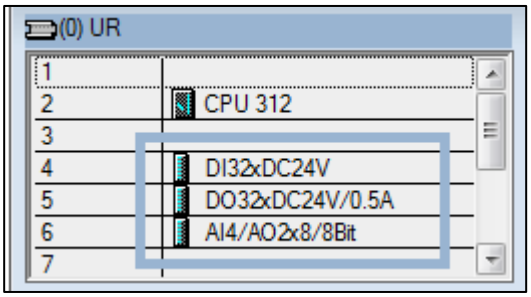


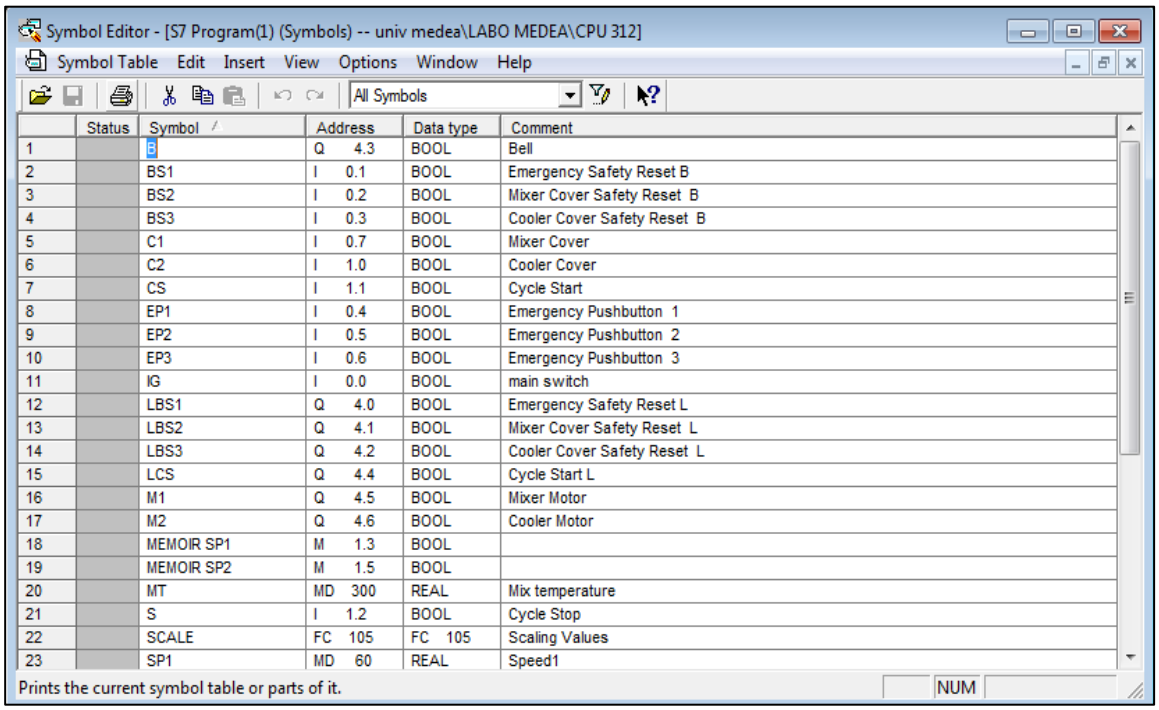
Figure 3.13: Add the modules

3.6 Symbol table

A Symbol table a name that the user defines by respecting the rules.

It is intended to make the program readable and therefore helps to easily manage a large number of variables commonly in this kind of program. This name we have given to the address can be used directly in the program once the assignments completed.

The following Figure. illustrate part of the symbol table of our project.



	Status	Symbol	Address	Data type	Comment
1		B	Q 4.3	BOOL	Bell
2		BS1	I 0.1	BOOL	Emergency Safety Reset B
3		BS2	I 0.2	BOOL	Mixer Cover Safety Reset B
4		BS3	I 0.3	BOOL	Cooler Cover Safety Reset B
5		C1	I 0.7	BOOL	Mixer Cover
6		C2	I 1.0	BOOL	Cooler Cover
7		CS	I 1.1	BOOL	Cycle Start
8		EP1	I 0.4	BOOL	Emergency Pushbutton 1
9		EP2	I 0.5	BOOL	Emergency Pushbutton 2
10		EP3	I 0.6	BOOL	Emergency Pushbutton 3
11		IG	I 0.0	BOOL	main switch
12		LBS1	Q 4.0	BOOL	Emergency Safety Reset L
13		LBS2	Q 4.1	BOOL	Mixer Cover Safety Reset L
14		LBS3	Q 4.2	BOOL	Cooler Cover Safety Reset L
15		LCS	Q 4.4	BOOL	Cycle Start L
16		M1	Q 4.5	BOOL	Mixer Motor
17		M2	Q 4.6	BOOL	Cooler Motor
18		MEMOIR SP1	M 1.3	BOOL	
19		MEMOIR SP2	M 1.5	BOOL	
20		MT	MD 300	REAL	Mix temperature
21		S	I 1.2	BOOL	Cycle Stop
22		SCALE	FC 105	FC 105	Scaling Values
23		SP1	MD 60	REAL	Speed1

Figure 3.14: Symbol Editor

In our symbol table we have:

The Digital outputs which are addressed with Q (Q4.2, Q0.3….).

The Digital inputs which are addressed with I (I0.2, I0.5….).

The analog outputs which are addressed with PQW (PQW288, PQW289….).

The analog inputs which are addressed with PIW (pIW288, PIW289….).

Also, we have the time memory ….

3.7 Program structure

The writing of the complete user program can be done from the organization block OB1, this is not recommended for large programs or even medium ones.

For complex automation, the subdivision into smaller parts is recommended, these correspond to the technological functions of the process, and are called blocks (structured programming).

This structure offers the following advantages:

- ❖ Standardize certain parts of the program.
- ❖ Simplify the organization of the program.
- ❖ Easily modify the program.
- ❖ Simplify the testing of the program by running it section by section.

3.8 Our Program:

The first part of bloc OB1 (bloc organization) includes our program and it has many networks, each network contains a target.

We programmed in STL language because it is a simulated C language, and we can use it without any program.

we wrote in a notepad like C language and then we compiled in STEP 7.

3.8.1 Network 1

In the first step: when the main switch is turned on, the protection light turns on

```
A     "IG"          I0.0          -- main switch
AN    "S"           I1.2          -- Cycle Stop
=     "LBS1"        Q4.0          -- Emergency Safety Reset L
```

Figure 3.15: Start the device

3.8.2 Network 2

Push the protection button after making sure everything is ready

```
A     "BS1"         I0.1          -- Emergency Safety Reset B
A     "IG"          I0.0          -- main switch
AN    "C1"          I0.7          -- Mixer Cover
AN    "C2"          I1.0          -- Cooler Cover
AN    "EP1"         I0.4          -- Emergency Pushbutton  1
AN    "EP2"         I0.5          -- Emergency Pushbutton  2
AN    "EP3"         I0.6          -- Emergency Pushbutton  3
S     "LBS2"        Q4.1          -- Mixer Cover Safety Reset  L
S     "LBS3"        Q4.2          -- Cooler Cover Safety Reset  L
S     "B"           Q4.3          -- Bell
```

Figure 3.16: protection

3.8.3 Network 3

Pressing the door buttons to stops the sound

```
A     "BS2"                    I0.2            -- Mixer Cover Safety Reset  B
A     "BS3"                    I0.3            -- Cooler Cover Safety Reset  B
A     "IG"                     I0.0            -- main switch
R     "B"                      Q4.3            -- Bell
```

Figure 3.17: stop the sound

3.8.4 Network 4

Start button light and engine speed time start

```
A     "CS"                     I1.1            -- Cycle Start
L     MW     4
SE    T      1
=     "LCS"                    Q4.4            -- Cycle Start L
```

Figure 3.18: cycle start

3.8.5 Network 5

In the first speed, the engine runs for a specified period

```
      A     M      0.7
      =     L     20.0
      BLD   103
      AN    "S"                      I1.2            -- Cycle Stop
      A     T      1
      A     "IG"                     I0.0            -- main switch
      AN    "EP1"                    I0.4            -- Emergency Pushbutton  1
      AN    "EP2"                    I0.5            -- Emergency Pushbutton  2
      JNB   _001
      CALL  "UNSCALE"                FC106           -- Unscaling Values
       IN     :="SP1"                MD60            -- Speed1
       HI_LIM :=2.800000e+003
       LO_LIM :=0.000000e+000
       BIPOLAR:=L20.0
       RET_VAL:=MW8
       OUT    :=PQW288
_001: A     BR
      =     "M1"                     Q4.5            -- Mixer Motor
```

Figure 3.19: Mixer Motor (speed 1)

3.8.6 Network 6

Move to the second speed after the expiring of the specified time

```
A     M      0.7
=     L     20.0

A     "IG"                        I0.0              -- main switch
A     "LCS"                       Q4.4              -- Cycle Start L
AN    T      2
A(
L     "MT"                        MD50              -- Mix temperature
L     1.200000e+002
<R
)
AN    "S"                         I1.2              -- Cycle Stop
AN    "EP1"                       I0.4              -- Emergency Pushbutton  1
AN    "EP2"                       I0.5              -- Emergency Pushbutton  2

CALL  "UNSCALE"                   FC106             -- Unscaling Values
 IN     :="SP2"                   MD64              -- Speed2
 HI_LIM :=2.800000e+003
 LO_LIM :=0.000000e+000
 BIPOLAR:=L20.0
 RET_VAL:=MW8
 OUT    :=PQW288

=     "M1"                        Q4.5              -- Mixer Motor
```

Figure 3.20: Mixer Motor (speed 2)

3.8.7 Network 7

the third speed time has begun when the temperature equals 120 C°

```
L     "MT"                        MD50              -- Mix temperature
L     1.200000e+002
>=R
L     MW    12
SE    T      2
=     M      1.2
```

Figure 3.21: The mix temperature

3.8.8 Network 8

In the third speed, the engine runs and the mixer valve opens for a specified time to get the mix out of the mixer to cooler

```
A     T      2
A     "IG"                    I0.0            -- main switch
AN    "S"                     I1.2            -- Cycle Stop
AN    "EP1"                   I0.4            -- Emergency Pushbutton  1
AN    "EP2"                   I0.5            -- Emergency Pushbutton  2
=     L     20.0
A     M      0.7
=     L     20.1

A     L     20.0

CALL  "UNSCALE"               FC106           -- Unscaling Values
 IN     :="SP3"               MD68            -- Speed3
 HI_LIM :=2.800000e+003
 LO_LIM :=0.000000e+000
 BIPOLAR:=L20.1
 RET_VAL:=MW8
 OUT    :=PQW288

=     "M1"                    Q4.5            -- Mixer Motor
A     L     20.0

=     "VM"                    Q4.7            -- MIXER VALVE
```

Figure 3.22: Mixer Motor(speed3)

3.8.9 Network 9

After the mixer work is finished, the cooler will start and the water valve open

```
AN    T      2
A     "IG"                    I0.0            -- main switch
A     M      1.2
AN    "S"                     I1.2            -- Cycle Stop
AN    "EP1"                   I0.4            -- Emergency Pushbutton  1
AN    "EP3"                   I0.6            -- Emergency Pushbutton  3
S     "M2"                    Q4.6            -- Cooler Motor
S     "VW"                    Q5.1            -- Water valve
```

Figure 3.23: The cooler engine starting

3.8.10 Network 10

In specified temperature, water valve stops and the time began to open the cooler valve

```
L     "WT"                    MD400          --  Temperature discharge
L     8.000000e+001
>=R
L     MW   204
SE    "T3"                    T3             -- Discharge Time
R     "VW"                    Q5.1           -- Water valve
=     M      1.4
```

Figure 3.24: Discharge Time

3.8.11 Network 11

The cooler valve opens for a specified time to discharge the mix out of the cooler

```
A     "IG"                    I0.0           -- main switch
A     T      3
AN    "S"                     I1.2           -- Cycle Stop
AN    "EP1"                   I0.4           -- Emergency Pushbutton  1
AN    "EP3"                   I0.6           -- Emergency Pushbutton  3
=     "VC"                    Q5.0           -- COOLER VLAVE
```

Figure 3.25: Cooler valve

3.8.12 Network 12

After the discharging time is up, the cooling motor stops

```
A     "IG"                    I0.0           -- main switch
A     M      1.4
AN    T      3
AN    "S"                     I1.2           -- Cycle Stop
AN    "EP1"                   I0.4           -- Emergency Pushbutton  1
AN    "EP3"                   I0.6           -- Emergency Pushbutton  3
R     "M2"                    Q4.6           -- Cooler Motor
```

Figure 3.26: Cooler engine stopping

3.9 Simulation

Before downloading the program in PLC, we can verify the program by PLCSIM software, it allows us to simulate a PLC from the SIEMENS family with all these modules. The simulator presents a simple and accessible interface to change the state of an input/Time/speed, just check the box, the output states change automatically according to the evolution of the program.

During the simulation and in the programming block (OB), each contact representing an active variable is displayed in green (the contacts not active in dotted lines). This allows us to follow the progress of the program in detail.

The simulation allowed us to test the different situations for this system.

We conclude at the end that our program exactly meets the requirements and that it can be transferred from the PC to the PLC.

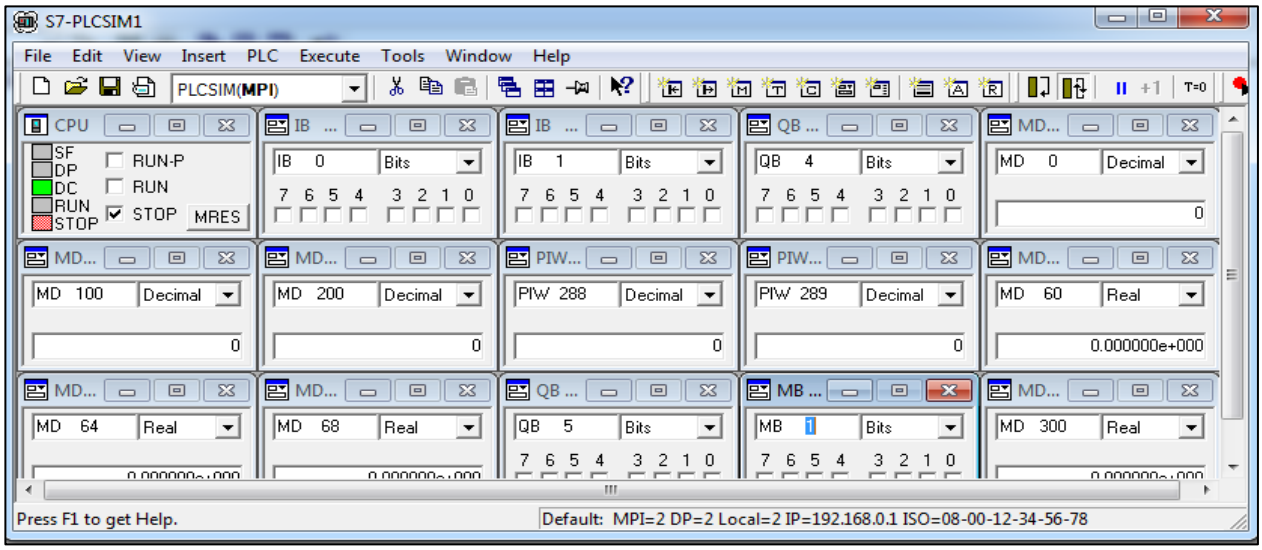


Figure 3.26: STEP7 simulation tool (PLCSIM)

3.10 PC-Adaptor USB

For download our program in plc we must have a cable MPI because the standard direct connection to an S7 CPU involves using the PC Adapter and a serial cable from our PC to the DP/MPI port on the CPU. With the cable in place and the appropriate switch setting on the adapter, all that is required is to ensure that the appropriate interface settings have been made using the "Setting the PG/PC Interface" utility of STEP 7. This utility allows us to select any available interface by an online connection to a CPU that can be established. It also allows us to define specific protocol settings for these interfaces. [9]

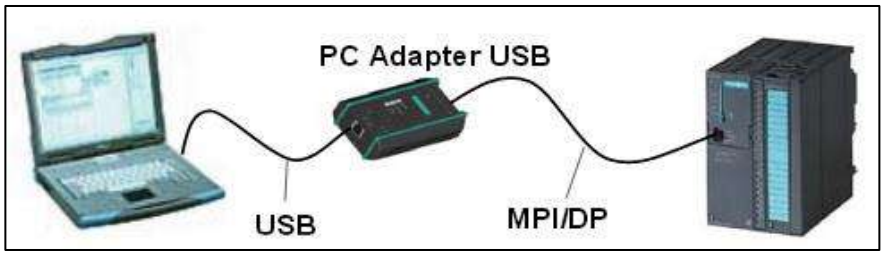


Figure 3.27: PC Adapter USB

3.11 Setting MPI

The MPI also has a setting we must prepare, in the first step we connect stations with MPI, And then we Connect the opposite end of the serial cable to the RS-232 serial port of our PC, and

Connect the opposite of cable end of the PC Adapter, marked MPI/DP, to the MPI/DP port of the CPU to which the online connection is being established.

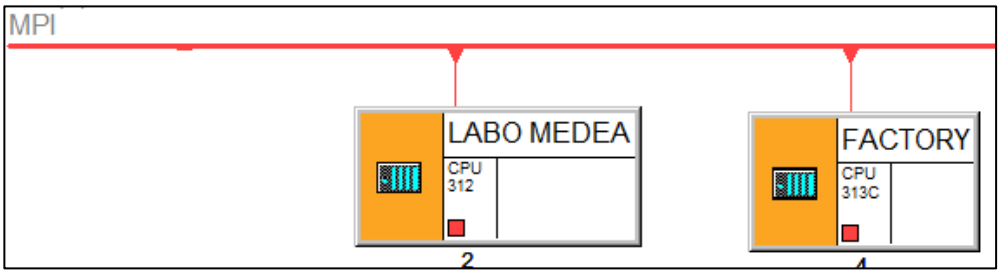


Figure 3.28: MPI connection

With the cable in place, the STEP 7 online interface must be set to use the PC Adapter.

From the SIMATIC Manager menu, we select Options Set PG/PC Interface to launch the utility for setting the online Interface for the PC or PG programming system.

Now we ensure we can download the program without any problem. [9]

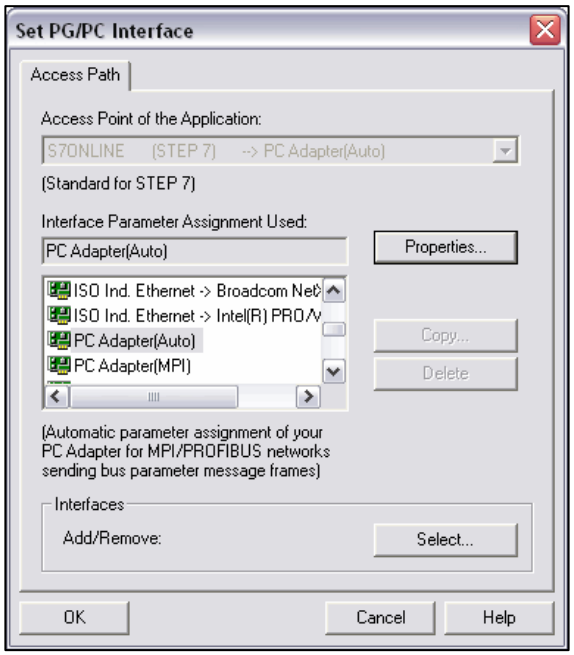


Figure 3.29: Setting PG/PC Interface

3.12 Conclusions

In this chapter, we had the opportunity to present the STEP7 software which allowed us to program the operation of our machine, and many settings to download without any problem, also we saw our program step by step to be able to simulate and practice our work in real.

CHAPTER IV:

CONTROL AND SUPERVISION OF THE MIXER AND COOLER

4.1 Introduction

When the complexity of processes increases and machines and installations have to meet ever more stringent functionality specifications, the operator needs as much information as possible to observe the current state of the system. This information is obtained through the Human Machine Interface (HMI).

The objective of this chapter is to supervise our system of the mixer and cooler, in order to allow operators to control and manipulate more command in real-time by means of touch screens. programmed, using supervision and control software "WINCC".

4.2 Human Machine Interface

A Human Machine Interface (HMI) allows the operator to control the process and supervise it

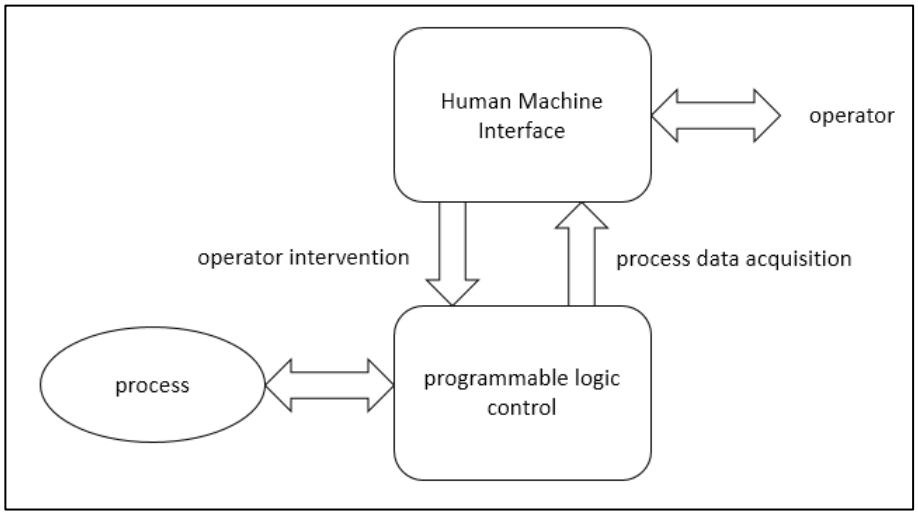


Figure 4.1: Human Machine Interface in automated process

4.3 HMI system takes care of the following tasks

- The representation of the process: The process is represented on the operator panel or on the screen of the control station.
- Process control: The operator can control the process via the graphical user interface.
- alarm view: When critical states occur in the process, an alarm is immediately triggered.
- Archiving of process and alarm values: Alarms and process values can be archived.
- Documentation of process and alarm values: The alarms and process values can be edited in the form of a log, so we can consult production data. [10]

4.4 SIMATIC HMI

SIMATIC HMI offers a full range of tools to cover all control tasks. It makes it possible to control the process at all times and to keep machines and installations in working order.

SIMATIC HMI systems are used for simple projects, such as for the control and monitoring of production lines. [10]

4.5 Presentation of the WinCC flexible software

SIMATIC WinCC Flexible is an innovative Windows-based HMI software, suitable for all machine-side applications. It allows the operator to view the process status in real-time and also to control it thanks to a graphics screen called a console, the process status display is updated as soon as the process is evolving.

4.6 WinCC flexible Interface

In the first step, we create an empty project and then we see this page (**Figure 4.2)** to choose our device

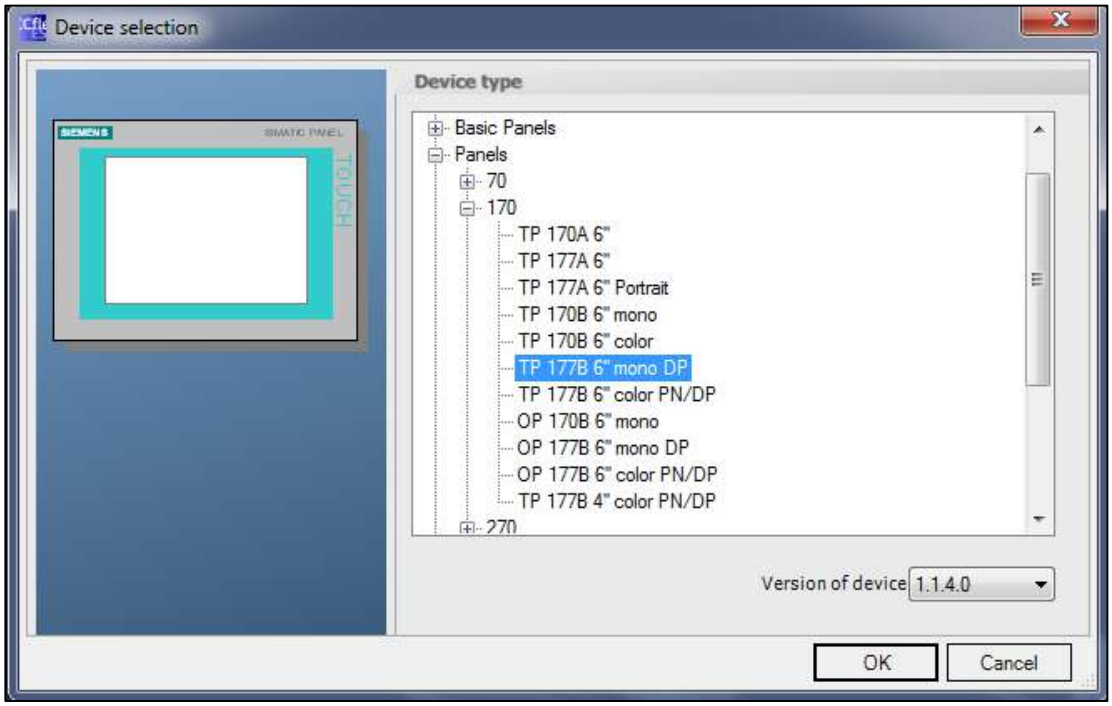


Figure 4.2: device selection

4.7 Main functions offered by WinCC flexible:

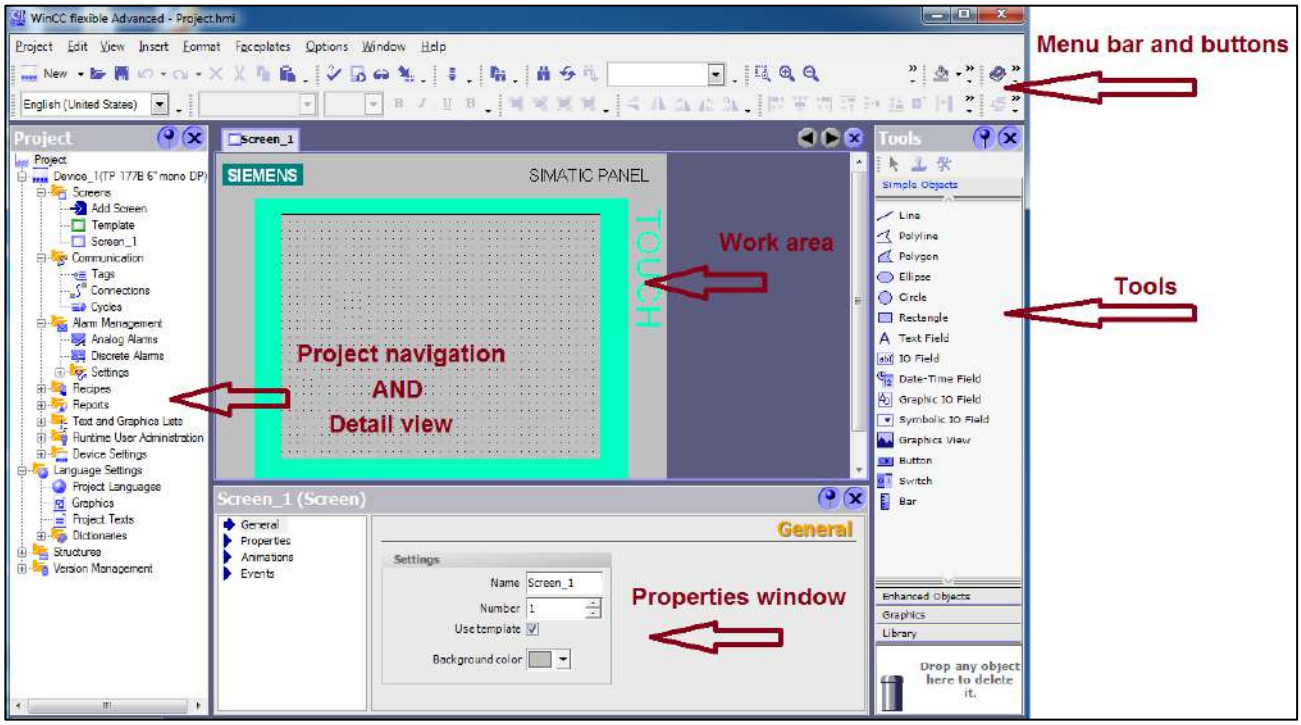


Figure 4.3: The WinCC Interface

4.7.1 Work Area

In the work area, we edit the objects of the project. All elements of WinCC flexible are arranged around the work area. In the work area, we edit the project data either in the form of tables (for example, variables) or graphically (for example, a process display). The upper part of the work area contains a symbol bar. Here, the font, the font color, or functions such as Rotate, Align, etc. can be selected.

4.7.2 Tools

The tool window provides a selection of objects that you can insert in your screens; for example, graphic objects and operating elements. In addition, the tool window contains libraries with assembled library objects and collections of picture blocks. The objects are dragged and dropped into the work area.

4.7.3 Properties Window

The properties of objects are edited in the properties window; for example, the color of screen objects. The properties window is available only in certain editors. The properties of the selected object are displayed in the properties window, arranged according to categories. Value changes become effective as soon as an entry field is exited. [10]

4.8 Connections to S7 Control Systems

A connection to the control system has to be configured first. Here we specify how the panel communicates with the control system, and with which interface.

In Project navigation, we click on Connections. Because of the settings in the hardware configuration, all parameters are already set (because we integrated the project in step7).

We have two CPUs that means we have two connections.

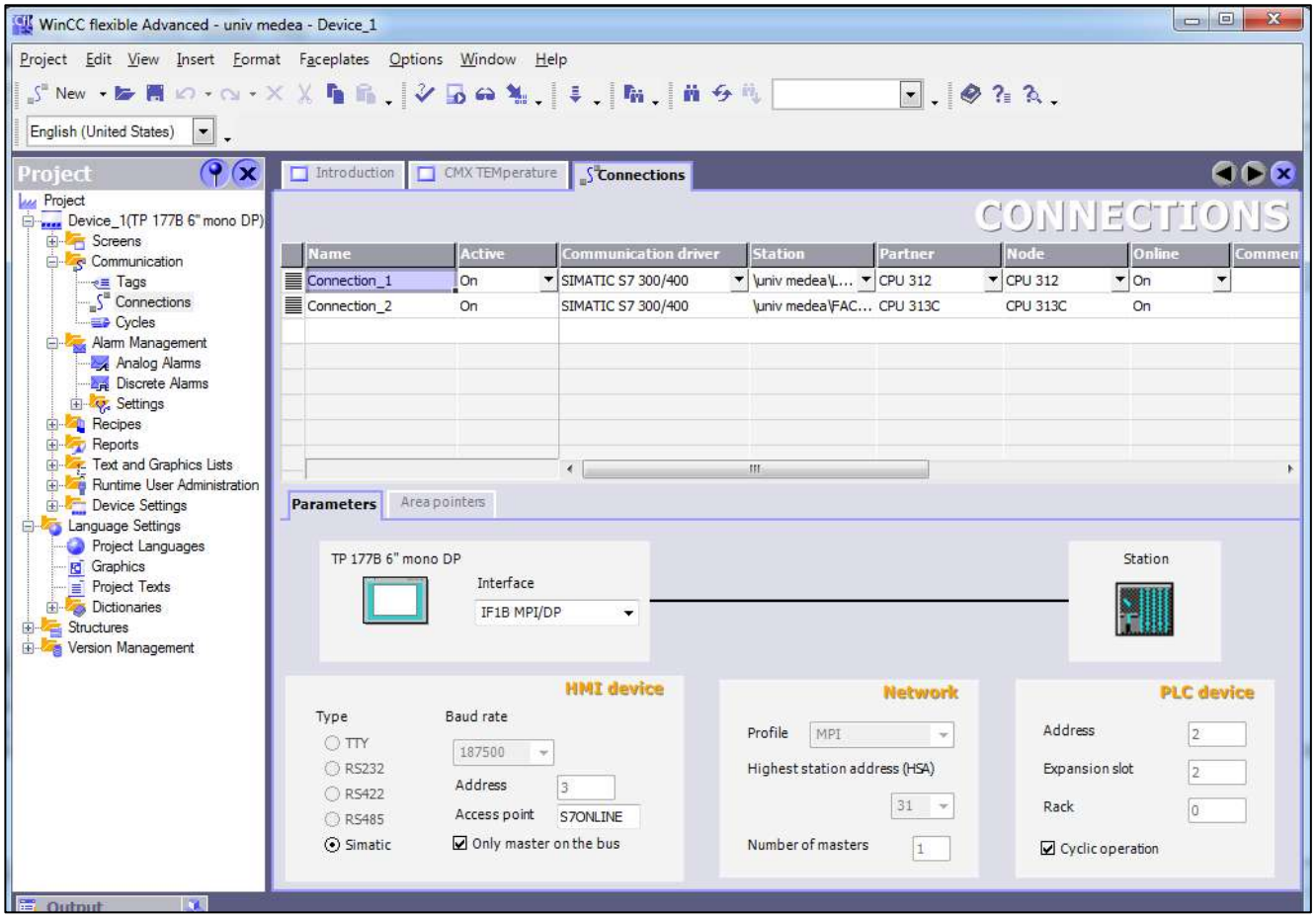


Figure 4.4: Establishing the PLC Connection

And then we make PLC / HMI connection, the connection is established by choosing the case protocol the multipoint interface (MPI)

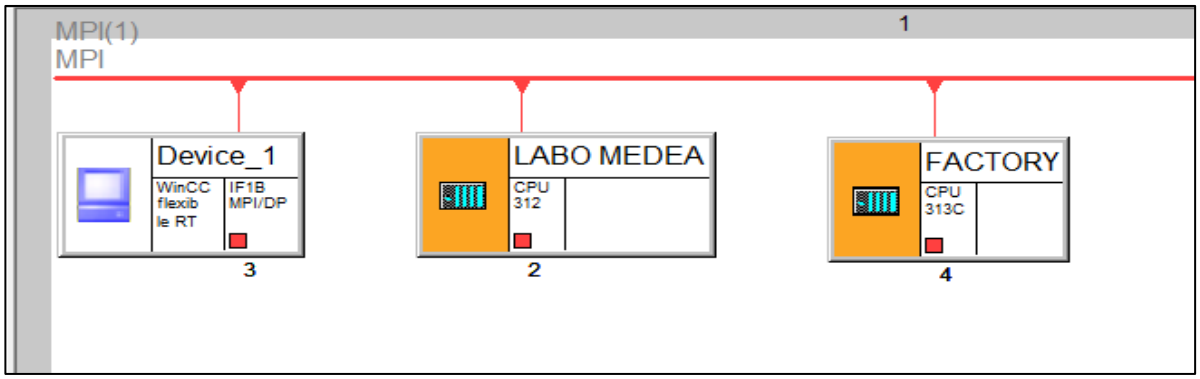


Figure 4.5: MPI link communication

4.9 Supervision and control screens:

4.9.1 Introduction

When the machine is turned on, the start page (shown below) is always displayed. From this page, we find (two languages and two PLCs) choices.

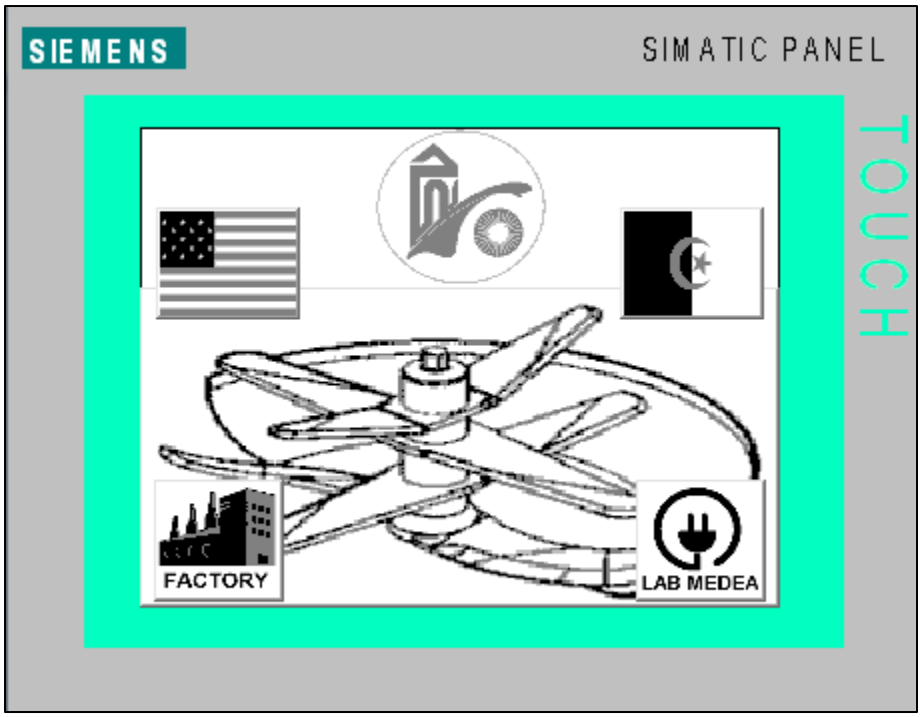


Figure 4.6: The start page

By touching on the screen, the Subpage (shown below) is displayed.

4.9.2 Sub-Pages

From here it is possible to go to all the sub-pages systems.

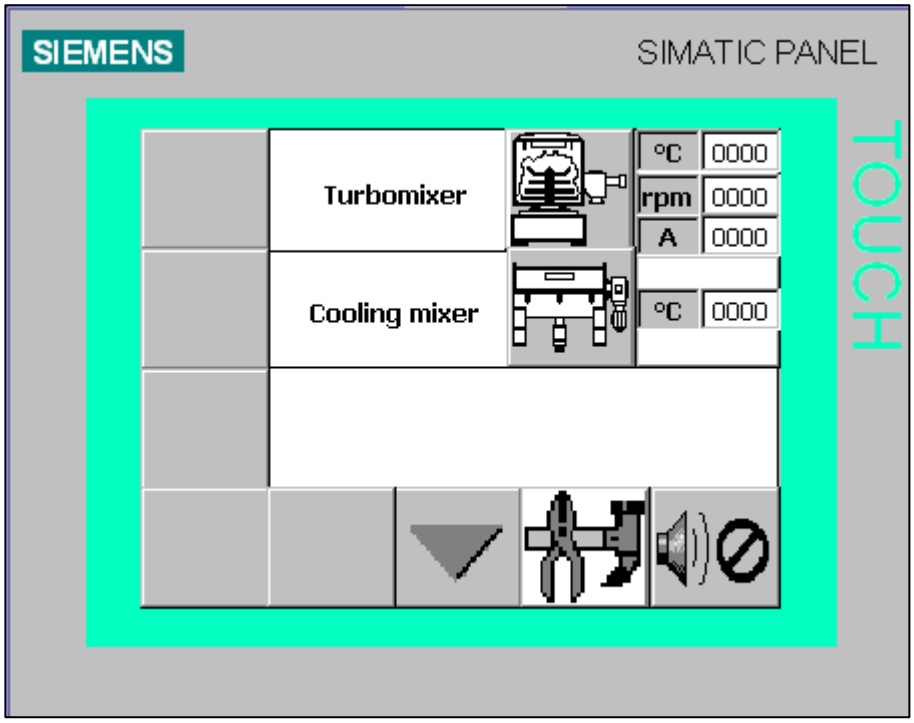


Figure 4.7: sub-pages

Pressing on  displays the "**Turbo mixer**" pages.

Pressing on  displays the "**Cooling Mixer**" pages.

Pressing on  displays the "**Turbo Mixer Data**" pages.

Pressing on  displays the "**Cooling Mixer Data**" pages.

Pressing on  moves to the "**Mimic**" page.

Pressing on  displays the "**General maintenance**" pages.

Pressing on  stops the sound of active alarms.

4.9.3 General maintenance

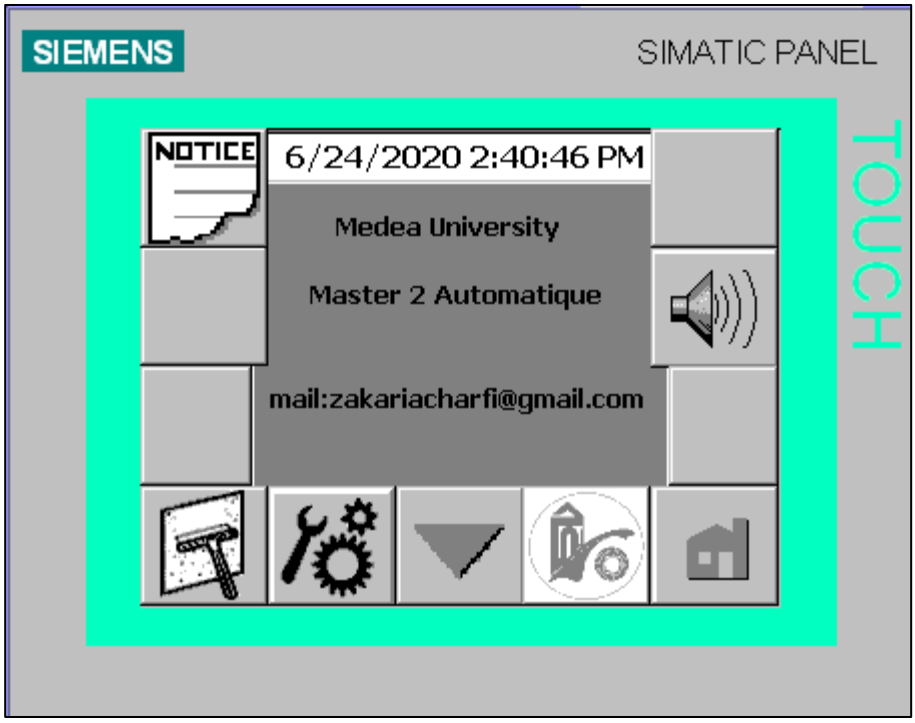


Figure 4.8: General maintenance

Pressing on  actives, the "**Screen Cleaning**".

Pressing on  accesses the "**System setting**" page.

Pressing on  moves to the "**Machine maintenances**" page.

Pressing on  move to the "**Start**" page.

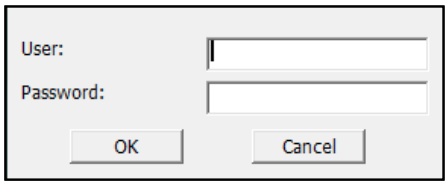
Pressing on  goes back to the "**sub-pages**" page

Pressing on  actives the "**Hysterical Alarms**" page.

Pressing on  actives a test of alarm sound.

4.9.4 System setting

From the "**General Maintenance**" page, pressing takes you to the "**System setting**" page. Access to this page is protected by password, we have two passwords the first one special for engineer and the second for operator.



administrator login
(fully access)
User: **Admin**
Password:**100**

Operator login
(Partial access)
User:**50**
Password:**500**

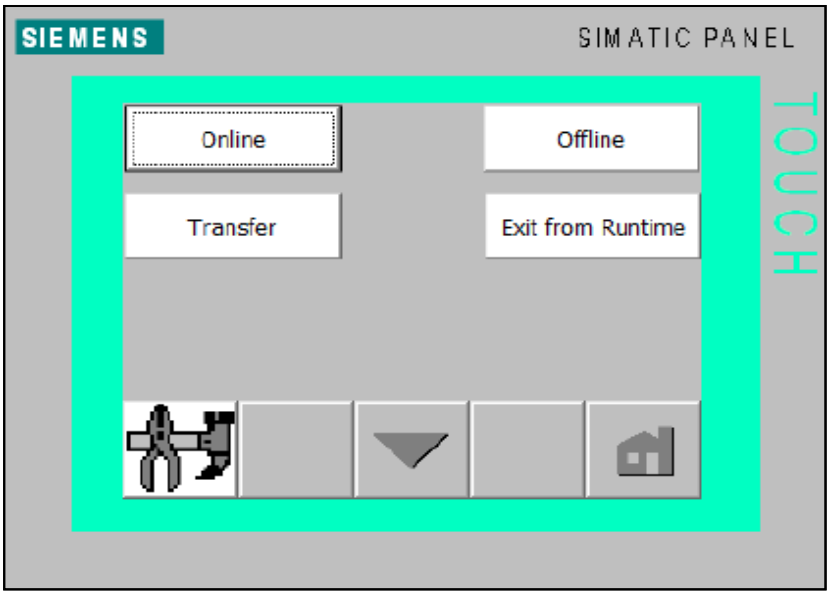


Figure 4.9: System setting

On the "**System setting**" page, you can change the operating mode of the operator panel: Press on **Online** to make the connection between the operator panel and the PLC.

Press on **Offline** to disconnect the operator panel from the PLC.

Press on **Transfer** to switch to transfer mode.

Press on **Exit from Runtime** to exit the application program.

Pressing on  goes back to the "**sub-pages**" page.

Pressing on  goes back to the "**General Maintenance**" page.

Pressing on  accesses the "**OP setting**" page.

4.9.5 OP Setting

On the "OP setting" page you can adjust the screen contrast and touching area calibration of the operator panel.

Press on **"−"** or **"+"** to adjust the screen contrast of the operator panel.

Press on **"Screen calibration"** to run the procedure to calibrate the screen touching area of the operator panels.

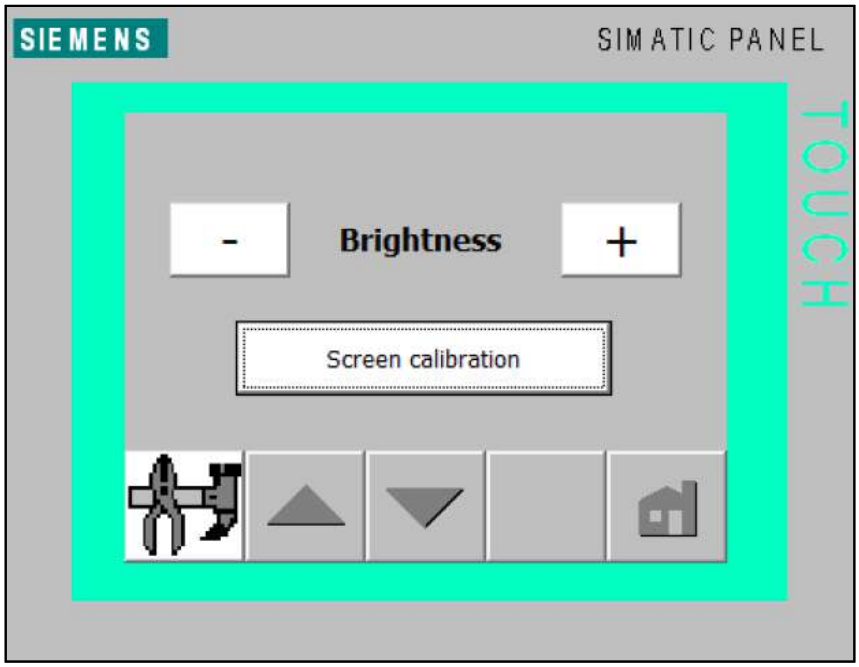


Figure 4.10: OP setting

Pressing on  goes back to the "**General Maintenance**" page.

Pressing on  goes back to the "**System setting**" page.

Pressing on  accesses the "**Password**" page.

Pressing on  goes back to the "**sub-pages**" page.

4.9.6 Password management

On the "Password management" page, you can enter USER and PASSWORD to enable a new user in a precise level group.

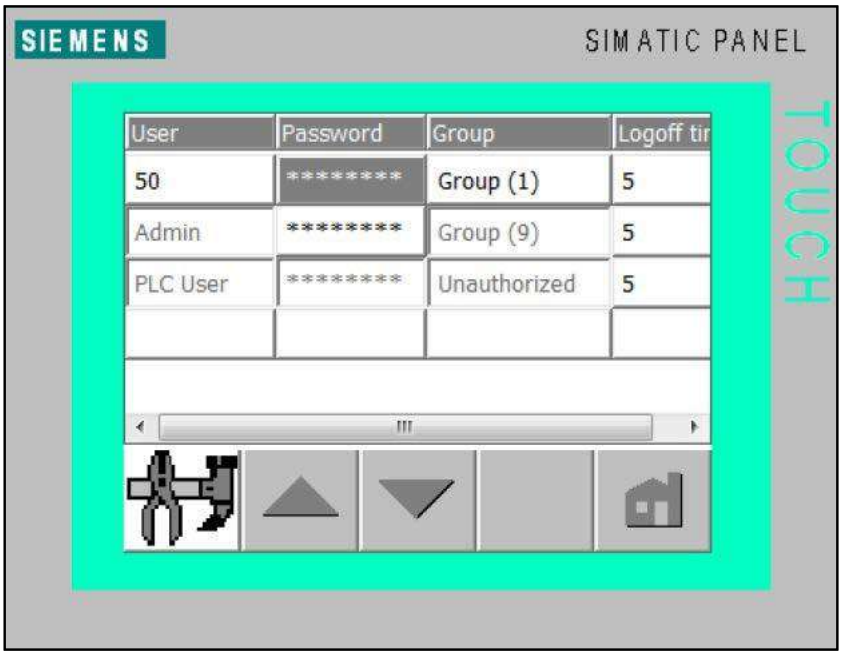


Figure 4.11: Password management

Pressing on  goes back to the "**General Maintenance**" page.

Pressing on  goes back to the "**OP setting**" page.

Pressing on  accesses the "**Date and Time setting**" page.

Pressing on  goes back to the "**sub-pages**" page.

4.9.7 Date and Time setting

On the "Date and Time setting" page, you can enter the current Date and Time and pressing the button Set to synchronize the OP and PLC Date and Time.

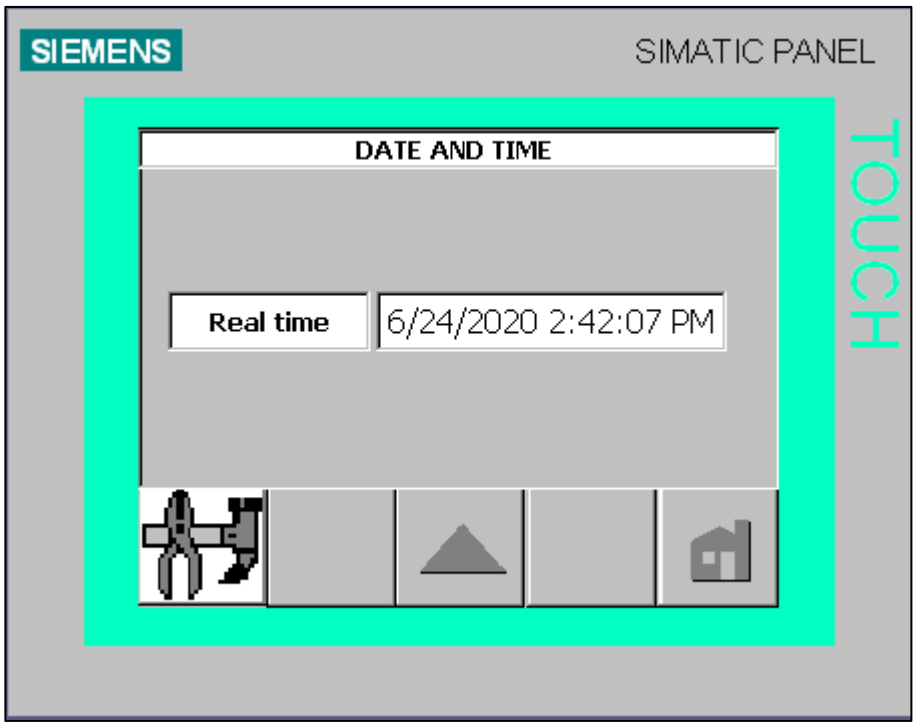


Figure 4.12: Date and Time setting

Pressing on  goes back to the "**General Maintenance**" page.

Pressing on  goes back to the "**Password**" page.

Pressing on  goes back to the "**sub-pages**" page.

4.9.8 Machines maintenances

From the "**General Maintenance**" page, pressing on  takes you to the "**Machines maintenances**" page, which shows the information on the name of the TC2 **thermoregulator** that generates the mixture over-temperature alarm in the Heating Mixer.

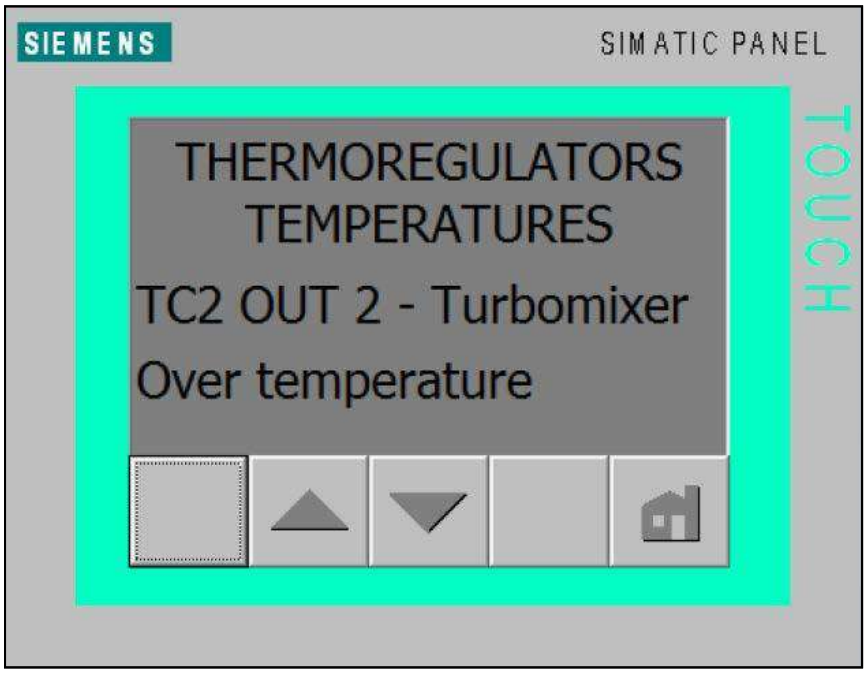


Figure 4.13: Machines maintenances

Pressing on  goes back to the "**General maintenance**" page.

Pressing on  accesses the "**Heating Mixer maintenance**" page.

Pressing on  goes back to the "**sub-pages**" page.

4.9.9 Heating Mixer Maintenances

This page displays the total hours and hours worked for each scheduled maintenance event of the Heating Mixer.

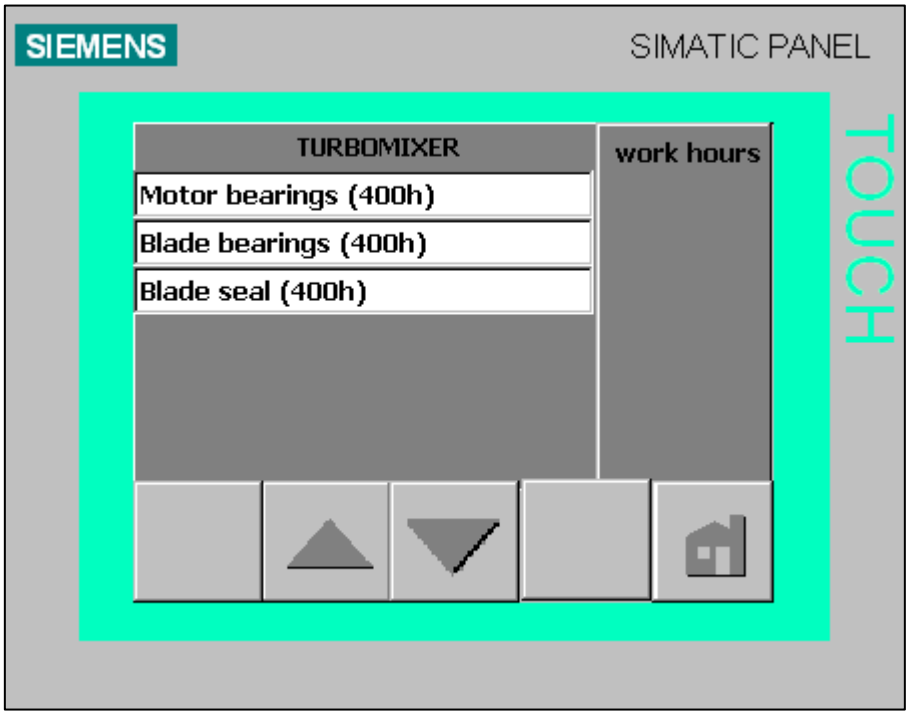


Figure 4.14: Heating Mixer Maintenances

Pressing on  goes back to the "**Machine maintenance**" page.

Pressing on  accesses the "**Horizontal Cooler Mixer maintenance**" page.

Pressing on  goes back to the "**sub-pages**" page.

4.9.10 Cooler Mixer maintenance

This page displays the total hours and hours worked for each scheduled maintenance event of the Horizontal Cooler mixer.

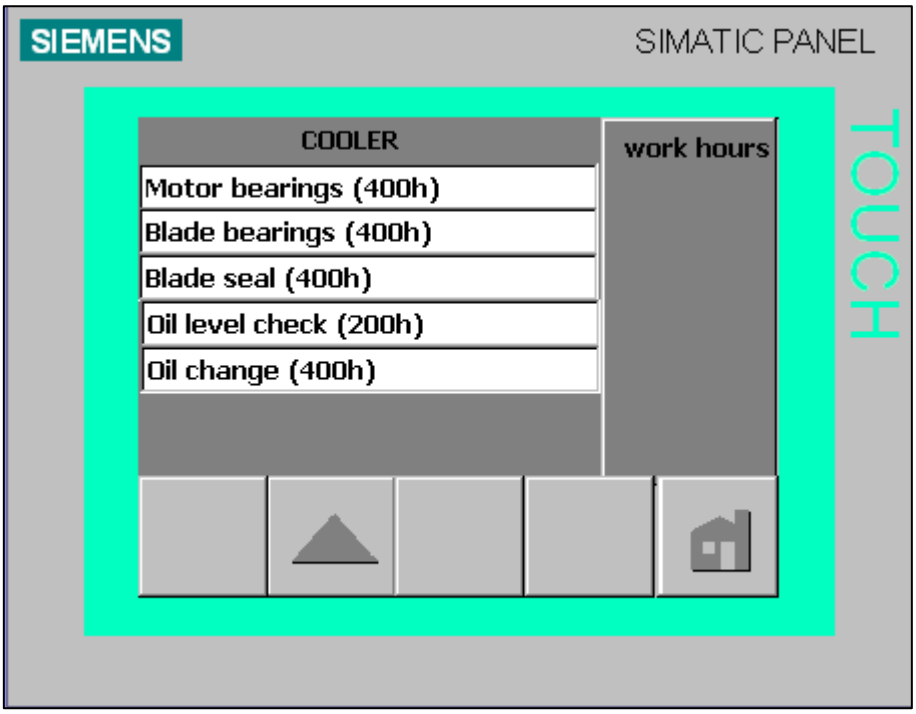


Figure 4.15: Cooler Mixer maintenance

Pressing  goes back to the "**Heating Mixer maintenance**" page.

Pressing  goes back to the "**sub-pages**" page.

4.9.11 screen cleaning

From the "**General Maintenance**" page, pressing on  actives the screen cleaning page. While the cleaning page is active it is possible to clean the screen.

Cleaning page will close automatically at cleaning time expiring.

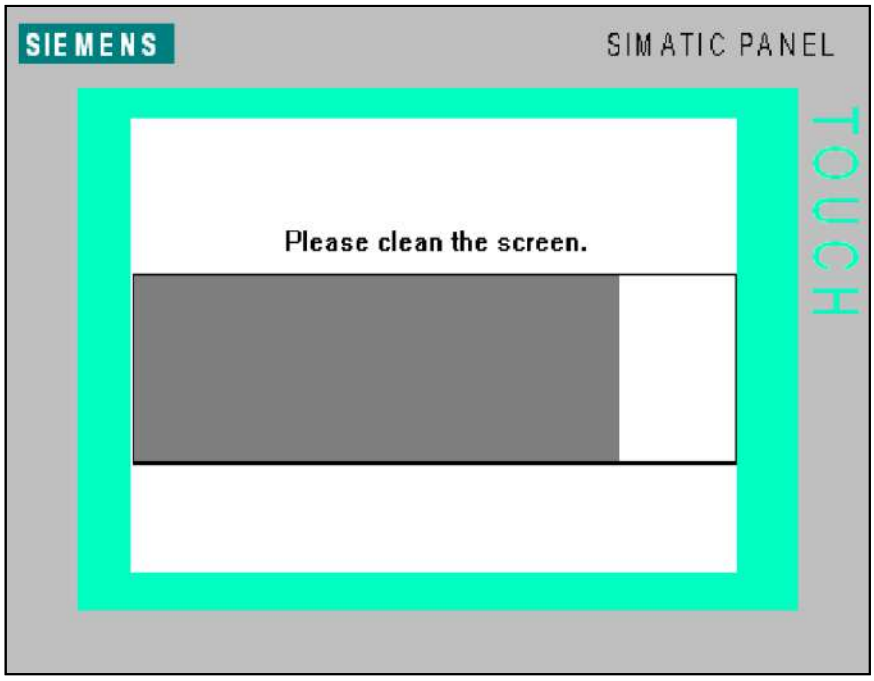


Figure 4.16: screen cleaning

4.9.12 Heating Mixer Data

From "**sub-pages**" page, pressing on **TMX data** displays the "**Heating Mixer Data**" pages.

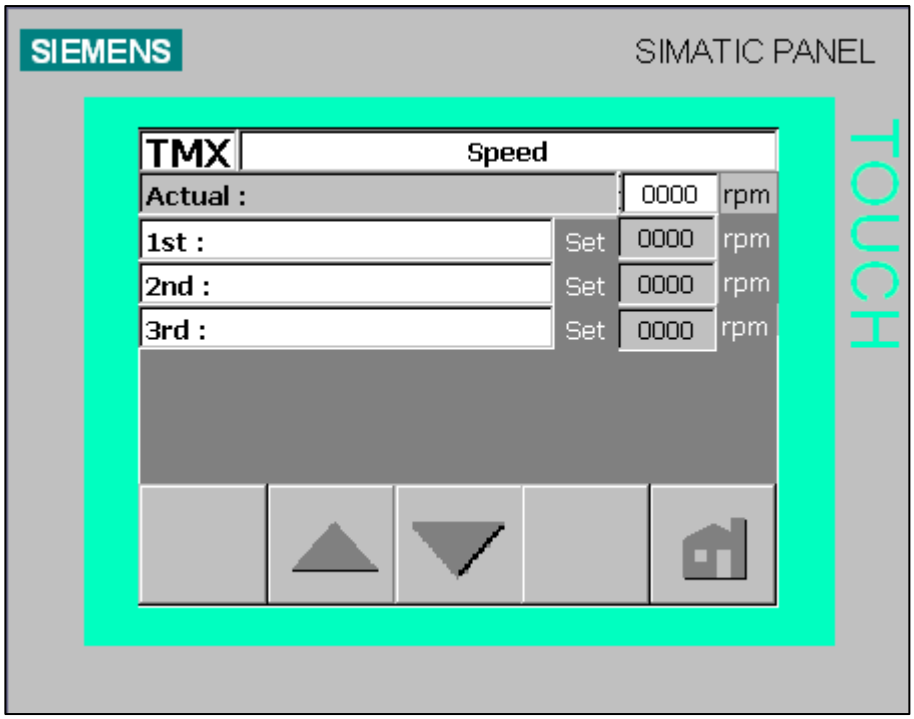


Figure 4.17: Heating Mixer Data

The top row shows the current speed of the Heating Mixer motor. On the next rows, you can set the following **speeds set points**:

- **1st speed**, running while loading main powders at the beginning of mixing cycle.
- **2nd speed**, running while mixing.
- **3rd speed**, running while unloading.

Pressing on  goes back to the "**Heating Mixer Components Status**" page.

Pressing on  accesses the "**Heating Mixer Temperatures**" page.

Pressing on  goes back to the "**sub-pages**" page.

4.9.13 Heating Mixer Temperatures

The top row shows the current temperature in the Heating Mixer.

The row below shows the current over temperature set point for the Heating Mixer. you can set the following **temperatures set points**:

- **Discharge temperature** (unloading – final compound temperature).

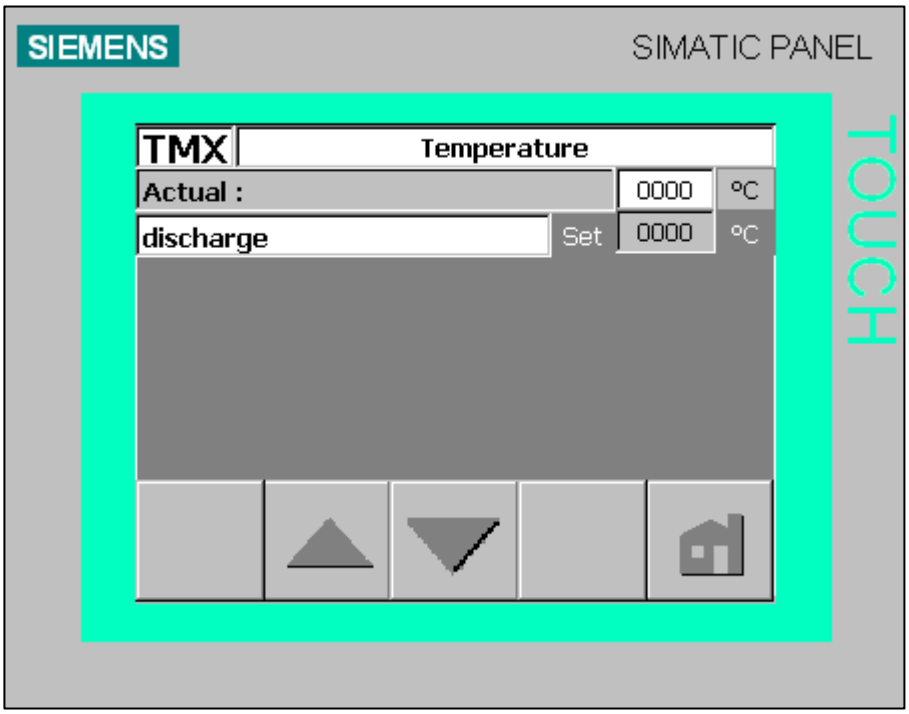


Figure 4.18: Heating Mixer Temperatures

Pressing on  goes back to the "**Heating Mixer Speed**" page.

Pressing on  accesses the "**Heating Mixer Timers**" page.

Pressing on  goes back to the "**sub-pages**" page.

4.9.14 Heating Mixer Timers

On this page, you can set the following **times set points**:

- **1st-speed time**. Once the main powders have been loaded, this speed is maintained for this time. Generally used for a little pre-dispersion at the beginning of the mixing cycle.
- **3rd-speed time**. Additional period of third speed once the compound temperature is reached. Generally used for additional compound drying at the end of mixing cycle (plasticizers last absorption).

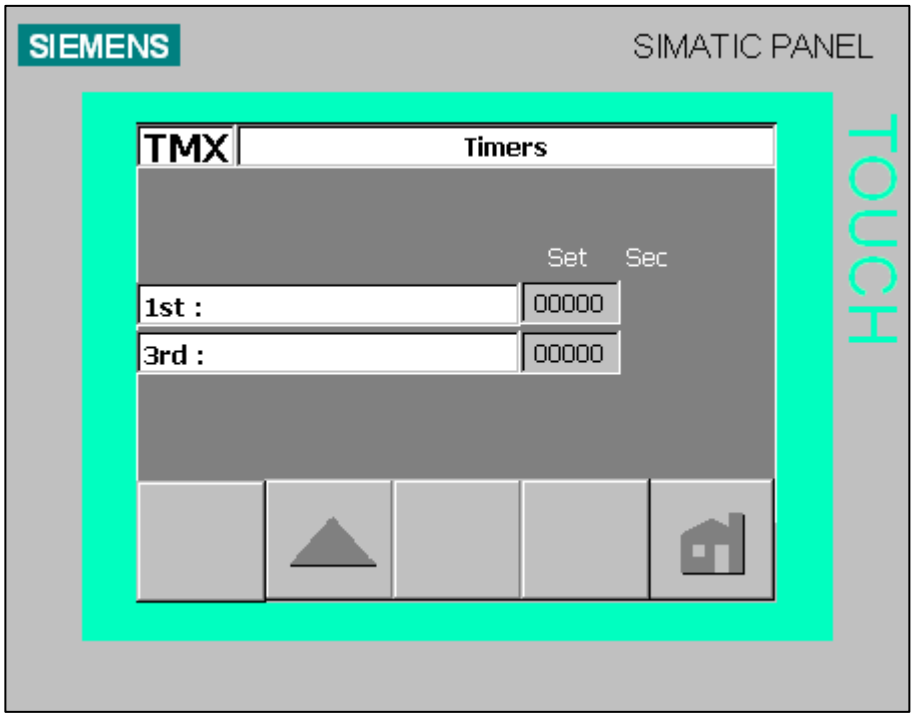


Figure 4.19: Heating Mixer Timers

Pressing on  goes back to the "**Heating Mixer Temperature**" page.

Pressing on  accesses the "**Heating Mixer Components Timers**" page.

Pressing on  goes back to the "**sub-pages**" page.

4.9.15 Horizontal Cooling Mixer Data

From "**sub-pages**" page, pressing on **CMX data** displays the "**Horizontal Cooling Mixer Data**" pages.

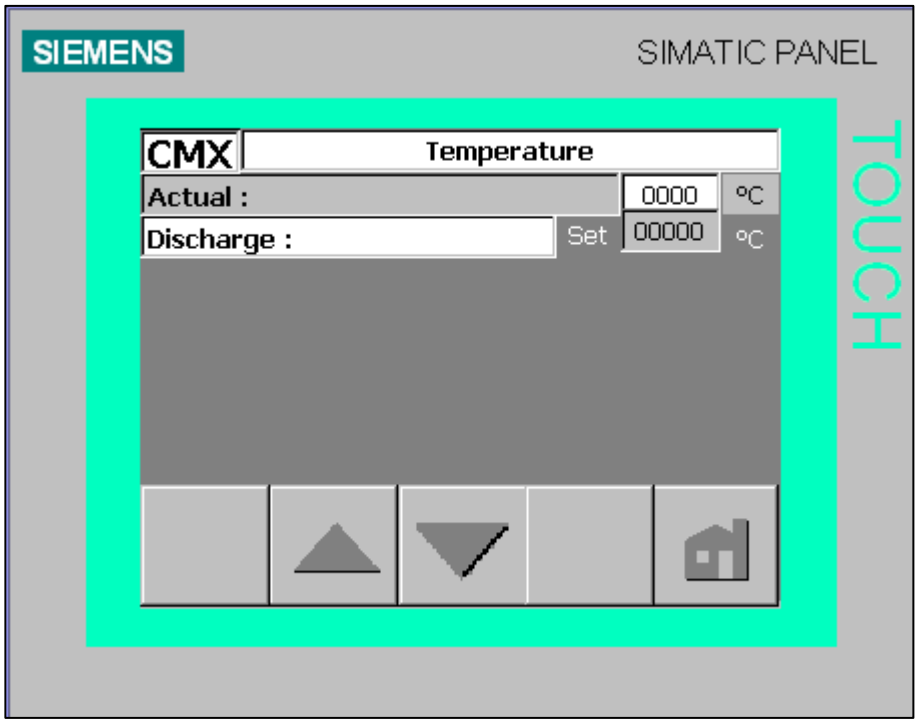


Figure 4.20: Horizontal Cooling Mixer Data

The top row shows the current temperature in the Horizontal Cooling Mixer.

On the next rows, you can set the following **temperatures set points**: **Discharge temperature** (unloading – final dry blend temperature).

Pressing on  goes back to the "**Cooler Status**" page.

Pressing on  accesses the "**Cooler Timers**" page.

Pressing on  goes back to the "**sub-pages**" page.

4.9.16 Cooler Timers

On this page, you can set the following **times set points**:

- **Discharge time**. Duration of the Horizontal Cooler Mixer unloading.

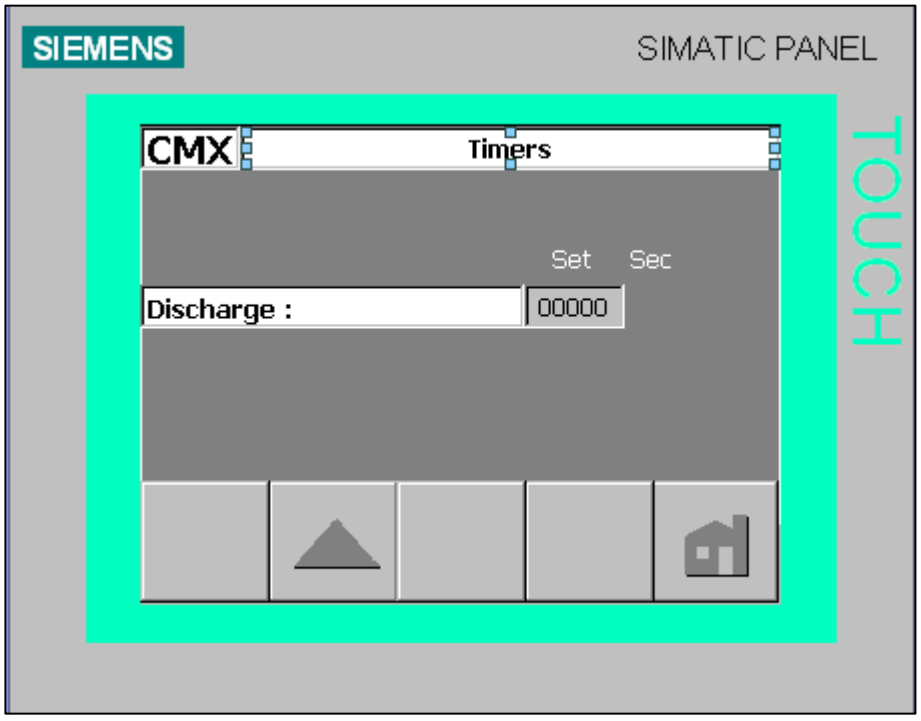


Figure 4.21: Cooler Timers

Pressing on  goes back to the "**Cooler Temperature**" page.

Pressing on  goes back to the "**sub-pages**" page.

4.9.17 Heating Mixer Commands

From "**sub-pages**" page, pressing  displays the "**Heating Mixer**" pages.

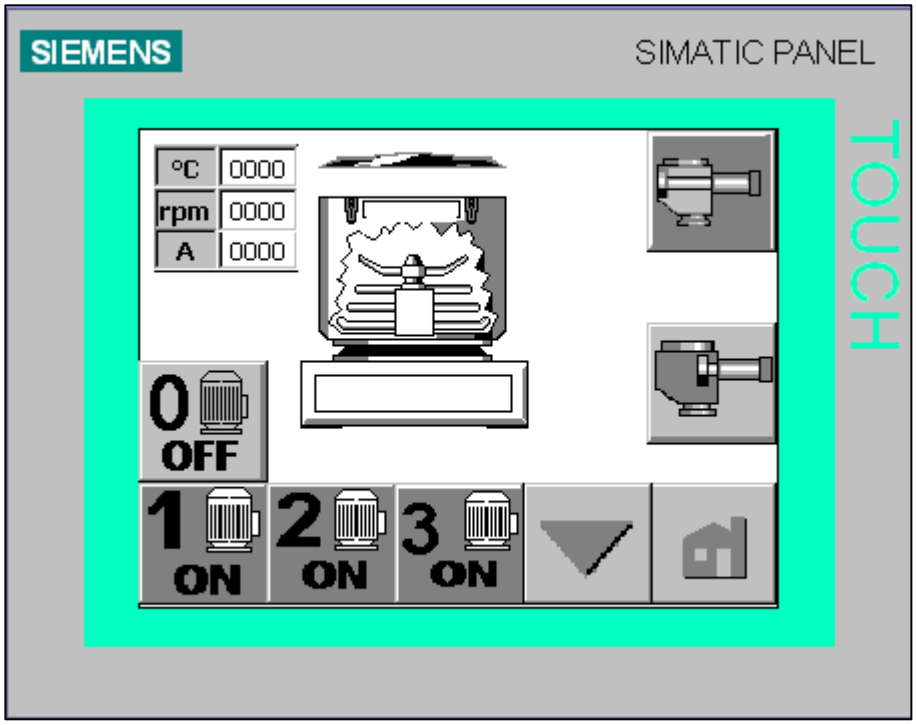


Figure 4.22: Heating Mixer

Pressing on  stops the Heating Mixer cycle.

Pressing on  activates the Heating Mixer first speed.

Pressing on  activates the Heating Mixer second speed.

Pressing on  closes the Heating Mixer discharge valve.

Pressing on  opens the Heating Mixer discharge valve.

Pressing on  displays the "**Heating Mixer Data**" pages.

Pressing on  accesses the "**Heating Mixer cycle commands**" page.

Pressing on  goes back to the "**sub-pages**" page.

4.9.18 Horizontal Cooler Mixer

From "**sub-pages**" page, pressing  displays the "**Horizontal Cooler Mixer**" pages.

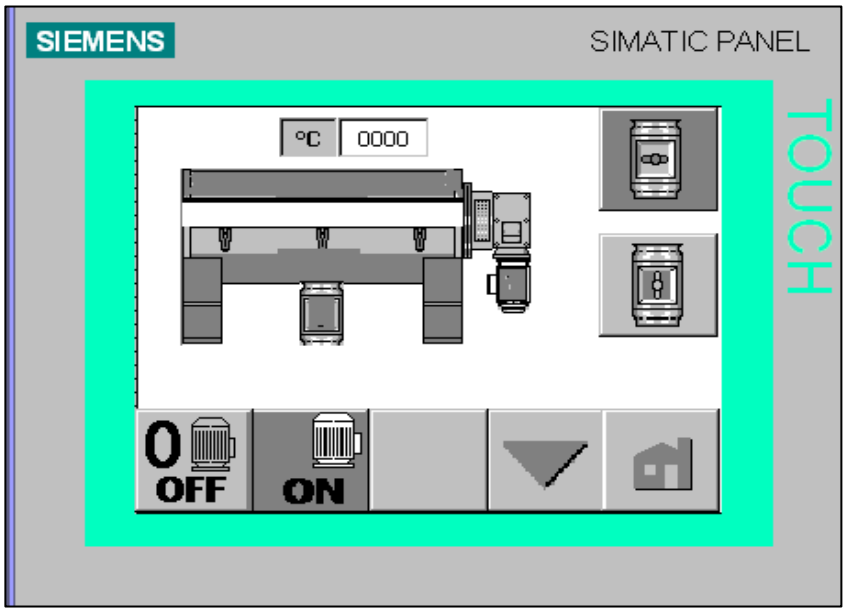


Figure 4.23: Horizontal Cooler Mixer

Pressing on  stops the Cooler mixer cycle.

Pressing on  starts the cooler mixer cycle.

Pressing on  closes the Cooler mixer discharge valve.

Pressing on  opens the Cooler mixer discharge valve.

4.10 Conclusion

The new PLC-based solution of Siemens S7 300 type presents a new strategy to control, supervise, and maintain the training system which represents. In this last chapter, the different functions that WinCC can offer have been mentioned. As well as the approach that we followed for the realization of the application which is the object of this work. This application, which meets the specifications, represents a human/machine interface that is easy to handle, whether by the supervisor or the operator responsible for production. Besides, navigation between views can be done by buttons that are always visible or by arrows found in the majority of views.

GENERAL CONCLUSION

General conclusion

During the hands-on period of BELAID AND HIS SONS, the work we did was automate the mixer and cooler machine, knowing that it is currently controlled by PLC S7 300.

First, we proceeded to a descriptive study of the mixing and cooling machines in addition to its operating specifications. Then we developed a model of the machine using GRAFCET. The developed GRAFCET model allowed us to access the programming language on STEP7 more easily, once the programmable solution was put into the S7-300 PLC that we will use, the control program was implemented and tested using the S7-300-PLCSIM program. the screen user is used to facilitate and increase the machine's performance as well as to inform the operator of the danger situation during operation.

In this project, we introduced a new program of technical work on the mixer and cooler installation, based on these electrical schemes reducing the breakdown of machines and that is the goal of any automation.

Taking notes during training at BELAID AND HIS SONS allowed us to discover the industrial world, which is essential in our future career as an engineer, so we were able to benefit from the experience that community engineers have gained through their humility and cooperation with us in this field, after achieving the goal, it is possible to expand the automation and supervision of other workshop machines.

bibliography

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ANNEX

Machines processes

We turn on the IG main switch, BS1 will light on, then press on BS1 and the alarm siren will start, Lights are lit up ‘’LBS2 and LBS3’’ (sound to warn that the process has started).

By pressing BS2 and BS3 the sound stops (lights to declare that doors are closed).

We press the CS then its light ignites and the mixer motor runs at a speed of 800 rpm for 30 seconds and then turns to a speed of 1740 rpm remains at this speed until the temperature reaches 120 C° and then moves to the third speed 800 rpm and at the same time the valve opens to discharge in the cooler and the cooler drive works with it (the cap opens for ten seconds Just then shuts down).

After the cooler engine is running, the water valve opens and the water passes on the sides the cooler, (water enters with 12C° and exits with 25C°).

When the mix temperature reaches 40C°, the cooler cover opens for two minutes to empty the mix in a special bag to use in our industry.

To stop the process, we have many elements like a stop button and an emergency button.

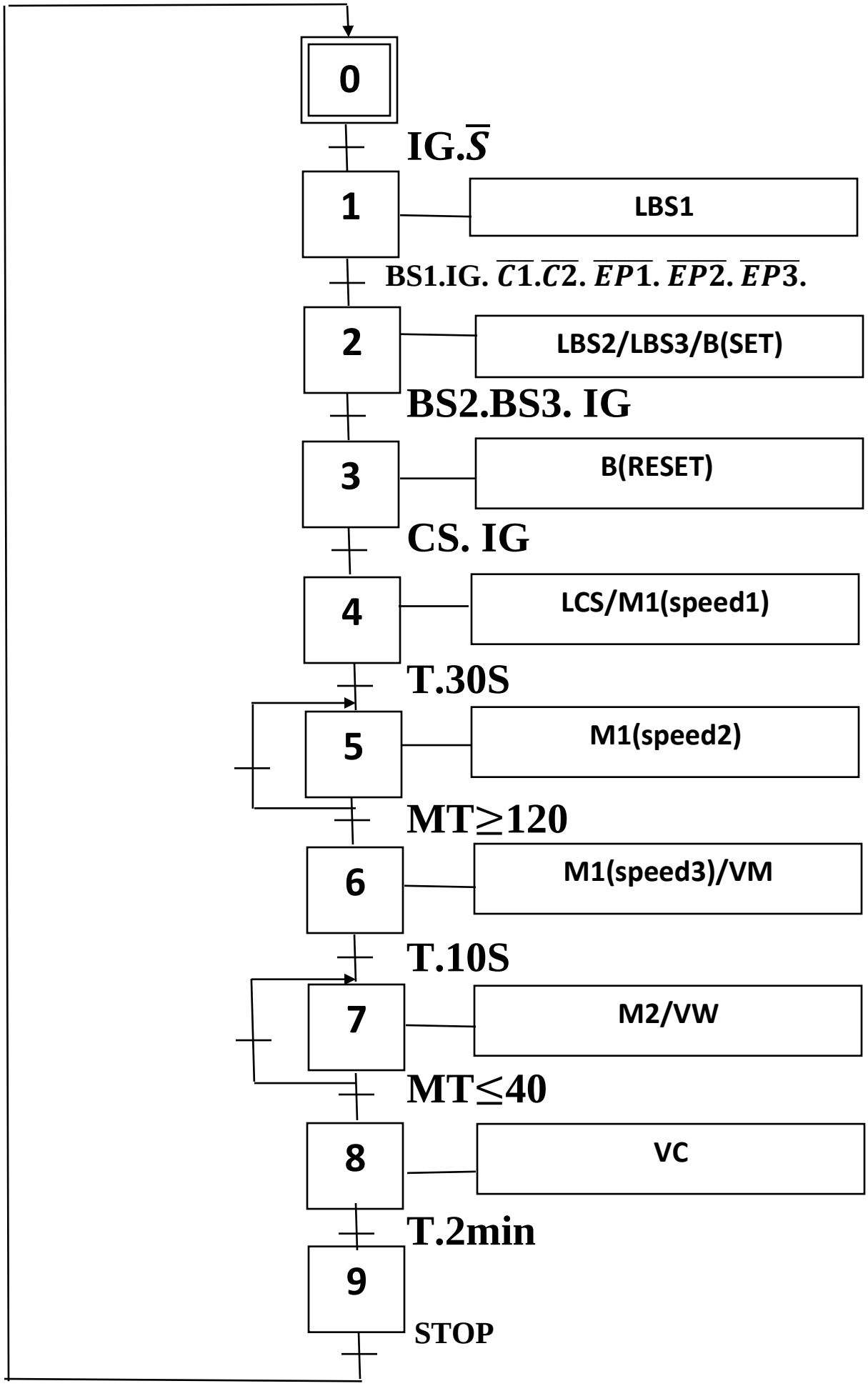
GRAFCET

Is the abbreviation for “Graphe Fonctionnel de Commande des Étapes et Transitions.”

It’s a mode of representation and analysis of automation, particularly well-suited to systems with sequential evolution, that is to say, so GRAFCET is a graphic language representing the functioning of automation by a set:

- stages with which actions are associated.
- transitions between stages with which transition conditions are associated.
- oriented links between steps and transitions.

❖ Below we show our scheme ‘’GRAFCET’’


0
IG.$\overline{S}$
1
LBS1
BS1.IG. $\overline{C1}.\overline{C2}.\ \overline{EP1}.\ \overline{EP2}.\ \overline{EP3}.$
2
LBS2/LBS3/B(SET)
BS2.BS3. IG
3
B(RESET)
CS. IG
4
LCS/M1(speed1)
T.30S
5
M1(speed2)
MT≥120
6
M1(speed3)/VM
T.10S
7
M2/VW
MT≤40
8
VC
T.2min
9
STOP

LADDER (LAD)

We programed the factory station with STL and the university station with ladder

Our program

3.8.1 Network 1

in the first step:

When the main switch is turned on, the protection light turns on

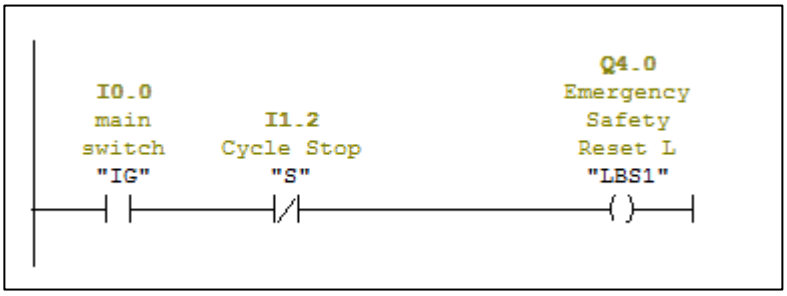


Figure.3.15: Start the device

3.8.2 Network 2

Push the protection button after making sure everything is ready

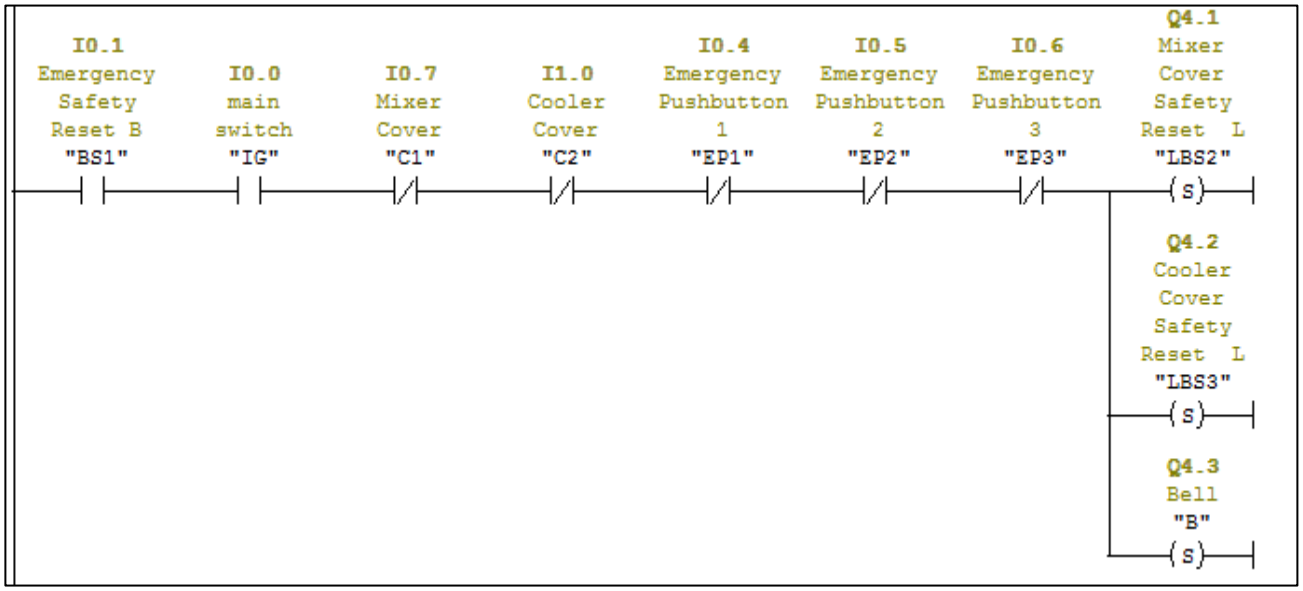


Figure.3.16: protection

3.8.3 Network 3

Pressing the door buttons to stops the sound

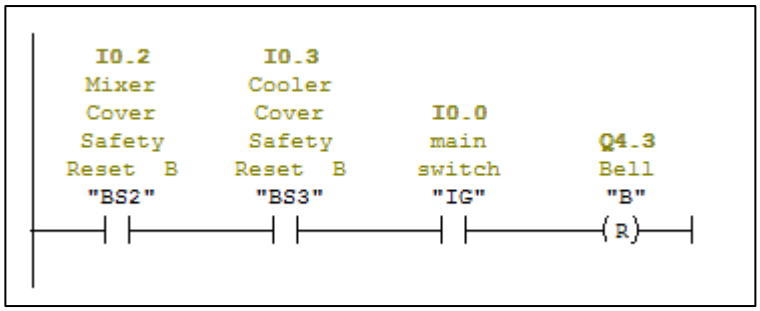


Figure.3.17: stop the sound

3.8.4 Network 4

Start button light and engine speed time start

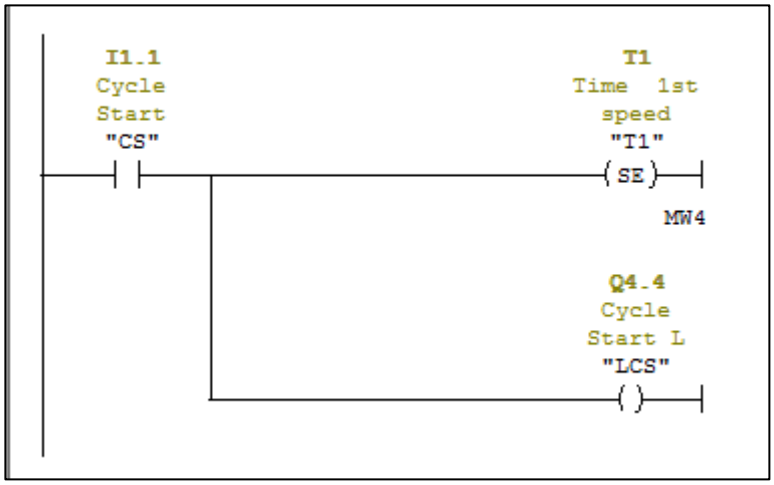


Figure.3.18: cycle start

3.8.5 Network 5

In the first speed, the engine runs for a specified period

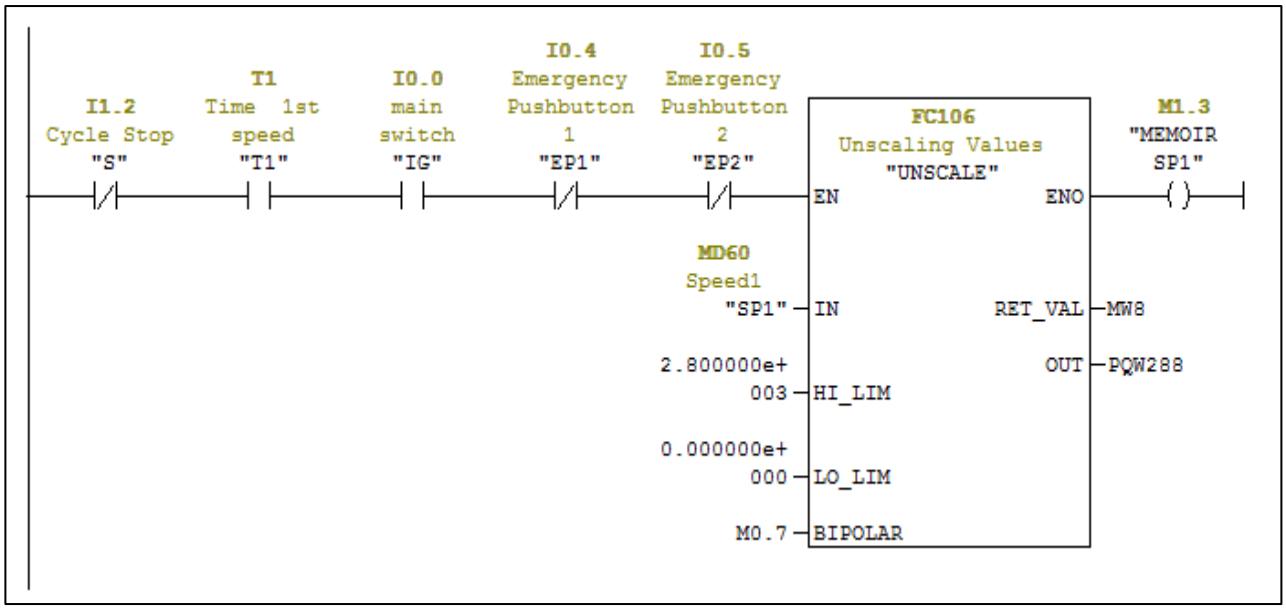


Figure.3.19: Mixer Motor (speed 1)

3.8.6 Network 6

Move to the second speed after the expiring of the specified time

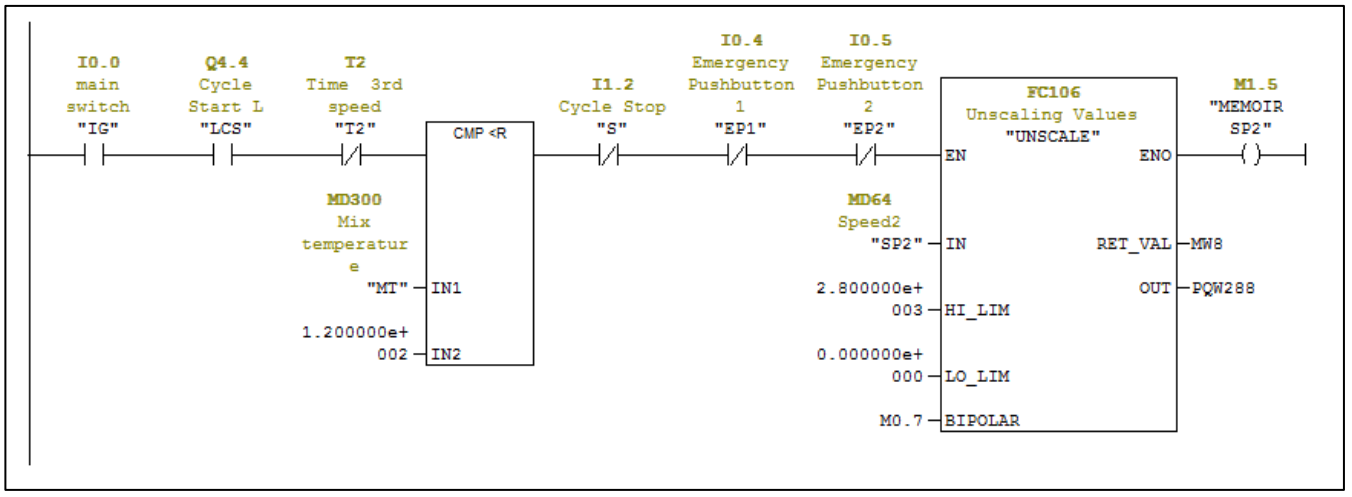


Figure.3.20: Mixer Motor (speed 2)

3.8.7 Network 7

the third speed time has begun when the temperature equals 120 C°

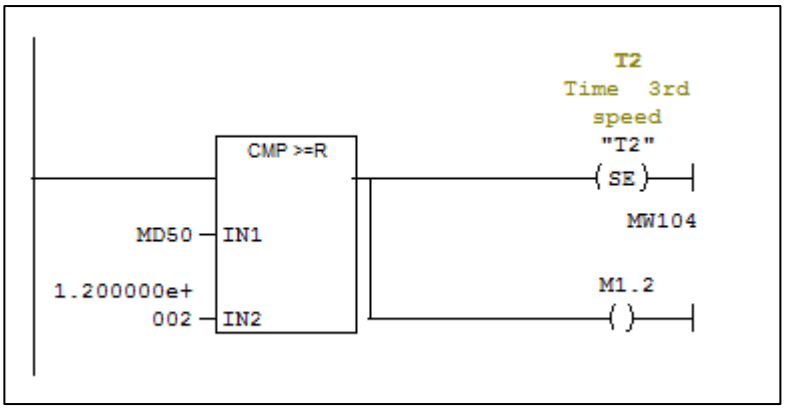


Figure.3.21: The mix temperature

3.8.8 Network 8

In the third speed, the engine runs and the mixer valve opens for a specified time to get the mix out of the mixer to cooler

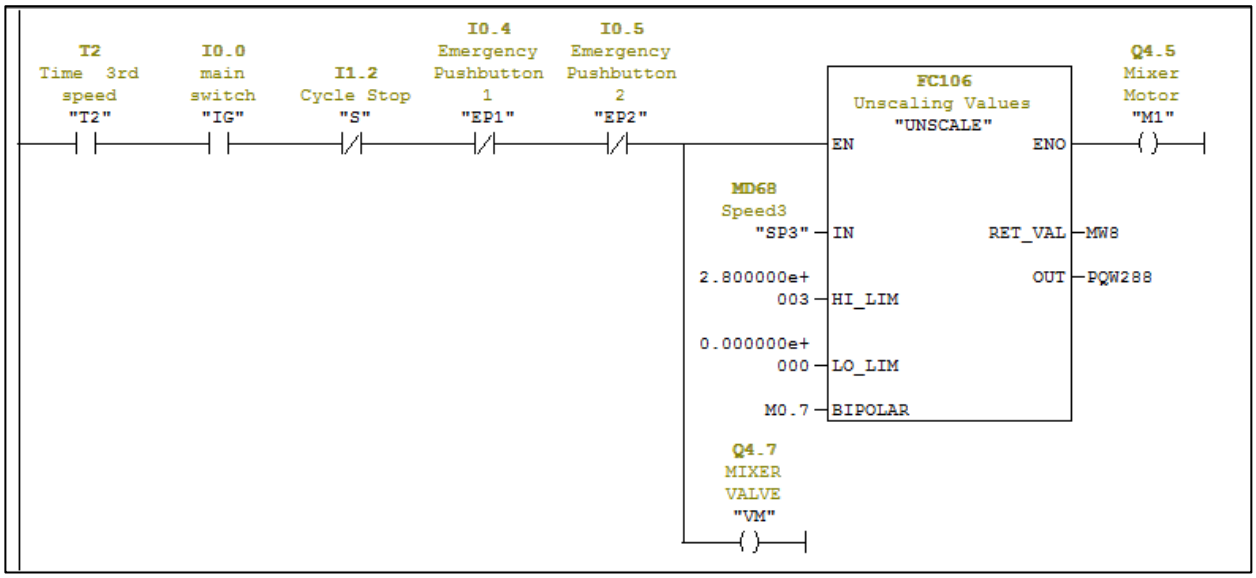


Figure.3.22: Mixer Motor(speed3)

3.8.9 Network 9

After the mixer work is finished, the cooler will start and the water valve open

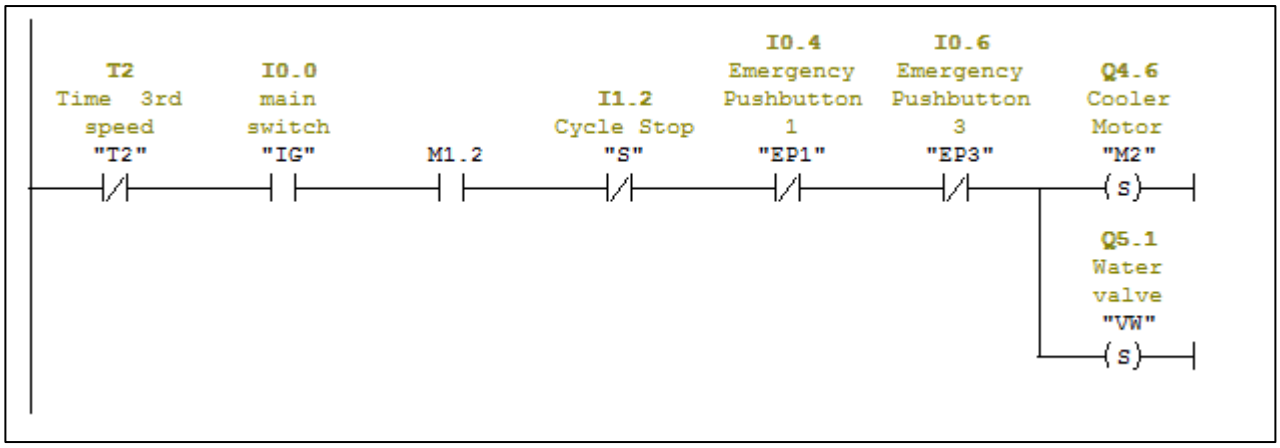


Figure.3.23: The cooler engine starting

3.8.10 Network 10

in specified temperature, water valve stops and the time began to open the cooler valve

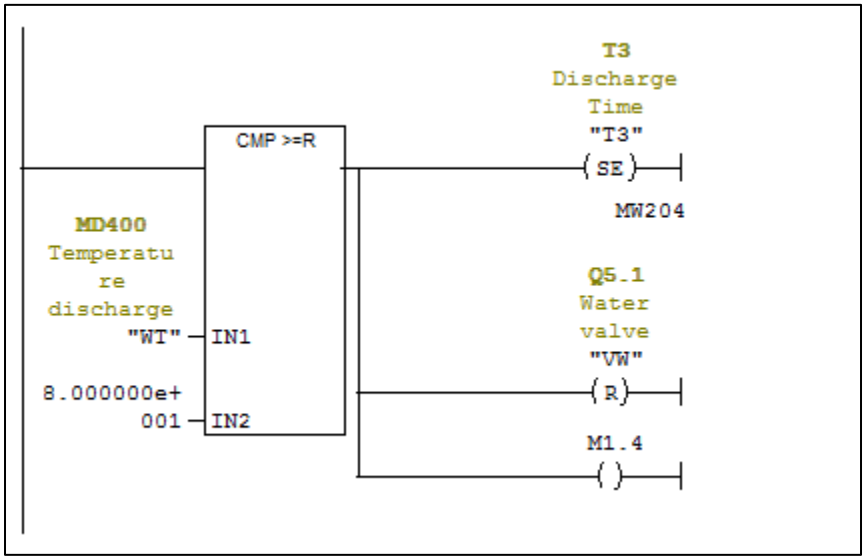


Figure.3.24: Discharge Time

3.8.11 Network 11

the cooler valve opens for a specified time to discharge the mix out of the cooler

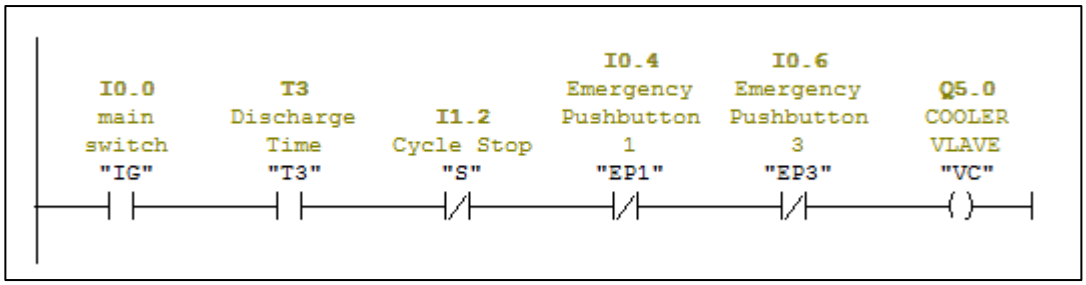


Figure.3.25: Cooler valve

3.8.12 Network 12

After the discharging time is up, the cooling motor stops

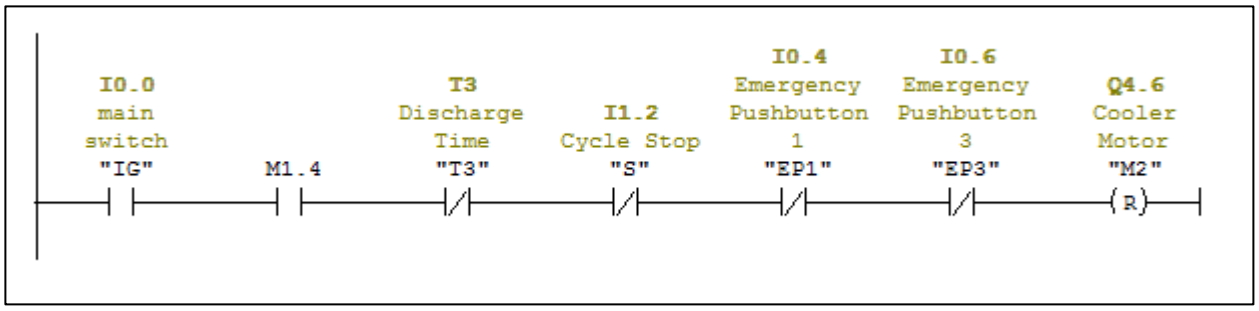


Figure.3.26: Cooler engine stopping