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Présenté par :

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Automated control of industrial models via S7-1200 PLC with HMI interface on PC

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By Lamis Chetabi.

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Thank you all for being part of this.

By Anis Makhlouf.

Dedication:

To my dear parents, who was always there for me,

To my brother, who always added a touch of fun to my life,

To my uncle Nour Eldine, who have educated me and stayed by my side in my path,

To my friend Racha, who was always with me,

To all my teachers who have motivated and advised me,

To all those who have supported me wholeheartedly,

I dedicate this work to you.

By Lamis Chetabi.

Dedication:

To my dear parents, who was always there for me,

To my siblings, who always added a touch of fun to my life,

To all my teachers who have motivated and advised me,

To all those who have supported me wholeheartedly,

I dedicate this work to you.

By Anis Makhlouf.

Abstract:

This report focuses on the design and implementation of an HMI program for the FESTECH SMS Station 2 testing system. The FESTECH SMS Station 2 is a smart module system that detects the material of a workpiece and either ejects it with a solenoid actuator or transfers it to the next station. The system includes components such as a conveyor belt unit, control relay, control switch module, and tower lamp module.

Key words: The FESTECH SMS Station 2 testing, HMI program, WinCC SCADA, Siemens PLC, TIA Portal v16, Ladder Logic Programming.

Résumé :

Ce mémoire se concentre sur la conception et la mise en œuvre d'un programme HMI pour le système de test FESTECH SMS Station 2. Le FESTECH SMS Station 2 est un système de module intelligent qui détecte le matériau d'une pièce et l'éjecte avec un actionneur solénoïde ou le transfert à la station suivante. Le système comprend des composants tels qu'une unité de bande transporteuse, un relais de commande, un module de commutateur de commande et un module de lampe de tour.

Mots clés: La station de test FESTECH SMS 2, Programme IHM (Interface Homme-Machine), WinCC, SCADA, Automate Siemens PLC, TIA Portal v16, Programmation en langage Ladder

ملخص:

تركز هذه المذكرة على تصميم وتنفيذ برنامج واجهة المستخدم البشرية HMI لنظام اختبار2 FESTECH SMS Station.
FESTECH SMS Statio2 هو نظام وحدة ذكي يكشف عن مادة القطعة والعمل إما أن يقذفها بمشغل الملف اللولبي أو ينقلها إلى المحطة التالية. يتضمن النظام مكونات مثل وحدة الحزام الناقل، والتتابع التحكم، ووحدة 2 التبديل التحكم، ووحدة مصباح البرج.

الكلمات الرئيسية :FESTECH SMS Station 2 ، برنامج HMI، WinCC SCADA، جهاز التحكم المنطقي القابل للبرمجةSiemens PLC،بوابة TIA Portal v16 ،برمجة منطق السلم(Ladder Logic Programming) .

List of abbreviations:

PLC: Programmable Logical Controller.

SQL: Structure query language.

FME: Feature Manipulation Engine.

PC: Personal computer.

IoT: Internet of Things.

WinCC: Windows Control Center.

HMI: Human Machine Interface.

SIMATIC: Siemens Automatique.

I/O: Input / Output.

SMS: Smart Module System.

DC: Direct Current.

APP: Aluminum profile panel.

IE: Industrial Engineer.

SCADA: Supervisory control and data acquisition.

MPS: Modular Production System.

Fig: Figure.

PROFIBUS: Process Field Bus.

TIA Portal : Totally Integrated Automation Portal

List of tables:

List of figures:

General introduction and the composition of the manuscript:

Automation and control systems are essential to manufacturing and testing procedures in the age of Industry 4.0. One such system is the FESTECH SMS Station 2, a smart module system made to identify a workpiece's material and then move it to the next station or expel it using a solenoid actuator. although the system is reliable and effective, a Human-Machine Interface (HMI) application might improve its performance even further.

The HMI serves as a bridge between the user and the system, offering a visual representation of the system's state and allowing the user to engage with it efficiently. The effectiveness, safety, and usability of a system can all be markedly enhanced by a well- designed HMI program.

This report aims to design and implement an HMI program for the FESTECH SMS Station 2 testing system. The program will be designed with a focus on usability, providing a clear and intuitive interface for users to interact with the system. The implementation of the program will involve programming control functions, sensor applications, and system maintenance components.

The report will also include testing of the implemented HMI program and evaluation of its performance. The results of this study will provide valuable insights into the design and implementation of HMI programs for industrial testing systems, contributing to the field of automation and control systems.

The following chapters will provide a detailed description of the FESTECH SMS Station 2, an overview of HMI basics, the design and implementation process of the HMI program, and the testing and results of the implemented program. The report will conclude with a discussion of potential improvements and future research directions.

Contents

Chapter 1: Company description, Motivation, and Issues:

1.1. Introduction:

This chapter provides an in-depth look at FESTECH, a leading automation system company in Seoul, South Korea, has been recognized for its innovative and family- friendly products. The company's involvement in Industry 4.0, including IoT, augmented reality, cybersecurity, and big data, is significant. The report aims to create an intuitive interface for the Festech Smart Module System, a key component of Industry 4.0, using TIA Portal, an automation software platform.

1.2. Description of the Company:

FESTECH is an automation system that offers comprehensive solutions for training institutions across various fields.

1.3. History of FESTECH:

FESTECH, a South Korean company founded in 2001, specializes in manufacturing training equipment for factory automation systems. They have been recognized with awards and certificates, including the Family-friendly certificate from the Ministry of Gender Equality and Family in 2018. They have established partnerships with educational institutions and have re-certified for Family-friendly Certification in 2023 **[1]**.

1.4. Importance in the industry:

FESTECH is involved in Industry 4.0 by offering solutions in IoT, augmented reality, cybersecurity, autonomous robots, additive manufacturing, big data, system integration, simulation, and cloud computing. it also offers factory solutions like equipment relocation and production line optimization and offer custom automation systems, catering to specific client needs.

1.5. Product line:

FESTECH manufactures a wide range of products, primarily focused on training equipment related to factory automation systems such as:

- Pneumatics: Offers Pneumatics, Electro-Pneumatics, and Portable Pneumatics Trainers.
- Hydraulics: Offers Hydraulics, Electro-Hydraulics, and Hydraulic Transparent Models.
- Programmable Logic Controllers (PLC): Provides OMRON PLC, SIEMENS PLC, and PLC Trainers.
- Sensors: Offers Sensor Training Set including Proximity Sensor, Distance & Displacement Sensor, and Force & Pressure Sensor.
- Human Machine Interface (HMI): Offers Bare HMI, HMI Kits, and HMI with PLC Kits.

- Motors: Provides Position Control Trainer, Servo Motor Trainer, and Stepping Motor Trainer.
- Factory Automation Applications: Offers Servo Mechatronics Trainer, Mechatronics Automation System Trainer, and Elevator Trainer.
- Process Control System (PCS): Composed of a computer system, process control device, and process interface system.
- Software: Offers Simulation Software for Mechatronics Teaching and Learning, and 3D Training Software for PLC Programming.
- Compressors: Manufactures Silent Portable Compressors.

1.6. Motivation and problematics:

The Festech Smart Module System, a key component of Industry 4.0, offers numerous benefits for industrial operations. However, its full potential requires an intuitive interface. Using TIA Portal, a leading automation software platform, could create such an interface, simplifying the system's functionality and increasing its usability for end users.

The report aims to develop an interface for the Festech Smart Module System using TIA Portal, addressing challenges such as compatibility, reliability, and user-friendliness. It also focuses on handling real-time data efficiently and securely. The study proposes a comprehensive solution for the development of an effective interface for end users, ensuring the system's robustness and reliability.

1.7. Conclusion:

In conclusion, FESTECH, a key player in the automation system industry, is focusing on developing an intuitive interface for its Festech Smart Module System. The report aims to address compatibility, reliability, and user-friendliness challenges while ensuring efficient handling of real-time data. The proposed solution enhances the system's robustness and reliability, increasing its usability for end users. Further details will be discussed in subsequent chapters.

CHAPTER 2: FESTECH SMS Station 2 Overview:

2.1. Introduction:

Chapter 2 discusses the Smart Module System (SMS) and Station n°2 Testing, which are essential components of the SMS system. The SMS focuses on teaching automation technologies and provides real-time communication, alerting operators about equipment failures and predictive maintenance.

2.2. Description of the smart module system:

The SMS (Smart Module System) teaches many automation technologies as well as system design, assembly, installation, commissioning, and maintenance. Easy training, easy learning, and easy industrial application are prioritized. Distribution, Testing, Processing, Indexing, Handling, Buffer, Assembly, Automated Warehouse, and Sorting Station are among the components that make up SMS. It is possible to utilize each station separately **[2]**.

Any kind of PLC, and they don't all have to be the same, can control each SMS module. A straight connected 4mm socket or a one-touch IO-Link cable can be utilized to connect the PLC to each module. Storage boxes are used for delivery of SMS modules.

Fig 2.1. SMS modules

2.3. The importance of SMS modules:

SMS provide real-time communication, alerting operators about equipment failures and predictive maintenance requirements.

2.4. Description of station n°2 Testing (FME-SMS-TEST):

2.4.1. Function:

Testing station detects material of work piece. It ejects with solenoid actuator or transferred to next station **[2], [3], [4], [5]**.

Fig 2.2. Station 2 Testing (FME-SMS-TEST)

2.4.2. Training contents:

1. Conveyor belt composition
2. DC motor
3. Motor control with relay
4. Solenoid actuator application
5. Sensor application: capacitive sensor, inductive sensor, optical sensor, pneumatic cylinder
6. System composition and assembling/ disassembling
7. Electric wiring and pneumatic piping
8. PLC program
9. FieldBus communication technology
10. Commissioning and fault tracking
11. System maintenance

2.4.3. Components:

-Conveyor belt unit

-Size: 60×300 mm

-Motor: DC24V geared motor

-Input: 11, Output: 9 points with LED

-D-sub connector: Input 25 pin, Output 25 pin

-Sensor protection: short circuit proof type

-Timing belt drive

• Capacitive sensor

• Inductive sensor

• Optical sensor

• Sensor bracket for 3 sensors

• Ejector unit

-Rotary solenoid actuator

-Work piece ejector

• Ejecting case

• Control relay: 2ea

• APP: 300×300×15 mm

• SMS Input/Output Terminal unit

• Control switch module

-START, STOP, AUTO(RESET), Emergency

• Tower lamp module

-Green / Yellow / Red

• Size & weight

-300×300×260 mm, 4.4kg

• IO-Link cable: 2ea

- Input cable, Output cable :D-sub 25 pin

• Connector between stations

• SMS module storage case

-Size: 350×340×270 mm

-APP for PLC installation

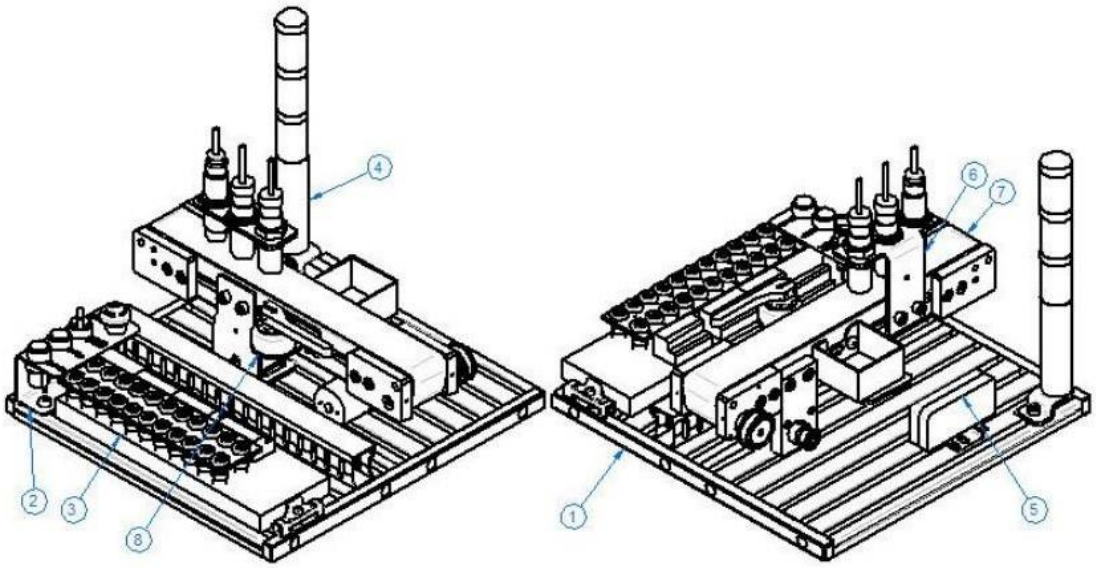


Fig 2.3. Testing Station

Table 2.1. Testing Station Components

Seq	Components
1	Aluminum profile panel
2	Control switch module
3	SMS IN/OUT terminal unit
4	Tower lamp module
5	Relay module
6	Testing module
7	Conveyor module
8	Sorting actuator module

2.5. The purpose of Station n° 2 Testing:

The primary purpose of the Testing Station is to detect the material of the workpiece. The system detects materials and makes decisions based on their results, ejecting non-compliant ones or transferring them for further processing. This ensures only materials meeting standards progress to manufacturing stages, maintaining product quality.

2.6. Conclusion:

In conclusion, SMS and Station n°2 Testing are vital in automation technology, providing flexible design and real-time communication for training and industrial applications. They focus on material detection and comprehensive training content, contributing to Industry 4.0 and practical applications.

CHAPTER 3: Description of used software:

3.1. Introduction:

Chapter 3 discusses the use of TIA PORTAL V16 for programming and managing Siemens PLCs and HMIs, including project creation, device configuration, and interface testing. It also introduces Siemens' WinCC SCADA and HMI system, the role of Industrial Engineers, the Siemens S7-1200 PNP 23151 Festech PLC Trainer, and Ladder Logic Programming.

3.2. Introduction of the application TIA PORTAL V16:

It's a potent software package for automation and control systems. Siemens PLCs and HMIs are programmed and managed using it, **[6], [7]**. The following are some and initial steps:

1. Starting a New Project: Launch the TIA Portal v16 and start a new project by giving it a directory and a name.

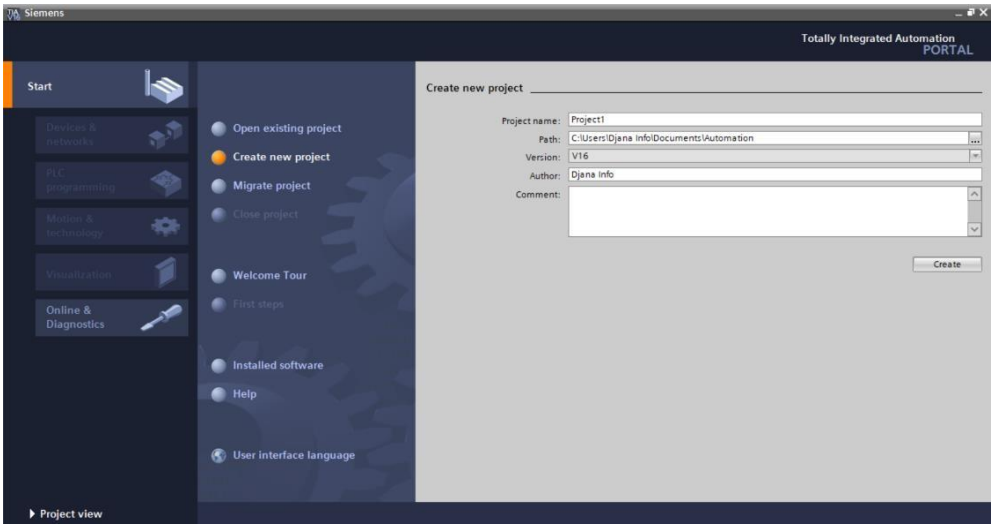


Fig 3.1. Create new project in Tia portal

2. Adding a PLC Device: From the controllers tab, choose the appropriate model and firmware to add a PLC device.

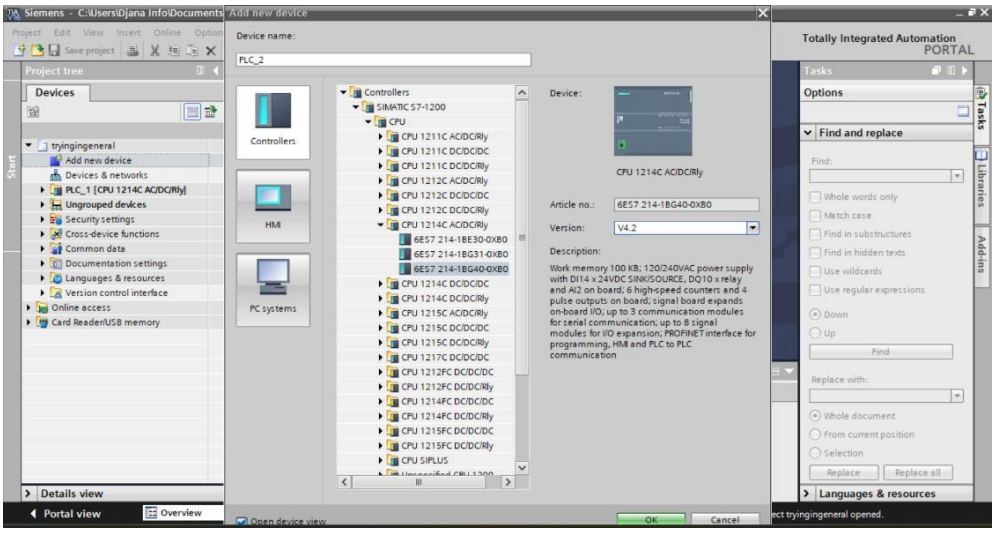


Fig 3.2. Adding PLC device

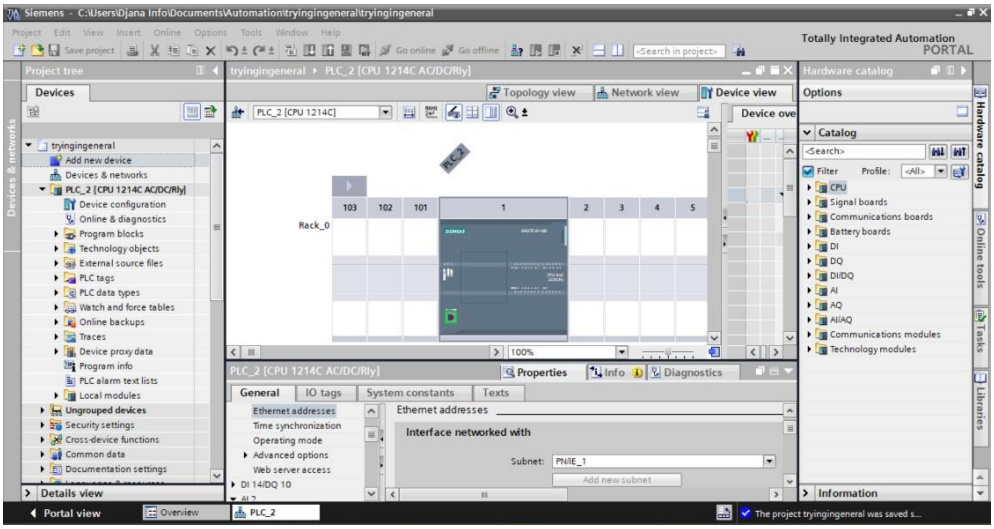


Fig 3.3. Device view

3. Adding an HMI Device: From the HMI tab, choose the appropriate type and size to add an HMI device.

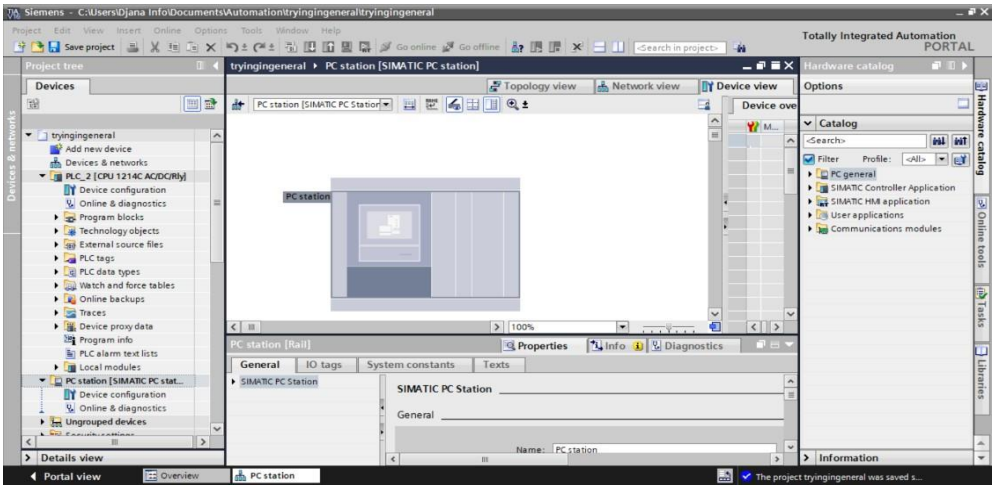


Fig 3.4. Adding HMI device

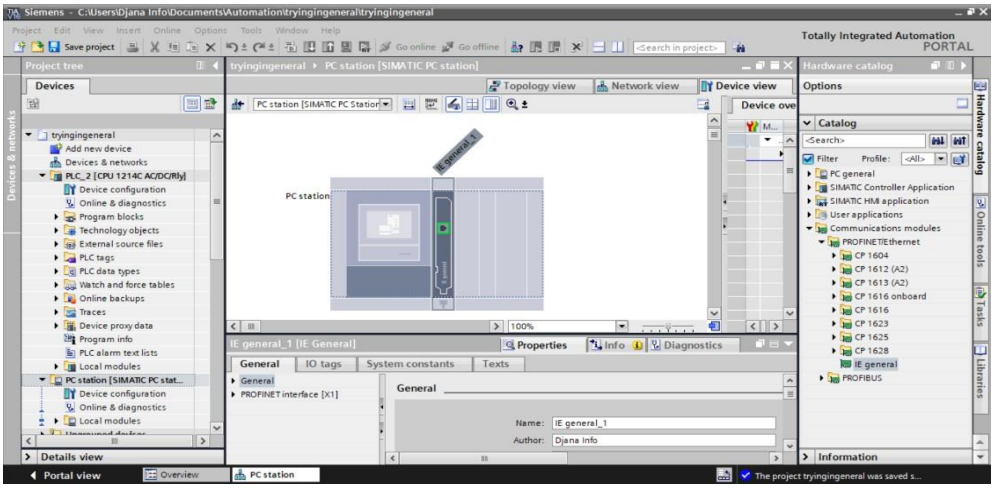


Fig 3.5. Adding EI general to the HMI device

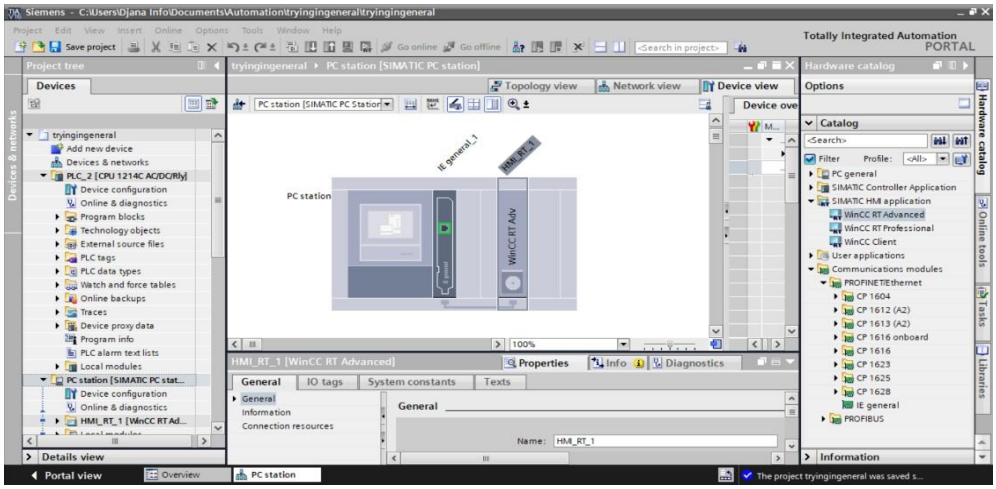


Fig 3.6. Adding WINCC advanced to the HMI device

4. Establishing a Connection: Drag and drop the Ethernet ports on the devices and net- works tab to create a link between the PLC and HMI.

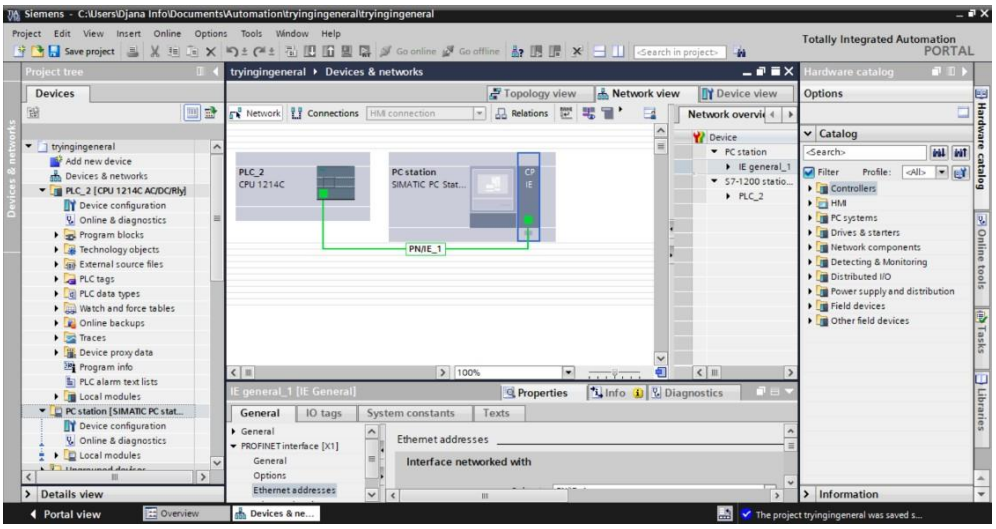


Fig 3.7. Connection between PLC and HMI

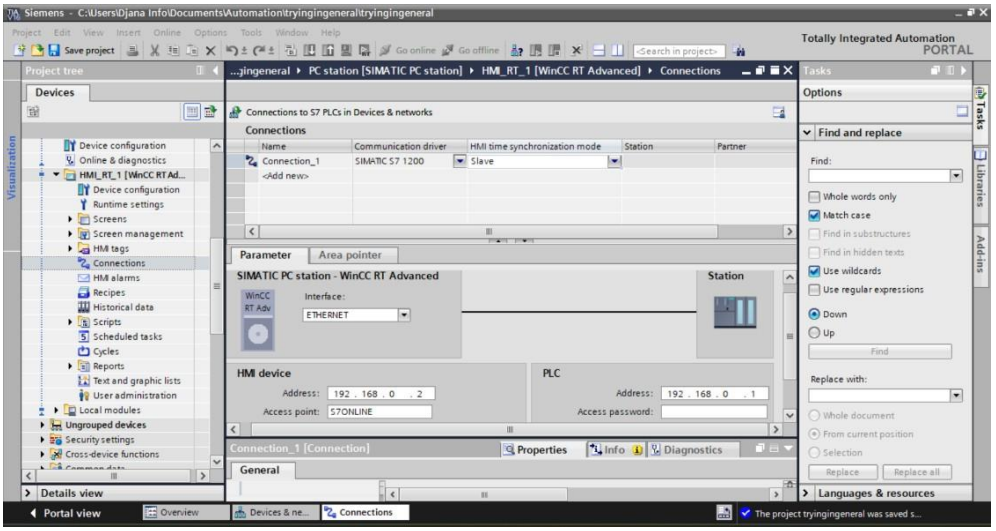


Fig 3.8. Choosing HMI time synchronization mode

5. Going Online with the PLC: Connect to the internet using the PLC by choosing the appropriate IP address and interface, then fixing any issues or warnings1.

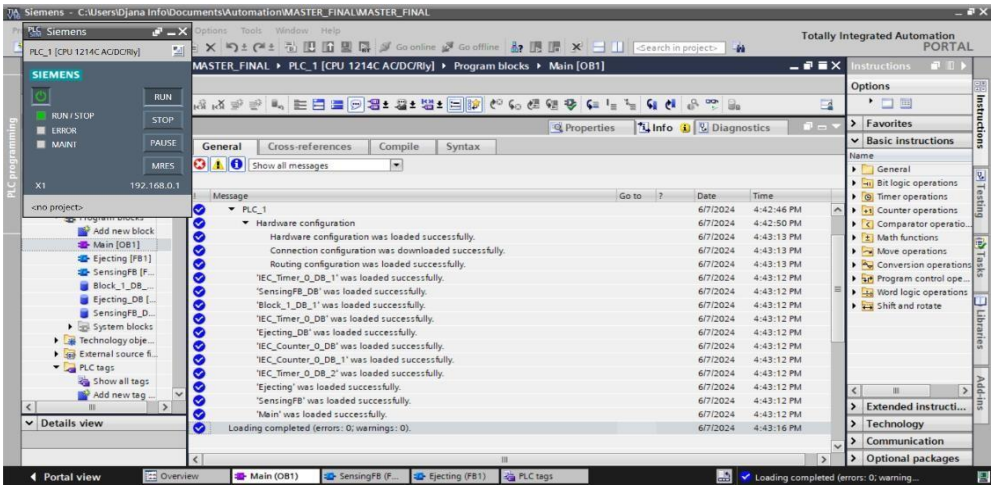


Fig 3.9. Going online with PLC and Compiling

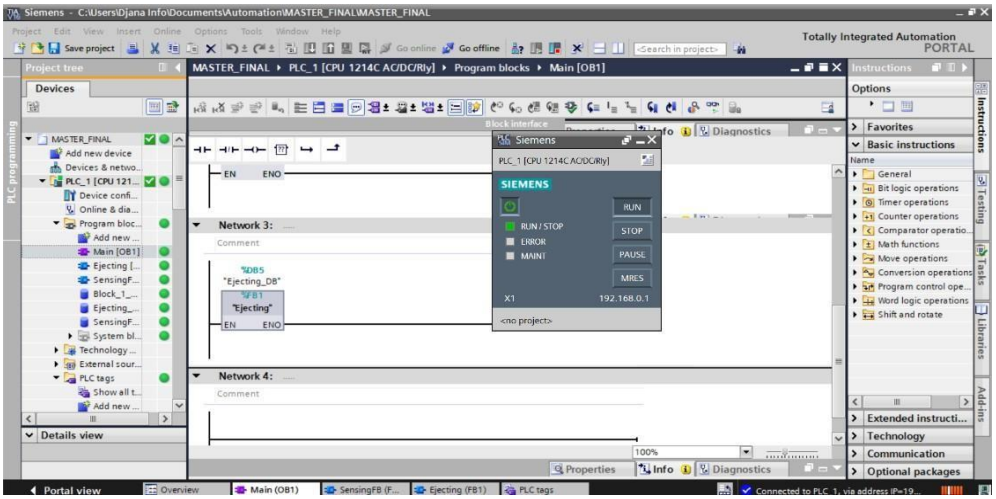


Fig 3.10. Program view

6. Downloading the PLC Program: Choose Download to Device after selecting the main OB1 block to download the PLC program to the device. Verify the safety protocol and halt the modules if necessary.

Apart from these, TIA Portal v16 lets you set up HMI and PLC tags, connect to real hardware and a simulator, create basic programs, and download them to the PLC.

3.3. Description of WINCC and it types:

Siemens' WinCC is a SCADA and HMI system designed for the Microsoft Windows operating system. It uses Microsoft SQL Server for logging and offers functionality for various industries. Despite being targeted by malware in 2010, WinCC remains a reliable and efficient configuration tool for industrial monitoring, scalable for simple and complex tasks.

There are different types of WinCC in the TIA Portal which they are:

- WinCC Basic: Configured for SIMATIC HMI Basic Panels.
- WinCC Comfort/Advanced: Used for configuring SIMATIC HMI Comfort Panels and Mobile Panels 2nd generation.
- WinCC Professional: Configured for PC-based SCADA systems with WinCC Runtime Professional software.

Each version is designed for different levels of complexity and requirements. The choice of version depends on the specific needs of your project, **[8], [9]**.

3.4. Description of IE General:

An Industrial Engineer (IE General) uses engineering principles to optimize systems and processes in various industries, aiming to improve efficiency, productivity, and overall performance. Their responsibilities include process analysis, workforce planning, layout design, and supply chain management, contributing to the success and competitiveness of organizations.

3.5. Introduction of Programmable Logic Controller PLC:

Fig 3.11. Programmable Logic Controller

The Siemens S7-1200 PNP 23151 Festech PLC Trainer is a specialist training tool intended to assist users in comprehending and practicing programming and using Siemens S7-1200 PLCs. Here are some of this trainer's key features and details:

1. Block Type PLC: The Festech PLC Trainer makes use of a block type PLC, which is a manageable and integrated device.
2. Module Type: The trainer is available in 16/16, 32/32, and 32/32/4ch/2ch configurations; among other module types. This is a reference to the PLC's numerous in- put/output channels, which enable a variety of automation activities.
3. 4mm Sockets: The PLC trainers are all readily wired and utilize 4mm sockets. This facilitates the connecting and unplugging of different input and output devices.
4. Application Modules: A variety of training scenarios and applications are possible by selecting and combining the application modules to achieve training goals.

3.6. The components of the Festech PLC Trainer Siemens S7-1200 PNP 23151:

1. Siemens S7-1200 Controller: This is the primary PLC device that is programmed and used during the training
2. Widescreen TP700 Comfort Panel: This is the HMI (Human Machine Interface) device that shows the PLC operations and permits user interaction
3. SCALANCE XB005 Unmanaged Industrial Ethernet Switch: This device is used for networking and communication between the PLC and other devices
4. Inputs and Outputs: The trainer has numerous inputs (16 digital inputs, including 6 high-speed counters and 4 universal analog inputs) and outputs (14 digital outputs, in- cluding 4 high-speed outputs and 2 configurable analog outputs) that are accessible from the front panel using 2-mm test leads.
5. Controls and Lights: The trainer can be linked to these for a variety of automated purposes.
6. Switches: During troubleshooting exercises, eight switches enable the inclusion of electrical issues.
7. The SysLink Interface: facilitates the connecting of Festo to Modular Production System (MPS) stations.
8. Engineering Software SimaTIC WinCC (TIA Portal): A single-seat license for this software, which is required to program the PLC, is also included in the system.

3.7. Ladder Logic Programming:

Ladder Logic is a graphical programming language for programming PLCs, derived from its ladder diagram-like structure, making it easy for beginners to understand.

Ladder Logic is a programming language for controlling PLCs and SCADA systems, consisting of inputs, outputs, contacts, coils, rungs, power rails, and instructions, primarily used for bit logic operations, **[6]**.

3.8. Conclusion:

This chapter provides an in-depth understanding of TIA PORTAL V16's application in programming and managing Siemens PLCs and HMIs. It introduces WinCC, Industrial Engineer roles, and Ladder Logic Programming, and explores practical applications in automation technology, material detection, and Industry 4.0.

CHAPTER4: HMI Design and Implementation:

4.1. Introduction:

Chapter 4 outlines the process of creating an Interface (HMI) in TIA Portal for FES- TECH SMS Station 2, covering the creation, testing, and dynamic changes of the interface, as well as programming, including the creation of PLC and HMI tags. The PLC used in this case is Siemens S7-1212C AC/DC/Rly

4.2. How to create an Interface (HMI) in Tia Portal:

Creating an interface in TIA Portal involves several steps:

1. Create a new project: Open TIA Portal and create a new project.
2. Add devices: Add the devices you are working with, such as PLCs or HMIs, to your project.
3. Configure devices: Configure the properties of your devices, such as their IP addresses and hardware configurations.
4. Create tags: Create tags for your inputs and outputs. These tags will be used to link your PLC and HMI.
5. Design the HMI interface: Design your HMI interface by adding screens and then adding objects (like buttons, switches, sliders, etc.) to these screens.
6. Link tags to HMI elements: Link your PLC tags to your HMI elements. This can be done by dragging and dropping the tags onto the HMI elements.
7. Configure HMI element properties: Configure the properties, events, and animations of your HMI elements to link them to your PLC tags and change their appearance and behavior.
8. Test your interface: Finally, test your interface by running a simulation. This will allow you to see how your HMI and PLC communicate.

4.3. Workflow Of HMI

The following workflow is designed with commands from the Human-Machine Interface (HMI) in mind while the behavior changes dynamically based on the user's selection in the PC interface.

Here we take an example for choosing the accepted piece that is plastic with dark color which shown on the following organigram:

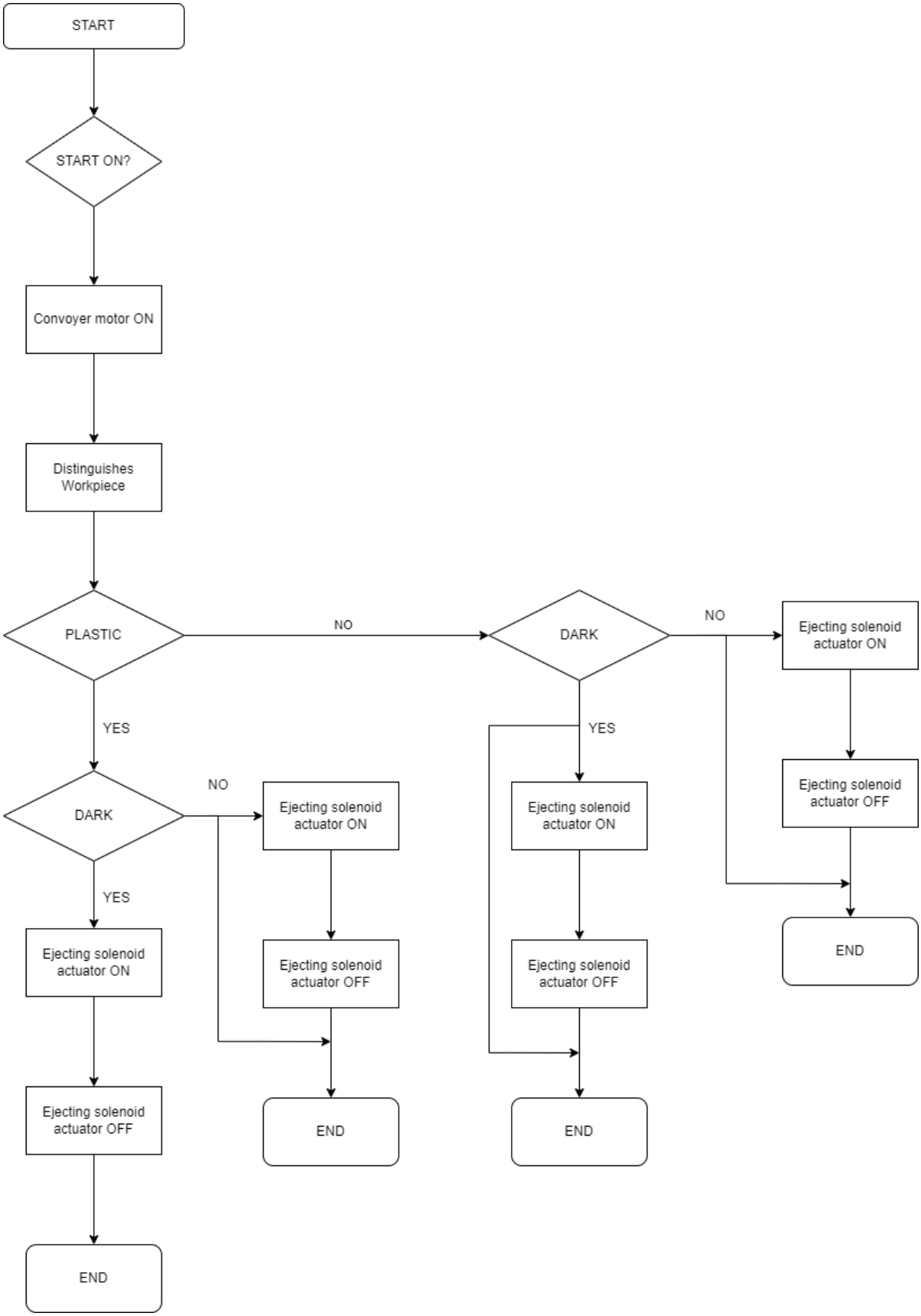


Fig 4.1. Workflow of HMI

4.4. Description of the interface:

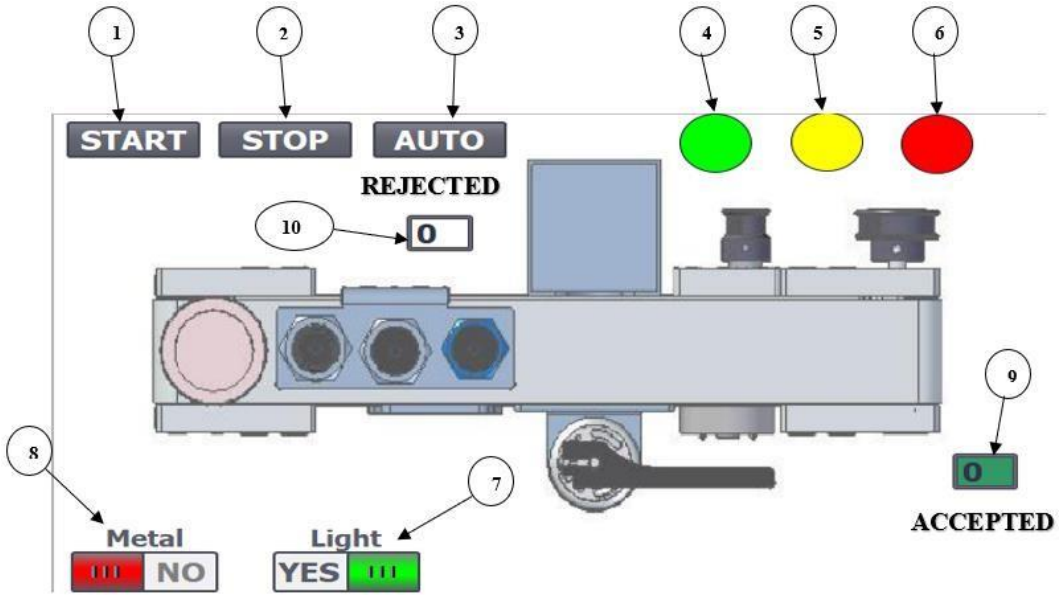


Fig 4.2. HMI screen

Table 4.1 HMI Components

Seq	Components
1	Start button
2	Stop button
3	Reset button
4	Green Lamp
5	Yellow Lamp
6	Red lamp
7	Light switch
8	Metal switch
9	Accepted Piece Counter
10	Rejected Piece Counter

4.5. Programming of button switch lights and counters on HMI:

This is the process I followed to program the button on the HMI:

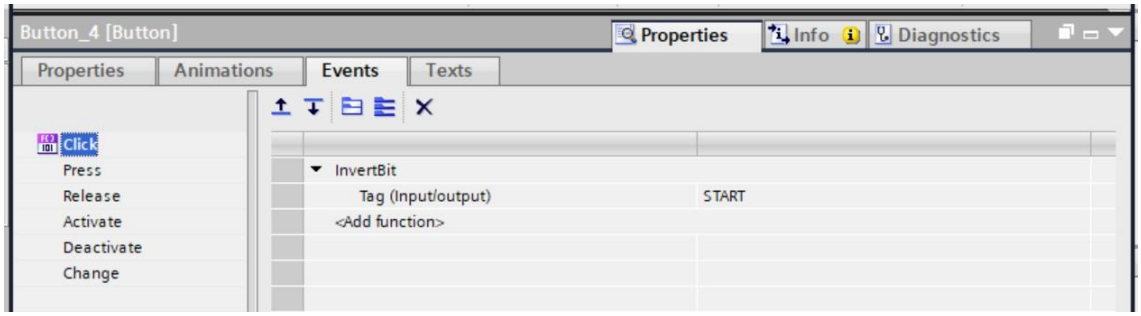


Fig 4.3. Button events

This is the process I followed to program the light circles on the HMI:

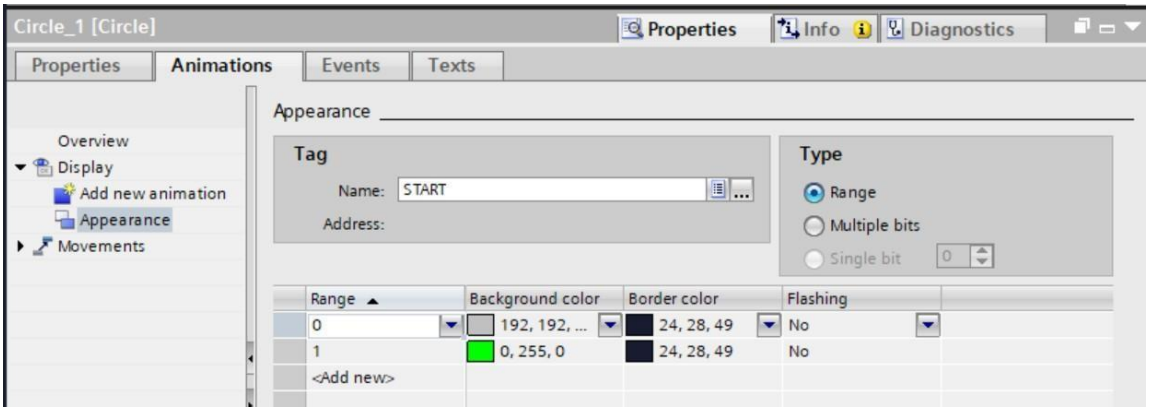


Fig 4.4. Light Animation

This is the process I followed to program the switches on the HMI:

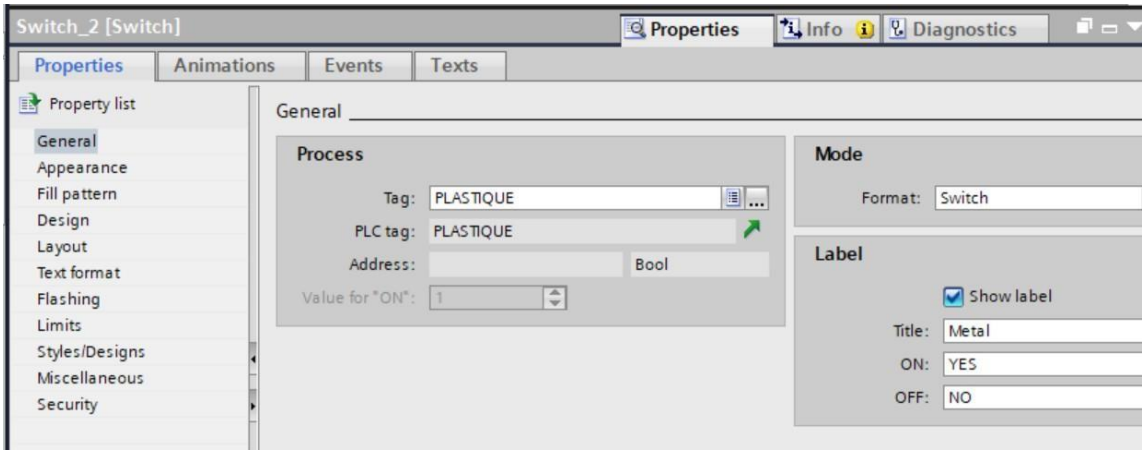


Fig 4.5. Tags PLC switch

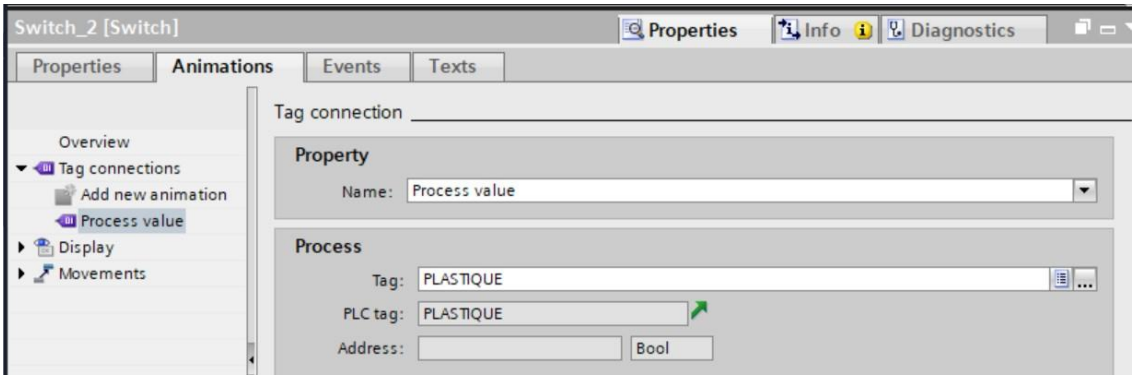


Fig 4.6. Process value switch

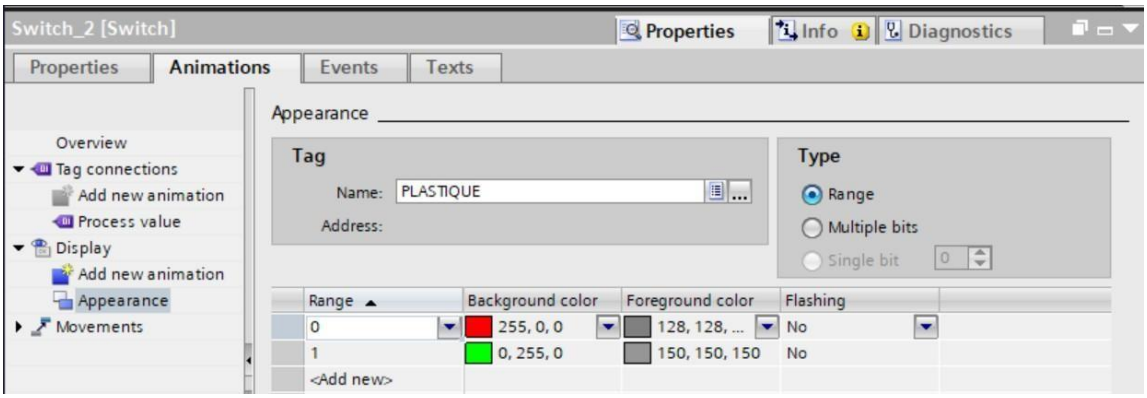


Fig 4.7. Animation for switch

This is the process I followed to program the counters for rejected and accepted pieces on the HMI:

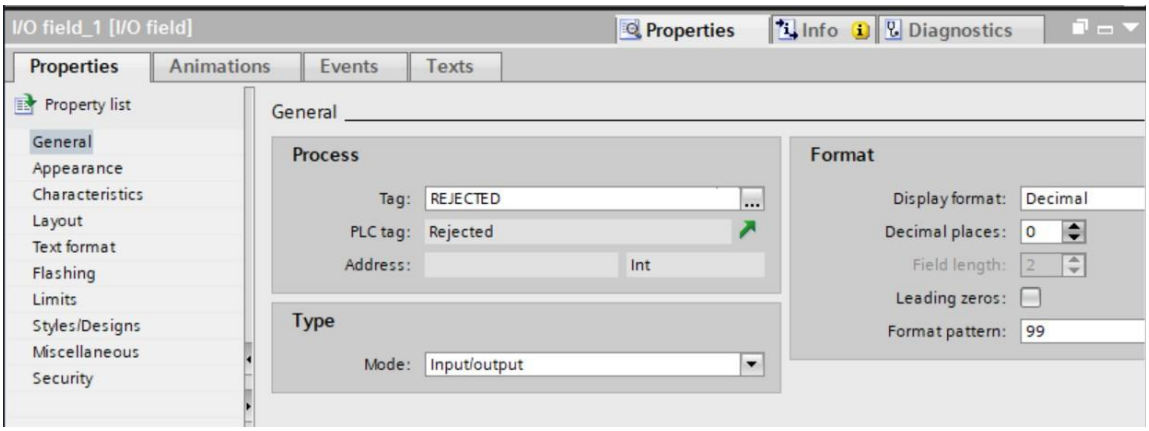


Fig 4.8. Tag PLC rejected pieces

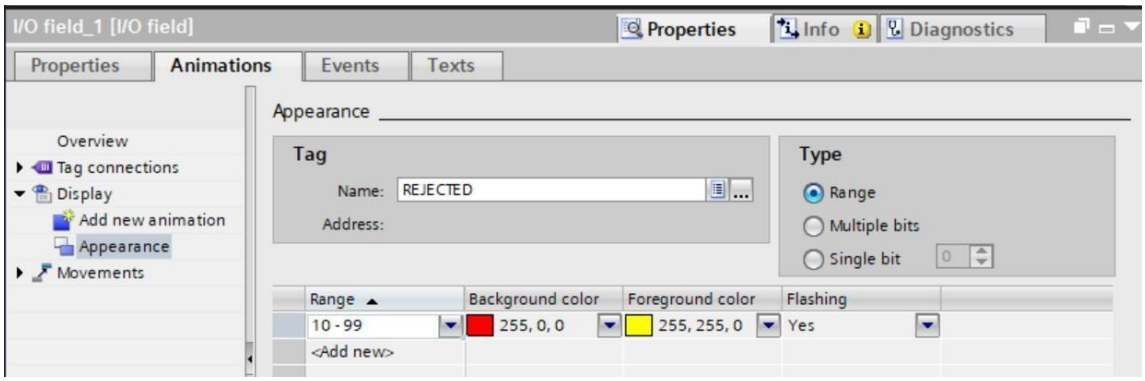


Fig 4.9. Animation of flashing lights when the rejected pieces above 10

4.6. Function:

1- Clicking the button start ⟹ the green lamp light up and the conveyor motor turns on

2- Clicking the button stop ⟹ the red lamp light up and the conveyor motor turns off

3- Clicking the button restart or auto ⟹ the yellow lamp light up and the counter of rejected and accepted piece will return to value 0

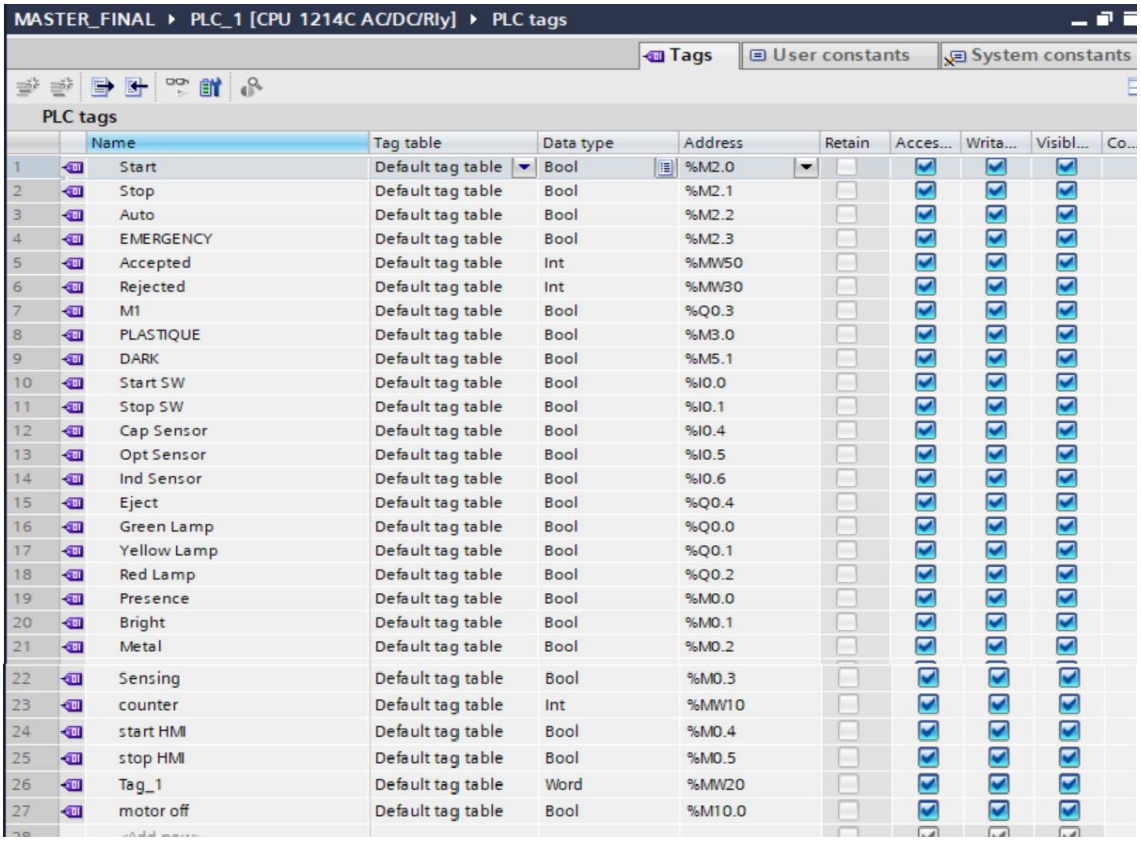
4- The light switch and the metal switch are for choosing between dark, light and metal or plastic pieces to be rejected ⟹ detecting by optical sensor and inductive sensor which will make the Ejecting solenoid actuator to change its position

5- The accepted pieces counter ⟹ counts the number of pieces every time the Ejecting solenoid actuator doesn't change it position

6- The rejected pieces counter ⟹ counts the number of pieces every time the Ejecting solenoid actuator change it position

4.7. Programming the interface:

4.7.1. PLC tags:



MASTER_FINAL ▸ PLC_1 [CPU 1214C AC/DC/Rly] ▸ PLC tags

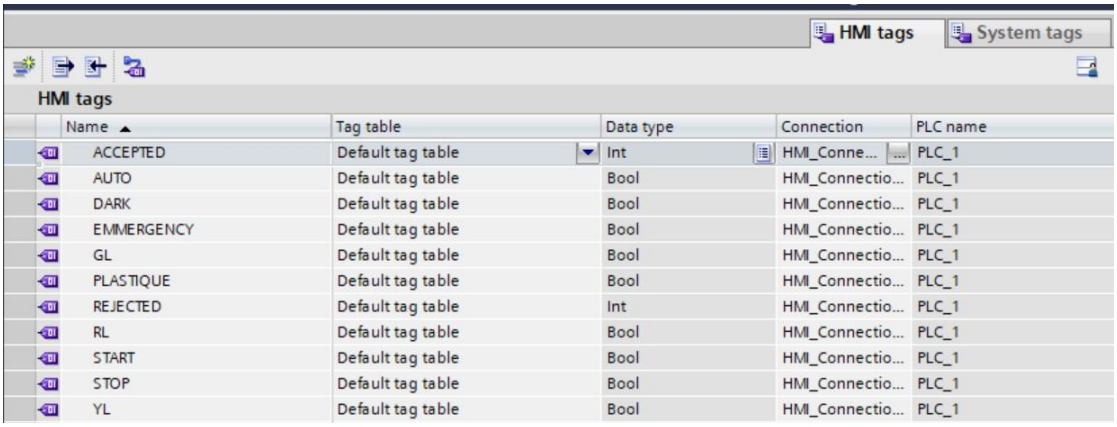
Tags | User constants | System constants

PLC tags

	Name	Tag table	Data type	Address	Retain	Acces...	Writa...	Visibl...	Co...
1	Start	Default tag table	Bool	%M2.0		✓	✓	✓	
2	Stop	Default tag table	Bool	%M2.1		✓	✓	✓	
3	Auto	Default tag table	Bool	%M2.2		✓	✓	✓	
4	EMERGENCY	Default tag table	Bool	%M2.3		✓	✓	✓	
5	Accepted	Default tag table	Int	%MW50		✓	✓	✓	
6	Rejected	Default tag table	Int	%MW30		✓	✓	✓	
7	M1	Default tag table	Bool	%Q0.3		✓	✓	✓	
8	PLASTIQUE	Default tag table	Bool	%M3.0		✓	✓	✓	
9	DARK	Default tag table	Bool	%M5.1		✓	✓	✓	
10	Start SW	Default tag table	Bool	%I0.0		✓	✓	✓	
11	Stop SW	Default tag table	Bool	%I0.1		✓	✓	✓	
12	Cap Sensor	Default tag table	Bool	%I0.4		✓	✓	✓	
13	Opt Sensor	Default tag table	Bool	%I0.5		✓	✓	✓	
14	Ind Sensor	Default tag table	Bool	%I0.6		✓	✓	✓	
15	Eject	Default tag table	Bool	%Q0.4		✓	✓	✓	
16	Green Lamp	Default tag table	Bool	%Q0.0		✓	✓	✓	
17	Yellow Lamp	Default tag table	Bool	%Q0.1		✓	✓	✓	
18	Red Lamp	Default tag table	Bool	%Q0.2		✓	✓	✓	
19	Presence	Default tag table	Bool	%M0.0		✓	✓	✓	
20	Bright	Default tag table	Bool	%M0.1		✓	✓	✓	
21	Metal	Default tag table	Bool	%M0.2		✓	✓	✓	
22	Sensing	Default tag table	Bool	%M0.3		✓	✓	✓	
23	counter	Default tag table	Int	%MW10		✓	✓	✓	
24	start HMI	Default tag table	Bool	%M0.4		✓	✓	✓	
25	stop HMI	Default tag table	Bool	%M0.5		✓	✓	✓	
26	Tag_1	Default tag table	Word	%MW20		✓	✓	✓	
27	motor off	Default tag table	Bool	%M10.0		✓	✓	✓	

Fig 4.10. PLC tags

4.7.2. HMI Tags:



HMI tags | System tags

HMI tags

Name	Tag table	Data type	Connection	PLC name
ACCEPTED	Default tag table	Int	HMI_Conne...	PLC_1
AUTO	Default tag table	Bool	HMI_Connectio...	PLC_1
DARK	Default tag table	Bool	HMI_Connectio...	PLC_1
EMMERGENCY	Default tag table	Bool	HMI_Connectio...	PLC_1
GL	Default tag table	Bool	HMI_Connectio...	PLC_1
PLASTIQUE	Default tag table	Bool	HMI_Connectio...	PLC_1
REJECTED	Default tag table	Int	HMI_Connectio...	PLC_1
RL	Default tag table	Bool	HMI_Connectio...	PLC_1
START	Default tag table	Bool	HMI_Connectio...	PLC_1
STOP	Default tag table	Bool	HMI_Connectio...	PLC_1
YL	Default tag table	Bool	HMI_Connectio...	PLC_1

Fig 4.11. HMI tags

4.7.3. Programming Ladder

1-Main block

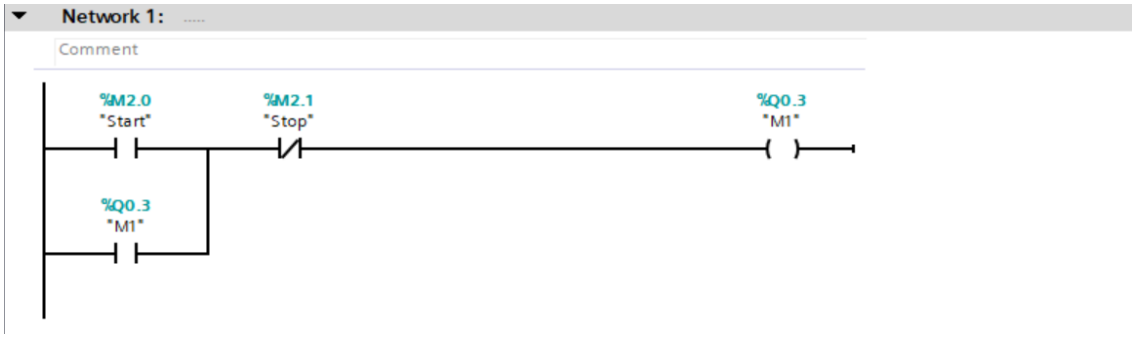


Fig 4.12. Network n°1 Auto maintain

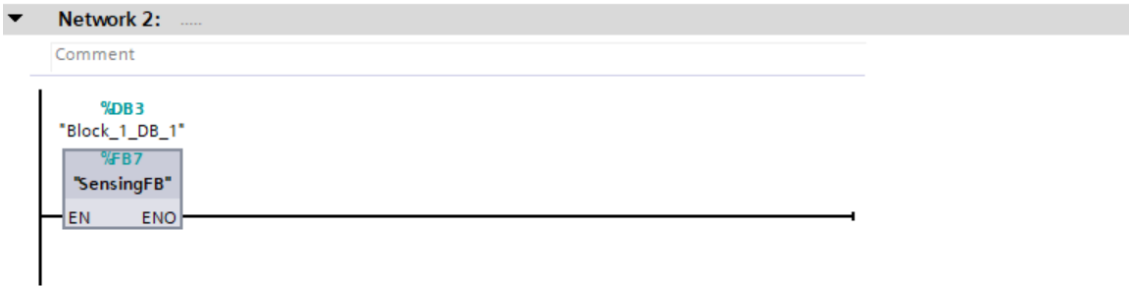


Fig 4.13. Network n°2 Sensing Bloc

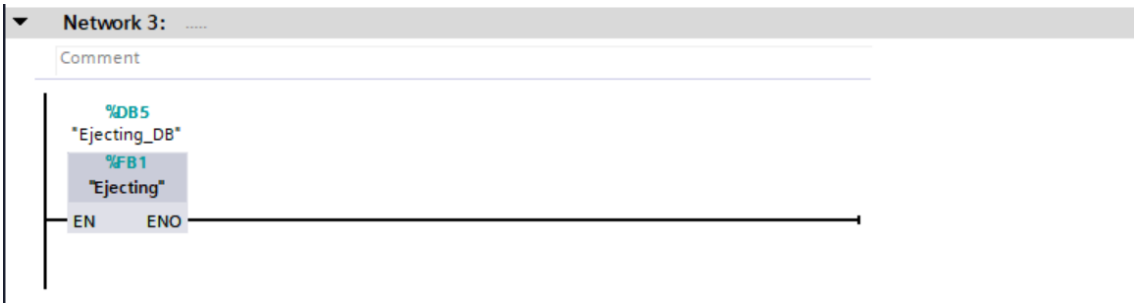


Fig 4.14. Network n°3 Ejecting Bloc

2-Sensing FC bloc:

We used a single timer in this part for the presence, brightness, and metallic sensors. The PLC can determine whether to accept or reject a component by using this timing. The sensor inputs provide the basis for the decision, and the outcomes are kept in the PLC's memory. We also included light switches that were assigned to each sensor.

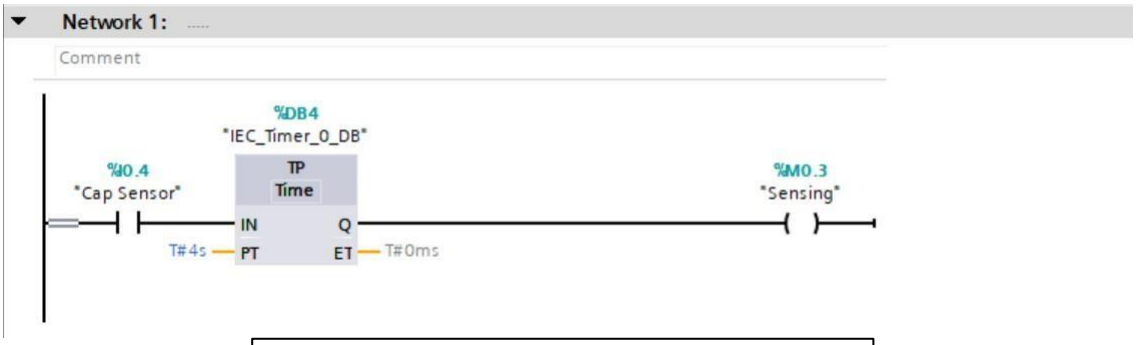


Fig 4.15. Network n°1 Timer for sensors

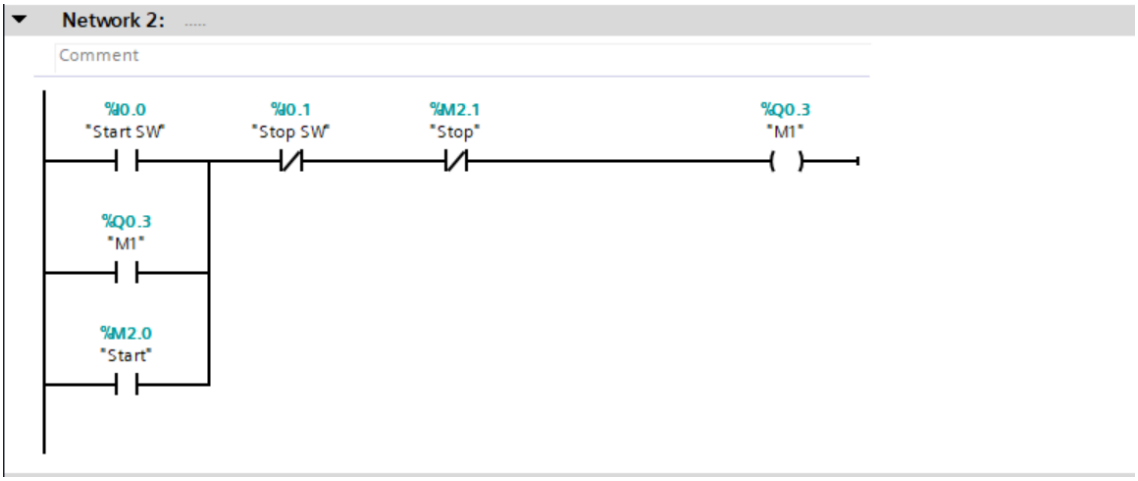


Fig 4.16. Network n°2 Auto maintain

Fig 4.17. Network n°3 Piece presence Detecting

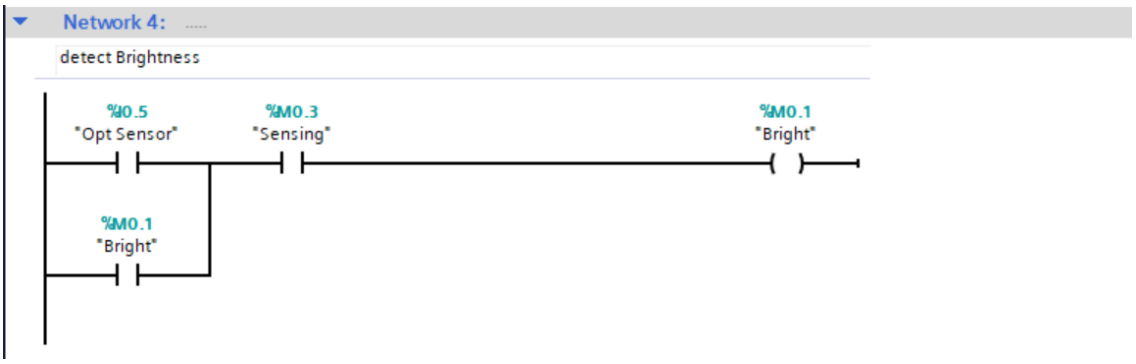


Fig 4.18. Network n°4 Light Detecting

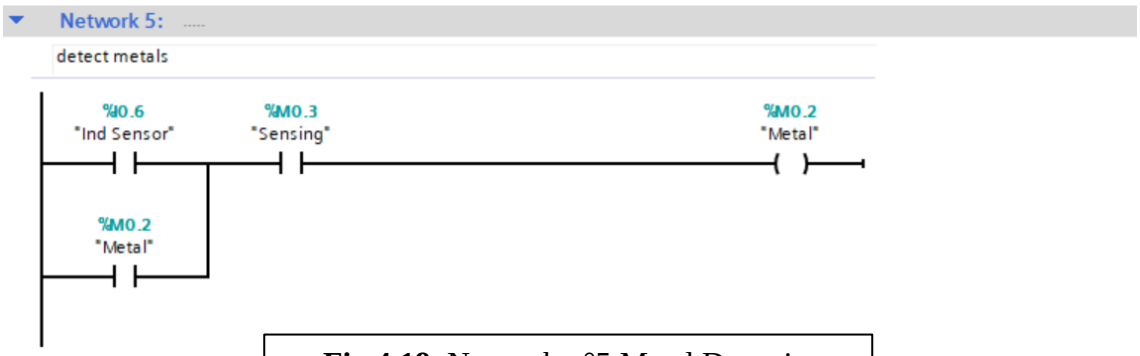


Fig 4.19. Network n°5 Metal Detecting

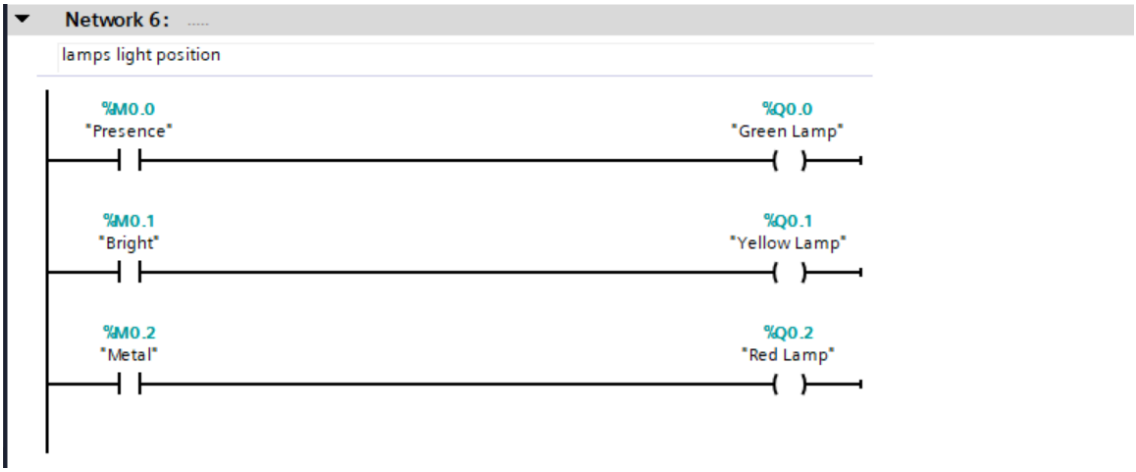


Fig 4.20. Network n°6 lamps light position

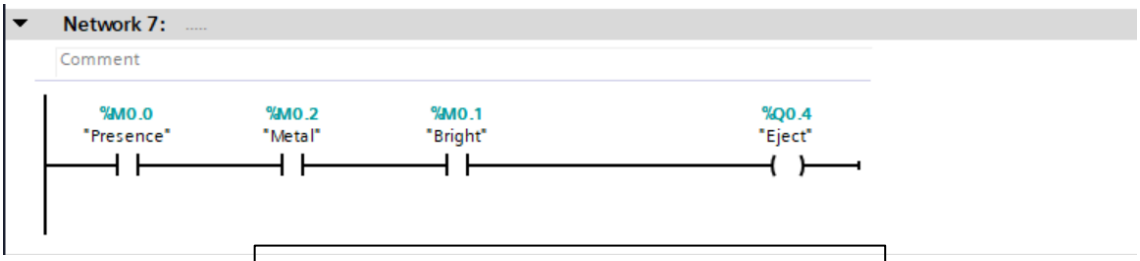


Fig 4.21. Network n°7 Sensors Ordering

3-Ejecting FC bloc:

In the ejection block, we configured the system to recognize different types of pieces and connected them to the HMI (Human-Machine Interface). This allows us to control the ejection process directly from the HMI. We implemented a timer for the ejection actuator to change its position, which makes decisions based on the sensor inputs. Additionally, we set up a counting condition that stops the conveyor motor if the number of rejected pieces exceeds 10.

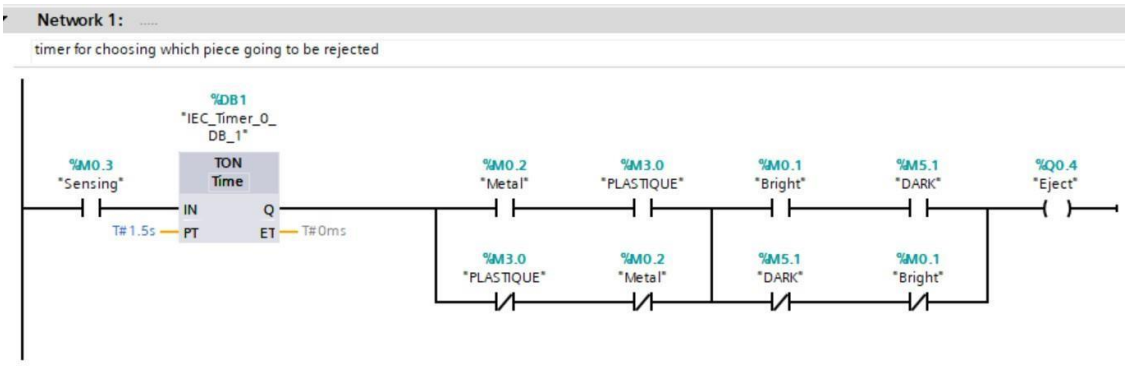


Fig 4.22. Network n°1 Rejected piece programming

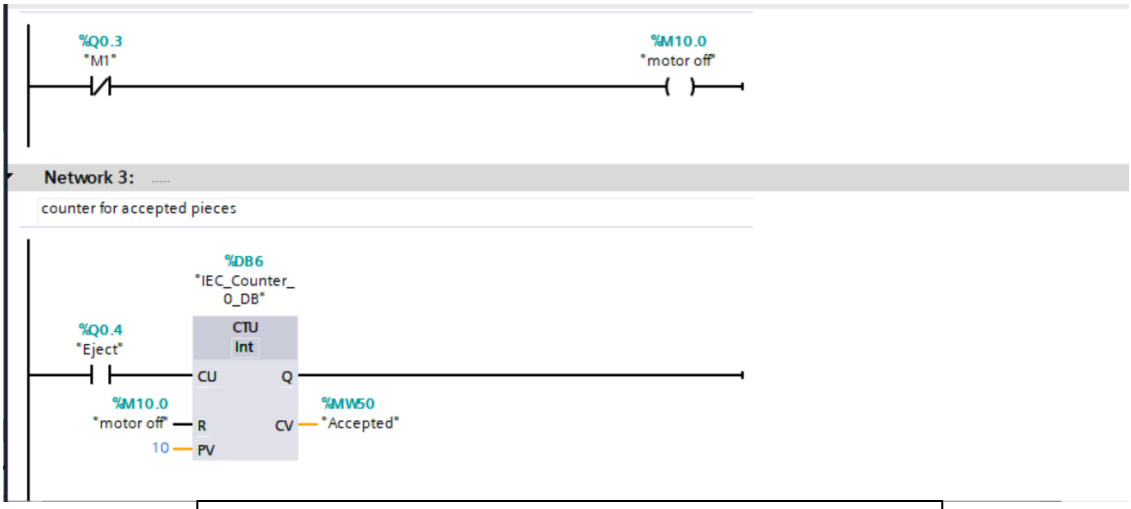


Fig 4.23. Network n°3 counter for accepted pieces

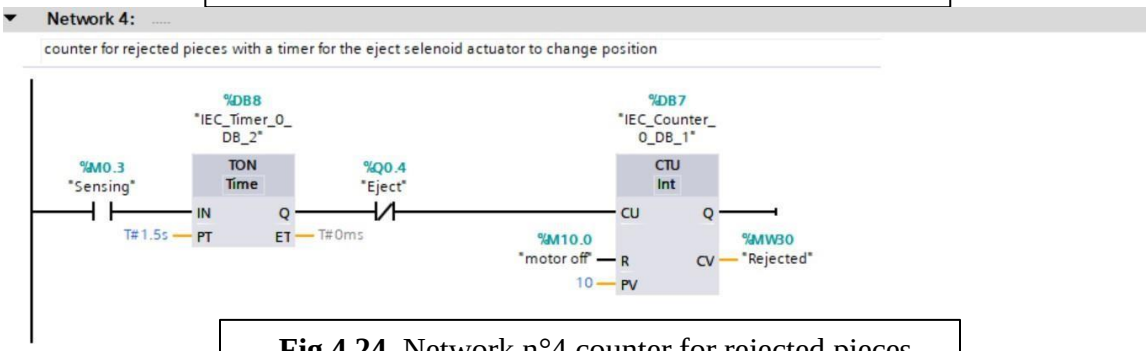


Fig 4.24. Network n°4 counter for rejected pieces

4.8. Conclusion:

This chapter presents the design process of the HMI program for the FESTECH SMS Station 2. It includes the selection of HMI software, placement of HMI elements, and design of effective interfaces. and it details the implementation of the HMI program, including the programming of control functions, sensor applications, and system maintenance components.

General conclusion and perspectives:

This work has presented the design and implementation of a Human-Machine Interface (HMI) program for the FESTECH SMS Station 2 testing system. The HMI program was designed with a focus on usability, providing a clear and intuitive interface for users to interact with the system. The implementation involved programming control functions, sensor applications, and system maintenance components.

The testing and evaluation of the implemented HMI program demonstrated its effectiveness in enhancing the operation of the FESTECH SMS Station 2. The program improved the efficiency, safety, and usability of the system, validating the importance of HMI in automation and control systems.

In conclusion, our work contributes to the field of automation and control systems by providing a practical guide to designing and implementing an HMI program for a specific industrial testing system. It combines theoretical knowledge with practical application, offering valuable insights for both academia and industry. The results underscore the pivotal role of HMI in the era of Industry 4.0 and highlight the potential of HMI programs in enhancing the operation of industrial testing systems.

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