“Siemens Simatic S7 1200 PLC Programming”

Submitted in partial fulfilment for the award of the degree
of
Bachelors of Technology
in
Mechanical Engineering

by

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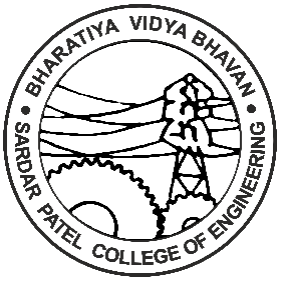

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Project Approval Sheet

This thesis/dissertation/report entitled **"Siemens Simatic S7 1200 PLC Programmingramming"** by **Suyash Mahale**, **Aniruddh Nangare** and **Dhaval Prabhudesai** is approved for the degree of Bachelors of Technology in Mechanical Engineering.

Examiners

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Declaration

I declare that this written submission represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Certificate

This is to certify that the project on **"Siemens Simatic S7 1200 PLC Programming"** is a bonafide work presented by,

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Under the guidance of,

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as a partial fulfilment for Final year Project as laid down by Sardar Patel College of Engineering during academic year 2022-2023.

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CONTENTS

ACKNOWLEDGEMENT

We express our sincere thanks and gratitude to all those who have extended their co-operation for our project.

We hereby take this opportunity to thank our project guide Prof. Sachin Vankar, for his valuable guidance. We are also thankful to our Dept. of Mechanical Engineering, Sardar Patel College of Engineering.

We also thank Mr. Aquib Shaikh (PLC Expert, Maze Automation) for helping and guiding us at various stages in our project.

In the end a special thanks to all the staff members at Sardar Patel college of Engineering, for their cooperation.

ABSTRACT

A constant demand for better and more efficient manufacturing and process machinery has led to the requirement for higher quality and reliability in control techniques. With the availability of intelligent, compact solid state electronic devices, it has been possible to provide control systems that can reduce maintenance, down time and improve productivity to a great extent. One of the latest techniques in solid state controls that offers flexible and efficient operation to the user is "PROGRAMMABLE LOGIC CONTROLLER".

Systems, whose logic can be modified but still, used without disturbing its connection to the external world, are achieved by PLC. Proper application of a PLC begins with conversion of information into convenient parameters to save money, time and effort and hence easy operation in plants and laboratories. PLC controls the total system; it is difficult to define where a PLC cannot be used.

Considering the importance of PLCs in technology and its widespread engineering applications the basics of PLC will be illustrated. Later ladder logic and functional block diagram programs of 44 applications of PLC using the situations to be handled as the problem statement will be covered. It then ventures into the very important stage that is virtual simulation of the PLC programs. It covers important features; configuration of a PLC, compilation of the program, running the ladder logic on the PLC and virtual simulation of the PLC Program.

The project works as a guideline to individuals who wish to learn about PLCs and helps them to write, compile and successfully simulate a PLC program using ladder logic and functional block diagram languages.

LIST OF FIGURES

LIST OF TABLES

1. Introduction

1.1 What is a PLC?

A PROGRAMMABLE LOGIC CONTROLLER or simply a PLC is an industrial computer control system that continuously monitors the state of input devices and makes decisions based upon a custom program to control the state of output devices.

Programmable Logic Controller (PLC) is a special computer device used in industrial control systems. Due to its robust construction, exceptional functional features like sequential control, counters and timers, ease of programming, reliable controlling capabilities and ease of hardware usage – this PLC is used as more than a special-purpose digital computer in industries as well as in other control-system areas. Most of the industries abbreviate these devices as "PC" but it is also used for personal computers; due to this, many manufacturers named these devices as PLCs.

The programmable logic controller is used not only for industrial purposes but also in civil applications such as washing machines, elevators working and traffic signals control. Different types of PLCs from a vast number of manufacturers are available in today's market. Therefore, in the following paragraphs, let us study about programmable logic controller's basics, principles and applications.

A standard unit of a PLC is as shown below;

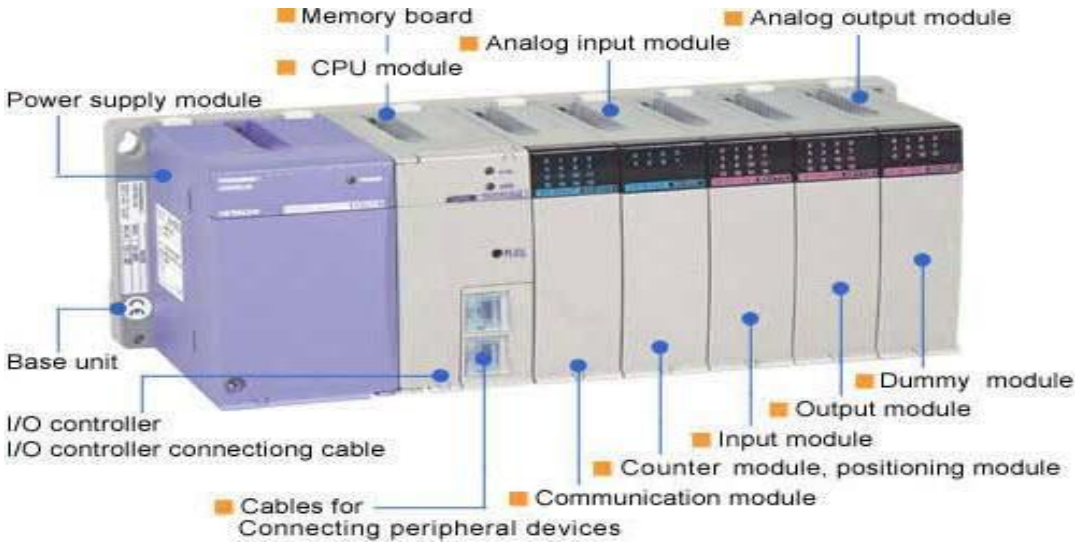


Fig. 1: Programmable Logic Controller

1.2 The Principle system of PLC

It consists of three basic sections:

1. Central processing unit (CPU).
2. Memory: EPROM, RAM, and so on.
3. Input/output section for communication with peripherals (ADC, DAC).

CENTRAL PROCESSING UNIT (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.

MEMORY:

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

I/O MODULES:

The input and output modules of the programmable logic controller are used to connect the sensors and actuators to the system to sense the various parameters such as temperature, pressure and flow, etc. These I/O modules are of two types: digital or analog.

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.

1.3 Applications of Programmable Logic Controller (PLC)

The PLC can be used in industrial departments of all the developed countries in industries like chemical industry, automobile industry, steel industry and electricity industry. Based on the development of all these technologies, functionality and application the scope of the PLC has increased dramatically.

1. Applications of PLC in Glass Industry

From the year 1980 the Programmable-logic controllers are in use in the glass industry, and they are assembled bit by bit. PLCs are used mainly in every procedure and workshop for controlling the material ratio, processing of flat glasses, etc.

With the development of PLC and increasing demand in the real world, the control mode of the programmable-logic controller with an intelligent device is applied in the glass industry. In making a float glass, PLC itself cannot finish some controlling tasks because of the complexity of the control system and processing of huge data. For the production of glass, we make use of bus technology to construct the control mode of a PLC with a distributed-control system. This control system deals with analog controlling and data recording; the PLC is also used for digital quality control and position control.

This type of control mode is a big advantage for PLC and DCS for improving reliability and flexibility of the control system.

2. Applications of PLC in Cement Industry

Along with the best-quality raw materials, the accurate data regarding process variables, especially during mixing processes within the kiln, ensures that the output provided should be of the best possible quality. Nowadays a DCS with bus technology is used in the production and management industry. By using this existing DCS control system, the PLC is in user mode of SCADA. This mode comprises PLC and configuration software. This SCADA mode comprises the PLC and host computer. The host computer consists of slave and master station. The PLC is used for controlling the ball milling, shaft kiln and Kiln of coal.

2. The Programming Languages

There are six programming languages available for any PLC, But the most common between them is Ladder Programming and Functional Block Diagram. The name of all of the programming Languages are:

- Ladder Diagram. (LD)

- Sequential Flow Chart. (SFC)

- Functional Block Diagram. (FBD)

- Instruction List. (IL)

- Structured Text. (ST)

- Continuous Function Chart. (CFC)

A program is loaded into PLC systems in machine code, a sequence of binary code numbers to represent the program instructions. Assembly language based on the use of mnemonics can be used, and a computer program called an assembler is used to translate the mnemonics into machine code. High level Languages (C, BASIC, etc.) can be used.

Since the project is still at the beginners stage, Ladder Diagram and Functional Block Diagram are used.

3. PROBLEM DEFINITION

In today's era of industry 4.0, automation is one of the important technologies of the industry. PLC is the current technology which is used for industrial automation.

To learn this kind of technology, it is a bit expensive. PLC programing courses nearly cost around 5,000-50,000/- It is difficult for those students who are pursuing engineering courses, to take additional courses like automation in the early stage of the engineering as they have to juggle many things. Also, the timings of the college and the course conducted sometimes do not match.

So, we decided to plan the entire course for the newcomers in the college as well as make an easy to understand lab manual. It will become easy for them to understand the current trends in PLC and will get hands-on practice inside the college. So, they can learn industrial automation technology along with the ongoing engineering course. At the end of the course, after giving the assessment test they shall get a Certificate from the College/Department. And this course will be offered at a very affordable price. It will not only help them in improving their resume, but will also enhance their knowledge and keep them updated with the current trends in technology.

4. Objectives, Scope and Methodology

4.1 Objectives

1. To compose an elite training manual for SIEMENS S7-1200 PLC.
2. To code real life application programmes using the SIEMENS TIA PORTAL V13.
3. To hold a short training session for UG students.
4. To publish a research paper based on real life application which is useful in Industries.

4.2 Scope

1. PLC in use: SIEMENS SIMATIC S7-1200
2. Programming language in use: Ladder Diagram and Functional Block Diagram
3. Softwares in use : Siemens TIA Portal V12 and Siemens PLCSIM

4.3 Methodology

1. Referring Research Paper on ResearchGate, Science Direct, etc.
2. Learning using Online Paid Courses on Udemy.
3. Consulting with PLC Technicians.
4. Referring Books and Youtube Videos.

5. Literature Review

Topic Name - Transformation method from HI graph language to FBD using Set-Reset block in siemens simatic software for PLC Programming.
Author Name - Vo Nhu Thanh.
Date/Year - 2013
Content - Siemens has introduced a new product line of S7-1200 PLC with low price and stable operation. Therefore, there are many companies using other PLC want to switch to the S7-1200 line. However, the PLC S7-1200 does not support the programming by Graph or HiGraph language as the S7-300, 400. This paper introduces a method for converting Graph or Hi-Graph language into the FBD language to program for the PLC of Siemens which doesn't support programming by Graph or Hi-Graph. The advantage of this method is that the FBD language takes much less space in memory than the Graph language. However, it takes more time and is more complex to program than the Graph language.

Topic Name - Fuzzy Controller based on PLC S7-1200 Application to a Servomotor
Author Name - Isaias Gonzalez Perez, A. Jose Calderon Godoy and Manuel Calderon Godoy.
Date/Year - 2014
Content - This paper presents the design and validation of a fuzzy logic controller implemented with an industrial programmable logic controller (PLC). The fuzzy controller is of Mamdani type and is applied to control the speed of a servomotor. A comparison with a Simulink/Matlab fuzzy controller is done to validate the developed software module and to show the feasibility of the PLC to manage this kind of control algorithm. This work has contributed to a better understanding of the abilities and procedures to implement fuzzy controllers in PLC.

Topic Name - On the practical integration of anomaly detection techniques in industrial control applications
Author Name - Piroska Haller, Bela Genge, Adrian-Vasile Duka
Date - 26 Oct 2018
Content - They developed an innovative methodology for the practical integration of a lightweight anomaly detection algorithm in industrial control applications. The methodology consists of a "monitoring" task and of a detection algorithm that distinguishes itself from previous studies. A Siemens SIMATIC S7-1200 controller demonstrated the practical integration of the proposed methodology; They observed that the approach does not replace existing security instruments. On the contrary, it aims at providing yet another security tool in the hands of security engineers. It helps to have a significant advantage in the prevention of cyber attacks.

Topic Name - An Industry 4.0 approach to develop auto parameter configuration of a bottling process in a small to medium scale industry using PLC and SCADA
Author Name - Kahiomba, Sonia Kiangala, and Zenghui Wang.
Date/Year - 2019
Content - The aim of this paper is to design, through a logical program in a S7-1200 Siemens PLC controller, an AUTOMATIC and independent experimental bottling process that reconfigures machine parameters, interprets production output and strives to meet daily targets. This paper develops a strategy to track closely Recent trends of manufacturing processes, like Industry 4.0 (I4.0), strive to replace existing manual systems with fully self controlled, reconfigurable processes to improve the overall production system. The developed strategy gets the production as close as possible to the daily target by configuring the daily production as a function of time and applying programming conditions to automatically boost the system when target is not reached.

Topic Name - Application of Siemens PLC in Thermal simulator control system
Author Name - Hailong su, zong-an luo, Ying ying feng.
Date/Year - 2019
Content - In this paper, Siemens PLC controller, real-time communication technology is used to design a control system of the thermal simulator for closed-loop control tasks in thermal simulation control systems.

Topic Name - Automatic control and detection systems for low-level radioactive waste drums
Author Name - P. Guili, T. Xianguo, L. Huailiang, S. Rui, W. Shoubin.
Date/Year - 2020
Content - The radioactive nuclear wastes are usually contained in special drums. Consequently, these nuclear waste drums must be tested, classified and their levels measured before they are placed in a final repository. It puts forward a detection device for the automatic control and monitoring system of low-level nuclear waste drums. The device is composed of machinery equipment, automated systems, a programmable logic controller, electric installations for equipment protection, an HPGe detector and an external gamma-radiation transmission source. This study describes the methods involved in scanning and measuring the vertical section of radioactive waste drums and describes using the programmable logic controller (PLC-SIEMENS S7-1200) in order to construct an automated system as well as a detection system.

Topic Name - Design of Intelligent Feeding Control System Based on S7-1200 PLC
Author Name - Tian feng, Li Guangpeng.
Date/Year - 2021
Content - In order to satisfy the needs of pig breeding, an intelligent feeding control system based on S7- 1200PLC is designed in this paper. The article has carried out the electrical design,

including I/O address allocation, the main circuit design, the control circuit design and written PLC control program in debugging and operational mode. The system is safe, reliable, stable and efficient, which realizes the automatic and intelligent requirements of an intelligent feeding system. It has achieved the expected goal of the design and has a certain value of popularization and application.

Topic Name - Technological revolution in Industrial Automation using PLC
Author Name - Dr.Kaushika Patel, Viraj Jogani, Prapti Bhajiyawala, Akshit Modi, Parul Panchal.
Date/Year - April 2021
Content - PLC are simplest forms of control structures that are now taking over the hard-wired Relays. One of the critical functions of PLC is that its input and output elements can be prolonged according to the requirement or motive. They are very easy to operate for those who are having even basic Information. PLC and SCADA have turned out to be an integral part of the industrial automation sector. SCADA is a system that helps inside the working of devices that are placed in remote locations. PLC is an industry wide device that will enhance the value of control education with a more holistic approach.

Topic Name - Design of gas drainage pipe network regulation and control system based on PLC
Author Name - ZuXun Wang.
Date/Year - 2022
Content - This study gives the techniques to improve efficiency. Gas drainage pipe network system adopts Siemens S7-1200 series PLC as the core control unit of the gas drainage pipe network. Through the explosion-proof treatment of the PLC control box, the gas drainage pipe network regulation and control system can effectively improve the regulation efficiency of the gas drainage pipe network and reduce the labour intensity of workers.

Topic Name - Siemens S7-1200 PLC DC Motor control capabilities
Author Name - Almedin Salkic, Haris Muhovic, Dejan Jokic.
Date/Year - 2022
Content - This paper contains the example of DC motor control in many ways. The control can be established by revolutions per minute, by PID (Proportional-Integral-derivative) controller and by position controlling. Using the Human Machine Interface (HMI), mode of control can be chosen. The control of various motor parameters is demonstrated. All this is combined and brought to the end user through a simple graphical user interface with the help of HMI devices.

6. Current Progress

After undertaking this project, we first started by checking the software and hardware. We found that the licence of Siemens TIA Portal V12 software had expired and hence we tried finding the licence of the software but only the newer version of the software was available, which was not supported by our Siemens S7-1200 PLC. Therefore we decided to install this software on our personal laptops. Then we tested the hardware and found that the tracks of the trainer PCB had worn out, because of which the PLC was not getting a power supply. Therefore we decided to give direct power supply to the PLC using a 24V DC Power Source. Upon using this power source the PLC started working, but unfortunately the trainer PCB did not work as it was not connected to any power source. Next we started searching for online PLC Courses and found out 3 courses on Udemy which would be useful for us. Then we enrolled ourselves in those courses and completed them over a period of 3 months. Using the Siemens TIA Portal V13, we made a total of 44 programs and simulated them using Siemens PLCSIM software.

The 44 programs are as follows:

1. AND Function	23. Running Light
2. OR Function	24. Counting Bottles
3. NOT Function	25. Windmill
4. NAND Function	26. Sequential Circuit
5. NOR Function	27. Parking Space
6. XOR Function	28. Monitoring Personnel Output
7. AND Before OR	29. Surveillance of a Ship
8. Changeover Circuit	30. Boiler
9. Cross Circuit	31. Temperature Monitor
10. Impulse Relay	32. Temperature with Light Indicator
11. Staircase Light Switch	33. Rolling Door
12. Switch On Delay	34. Flood Lights
13. Switch Off Delay	35. Inching Continuous Operation of a Motor
14. Selection Circuit 1 of 3	36. Reverse Drive
15. Selection Circuit 2 of 3	37. Reversing Contactor
16. Power Surge with Contactor	38. Turn Over Off
17. Garage Lighting	39. Direction of Rotation Detection
18. Mixing Plant	40. Speed Control with PWM
19. Gear Lubrication	41. Traffic Light System
20. Press	42. Solar Model 1 Axis
21. Lift	43. Cube
22. Automatic Star Triangle	44. Mixer with two Speeds

Table 1 : - List of 44 Completed Programs

7. SIEMENS SIMATIC S7-1200 PLC PROGRAMMING

7.1 Basic programs in ladder logic

Value 1	Value 2	AND	OR	NAND	NOR
FALSE	*FALSE*	FALSE	FALSE	TRUE	TRUE
TRUE	*FALSE*	FALSE	TRUE	TRUE	FALSE
FALSE	*TRUE*	FALSE	TRUE	TRUE	FALSE
TRUE	*TRUE*	TRUE	TRUE	FALSE	FALSE

Table 2:- Logic Gate Input-Output Values

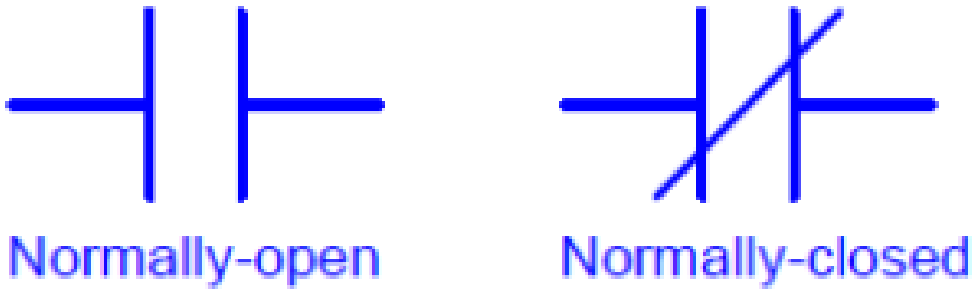


Fig 2 - Symbol of Normally Open and Normally Closed Switch

AND Function

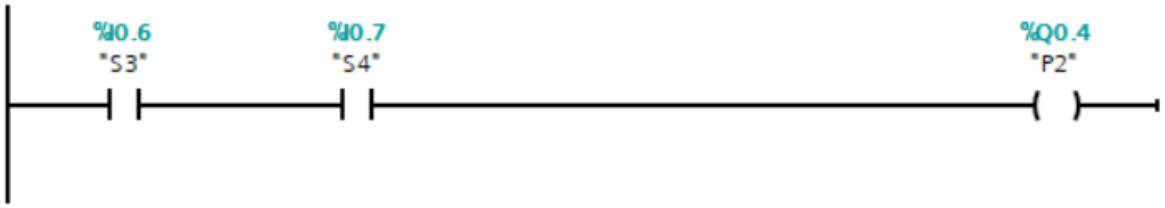


Fig 3 - AND Function Circuit made using Siemens TIA Portal V13

OR Function

Fig 4 - OR Function Circuit made using Siemens TIA Portal V13

NOT Function

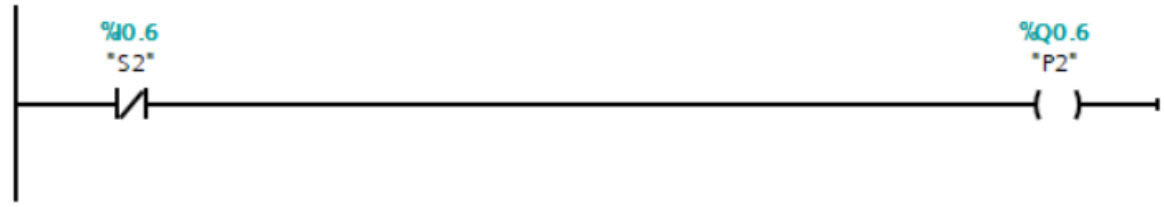


Fig 5 - NOT Function Circuit made using Siemens TIA Portal V13

NAND Function

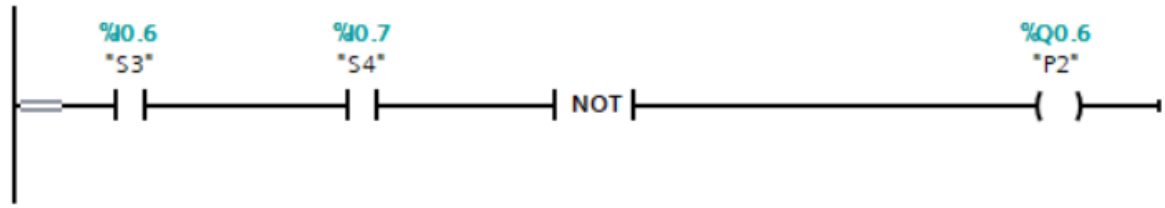


Fig 6 - NAND Function Circuit made using Siemens TIA Portal V13

NOR Function

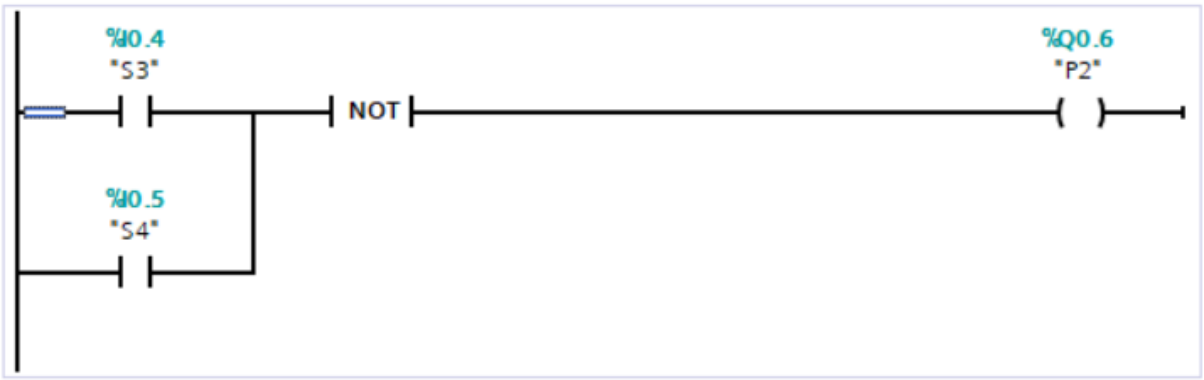
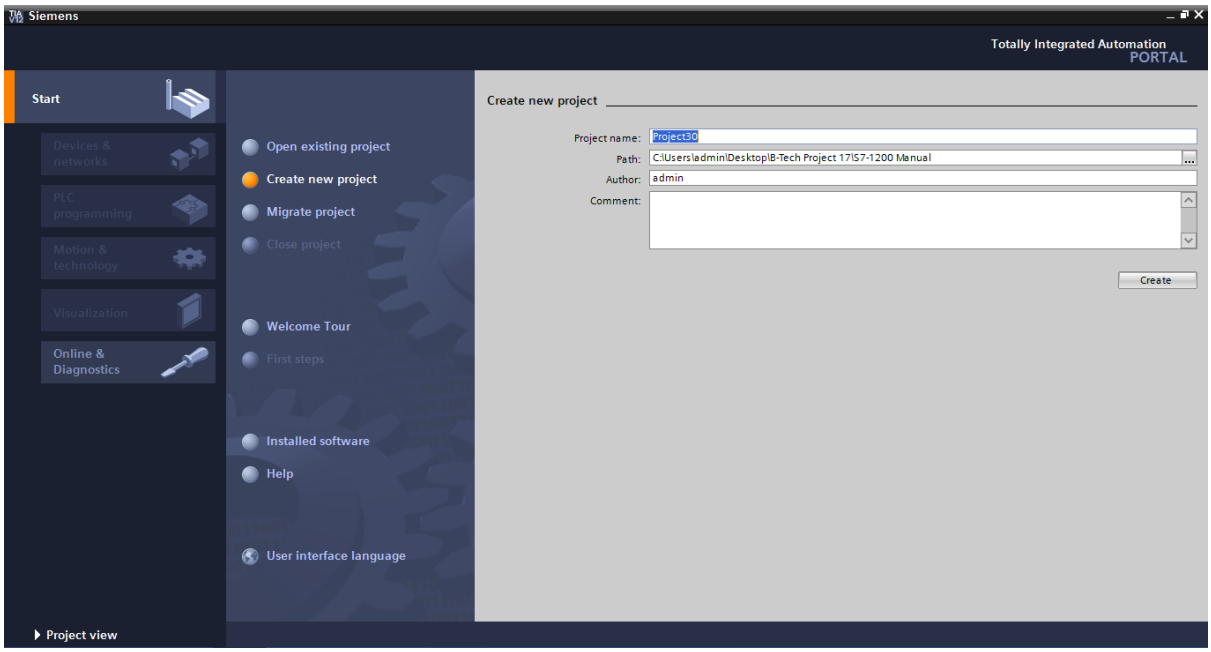


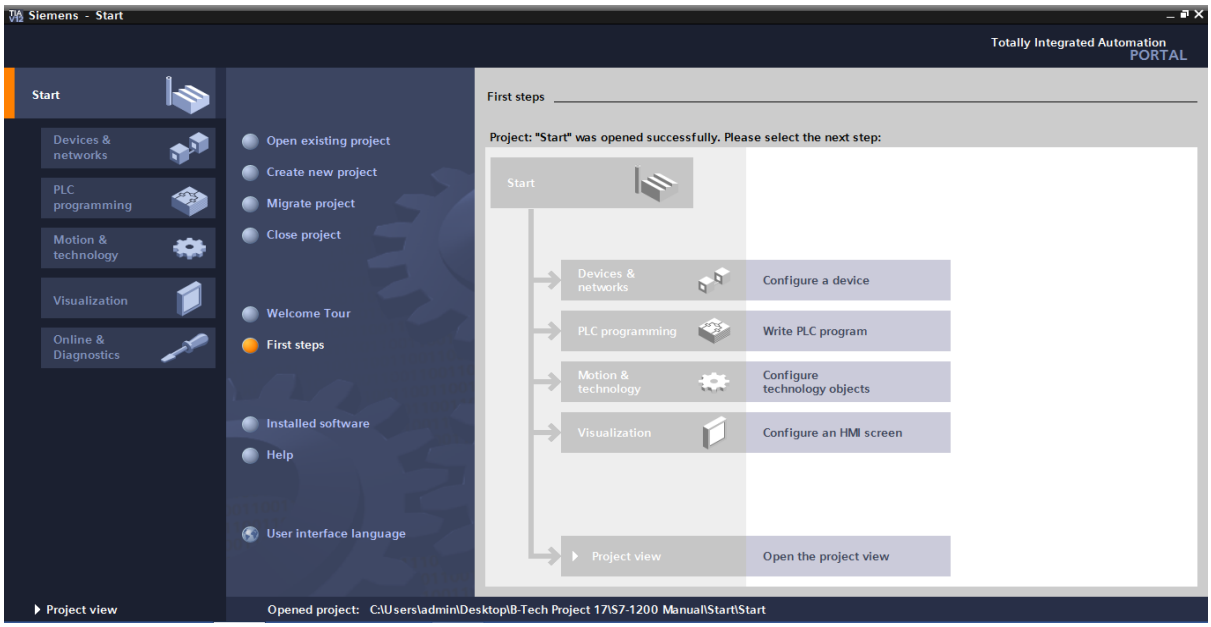
Fig 7 - NOR Function Circuit made using Siemens TIA Portal V13

7.2 Writing a program using Total Integrated Portal SIMATIC S7-1200

Once you start the PC, you can see the icon for the SIMATIC S7-1200 PLC, i.e., TIA V13 as highlighted below.
Click and open the TIA V13 Software.
You can open an existing program or create a new one.
To create a new program select ‘Create new project’. Name it.
You can select where to save it using the ‘Path’ option.

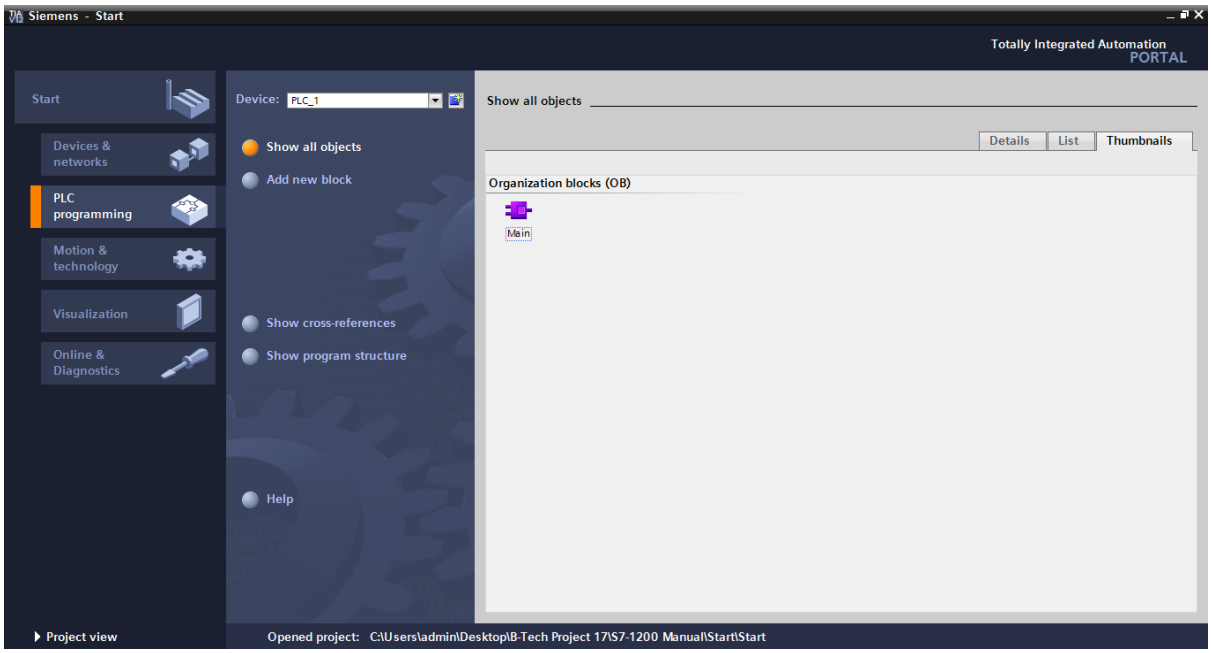


Now a new window will appear; where you can select multiple operations.
To write a new program select ‘Write PLC program’.



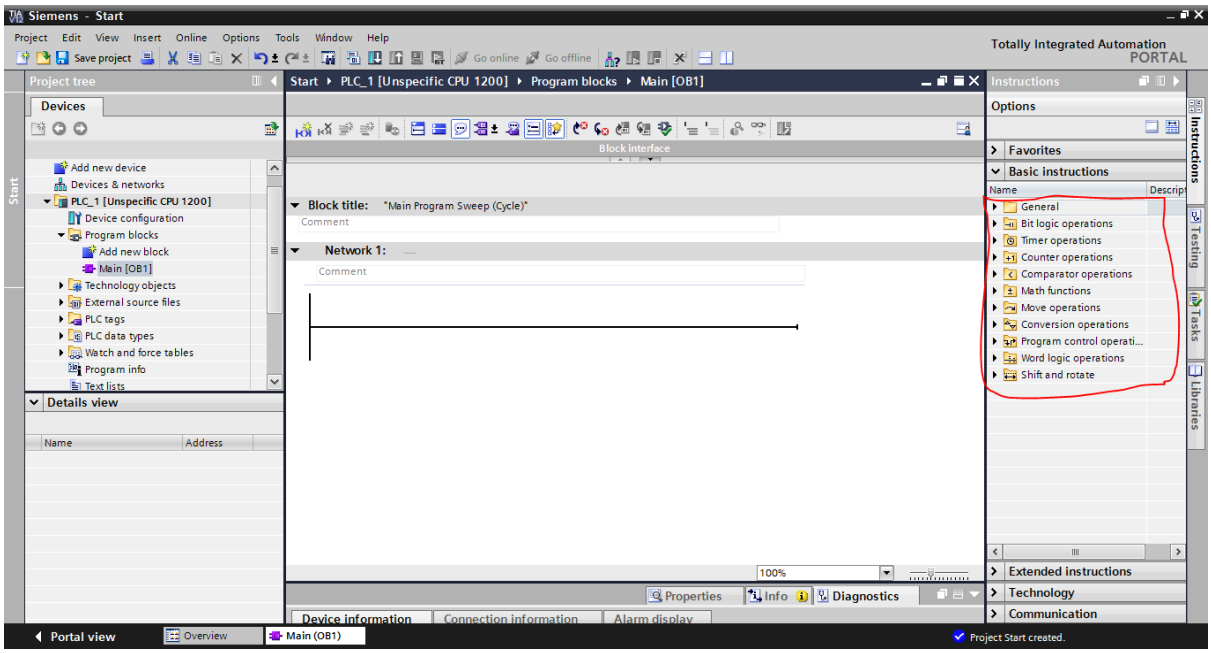
Double click on the ‘Main’ that can be seen below the ‘Organization Block (OB)’

This is where your program will be written.



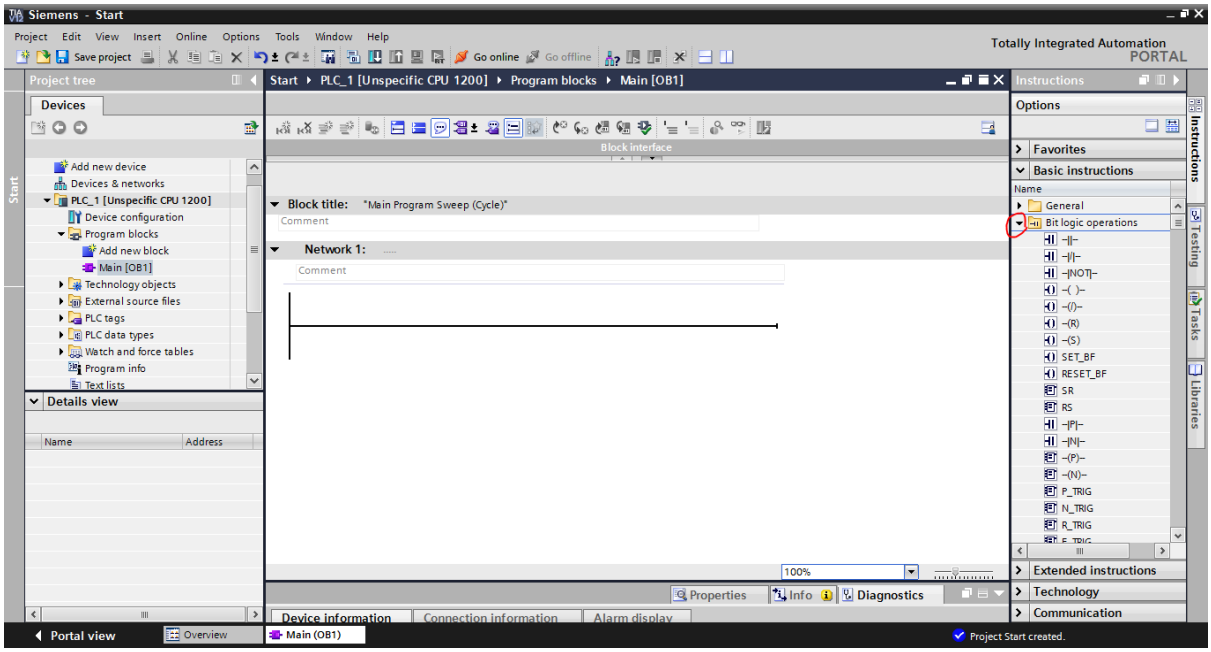
This is your workplace!

On the right side are the general operations and instructions required, as highlighted.

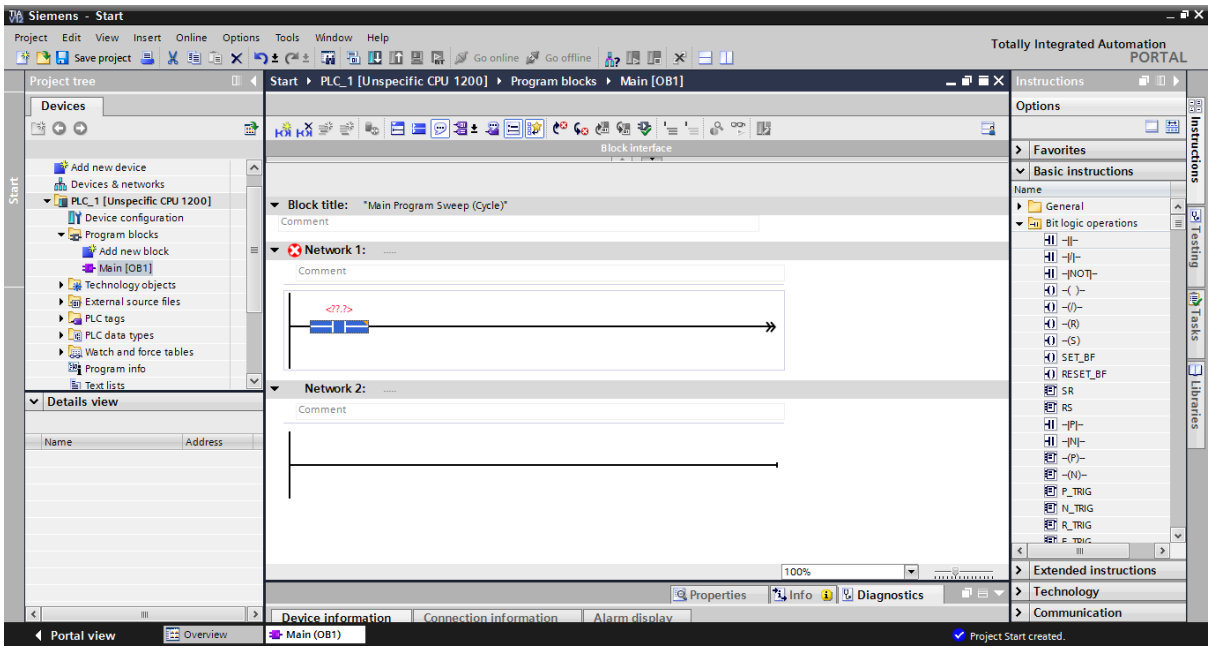


In the ‘Bit Logic Operations’ you will find basic switches.

You can either drag and drop the switch on the rung or select the rung first and then click on the switch.

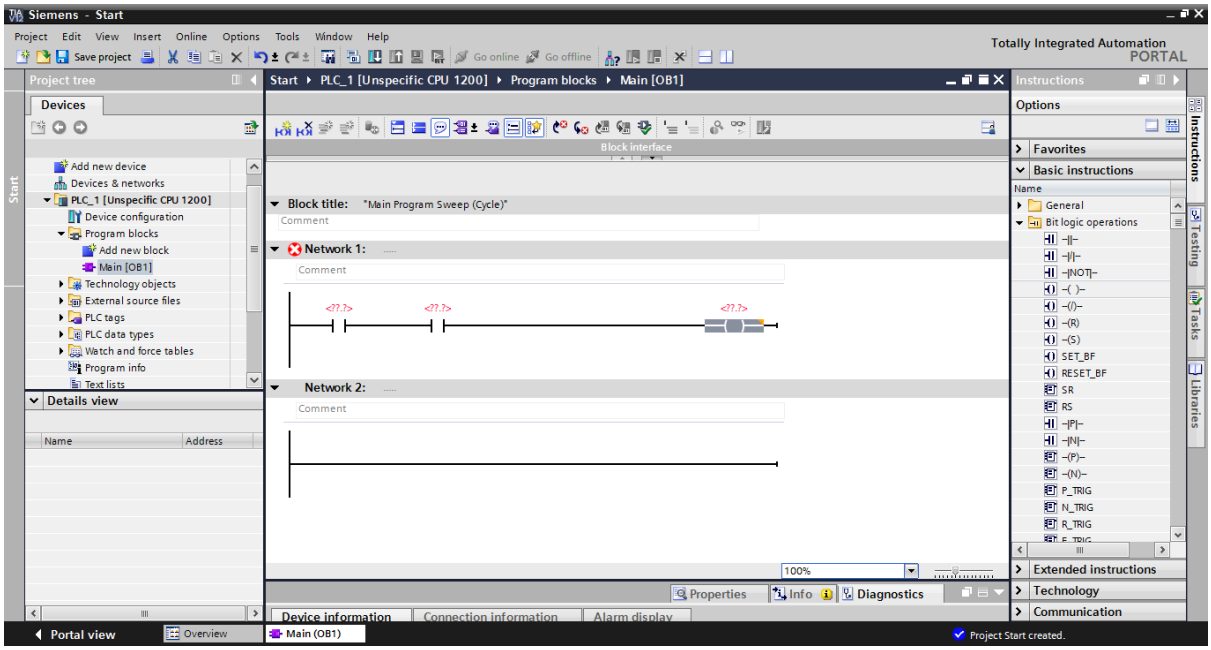


The run will look like this once the switch is placed on it.

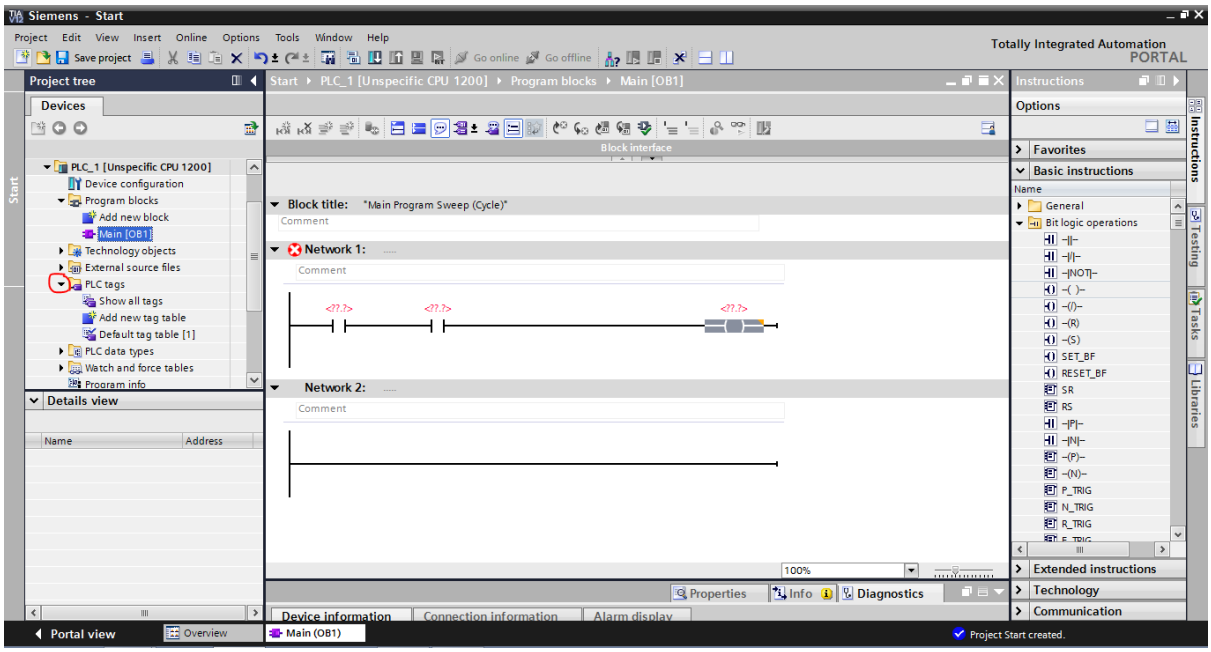


Add one more switch and an output.

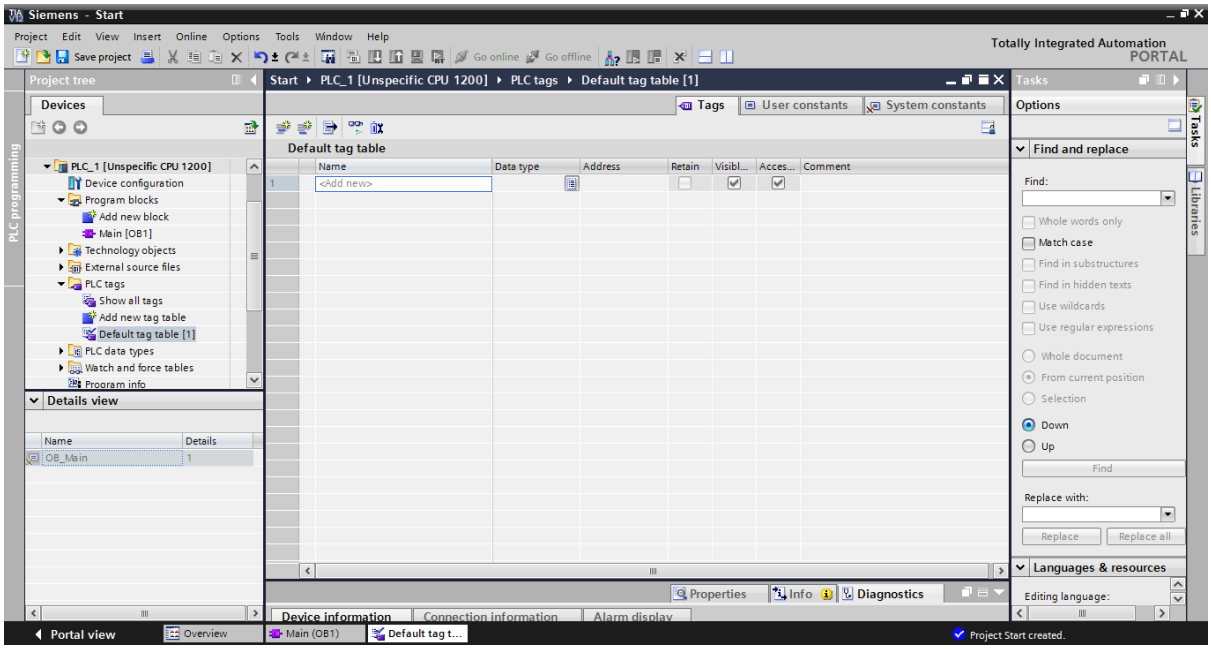
Here you can write the entire ladder logic.



On the left side you can see a highlighted area.
Click on the ‘PLC tag’ option.



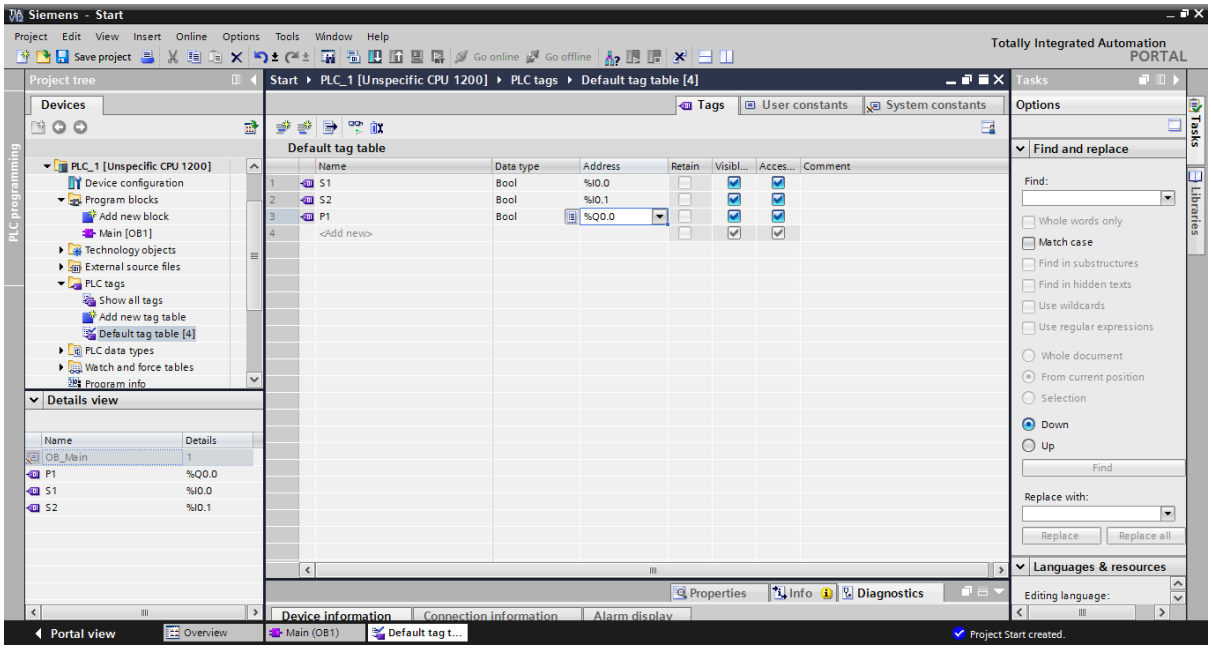
We use it to define addresses for different inputs and outputs.



Here we have defined switches as inputs given by symbol S1 and S2, and output is given by P1.

Note: In the address column, after defining the switch, click on the tiny black arrow to denote input/output characteristics.

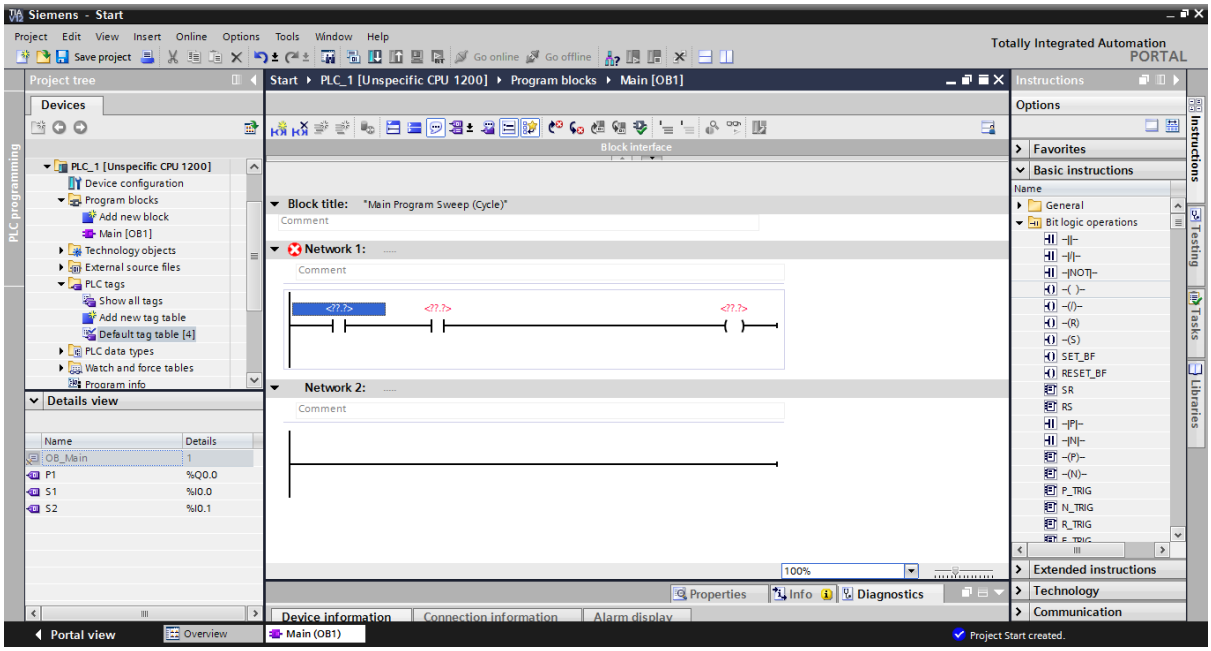
For input select ‘I’; for output select ‘Q’.



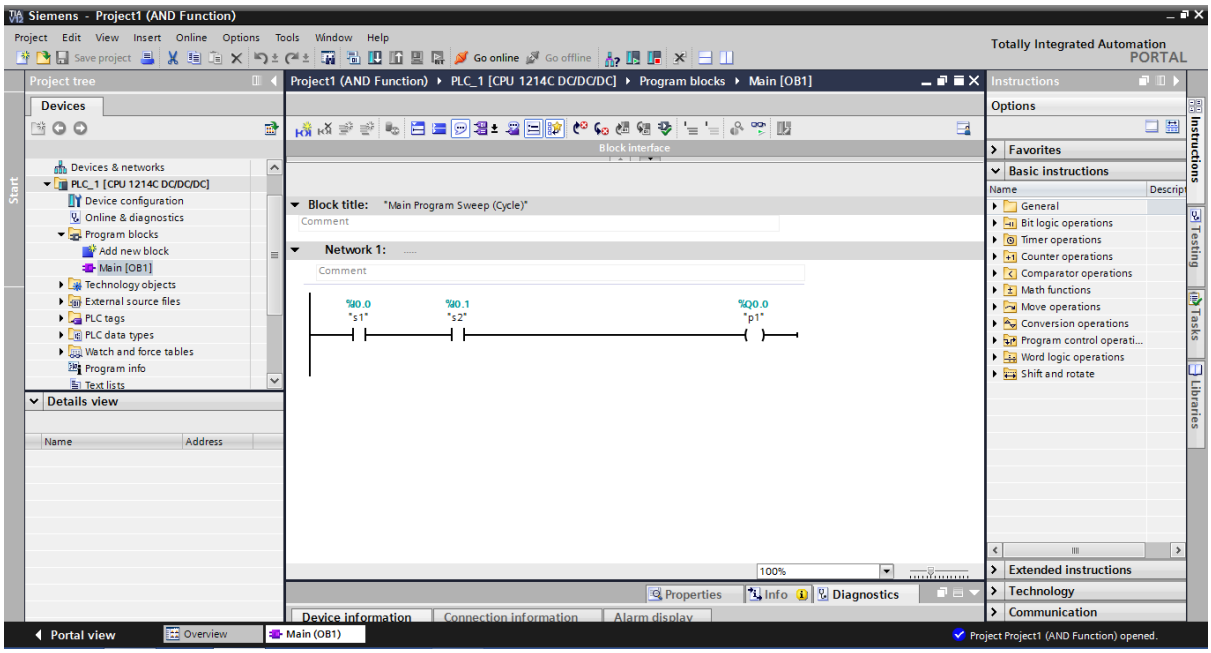
Close the tag table.

Select switch.

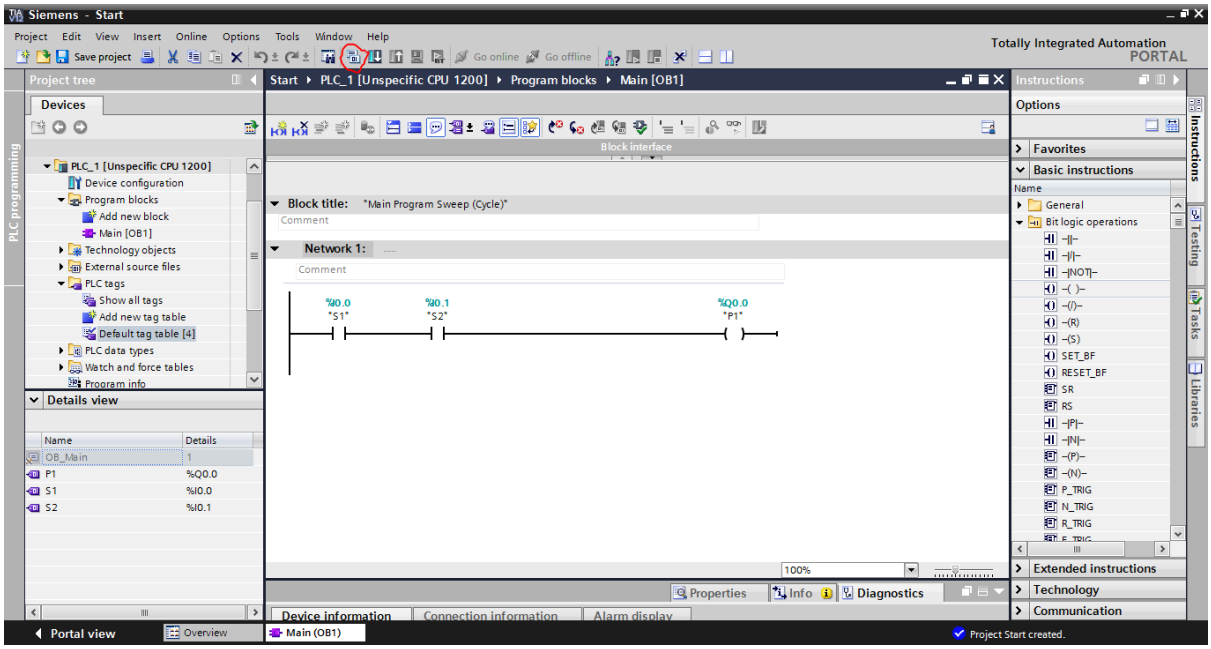
Allot address to the switch using the tag table.



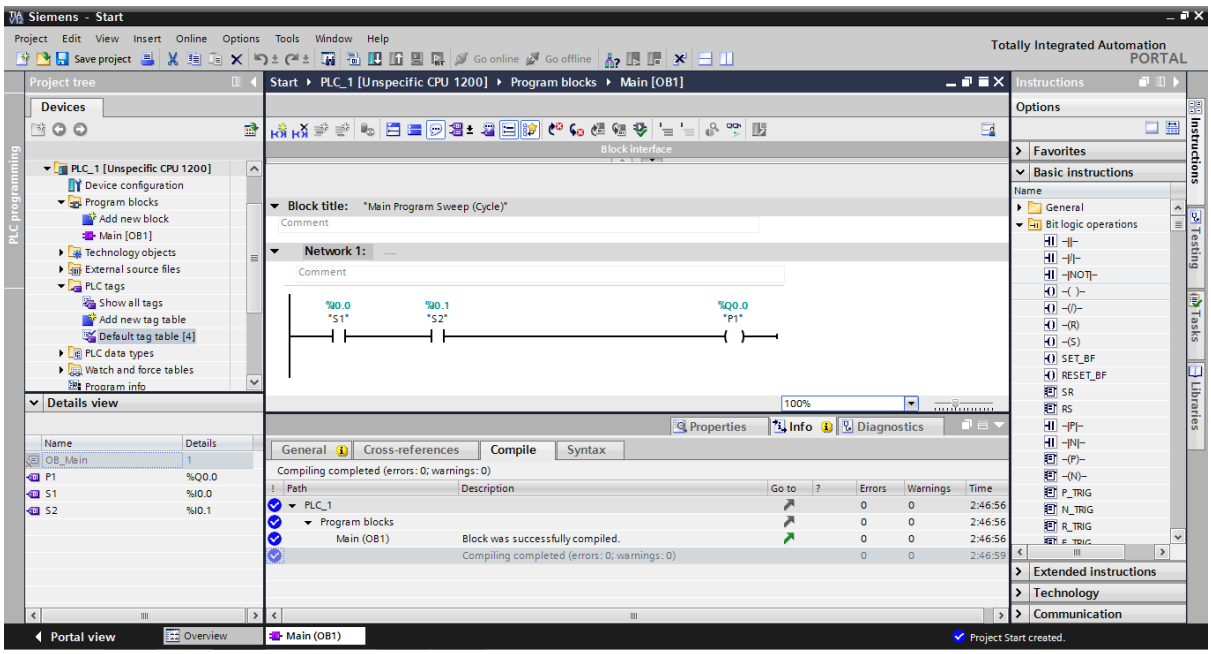
A correct address will have green colour, otherwise it will still show a red font. In that case review the tag table.



In the top toolbar the circled part shows the option ‘Compile’.
To check the logic for any errors, click on Compile.



As we can see in the screen below, the compiled logic has no errors.

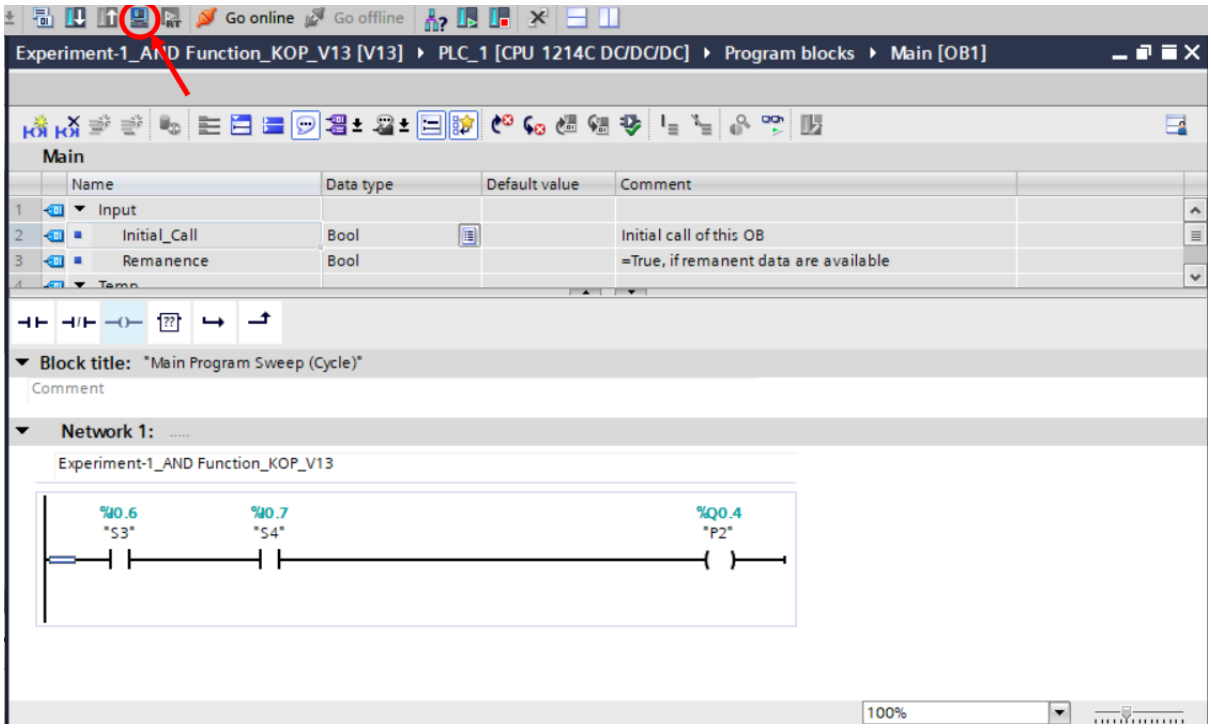


The ladder logic has been successfully written and compiled!

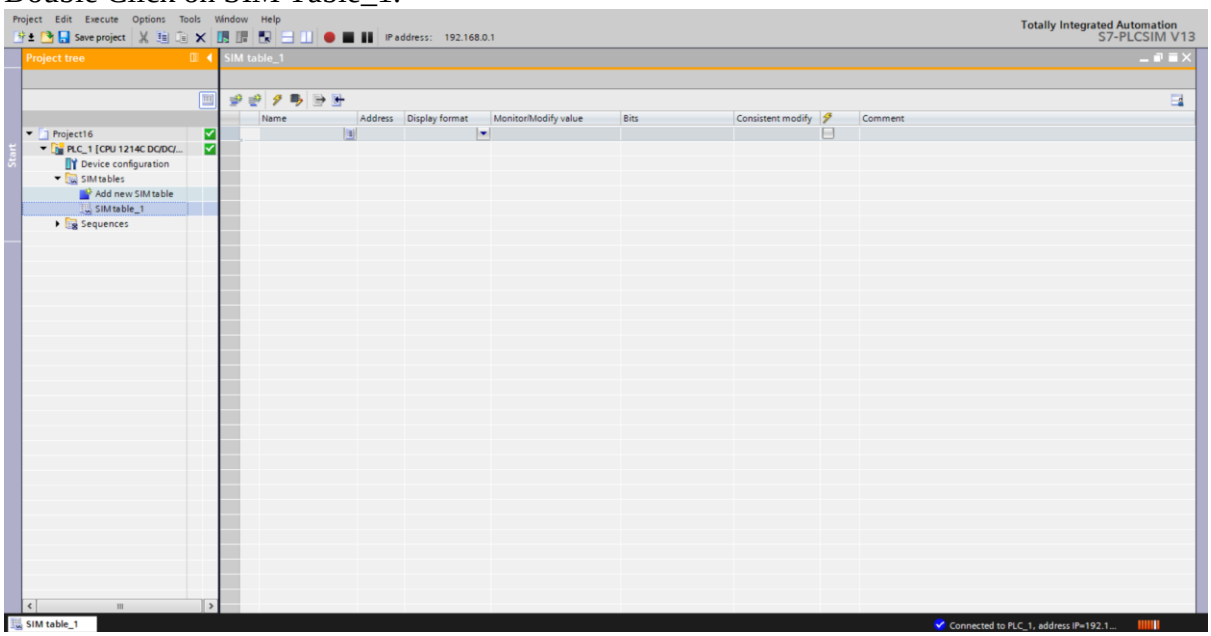
8. VIRTUAL SIMULATION OF SIEMENS S7-1200 PLC PROGRAM

8.1 Simulating a program using SIEMENS S7 PLCSIM V13

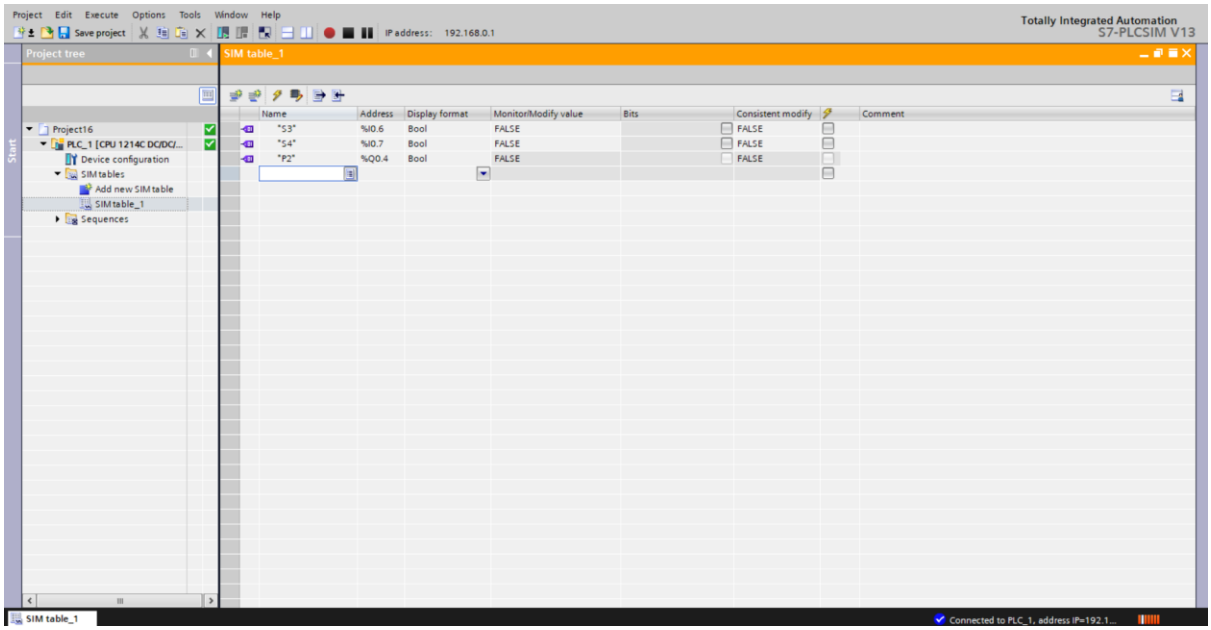
After compilation, click on Start Simulation



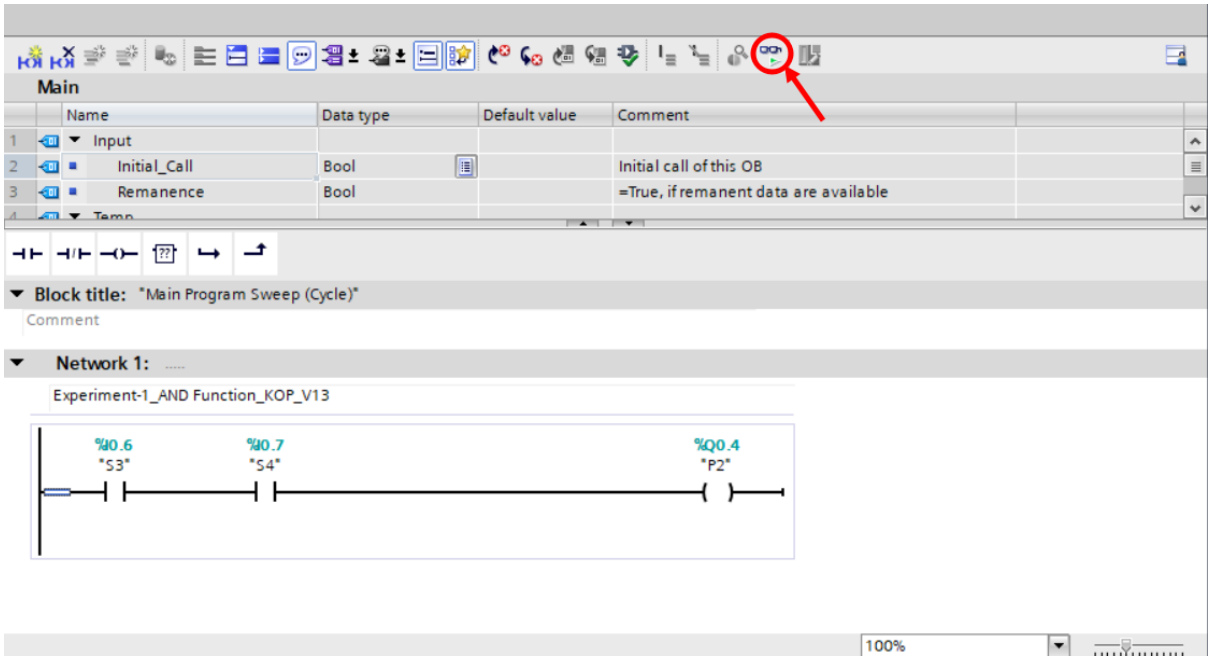
Now, the SIEMENS S7-PLCSIM V13 window will open up.
Click on SIM Tables.
Double Click on SIM Table_1.



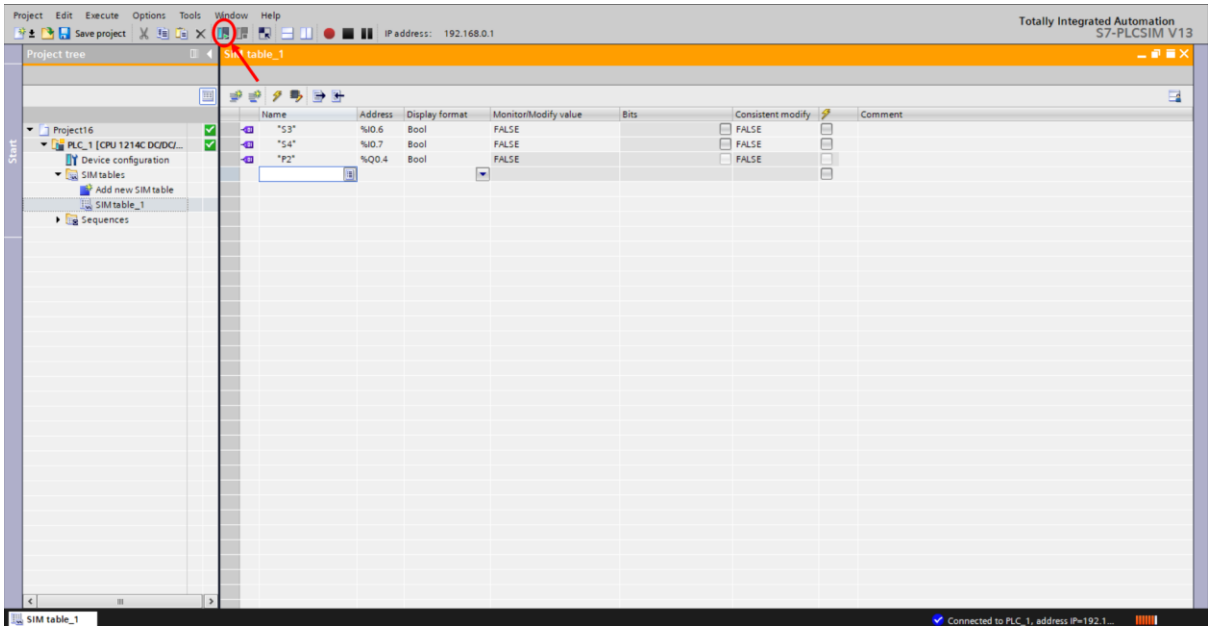
Select the names of switches that you have used from the drop down menu in the name column, Also select the name of the output from the drop down menu.



Click on the Monitoring On/Off option in the TIA Portal V13 window.

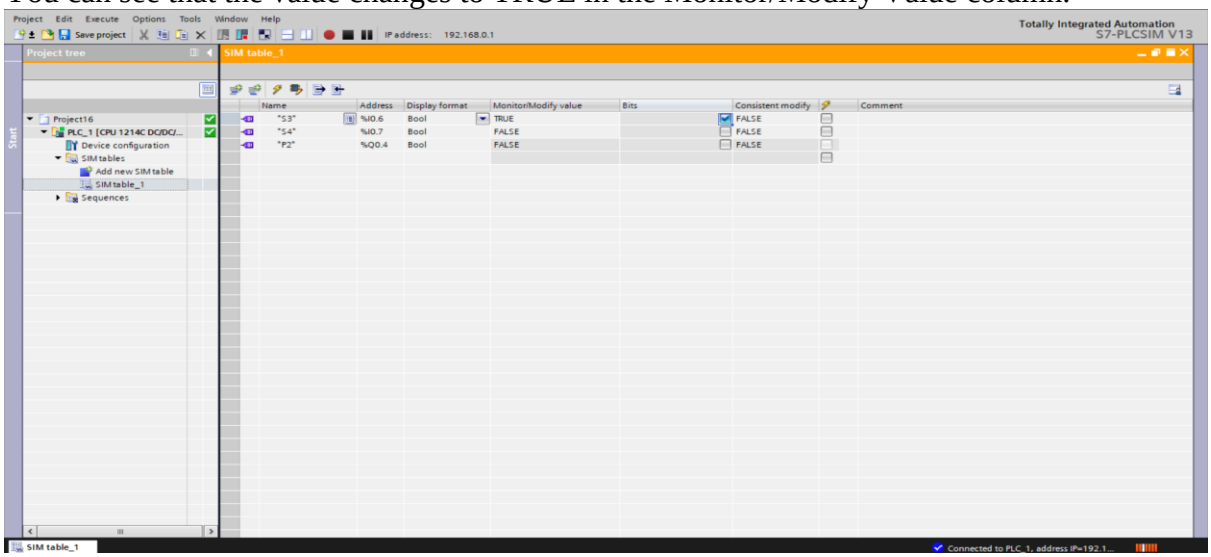


Click on Place CPU in Run Mode option in the SIEMENS PLCSIM V13 window.



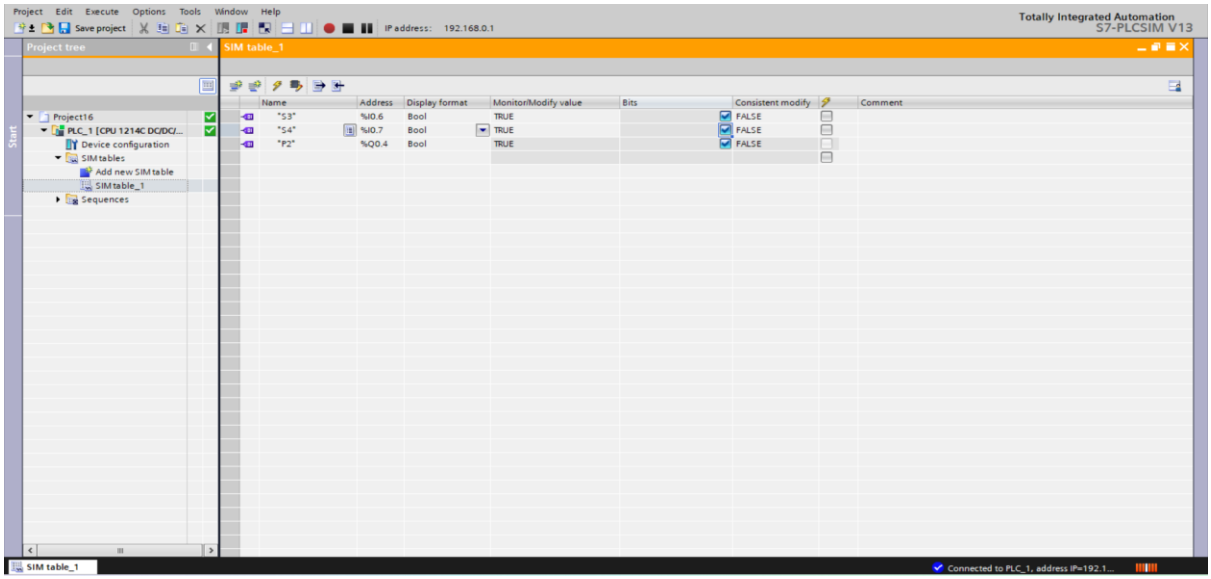
Now, open the TIA Portal V13 window.
The network will look like the below image.
Here, the green colour signifies that it is switched on, while blue colour signifies that it is switched off.

Go to the SIEMENS PLCSIM V13 window.
Click on the S3 checkbox in the bits column.
You can see that the value changes to TRUE in the Monitor/Modify Value column.

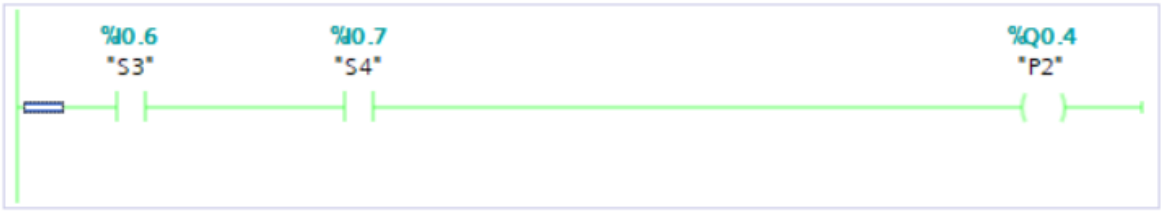


Now, in the TIA PORTAL V13 Window you can see that the line between S3 and S4 has become green, signifying that the S3 switch is on, but the S4 switch is off. Hence we do not get any output.

Go to the SIEMENS PLCSIM V13 window.
Click on the S4 checkbox in the bits column.
You can see that the value changes to TRUE in the Monitor/Modify Value column.
Also the value of output P2 changes to TRUE automatically.



Now, you can see that the whole program is in green colour, which signifies that both the S3 and S4 switches are switched on and hence we are getting an output.



Thus, we have successfully simulated the AND Function Program of Ladder Logic.

9. Future Work and Scope

9.1 Future Work

1. To hold a short training session for UG students.
2. To publish a research paper based on real life applications which are useful in Industries.

9.2 Future Scope for next batch of students

1. Virtual Lab of PLC.
2. Publication of Research Paper based on the Virtual PLC Lab.
3. Patent/Copyright of the Virtual PLC Lab.

10. Timeline

The following approximate timeline has been made by us in accordance with the brief academic calendar.

1) 8th August - 4th September - Deciding and Finalization of B.Tech Project Topic
2) 10th September - 9th October - Checking and Rectifying of PLC Hardware and Software along with Online Courses of PLC
3) 15th October - 25th November - Coding of the 44 Programs and Simulation of them
4) 13th February - 12th March - Training Program for UG Students
5) 16th March - 16th April - Work on Research Paper
6) 20th April - 2nd June - Work and Publication of Research Paper

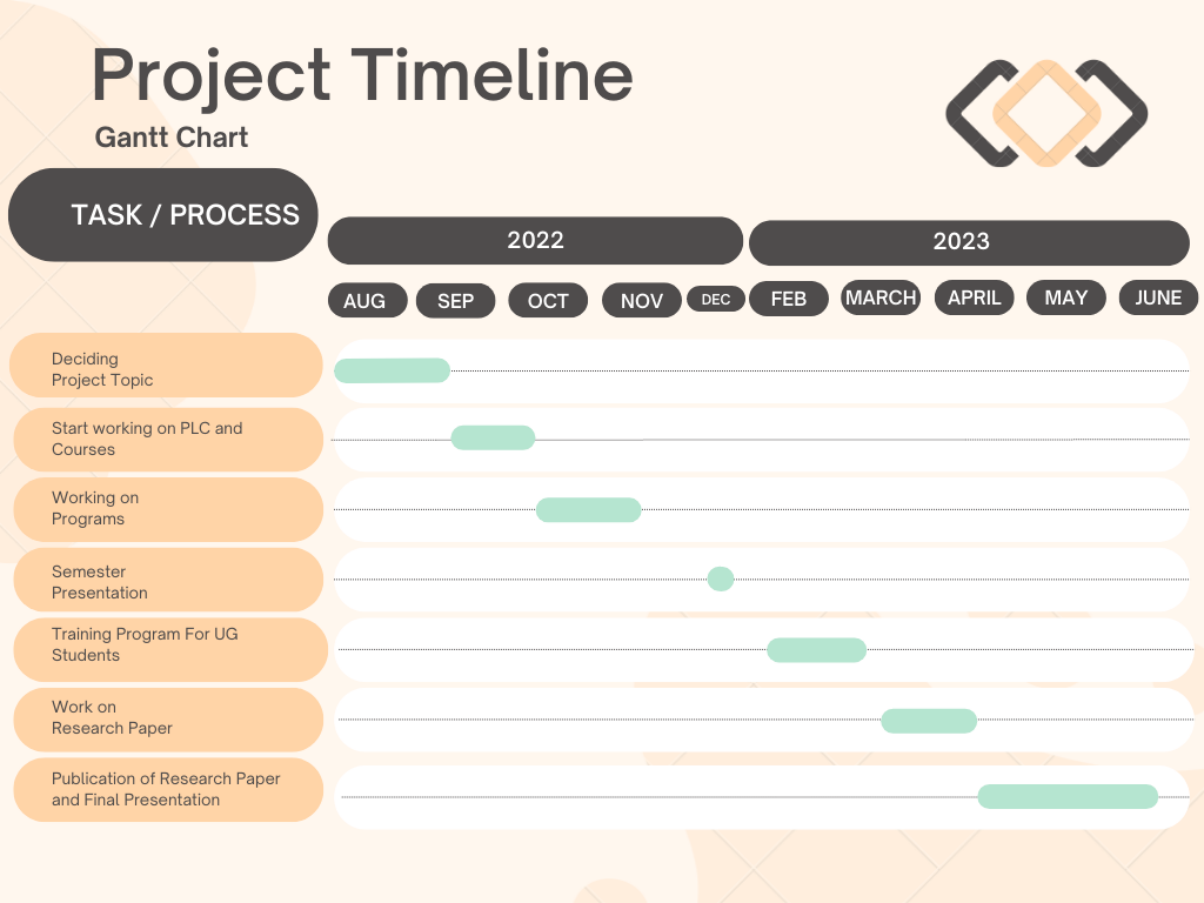


Fig. 8 - Gantt chart

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2. **https://www.udemy.com/course/learn-siemens-s7-1200-plc-from-scratch-using-tia/**
3. **https://www.udemy.com/course/learn-tia-portal-from-basics/**

Videos:

1. https://www.youtube.com/watch?v=zvS_BuQlSXo
2. https://www.youtube.com/watch?v=Q3_xs5kVZW8

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5. Hailong su, zong-an luo, Ying ying feng, "Application of Siemens PLC in Thermal simulator control system", Sciencedirect, 2019
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