PLC Laboratory

1 Objective

This PLC laboratory is aimed at providing hands-on experiences for students

- operating PLC-enabled sensors/actuators,
- learning the basic procedure for creating a control program for a Siemens S7-1200 series PLC using a ladder logic program.

2 Prerequisites

A hardware list is as follows.

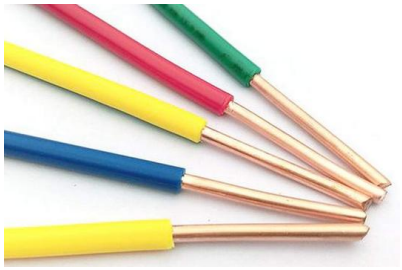
1. A Siemens S7-1200 series PLC Training Kit
2. A Microsoft Windows 11 computer

A software list is as follows.

1. VMware Workstation Pro 17.6.4
2. A VM image installed with Siemens TIA Portal V20 Update 4

3 Safety precautions

1. Do not remove any signal wires (yellow colour), DC power wires (red colour, blue colour) from the PLC Training Kit.



2. Do not remove any AC power twin wires (red and black colour) from the PLC Training Kit.

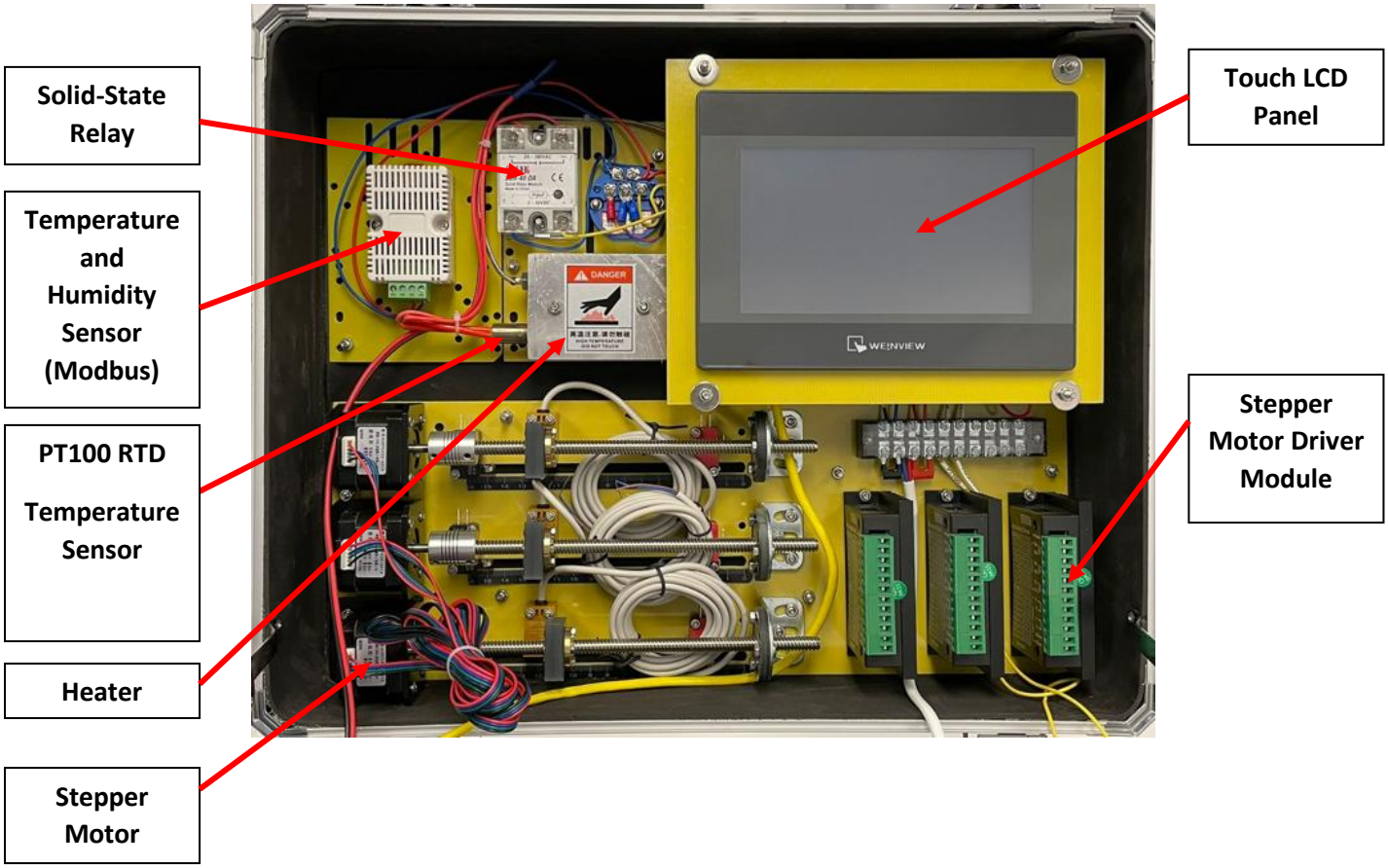


3. Do not touch the moving parts of motors.
4. Do not open the cover of the motor driver modules. (Electric shock)
5. Do not touch the internal conductor inside the motor driver module. (Electric shock)

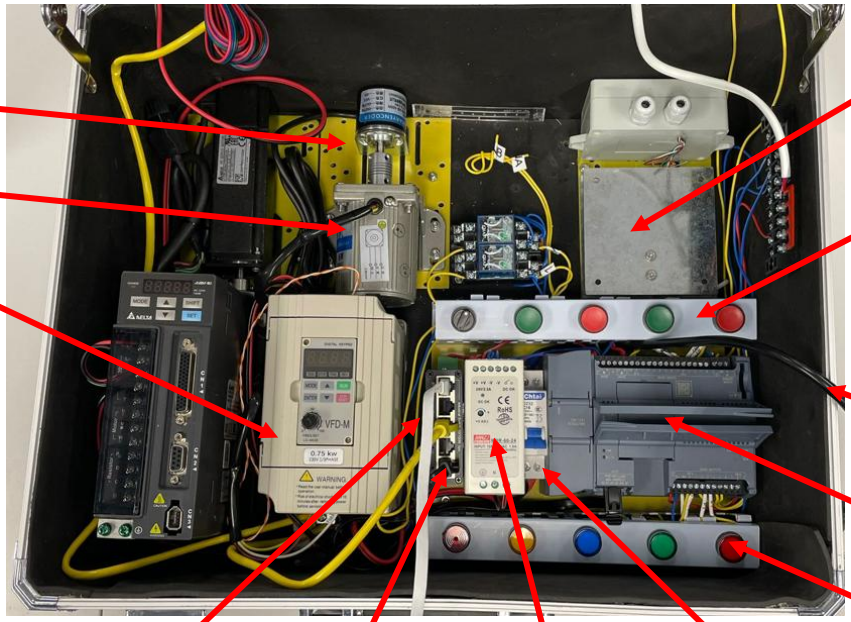
6. Do not touch the conductor of the Solid-State Relay. (Electric shock)
7. Do not touch any conductor carrying AC power. (Electric shock)
8. Do not touch the heater. (Thermal Injury)

4 Overview of PLC Training Kit

4.1 Top-half modules



4.2 Bottom-half modules

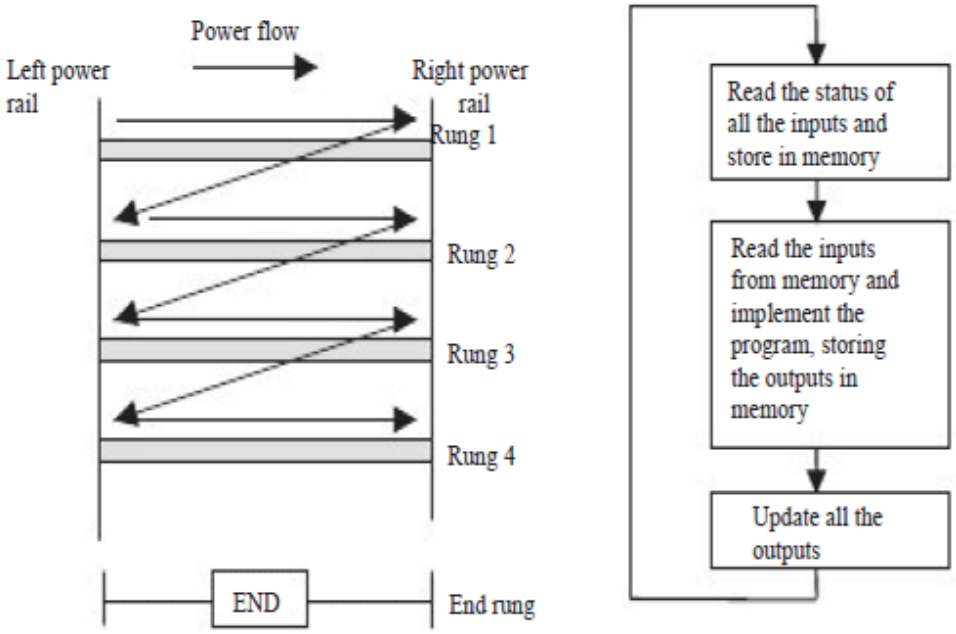






5 Scanning the Ladder Logic Program

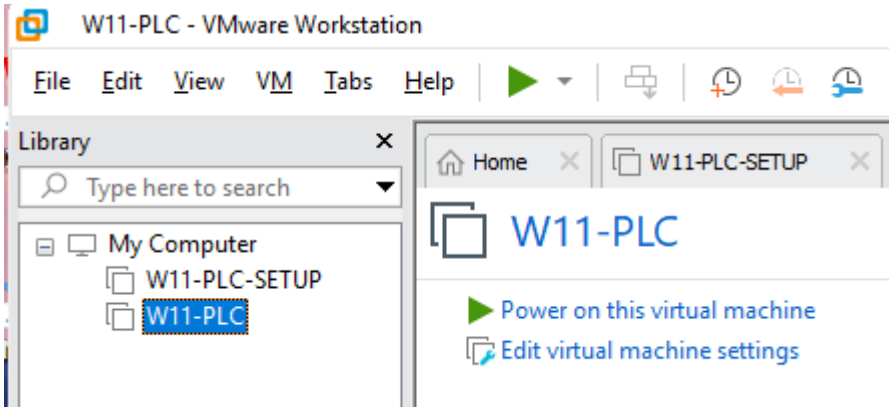
PLC ladder logic program execution is strictly sequential. Each rung processes instructions from left to right, similar to carefully processing successive commands. Once all vertical rungs have been completed, the program immediately returns to the top rung to begin the cycle. The time necessary to make a single pass from top to bottom and execute logic is known as scan time.



6 Launch VM image

A step-by-step procedure to launch a VM image.

1. Launch VMware Workstation Pro
2. Select “W11-PLC” and click the “Power on” button.



7 PLC program controlling buttons and LEDs

A ladder logic program provides the following functions.

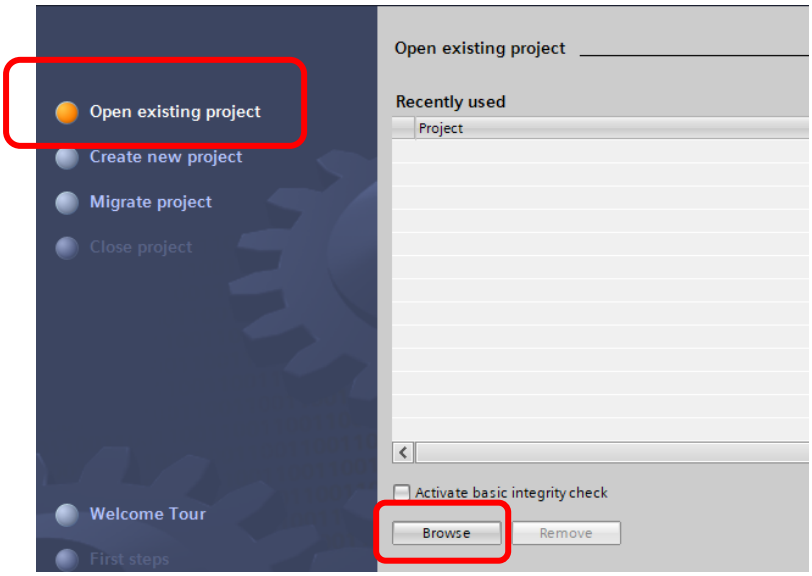
a. Turn on “LED 1” if the “Turn Switch” is set to the ON position. Turn off “LED 1” if the “Turn Switch” is set to the OFF position.
b. Turn on “LED 2” if the “Push Button 1” is pressed. Turn off “LED 2” if the “Push Button 1” is released.

A step-by-step procedure for programming and using the PLC program.

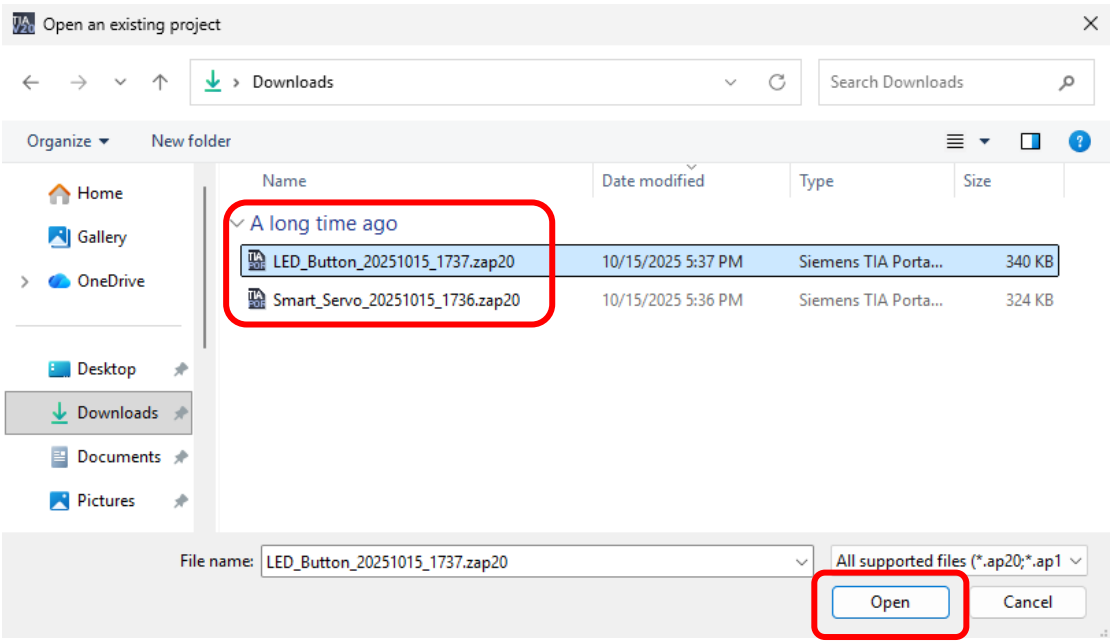
1. Copy PLC programs to the VM if they do not exist in the "Downloads" folder.
2. Launch “TIA Portal V20” from the desktop.



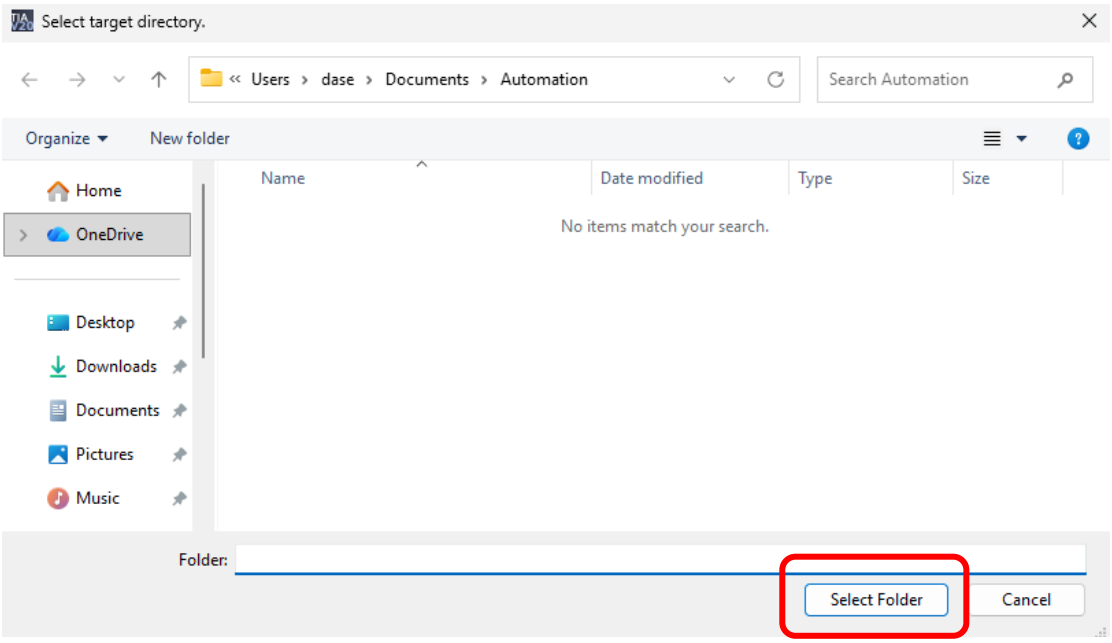
3. Click “Open existing project”. Click the "Browse" button.



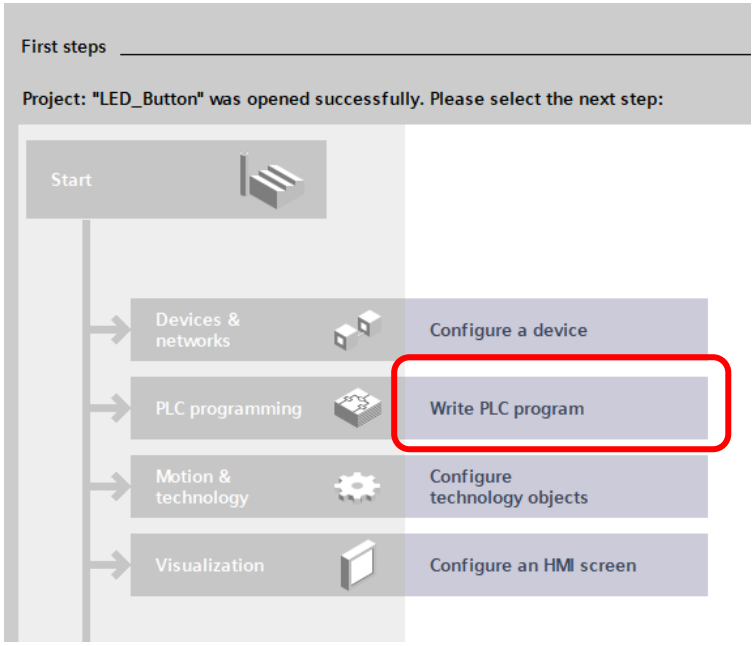
4. Select the file "LED_Button_20251015_1737.zap20" and click the "Open" button. The "zap20" file is a special file format for the TIA Portal V20 software for sharing a PLC project between computers.



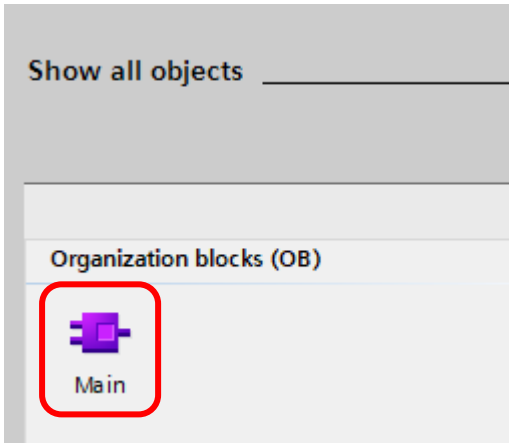
5. Click "Select Folder" to use the default folder to retrieve the data from the "zap20" file.



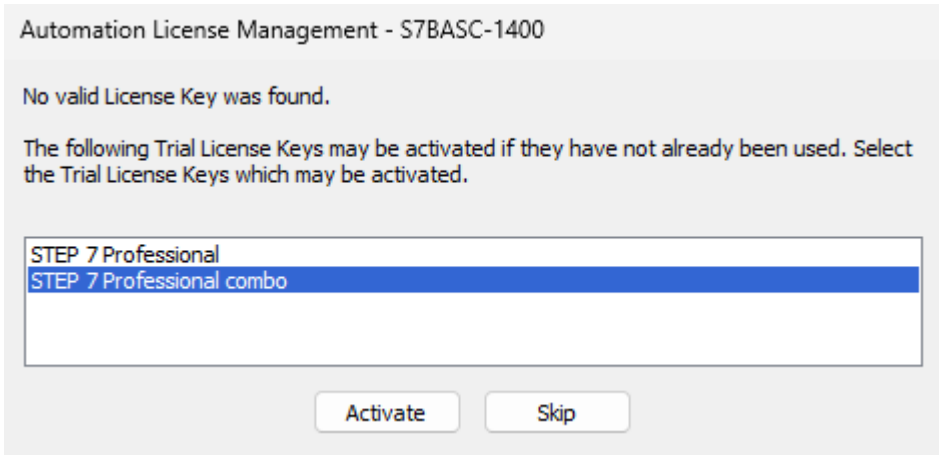
6. Double-click the "Write PLC program" button.



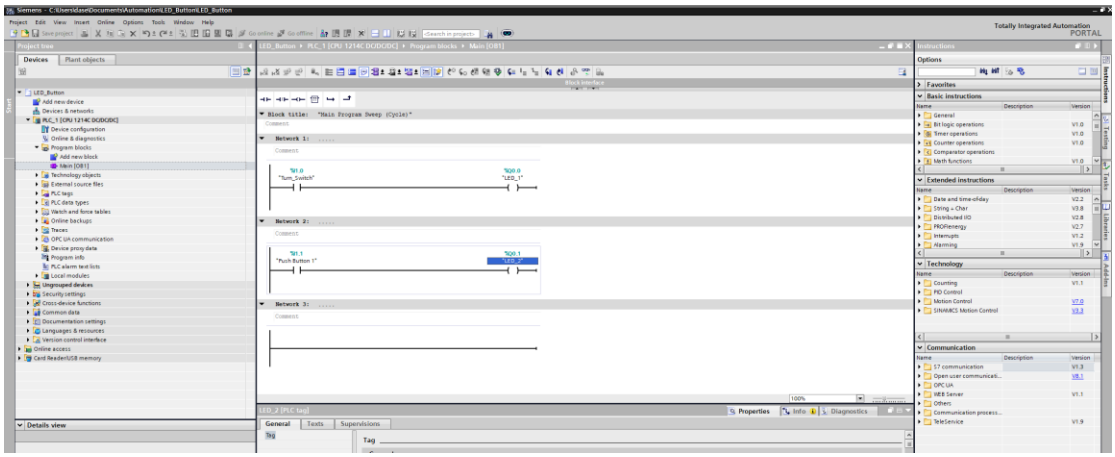
7. Double-click the "Main" organization block to view the ladder program.



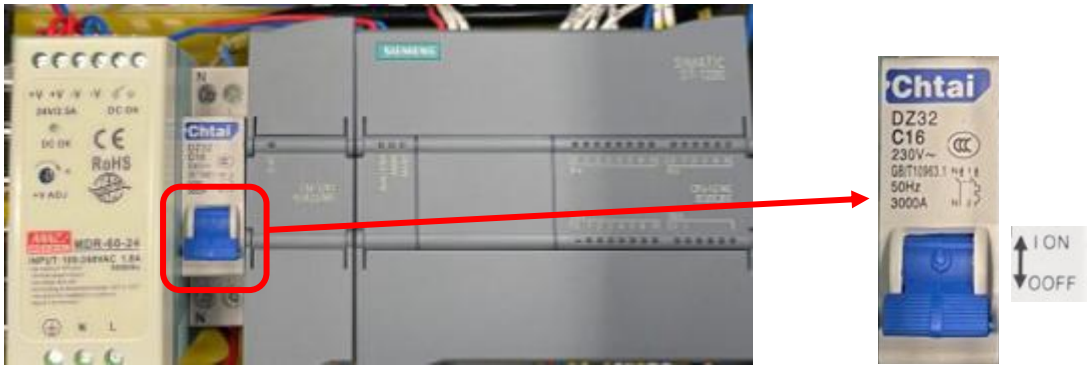
- If this is the first time running the TIA Portal software, the following screen will be displayed. Select either option and click “Activate”.



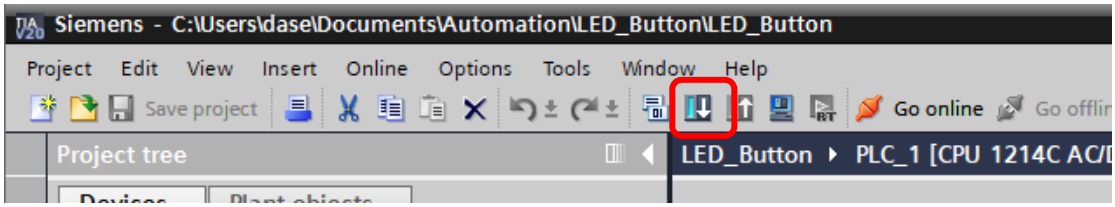
8. The ladder program will be displayed.



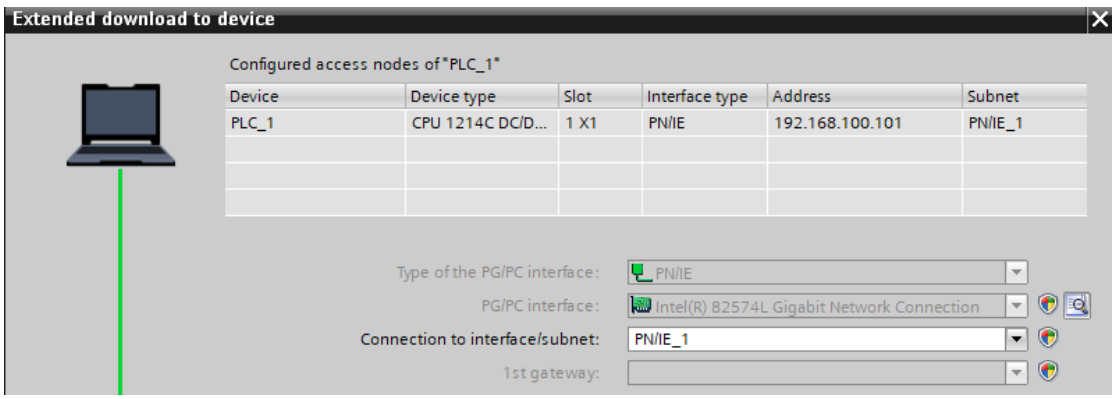
9. Make sure a network cable is connected to the PLC and the computer.
10. Switch on the PLC main power by moving the air switch lever to the "ON" position.



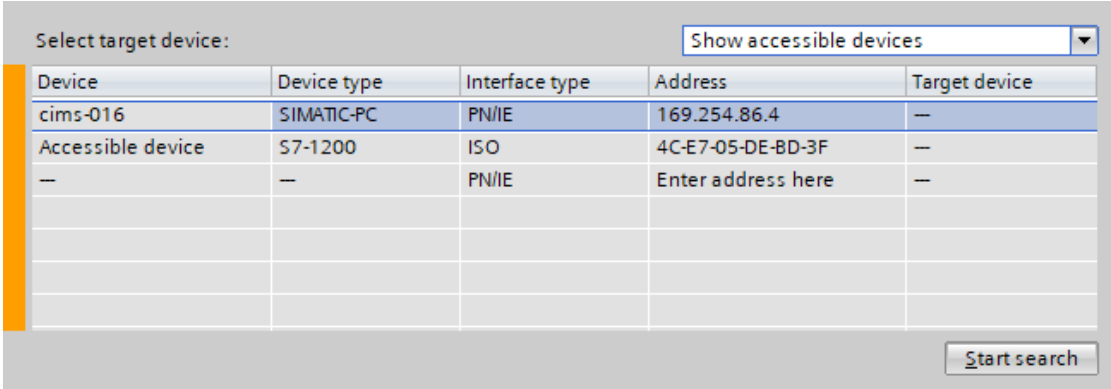
11. Click the “Download to device” icon from the toolbar to upload the new program to the PLC device.

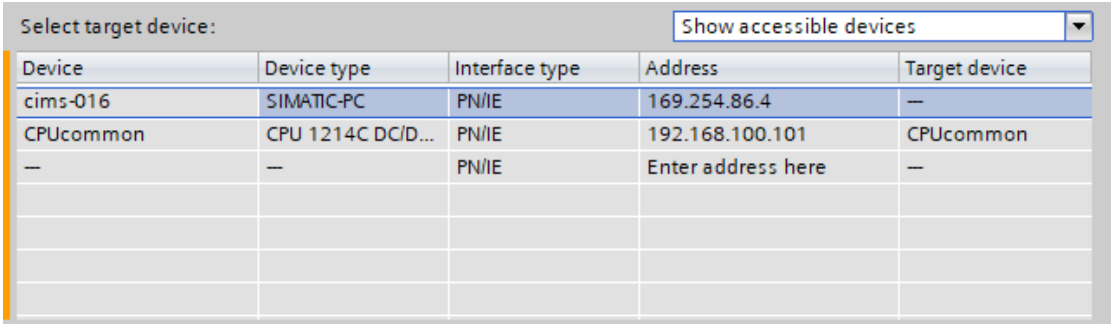


12. Select “PN/IE_1” in the “Connection to interface/subnet”.



13. Select “Show accessible device”. Click the “Start Search” button. After a while, the table will display all discovered network devices.

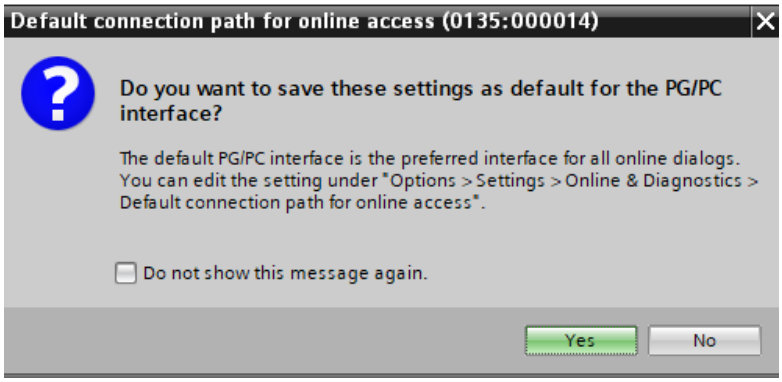




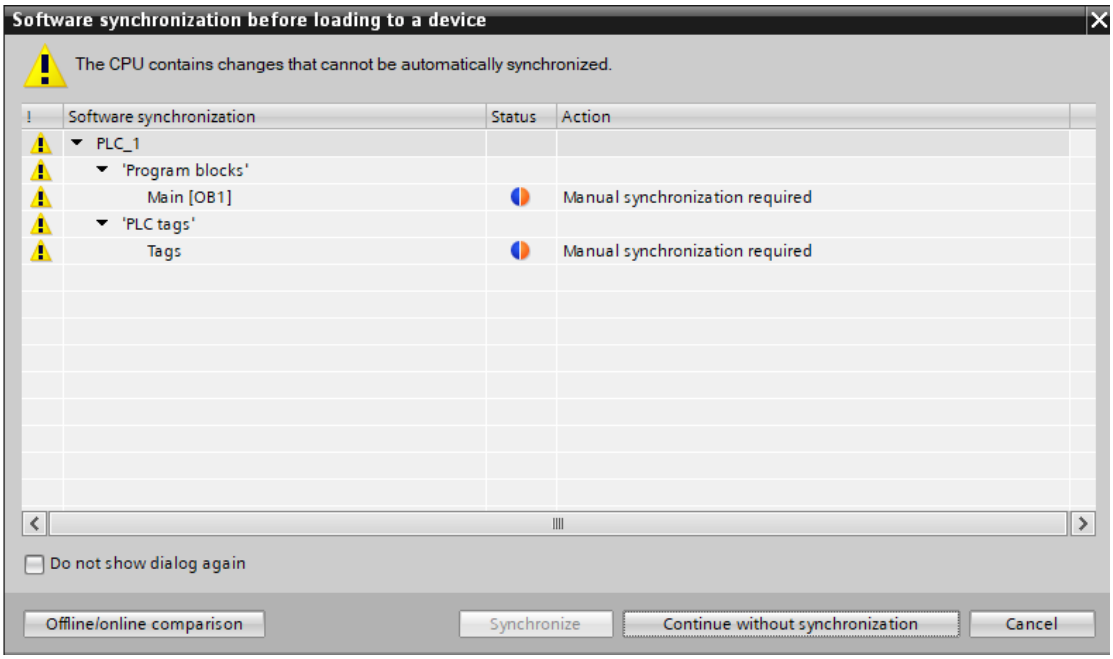
14. Click the item with device type “S7-1200” or “CPU 1214C”. Click the “Load” button to upload a new program to the selected device. Click the “Connect” button if the following window is displayed.



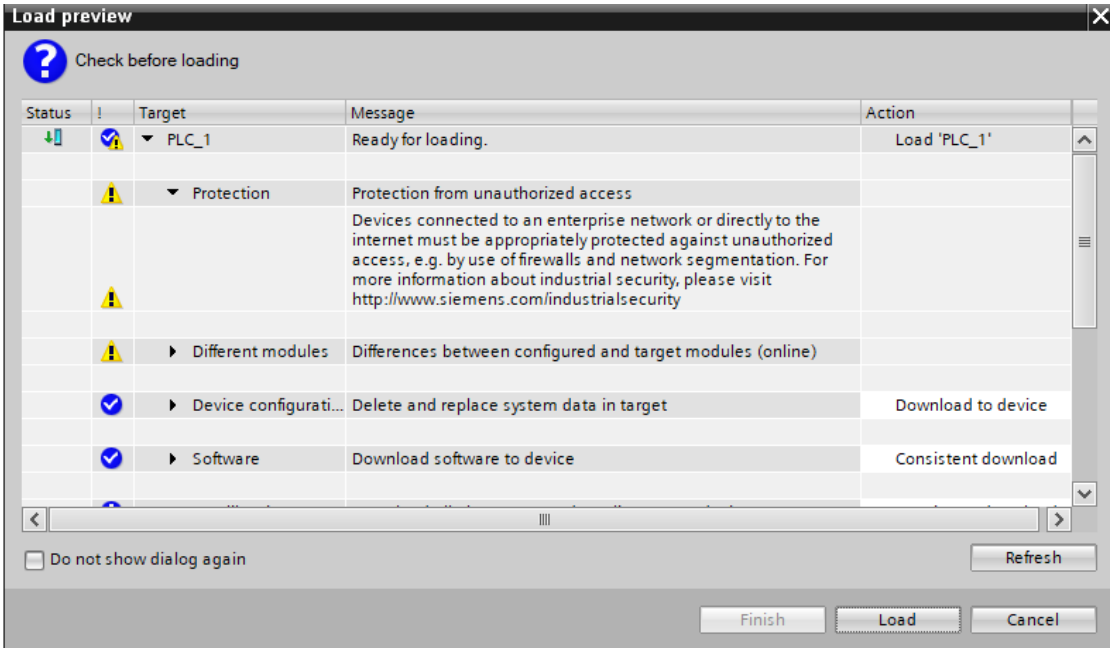
15. Click “Yes” if the following window is displayed.



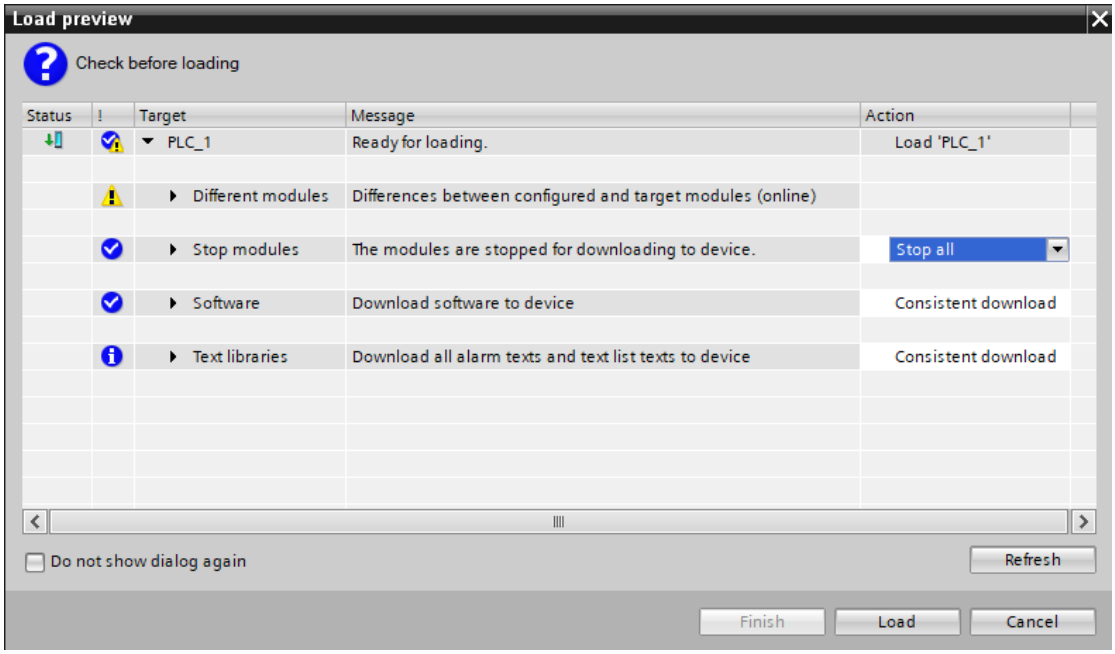
16. Click the “Continue without synchronization” button if the following window is displayed.



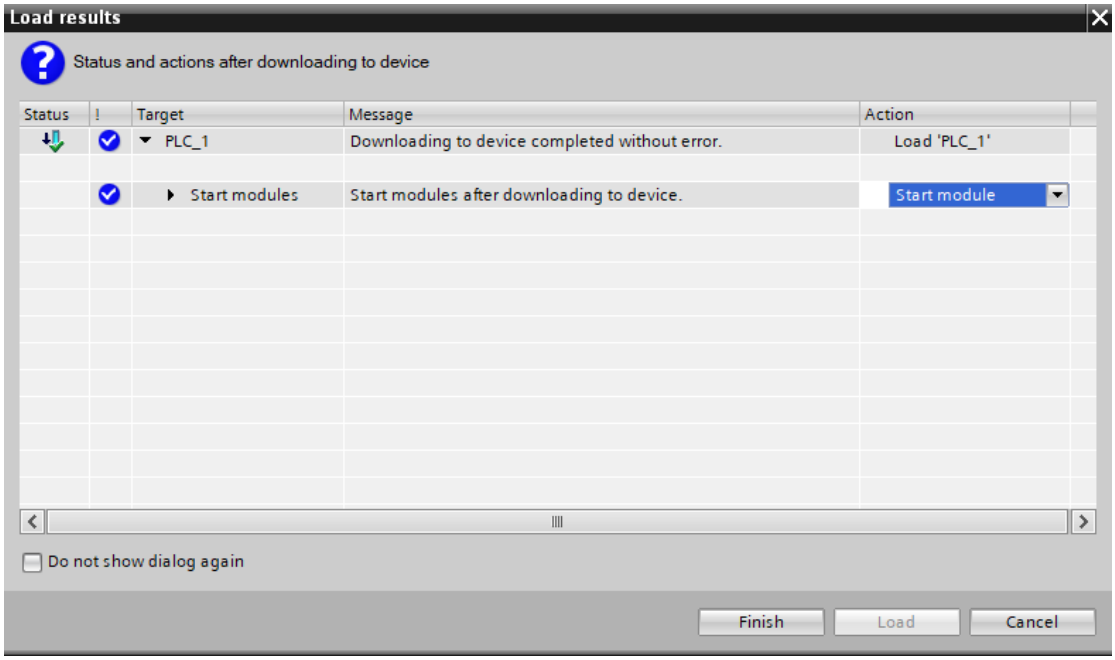
17. Click the “Load” button if no error is reported in the “Load preview” window.



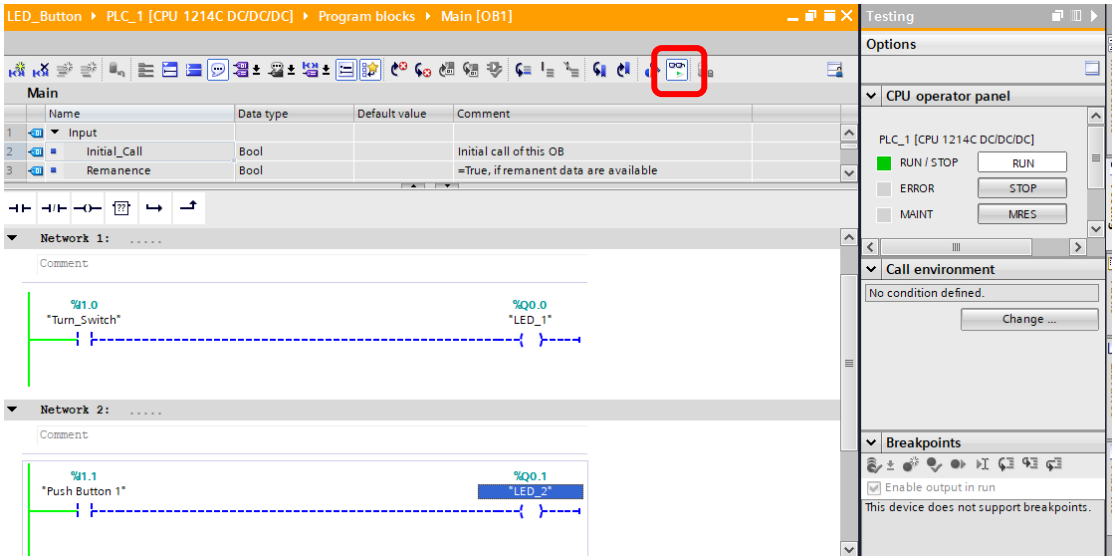
18. Select “Stop all” and click the “Load” button if the following window is displayed.



19. Select “Start module” if the PLC is not running any program. Click the “Finish” button.



20. Click the “Monitor On/Off” icon to view the current status of all inputs and outputs in the ladder logic program.



21. Test the program by turning the switch and pressing the push button.

8 PLC program to control a smart servo motor

A ladder logic program provides the following functions.

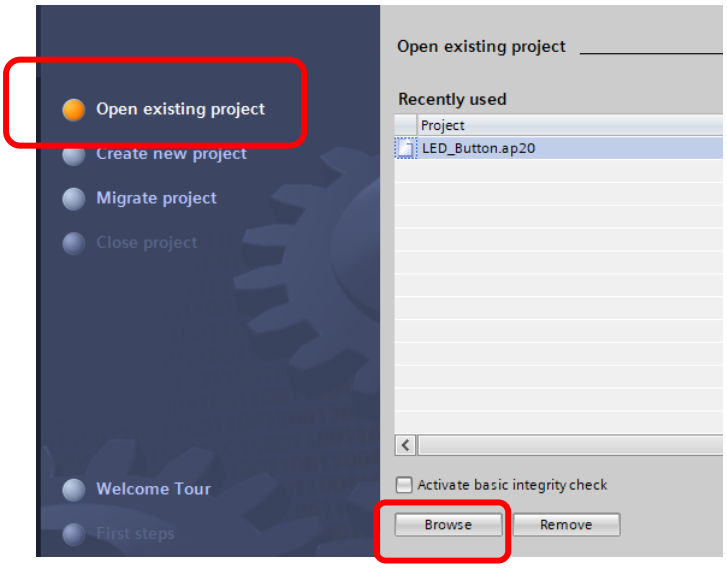
a. The “Turn Switch” controls the rotation direction (Forward/Reverse).
b. The “Push Button 1” controls the start/stop of the smart servo motor.

A step-by-step procedure for programming and using the PLC program.

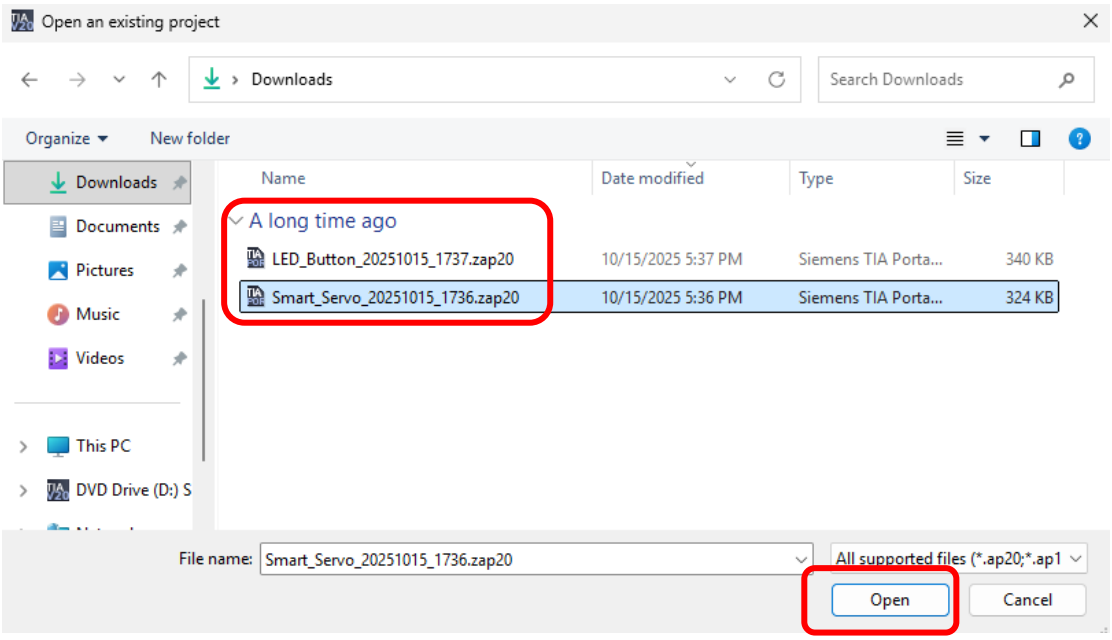
1. Close all opened “TIA Portal V20” if it is running.
2. Launch “TIA Portal V20” from the desktop.



3. Click “Open existing project”. Click the "Browse" button.

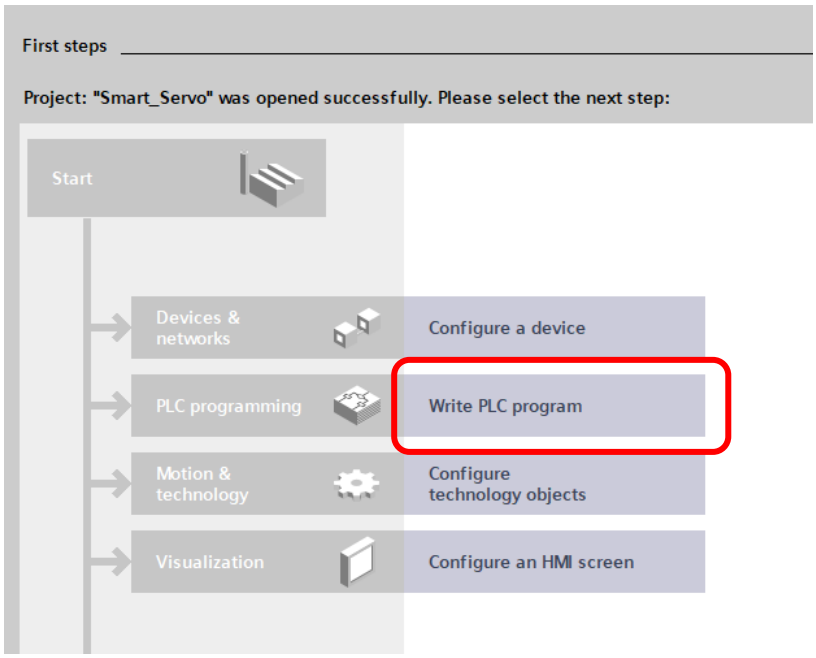


4. Select the file "Smart_Servo_20251015_1736.zap20" and click the "Open" button.

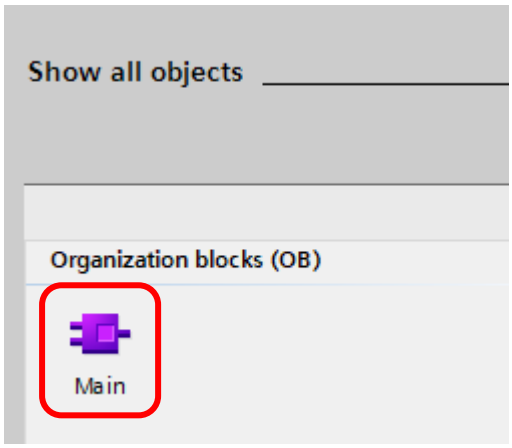


5. Click "Select Folder" to use the default folder to retrieve the data from the "zap20" file.

Double-click the "Write PLC program" button.

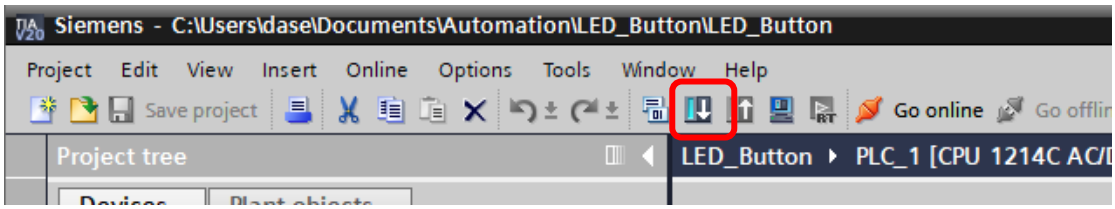


6. Double-click the "Main" organization block to view the ladder program.

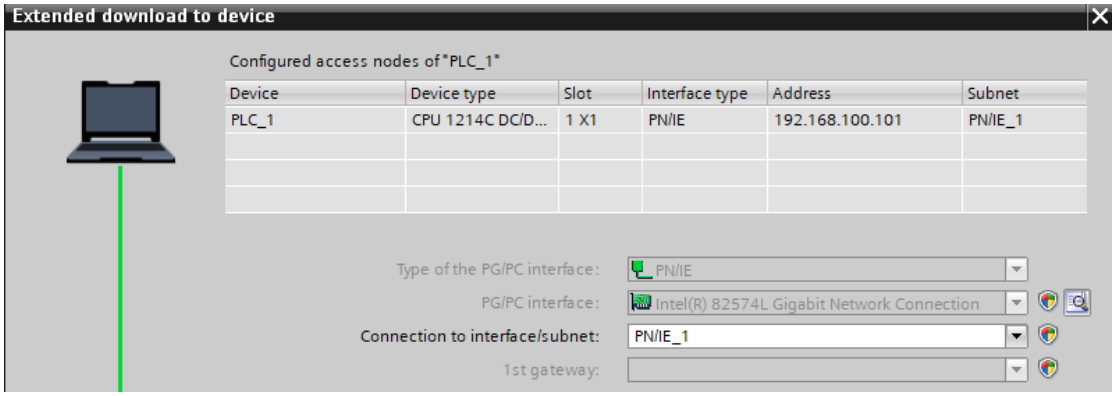


7. Make sure a network cable is connecting the PLC and the computer.
8. Switch on the power of the PLC Training Kit.

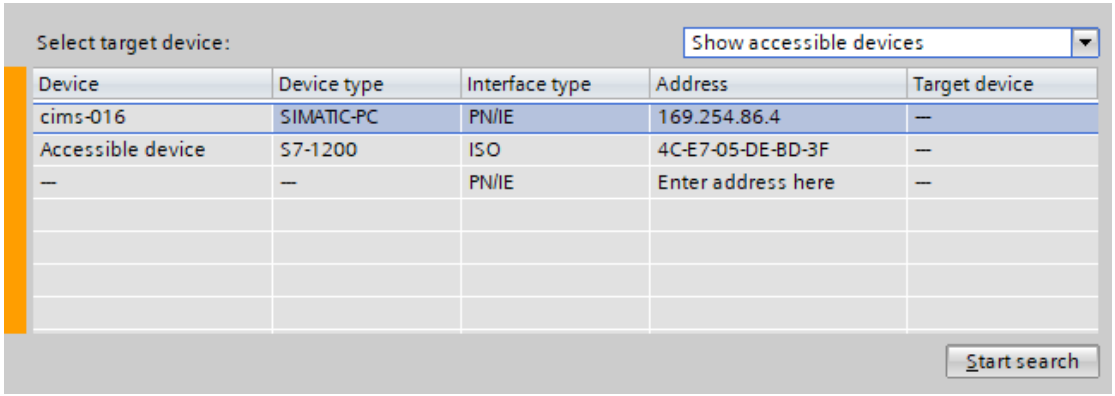
9. Click the “Download to device” icon on the toolbar to upload the new program to the PLC device.

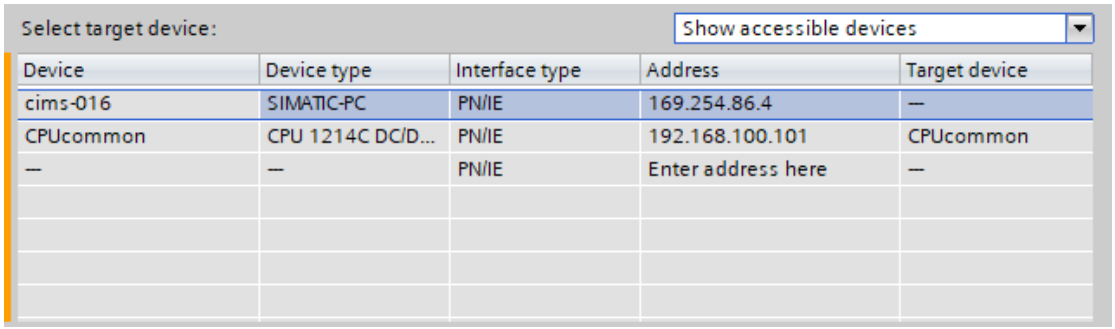


10. Select “PN/IE_1” in the “Connection to interface/subnet”.



11. Select “Show accessible device”. Click the “Start Search” button. After a while, the table will display all discovered network devices.

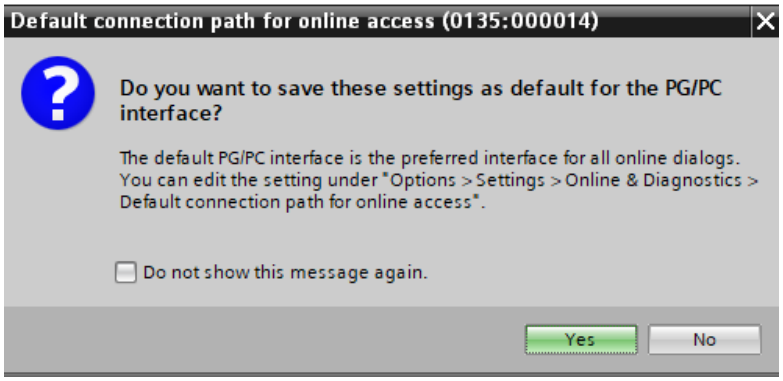




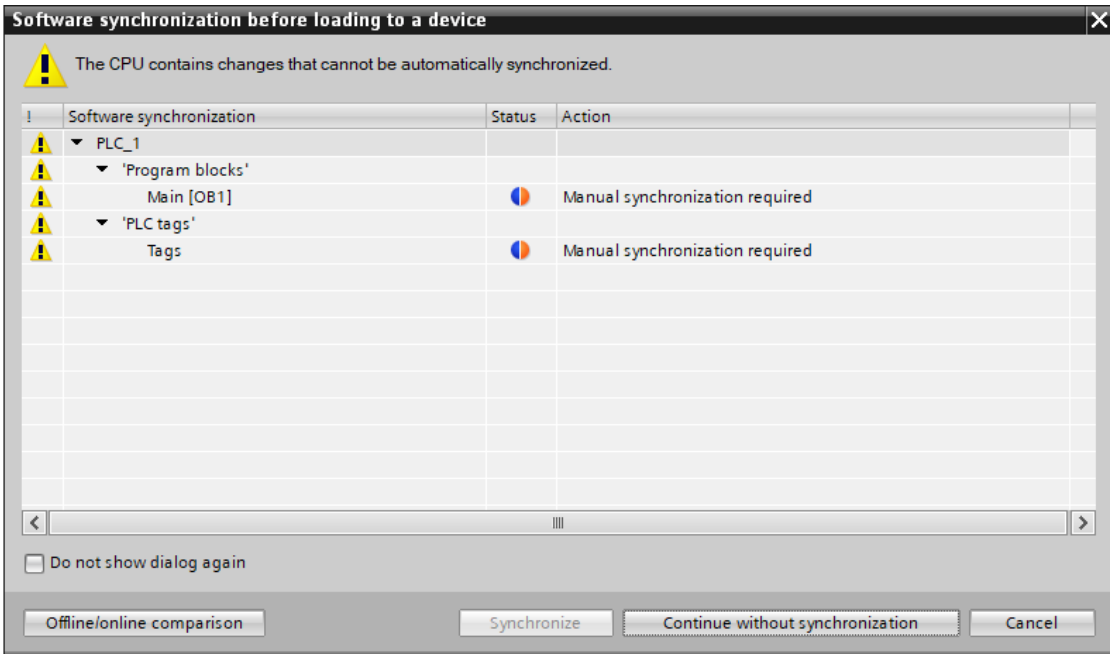
12. Click the item with device type “S7-1200” or “CPU 1214C”. Click the “Load” button to upload a new program to the selected device. Click the “Connect” button if the following window is displayed.



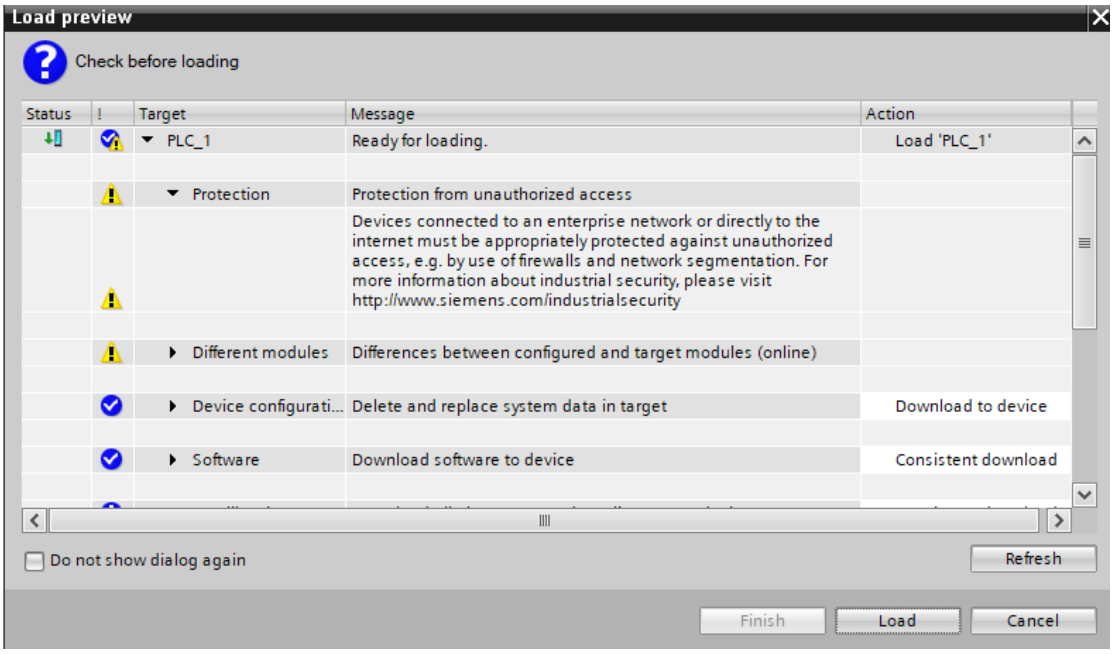
13. Click “Yes” if the following window is displayed.



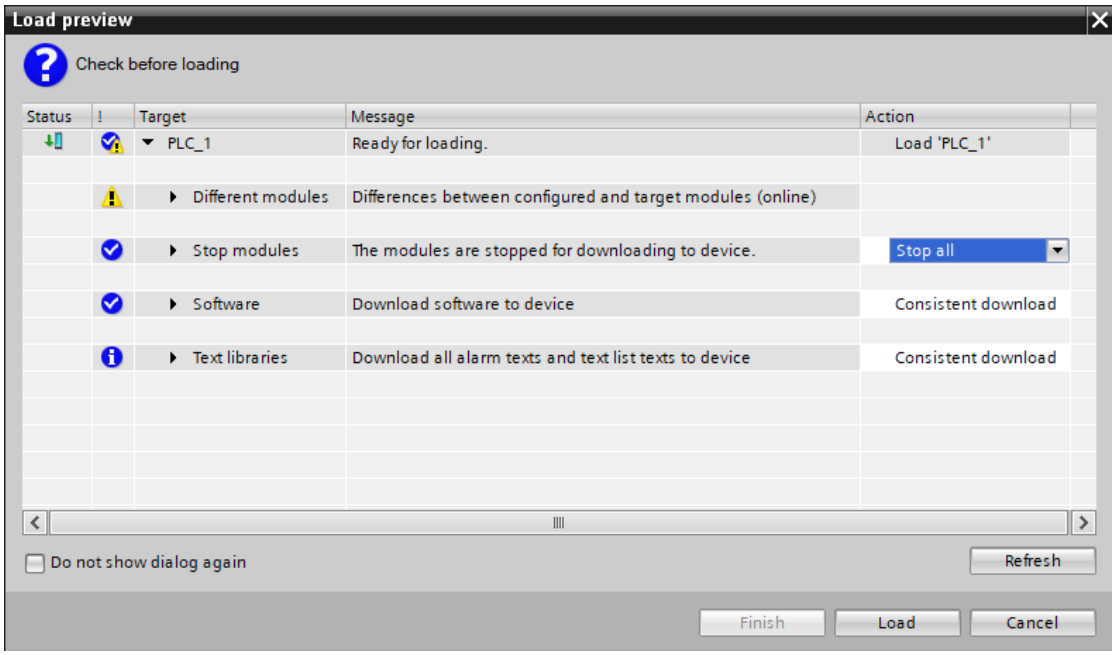
14. Click the “Continue without synchronization” button if the following window is displayed.



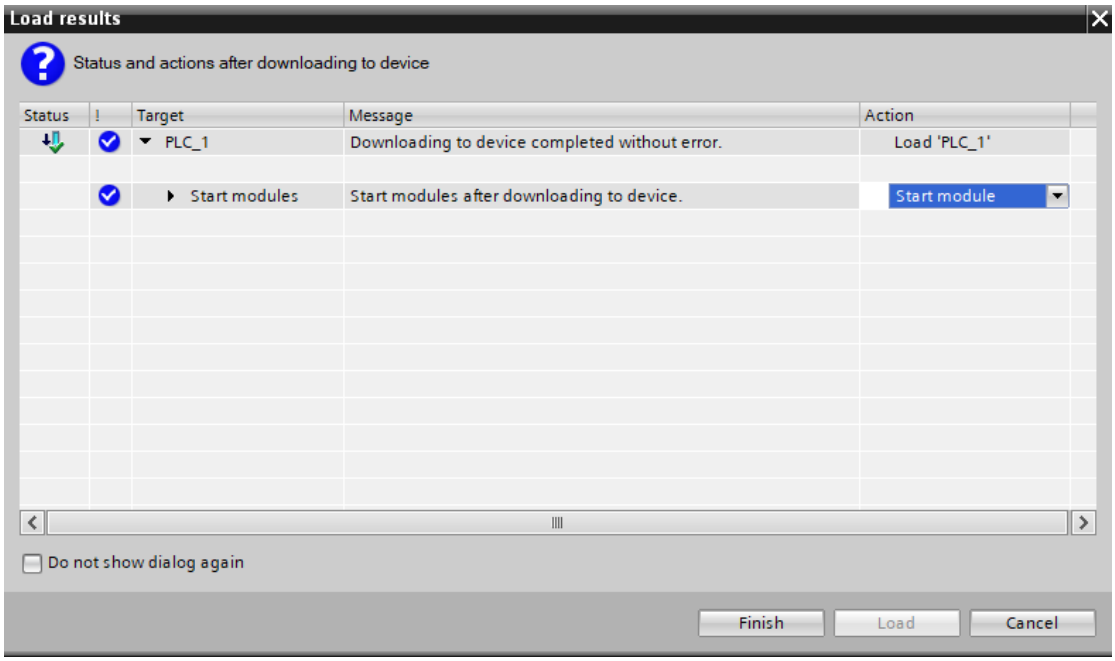
15. Click the “Load” button if no error is reported in the “Load preview” window.



16. Select “Stop all” and click the “Load” button if the following window is displayed.



17. Select “Start module” if the PLC is not running any program. Click the “Finish” button.



18. Click the “Monitor On/Off” icon to view the current status of all inputs and outputs in the ladder logic program.
19. Test the program by turning the switch and pressing the push button. The smart servo motor starts rotating when you press and hold Push Button 1 for a few seconds. Release Push Button 1 to stop the motor.

9 Acknowledgement

1. Siemens TIA Portal. https://docs.tia.siemens.cloud/

10 Reference

1. Ladder Logic Decoded: A Step-by-Step Tutorial for PLC Programmers

https://www.solisplc.com/tutorials/ladder-logic-tutorial-for-plc-programmers