Lab 1: Hardware Description of the PLC

Lab Objective

The objective of this lab is to familiarize you with the Siemens S7-1200 Programmable Logic Controller (PLC) available in the lab, by identifying its various modules and understanding their respective roles. By the end of this session, you will be able to:

- Identify the different modules that make up the Siemens S7-1200 PLC.
- Configure the Siemens PLC modules using the TIA Portal V16 software.

1. Hardware Description of the PLC

The figure below illustrates the PLC used in the lab, which is composed of several modules:

- a 24V DC switched-mode power supply, providing power to all PLC modules.
- a CPU of type S7-1214C.
- a Profibus communication module, type CM 1243-5.
- a decentralized I/O module (16 digital inputs / 16 digital outputs), configured as a slave on the network.
- Two analog input modules.
- One analog output module.

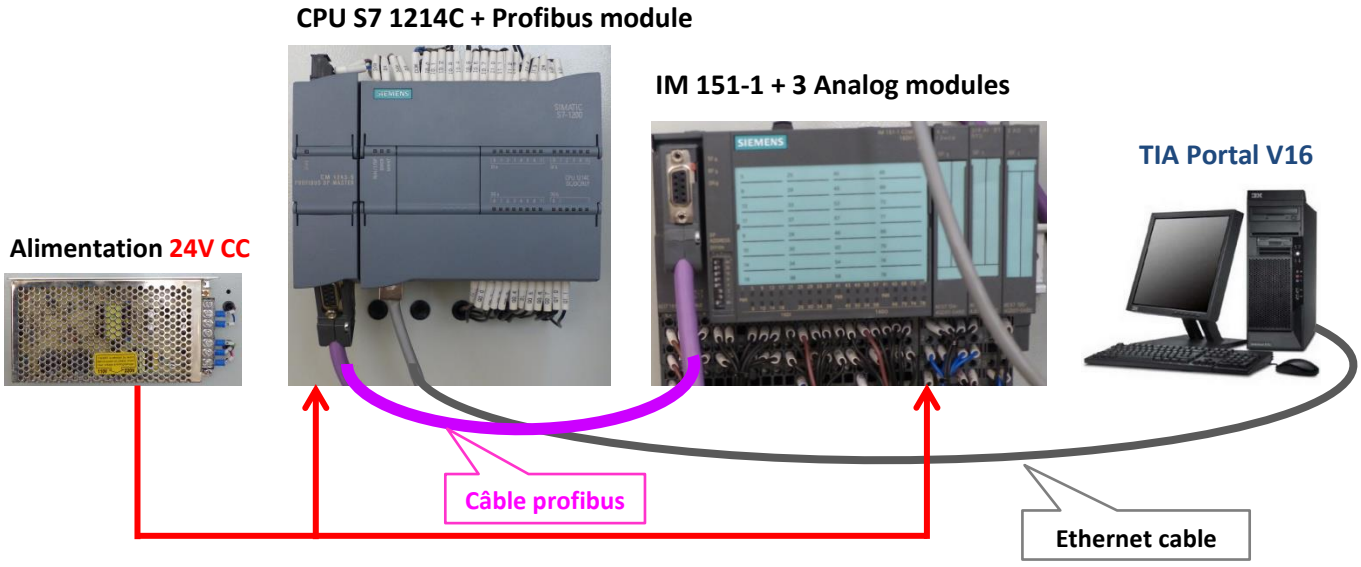


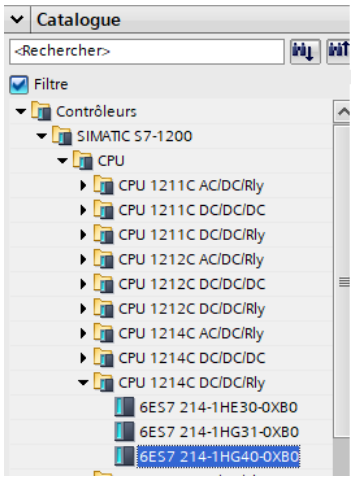
Figure 1. General view of the PLC available in the lab

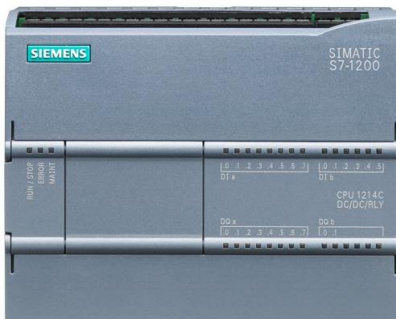
The S7-1214C CPU communicates with the PC through an integrated Ethernet (RJ45) interface. Program loading as well as data exchanges (diagnostics, monitoring) are carried out via this Ethernet port, typically using the TIA Portal software. This connection enables fast, direct, and reliable programming between the development PC and the S7-1200 PLC.

The CPU uses the CM1243-5 communication module to exchange data with the decentralized I/O module ET200S via the Profibus network, allowing the transfer of information. In the following section, we present the main technical specifications of each module that makes up the PLC system.

CPU Description

The CPU used is a Siemens S7-1214C DC/DC/RLY model (ref. 6ES7 214-1HG40-0XB0) from the S7-1200 series. It integrates digital inputs/outputs (DI/DO) and relay outputs, making it suitable for medium-sized automation applications. The CPU also features a built-in Ethernet interface for communication.





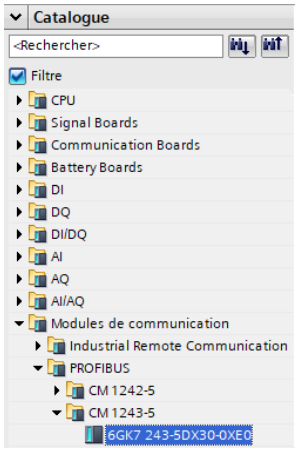
Specifications

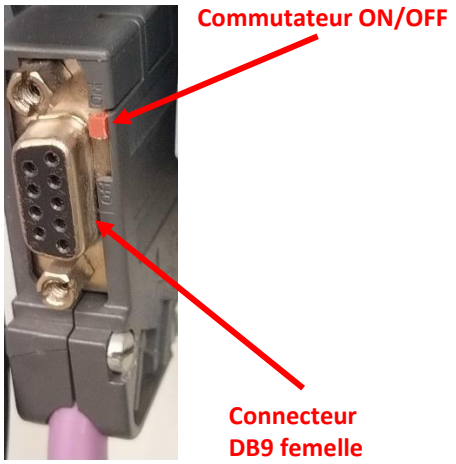
- 100 KB work memory
- 24V DC power supply with 14 digital inputs (24V DC sink/source), 10 relay digital outputs, and 2 integrated analog inputs
- 6 integrated high-speed counters and 4 pulse outputs
- I/O extension via Signal Board
- Supports up to 3 communication modules for serial communication
- Supports up to 8 I/O modules for I/O extension
- Instruction execution time: 0.04 ms per 1k instructions
- PROFINET interface for programming, HMI communication, and PLC-to-PLC communication.

PROFIBUS communication module

The CM 1243-5 communication module (ref: 6GK7 243-5DX30-0XE0) enables the S7-1200 PLC to connect to a PROFIBUS network as a master via the RS-485 communication interface. It is equipped with a female DB9 connector that includes a red switch used to easily enable or disable the termination resistor depending on the module's position in the network. These termination resistors define the physical ends of the PROFIBUS network.

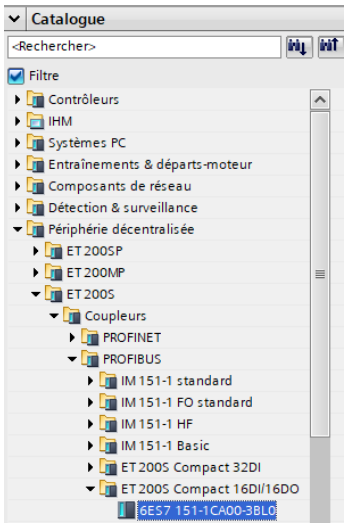
The switch must be set to "ON" for the last device on the network, and to "OFF" for all intermediate devices. Incorrect configuration of these switches may result in a bus error. Since our network consists of only two devices (the CPU and the ET200S), both switches must be set to "ON".

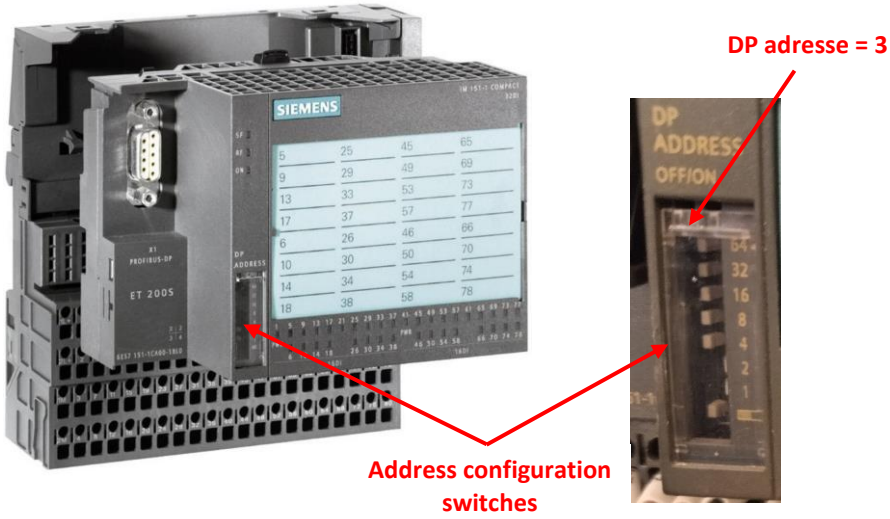




Decentralized I/O Module

The S7-1214C CPU is connected to a decentralized input/output module from the SIMATIC ET 200S series, the IM151-1 COMPACT 16DI/16DO DC24V/0.5A (ref: 6ES7 151-1CA00-3BL0). This module allows the addition of up to 12 extra I/O modules. It communicates with the CPU via the PROFIBUS DP (Decentralized Periphery) interface, using the RS-485 communication interface. It is equipped with a female DB9 connector (see figure below).

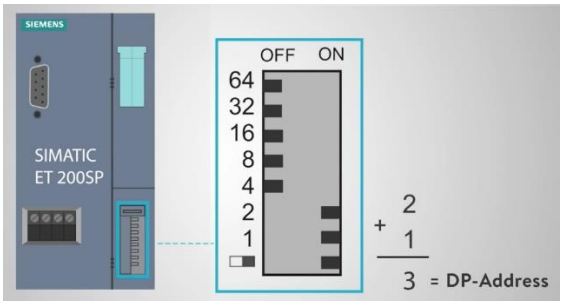




Configuration of Profibus Device Addresses

Each component on the network must be configured with a unique address ranging from 1 to 127. In other words, a Profibus network can theoretically support up to 127 devices.

The device address can be configured using TIA Portal or STEP7 software. For certain devices, the address must be set manually using DIP switches (20 ... 26) located on the front panel of the device. The Profibus network enables communication between the master (CPU 1214C) and the slave module (ET200S). Each component is identified by a unique address on the bus. In our case, the address of the S7-1214C CPU is 2, and the address of the ET200S is 3.

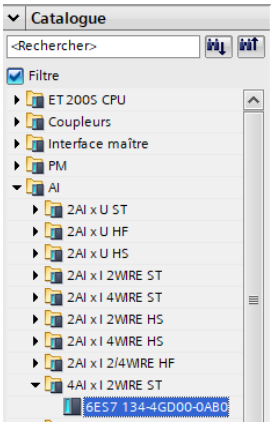


Analog Input/Output Modules

The IM module is connected to three analog modules: two analog input modules and one analog output module.

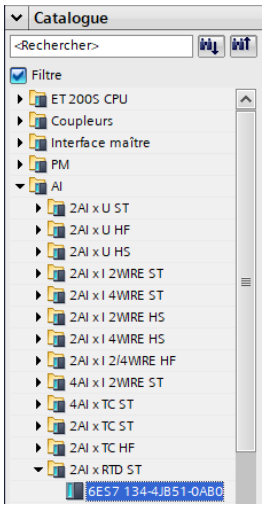
Analog Input Modules

One of the modules includes 4 current analog inputs, ET 200S, 4AI x I WIRE ST (ref: 6ES7 134-4GD00-0AB0).



Specifications
Analog input module 4AI x I, 2-wire measuring transducer (4–20 mA / 13-bit), standard.

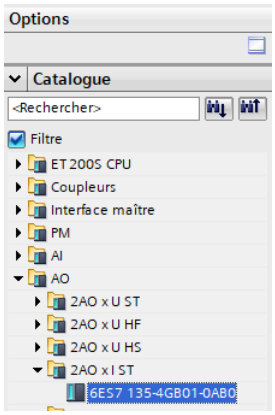
One module includes 2 analog resistance inputs, ET 200S, 2AI x RTD ST (ref: 6ES7 134-4JB51-0AB0).



Specifications
Analog input module 2/4AI x RTD, 15-bit + sign, standard.
Supported resistance values: 150 Ohm, 300 Ohm, 600 Ohm, PTC.
Supported RTD types: Pt100, Ni100.

Module de sorties analogiques

Module a 2 sorties analogiques de courant, ET 200S, 2AO x I ST (réf : 6ES7 135-4GB01-0AB0)

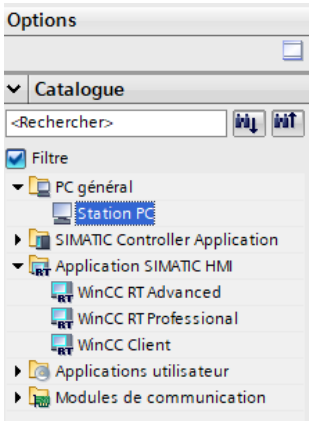


Caractéristiques

Module de sorties analogiques 2AO x I (**+/-20mA / 13bits+signe, 4..20mA / 13bits**), standard, à partir de la version 3.

PC Configuration

The PC configuration is carried out in three steps.



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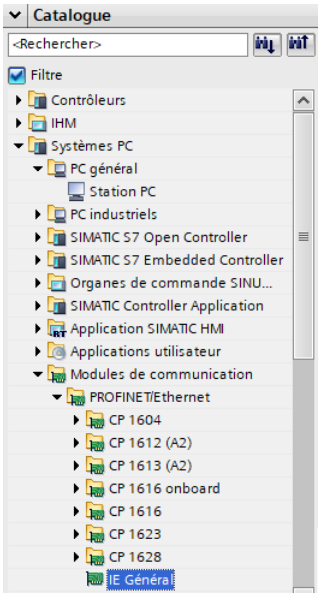

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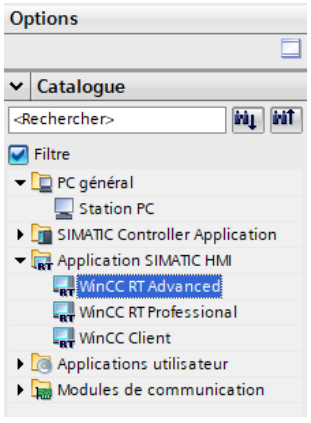
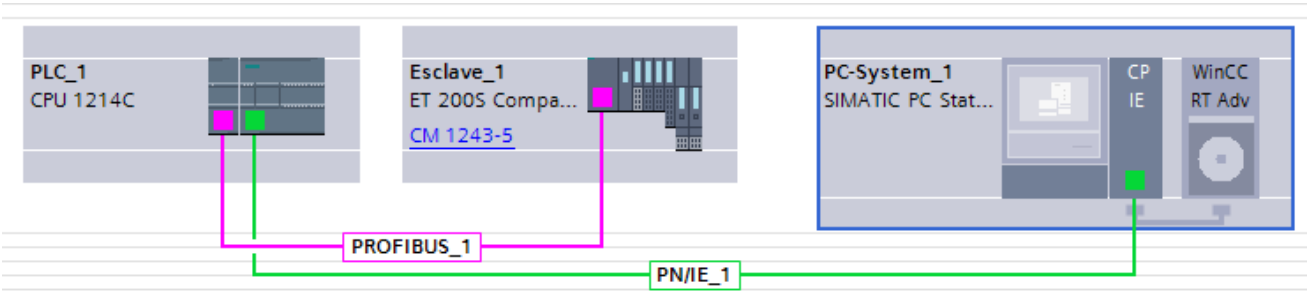


3

1- The PLC is programmed using a general-purpose PC (Intel i5; 4GB RAM).
2- The PC's communication interface must be configured as a standard IE (Profinet/Ethernet).
3- The SIMATIC HMI / WINCC RT Advanced application is used for human-machine interface purposes.

The final step consists of making the necessary connections between the different parts of the PLC system.

Device view in TIA Portal V16



Input/Output Addressing

The tables below present the addressing of the various inputs and outputs of the **CPU 1214C** PLC and the remote **ET200S module**, according to their type (digital or analog). These addresses are used for hardware configuration and programming within the TIA Portal environment.

CPU 1214C	Address
I (Inputs TOR 0/24V)	I0.0 … I0.7 , I1.0 … I1.5
Q (Outputs TOR 0/24V)	Q0.0 … Q0.7 , Q1.0 … Q1.2
IW (Analog inputs 0..10V)	IW64, IW66

ET200S	Address			
I (16 Digital Inputs 0/24V)	**Input**	**Address on module**	**Input**	**Address on module**
	I2.0	**5**	**I3.0**	**25**
	I2.1	**6**	**I3.1**	**26**
	I2.2	**9**	**I3.2**	**29**
	I2.3	**10**	**I3.3**	**30**
	I2.4	**13**	**I3.4**	**33**
	I2.5	**14**	**I3.5**	**34**
	I2.6	**17**	**I3.6**	**37**
	I2.7	**18**	**I3.7**	**38**
Q (16 Digital Outputs 0/24V)	**Input**	**Address on module**	**Input**	**Address on module**
	Q2.0	**45**	**Q3.0**	**65**
	Q2.1	**46**	**Q3.1**	**66**
	Q2.2	**49**	**Q3.2**	**69**
	Q2.3	**50**	**Q3.3**	**70**
	Q2.4	**53**	**Q3.4**	**73**
	Q2.5	**54**	**Q3.5**	**74**
	Q2.6	**57**	**Q3.6**	**77**
	Q2.7	**58**	**Q3.7**	**78**
4AI x I 2 wire ST_1 (analog inputs : Current range 4..20mA)	**IW68, IW70, IW72, IW74**			
2/4 AI x RTD ST_1 (Analog outputs : Resistance Temperature Detector (RTD) 4..20mA)	**IW76, IW78**			
2AO x 1 ST_1 (Analog outputs: 4–20 mA current signals)	**QW64, QW65**			