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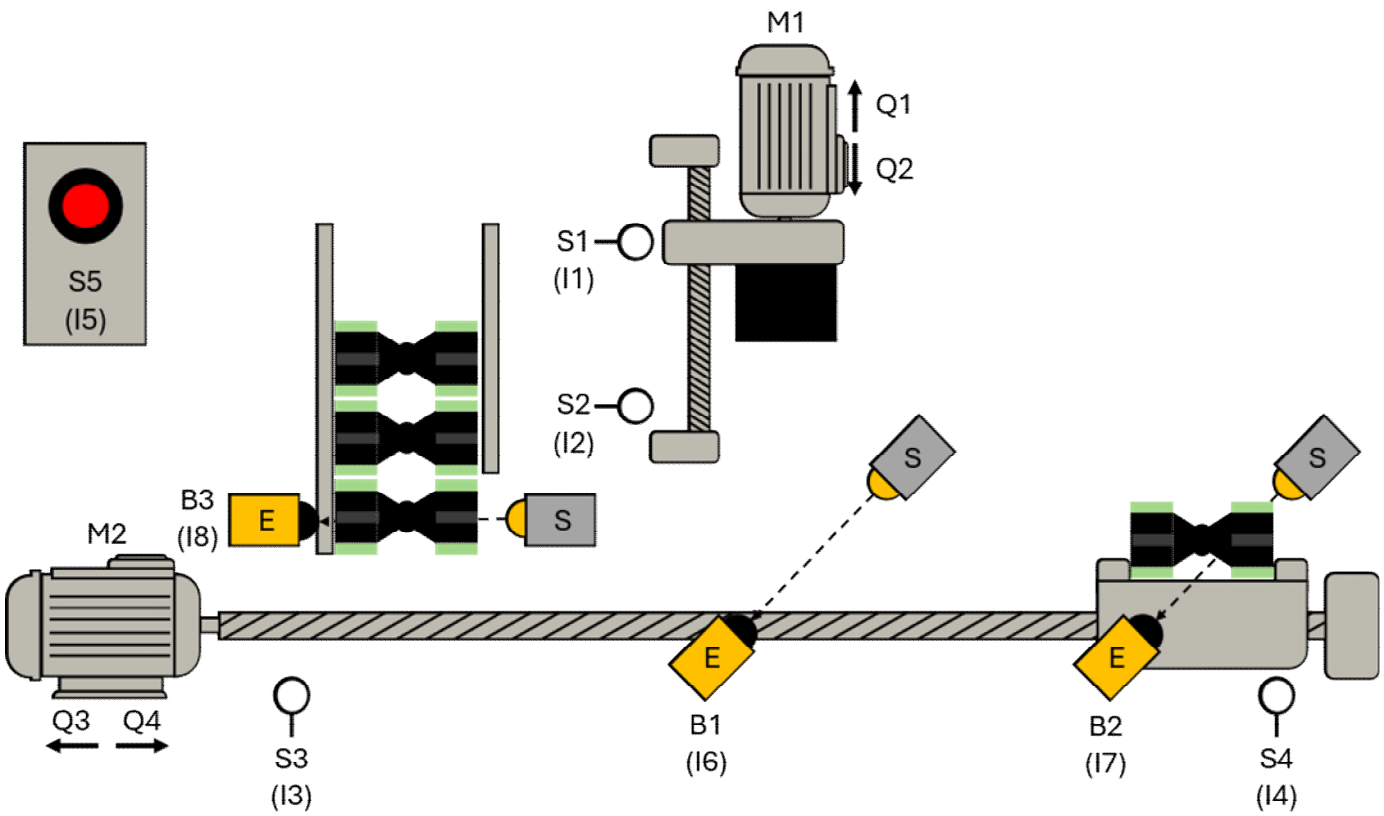
KNOWLEDGE | SOFTWARE | AUTOMATION

Bending machine 24V

Commissioning (hardware)



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3 Commissioning (hardware)

3.1 Introduction

In order to be able to transfer the hardware configuration to the control system, it must be switched on, which first requires a step-by-step commissioning of the system.

Commissioning is the first intended use of a machine or system. It may only be carried out if the machine meets the requirements of the relevant EC directives and has been proven by the EU declaration of conformity and CE marking. Commissioning is an important step in the construction of industrial plants and ensures that the plant functions properly and can be operated safely. This process requires careful planning and execution.

In the following, general steps of hardware commissioning are discussed. Depending on the structure of the real plant, this procedure may have to be adapted if necessary.

Before the actual commissioning begins, various preparatory works must be carried out to ensure that all the prerequisites for a successful launch are met.

- Document verification
  - Review of schematics, wiring diagrams, bills of materials, and feature descriptions.
  - Ensure that all necessary permits and safety documents are in place.
- Visual Inspection
  - Physical inspection of the system for damage, loose connections and correct installation.
  - Checking the mechanical installation and all electrical connections.
- Inspection of safety devices
  - Ensure that all guards are installed and functional.
  - Testing emergency stop switches and other safety-related devices.
- Check patency and insulation resistance
  - Measurement of the low resistance of all protective conductor connections.
  - Carry out insulation measurements to ensure that there are no unwanted ground connections or short circuits.

After the visual inspection and electrical inspection have been successfully completed, the gradual switching on of the system can begin. In this case, the circuits should be put into operation in a controlled manner one after the other and the corresponding voltages and rotating fields should also be checked, starting with the power supply of the controller and then the main power supply.

After the PLC is booted up, the hardware configuration can be transferred. Then check whether the configured assemblies and firmware versions also correspond to those of the real hardware components.

At the end of the commissioning of the hardware, an I/O check must be carried out, which checks whether the sensors and actuators are wired without errors and whether the signals are correctly located in the process image of the inputs and outputs.

3.2 Commissioning protocol

In order to be able to carry out a structured commissioning, it is imperative to create a commissioning protocol beforehand, which can be processed and in which the results are documented accordingly.

A simplified protocol has been prepared for the present annex. In addition to the hardware commissioning, this also includes the part for the software that will be needed at a later date.

Description	OK	Not OK
Visual inspection		
Device manuals for the (PLC) components used are available		
The electrical equipment matches the technical documentation		
The equipment is free of visible damage that could impair safety		
Selection and configuration of protective devices and monitoring devices		
Labeling of all equipment		
Professional conductor connection		
Wiring between model and PLC completed		
PLC-Hardware		
Voltage PLC switched on		
Voltage model switched on		
Device configuration (in TIA Portal) created		
Project data loaded in PLC		
Wiring of sensors checked (I/O check)		
Wiring of actuators checked (I/O check)		
PLC-Software		
Software translated		
software loaded into PLC		
Pressing S5 initializes the step chain		
System moves to the home position - Press in upper end position (S1 pressed) - Transport route in front end position (S4 pressed)		
Workpiece inserted (B3 interrupted)		
Pressing S5 starts the automatic sequence		
Slide moves to the magazine (Q3 activated)		
Slide stops movement below the magazine (S3 activated)		
Slide moves with workpiece towards the press (Q4)		
Movement is stopped when light barrier B1 is interrupted		
Press moves down (Q2)		
Movement is stopped in the lower end position (S2 activated)		
Press moves up (Q1)		
Movement is stopped in the upper end position (S1 activated)		
Slide moves with workpiece in direction of removal (Q4)		
Slide stops movement in removal position (S4 actuated)		
Chain jumps to initial step when workpiece has been removed (B2 not interrupted)		
Pressing S5 again starts a new automatic sequence when there is a workpiece in the magazine (B3 interrupted)		

Plant Expansion 1 - Time Function		
Automatic sequence is started by pressing S5 when a workpiece is in the magazine		
Slide stops Movement below the magazine (S3 activated)		
Slide moves with the workpiece towards the press (Q4)		
Movement is stopped when light barrier B1 is interrupted		
Bewegung wird gestoppt, wenn Lichtschranke B1 unterbrochen wird		
Press moves down (Q2)		
Movement is stopped in the lower end position (S2 activated)		
The press remains in the lower end position for a defined period of time (2 seconds).		
The press moves upwards (Q1).		
The movement is stopped in the upper end position (S1 actuated).		
The slide moves with the workpiece in the direction of removal (Q4).		
The slide stops the movement in the removal position (S4 actuated).		
Chain jumps to initial step when workpiece has been removed (B2 not interrupted)		
Pressing S5 again starts a new automatic cycle when there is a workpiece in the magazine (B3 interrupted)		
System Expansion 2 – Counting Function		
Automatic sequence is started by pressing S5 when a workpiece is in the magazine		
Slide moves to the magazine (Q3 activated)		
Slide stops movement below the magazine (S3 activated)		
Slide moves with workpiece towards the press (Q4)		
Movement is stopped when light barrier B1 is interrupted		
Press moves down (Q2) - [start first bending process]		
Movement is stopped in the lower end position (S2 actuated)		
Press remains in the lower end position for a defined period of time (2 seconds)		
Press moves up (Q1)		
Movement is stopped in the upper end position (S1 actuated)		
Press moves down (Q2) - [start second bending process]		
Movement is stopped in the lower end position (S2 actuated)		
Press remains in the lower end position for a defined period of time (2 seconds)		
Press moves up (Q1)		
Movement is stopped in the upper end position (S1 actuated)		
Press moves down (Q2) - [start third bending process]		
Movement is stopped in the lower end position (S2 activated)		
Press remains in the lower end position for a defined period of time (2 seconds)		
Press moves up (Q1)		
Movement is stopped in the upper end position (S1 activated)		
Slide moves with workpiece in direction of removal (Q4)		
Slide stops movement in removal position (S4 activated)		
Chain jumps to initial step when workpiece has been removed (B2 not interrupted)		
Pressing S5 again starts a new automatic sequence when there is a workpiece in the magazine (B3 interrupted)		

3.3 Exercise: Perform visual inspection

Goal:

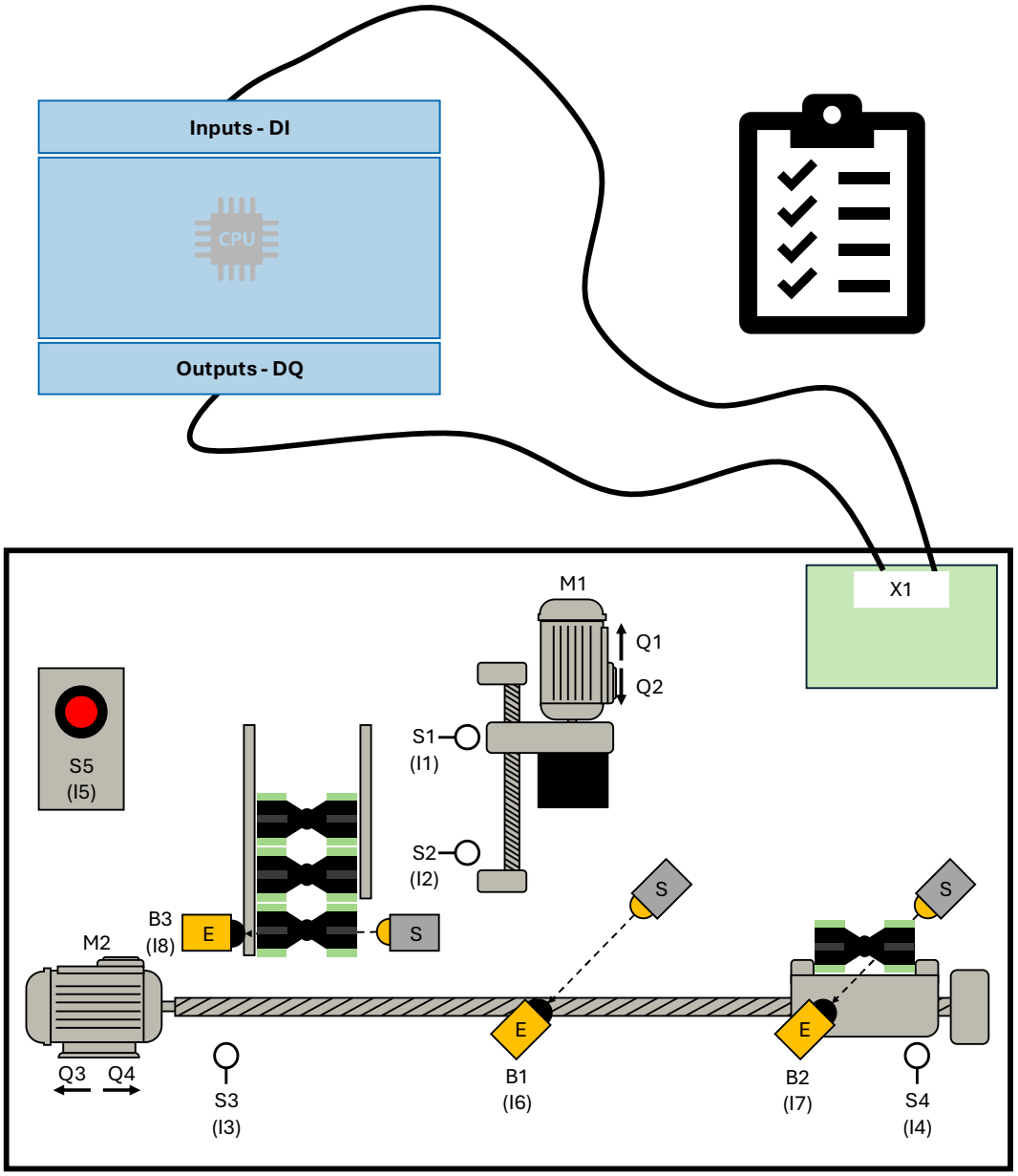
I can prepare my system for commissioning and carry out the visual inspection.

Task:

Prepare the plant for commissioning.

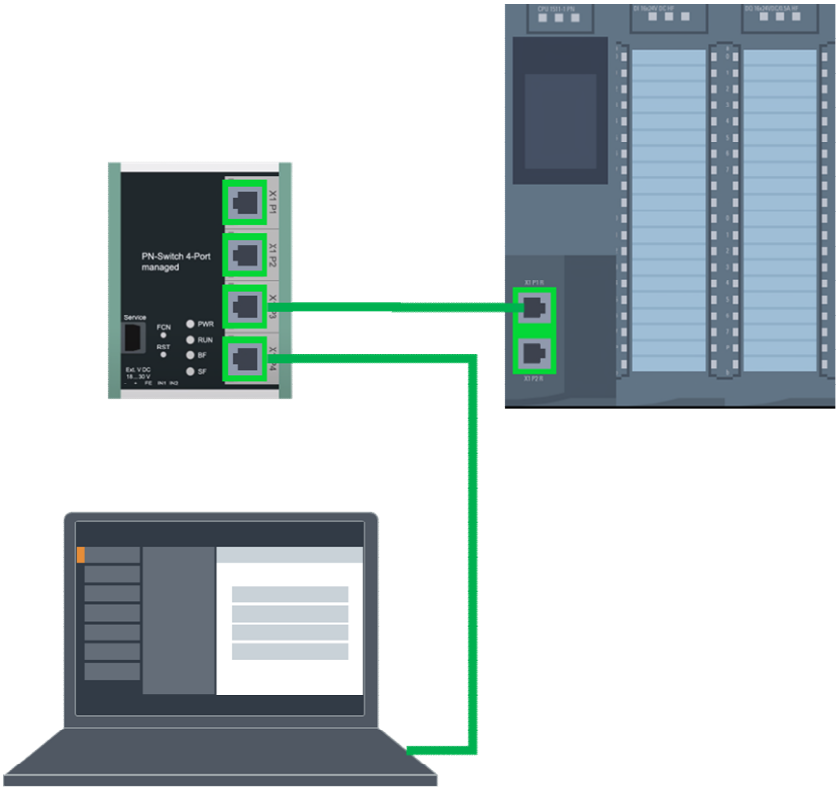
If the model has not yet been wired to the automation system you are using, do so. "Table 1 Allocation plan terminal strip X1", from the chapter "Model description", as well as the device manuals of the hardware used can be helpful for this.

Perform a visual inspection and document the result in a log.


Inputs - DI
CPU
Outputs - DQ
X1
M1
Q1
Q2
S1
(I1)
S2
(I2)
S5
(I5)
B3
(I8)
E
S
M2
Q3
Q4
S3
(I3)
B1
(I6)
B2
(I7)
S4
(I4)

3.4 Connecting the programmer and PLC

In order to be able to establish the connection to the PLC (target system), the programming device (PG) and the target system must be connected via an interface. Via this communication link to be defined, PG and PLC exchange data and information.



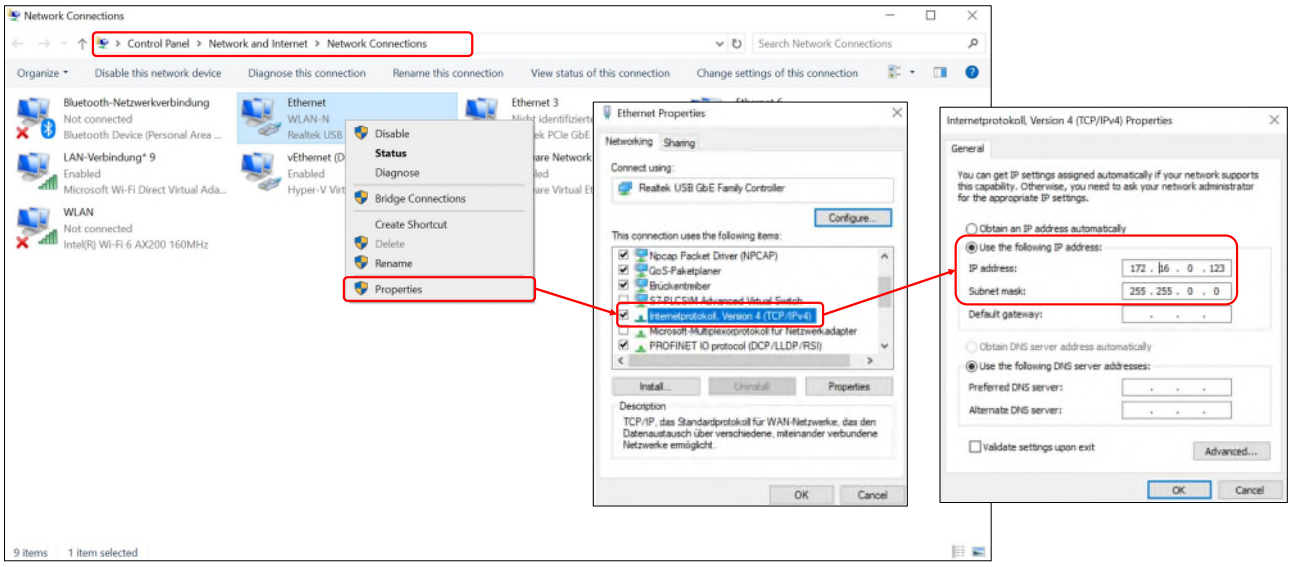
Picture 1 Physical networking

Common programming interfaces are, for example: PROFIBUS or PROFINET or Ethernet.

In order to establish communication, the following must be
Requirements must be met:

- both devices have an Ethernet port.
- both devices are physically connected to the same network.
- both devices are correctly parameterized (IP address set).

The IP address of the programming device can be adjusted in the Windows Control Panel under "Control Panel → Network and Internet → Network Connections".



Picture 2 Setting Windows Network Adapters

Here you have to select the appropriate network adapter, in the context menu under " → Internet Protocol Version 4 (TCP/IPv4 Properties)" you can manually assign a free IP address and subnet mask, which is located in the address space of the PLC.

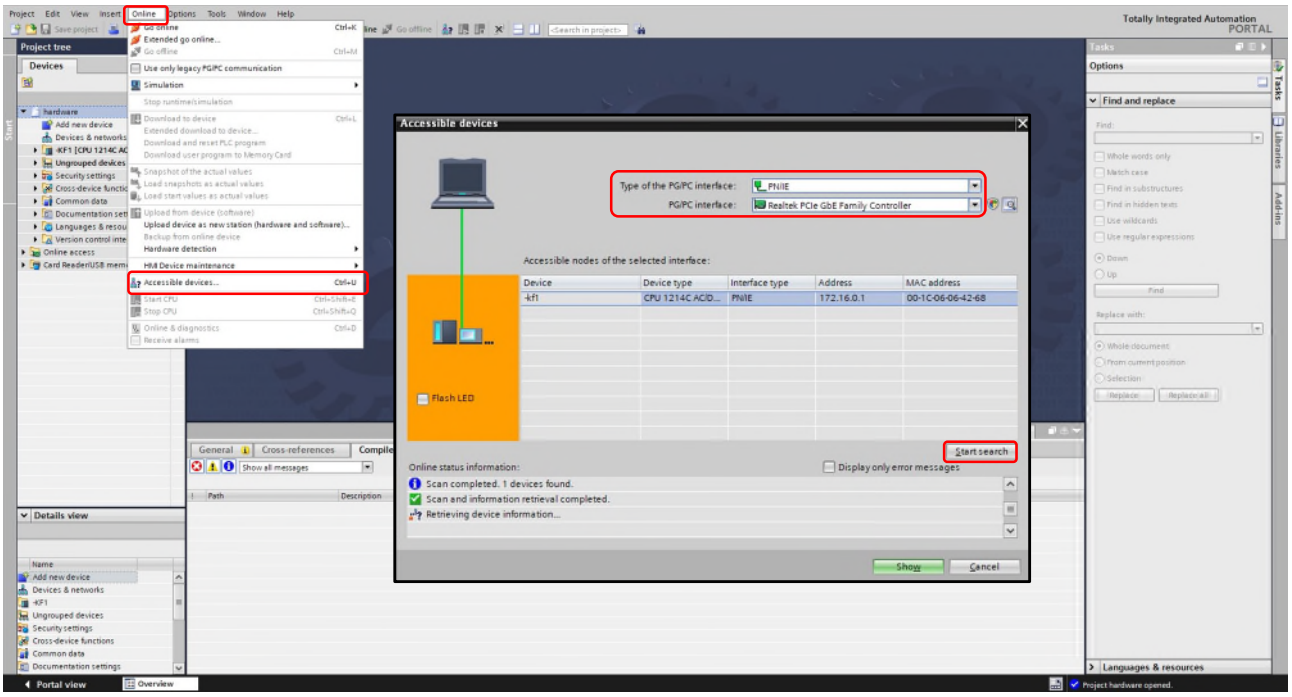
Reachable participants

After the physical networking and the parameterization of the online interface of the programming device have been completed, it must be checked whether a connection to the target system can be established.
Depending on the programming environment and target system used, various on-board tools are available for this purpose.

For example, Beckhoff offers the option of searching for reachable target systems in TwinCAT under "Select SYSTEM → Target System → Search (Ethernet)" using Broadcast Search.

In the following, the procedure in the TIA portal, in combination with an S7 1200 CPU, is shown in detail.

Under "Participants → who can be reached online..." the connection to the CPU can be checked.



Picture 3 Reachable participants in the TIA Portal

The "Reachable Participants" function offers an easy way to determine which participants can be reached via the set PG/PC interface. These are displayed in the table "Reachable participants of the selected interface" after the "Start search" button has been pressed.

If a detected device is marked, a flashing light can be activated on the selected device by ticking the "LED flashing" box. This allows it to be checked beyond doubt whether the selected device also corresponds to the expected one.

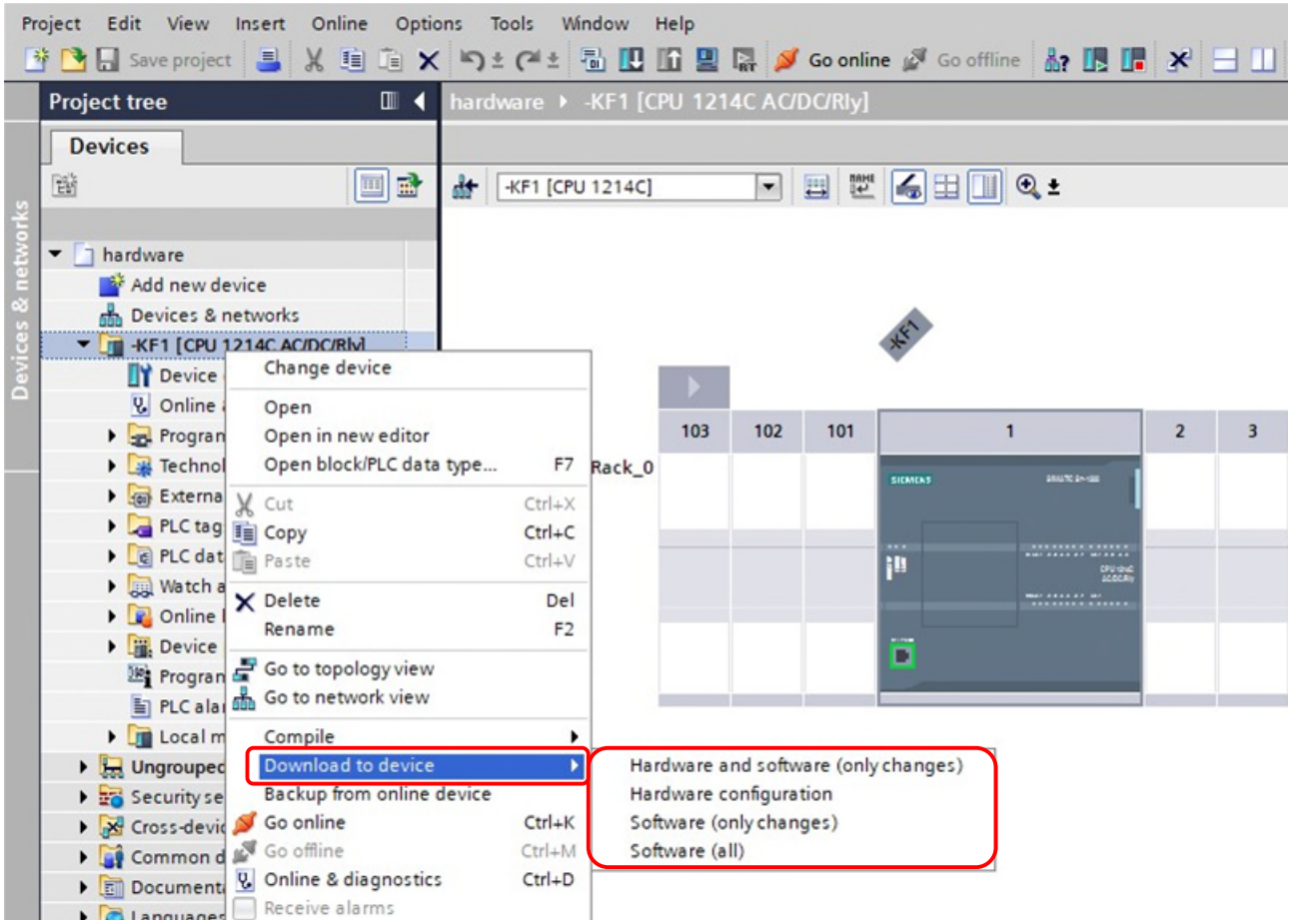
3.5 Load project data

After your project planning has been successfully translated, the project data that you have created offline must be loaded into the connected device.
When loading for the first time, the project data is fully loaded. Only changes are loaded during further loading processes.

3.5.1 TIA

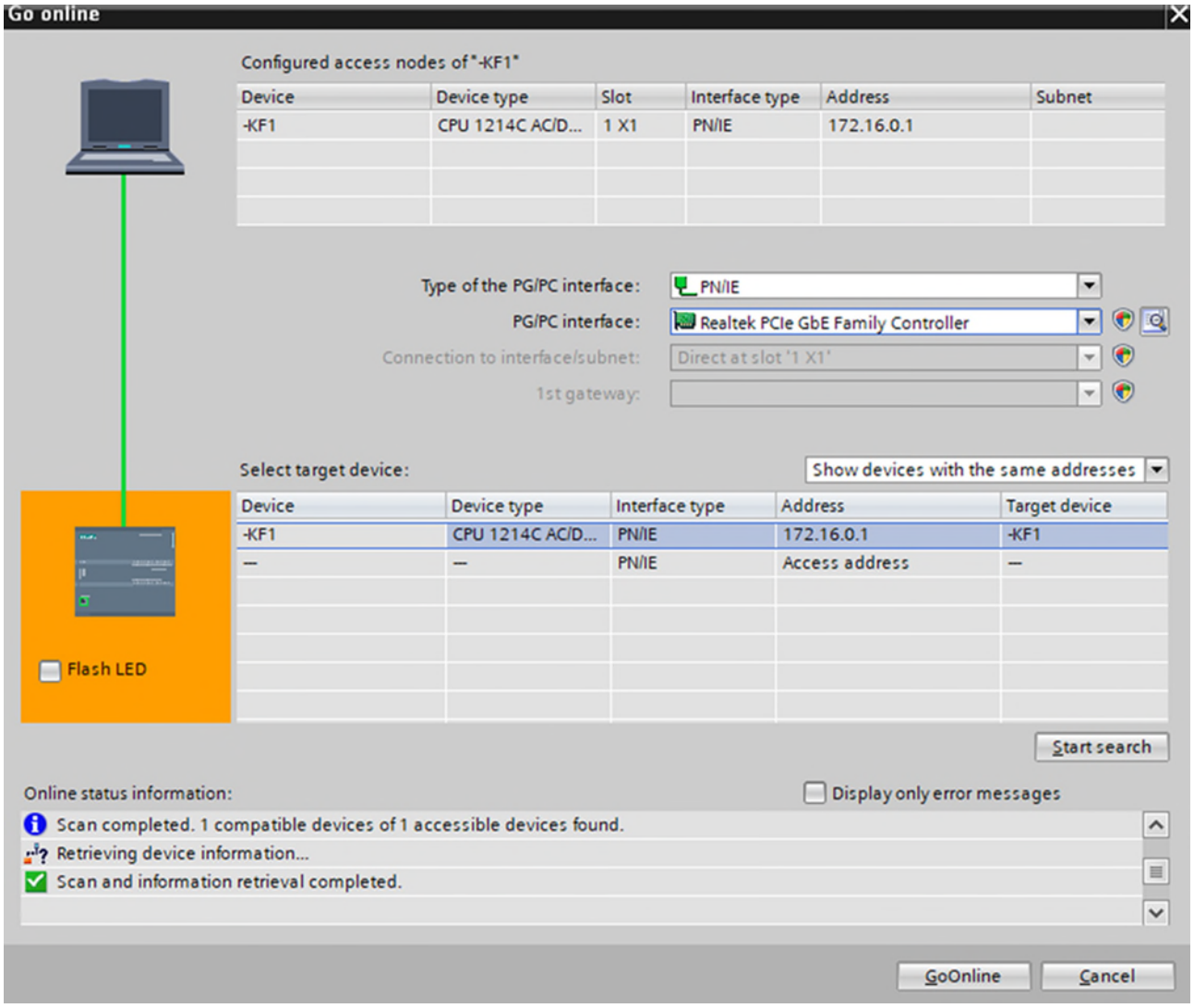
The procedure in the TIA Portal is described below.
To load the project data into the device, do the following:

- Select the desired device in the project navigation
- In the right-click context menu, select "Load in Device"
- Select what you want to load:
  - Hardware and software (changes only)
  - Hardware
  - Software (changes only)
  - Software (load completely); all values are reset to their starting values



Picture 4 Charging in Device

If the connection information of the configuration does not match a reachable device, the "Advanced Loading" dialog box appears.



Picture 5 Advanced Charging

Configured Access

In the Configured Access Nodes area, the parameters specified in the configuration are displayed.

Selected Interface

Here you can select the interface through which the PLC is connected to the programming device (PG).

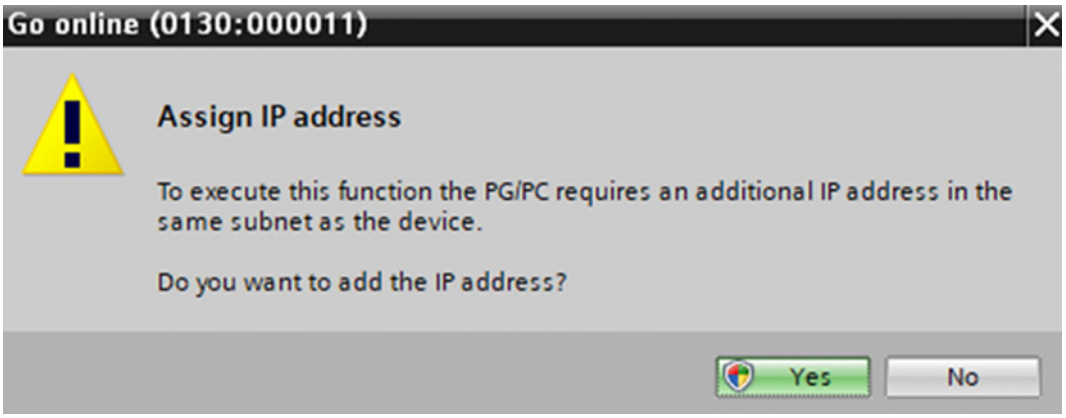
Devices found

The devices that can be reached via the set interface are displayed in a table after pressing the "Start search" button.

Load button

The selected loading action is executed via these buttons.

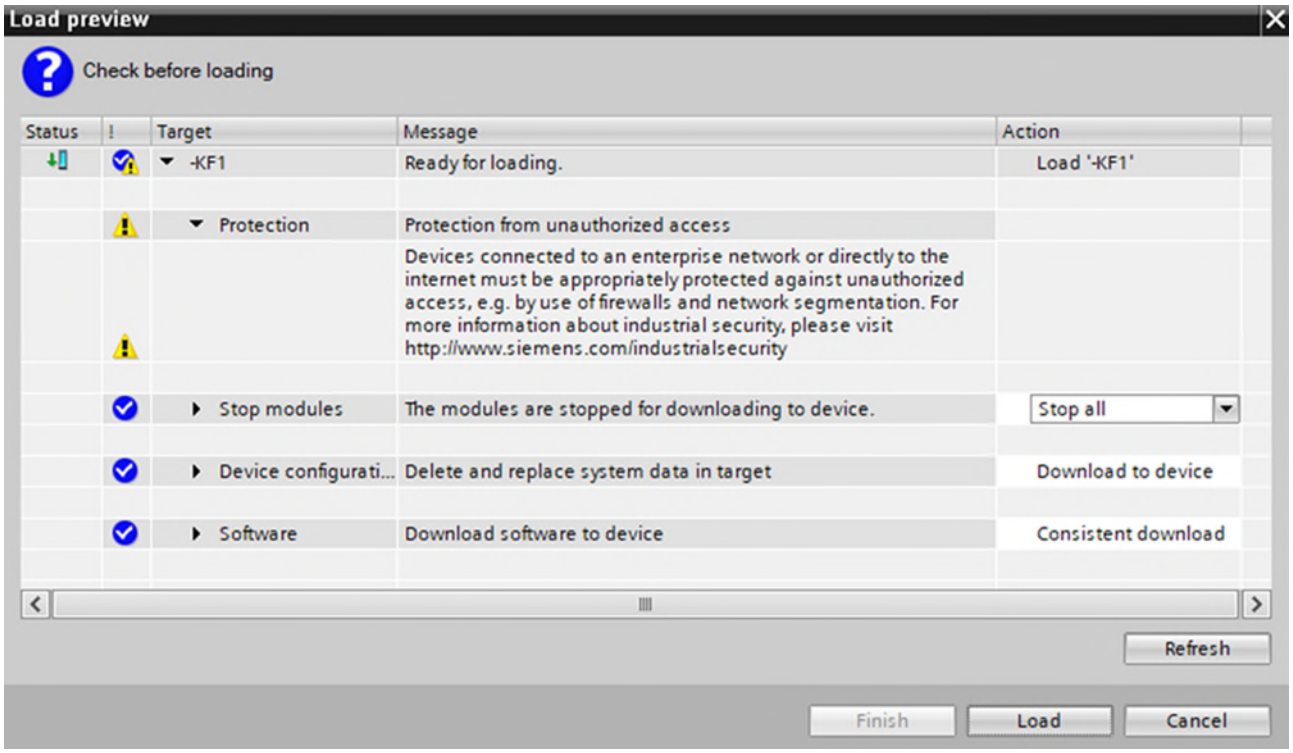
The TIA Portal searches for the projected PLC in the target subnet. If you have not yet assigned an IP address to the PG in the same subnet via the Windows Control Panel, you can now do so via the dialog shown in the following image.



Picture 6 Advanced Loading – Assign IP Address

By clicking on "Yes", the PG is temporarily assigned a suitable IP address from the device's subnet.

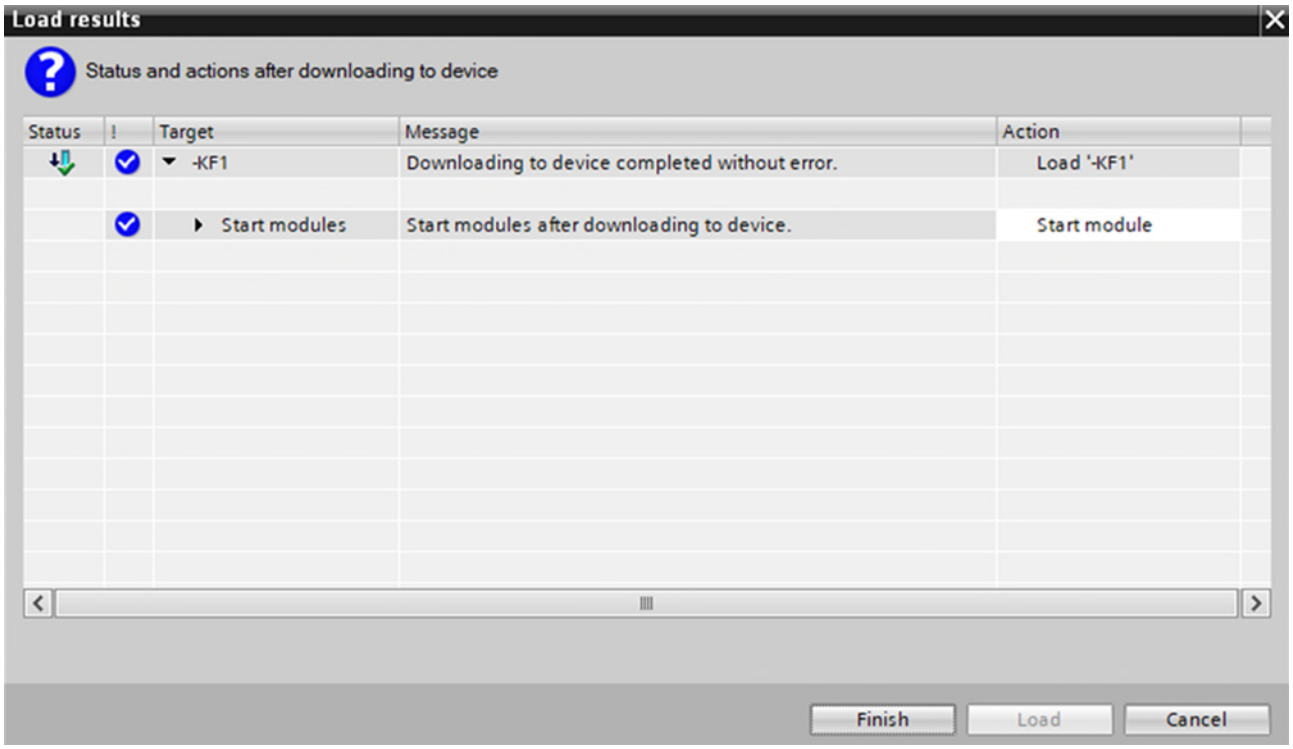
The "Load Preview" dialog will now appear.



Picture 7 Load preview

This lists the actions that are performed when loading. If necessary, warnings and errors are also uncovered here.
After pressing the "Load" button, the charging process is carried out.

After the process has been completed, the result is displayed in a corresponding dialog box.



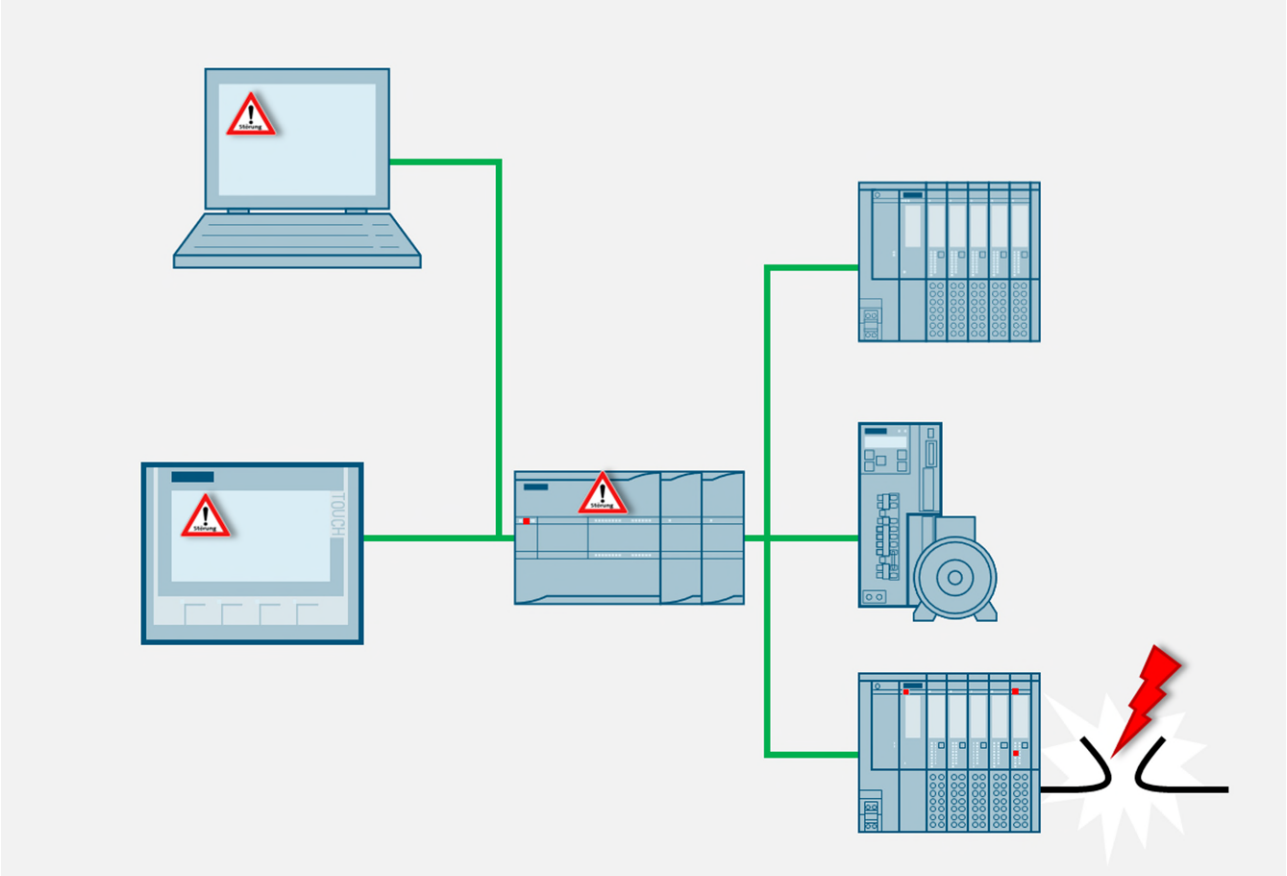
Picture 8 Results of the loading process

In the “Load Results” dialog box, you can view the
Start assemblies again. Finally, press the "Done" button.

The charging process is now finished.

3.6 System Diagnosis

In the SIMATIC environment, the diagnosis of devices and modules is referred to as system diagnostics. The components automatically report a malfunction in operation and provide additional diagnostic information.



Picture 9 System Diagnostics

The automation system monitors the following conditions in the running system:

- Device failure/recurrence
- Drag/Stick Event
- Assembly Error
- Peripheral Access Errors
- Channel error
- Parameterization error
- Failure of the external auxiliary voltage

The system diagnostics are integrated as standard in the firmware of the PLC S7-1200.
Faults are immediately detected and reported to the HMI device, the web server, the LED displays on the affected module and the TIA portal.

3.6.1 Diagnostic features and events

System diagnostics is the detection, evaluation and reporting of errors that occur within an automation system.

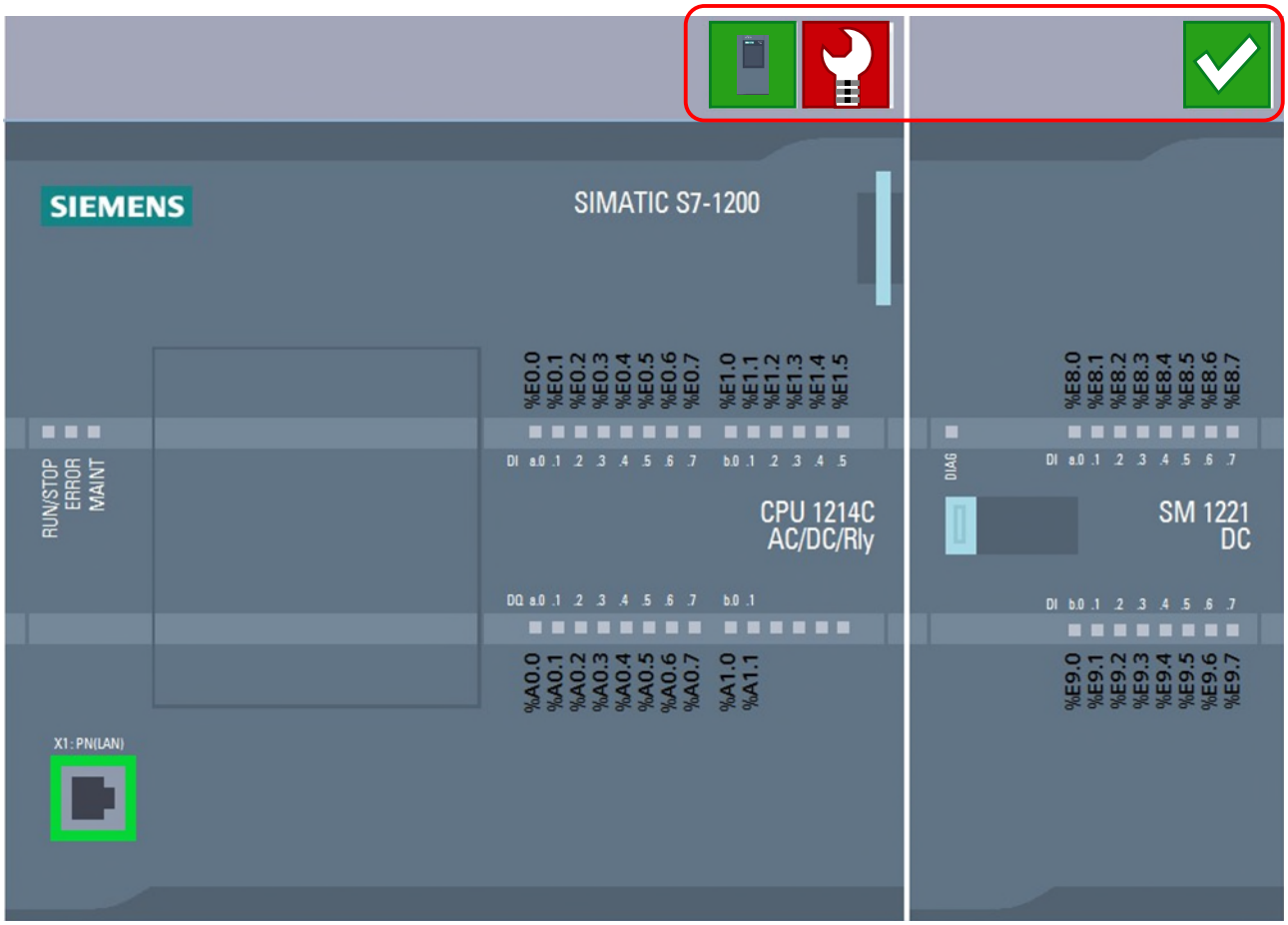
Acquisition of diagnostic data

The collection of diagnostic data by System Diagnostics does not need to be programmed, it is available by default and runs automatically. The PLC detects system errors, hardware errors, and errors in the user program, for which diagnostic events are entered into the system state list and the diagnostic buffer in the order in which they occurred.

If the PLC is extinguished and de-energized, the contents of the diagnostic buffer are preserved. Errors in the system can be evaluated by the diagnostic buffer even after a longer period of time in order to be able to trace and assign the occurrence of individual diagnostic events.

3.6.2 Diagnostics in the device view

In the device view, you will receive the status display for the individual assemblies via diagnostic icons. You can find these in various places in the TIA Portal.



Picture 10 Diagnostic Icon Device View

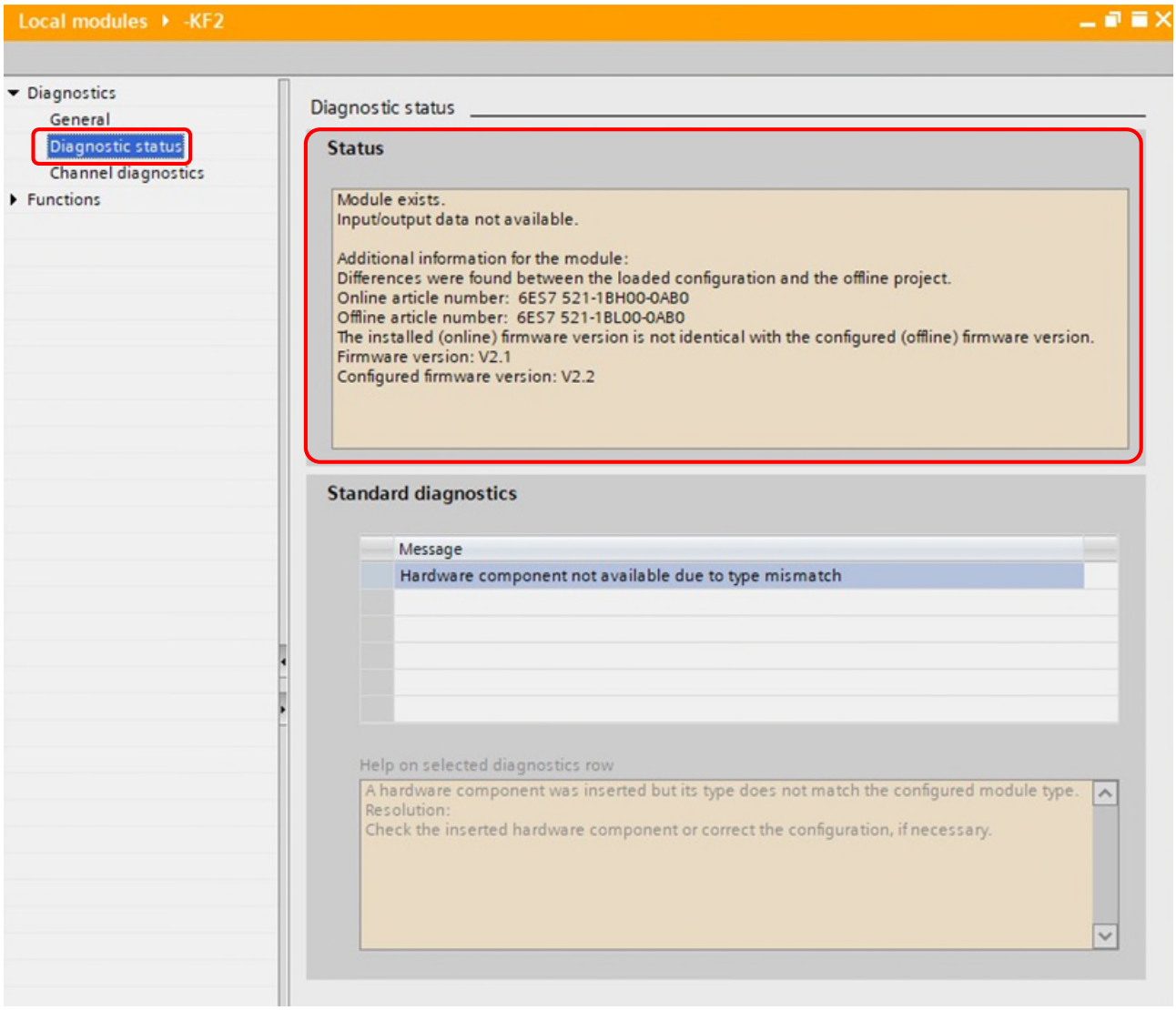
Fault categorization

In order to be able to categorize faults quickly and easily, the following symbols are used.

Symbol	Bedeutung
	Operating status "RUN"
	Operating status "STOP"
	Operating status "Anlauf"
	No disturbance
	Maintenance
	Maintenance Request
	Error

Table 1 Symbole System Diagnosis

Double-clicking on the diagnostics icon starts the online and diagnostic view (if available). Here, under "Diagnostic → Diagnostic Status", you will be informed of the status of the assembly. If the assembly does not work smoothly, the error that was diagnosed is listed here. In most cases, remedial measures are also indicated.



Picture 11 Diagnostic status Components

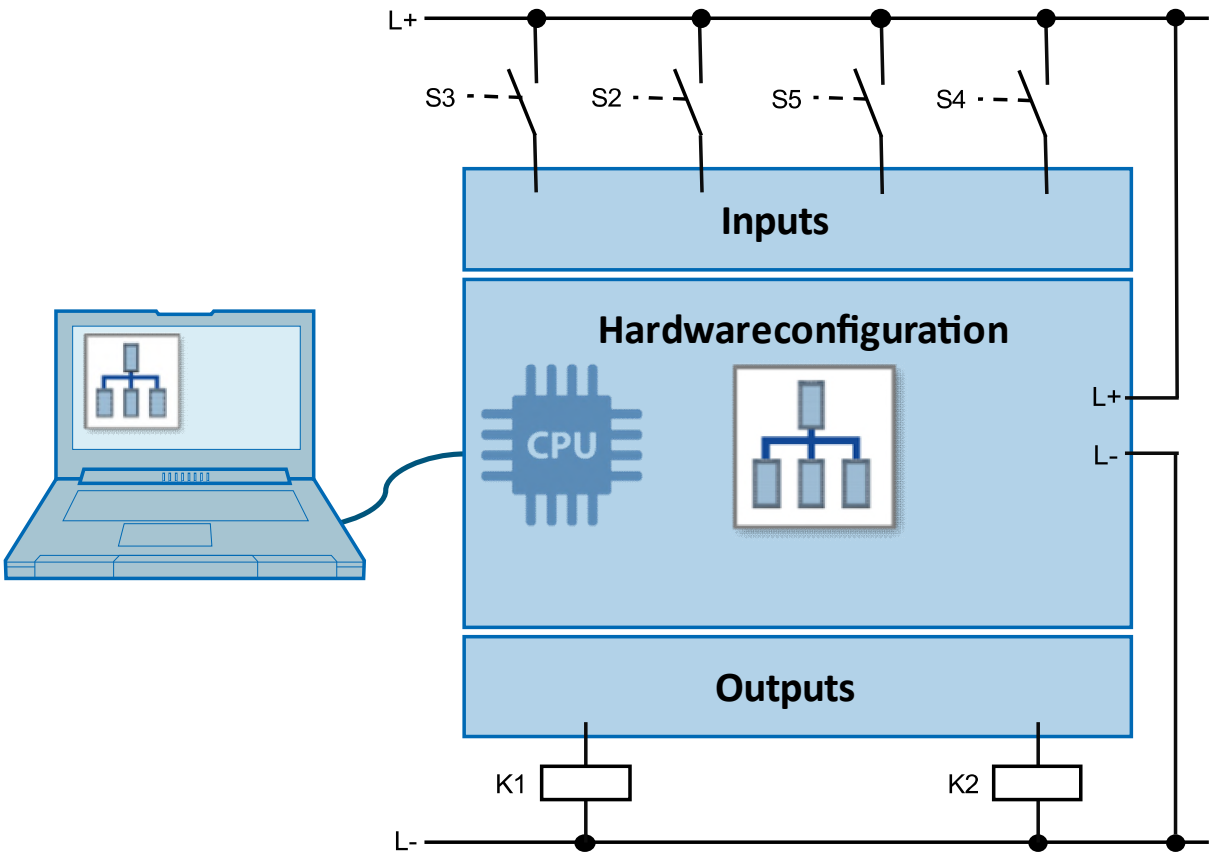
3.7 Exercise: Commissioning hardware configuration

Goal:

I can put the PLC hardware into operation independently.

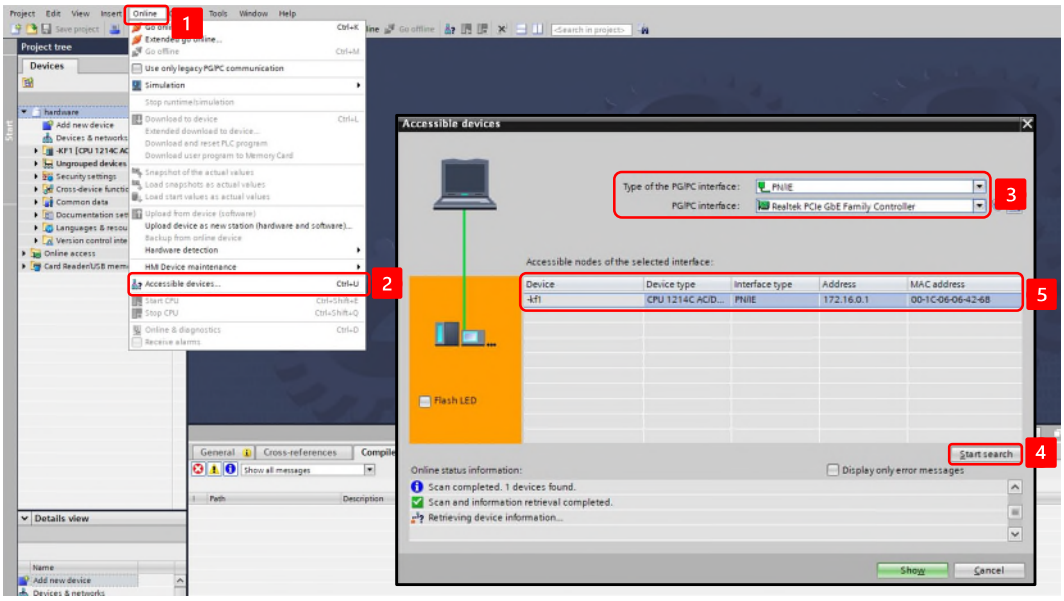
Task:

Connect the PLC to the programmer and transfer the PLC hardware by loading the design data into the device.

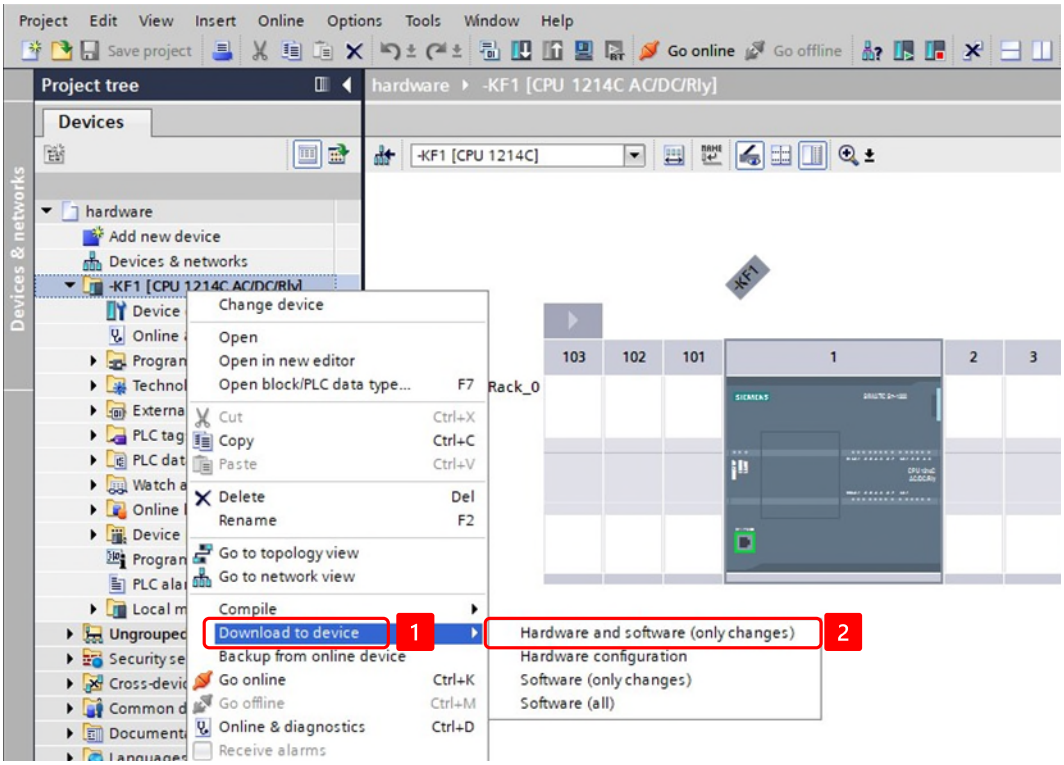


Procedure:

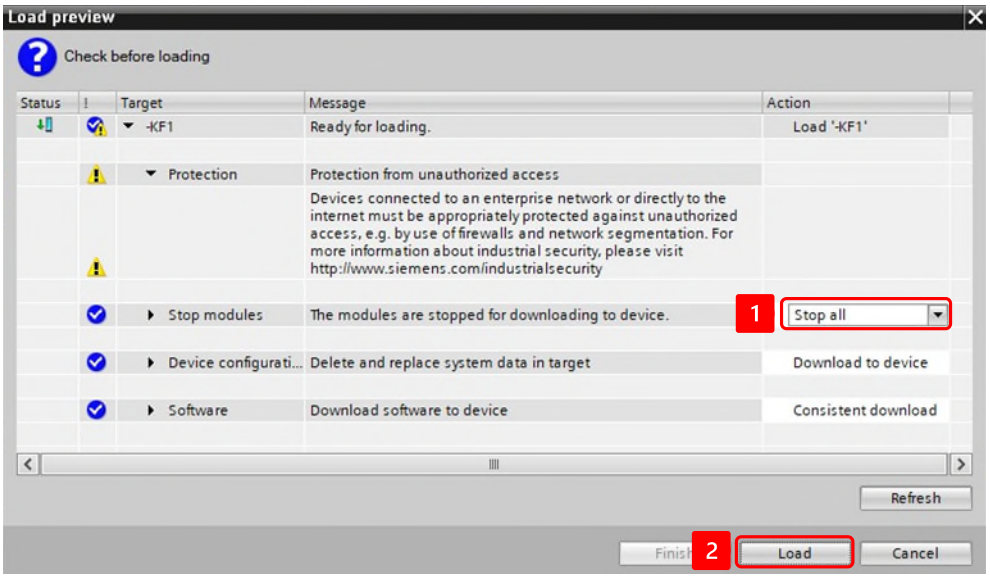
Use "Reachable Participants" to check whether a connection to the target system can be established:



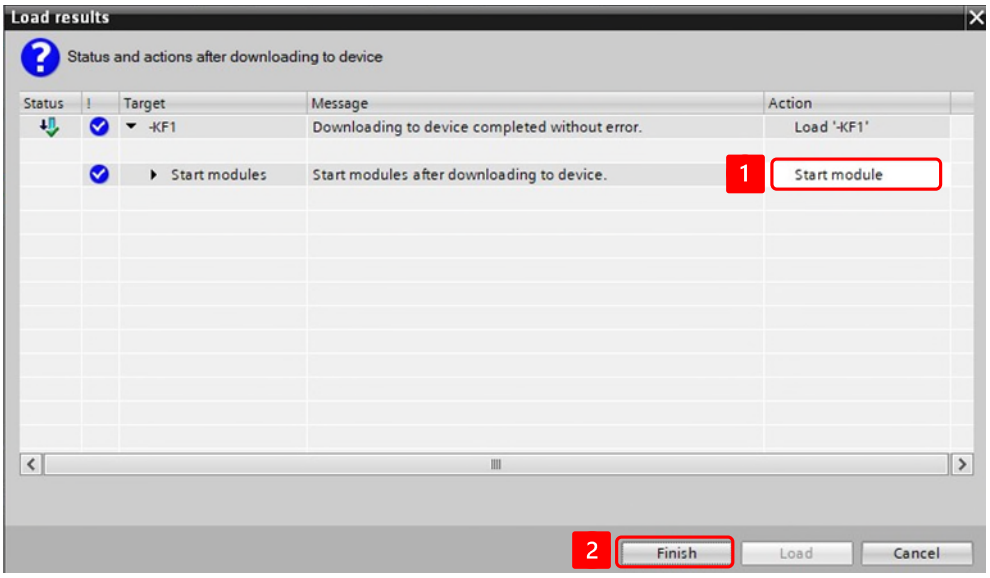
1. Select your PLC in the project navigation and select the following from the right-click context menu:
   "Load in Device" → "Hardware and Software (Changes Only)".



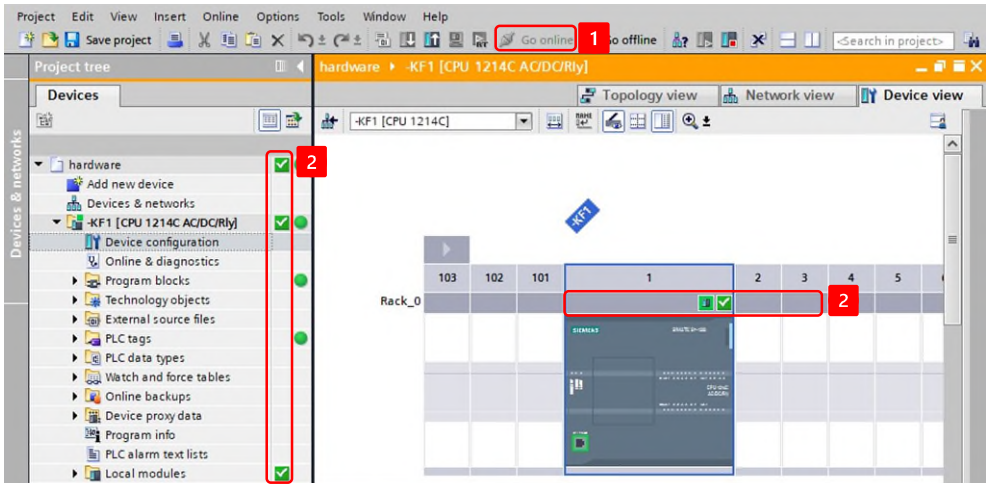
1. Follow the „Load Preview“ window:



2. After the successful charging process, start the PLC.



3. If the PLC is now in RUN mode and is trouble-free, the exercise is over.



3.8 I/O check

An I/O check (input/output check) is an essential step in commissioning. It is used to ensure that all inputs and outputs are correctly wired to the PLC and are functioning properly. This check is crucial to identify possible sources of error at an early stage and to ensure that the plant is operating as planned.

The I/O check is so important because an incorrect assignment or a defective sensor/actuator in a PLC system can have serious consequences, such as plant downtimes, unexpected movements of machines or even accidents. The I/O check ensures that each input variable (e.g. button, sensor) reacts correctly to the PLC and that each output variable (e.g. motor, valve) shows the desired behavior.

Due to possibly faulty wiring, unwanted system reactions can occur during the I/O check. A careful and well-considered approach must be used to ensure that any remaining wiring or hardware errors cannot at any time lead to a danger to people, the environment or plant components.

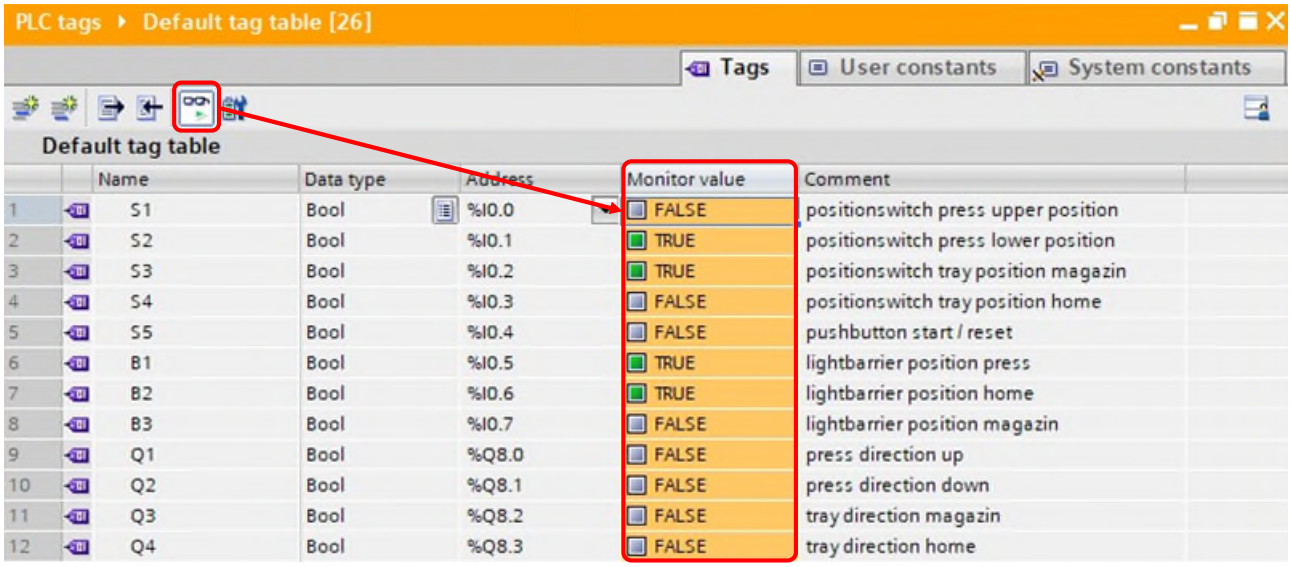
An I/O check is ideally carried out when no control program has yet been processed. This means that the manually controlled outputs are not overwritten and manually operated sensors do not result in a program reaction.

Depending on the target system, the following tools are available as tools:

- Observation table (Siemens) / Watchlist (Beckhoff)
- PLC-Variablentabelle (Siemens) / Globale Variablenliste (Beckhoff)

3.8.1 PLC Variable Table

With the help of the PLC variable table, you can set the peripheral inputs in operation
take.



	Name	Data type	Address	Monitor value	Comment
1	S1	Bool	%I0.0	FALSE	positionswitch press upper position
2	S2	Bool	%I0.1	TRUE	positionswitch press lower position
3	S3	Bool	%I0.2	TRUE	positionswitch tray position magazin
4	S4	Bool	%I0.3	FALSE	positionswitch tray position home
5	S5	Bool	%I0.4	FALSE	pushbutton start / reset
6	B1	Bool	%I0.5	TRUE	lightbarrier position press
7	B2	Bool	%I0.6	TRUE	lightbarrier position home
8	B3	Bool	%I0.7	FALSE	lightbarrier position magazin
9	Q1	Bool	%Q8.0	FALSE	press direction up
10	Q2	Bool	%Q8.1	FALSE	press direction down
11	Q3	Bool	%Q8.2	FALSE	tray direction magazin
12	Q4	Bool	%Q8.3	FALSE	tray direction home

Picture 12 PLC Variable Table

Check receipts

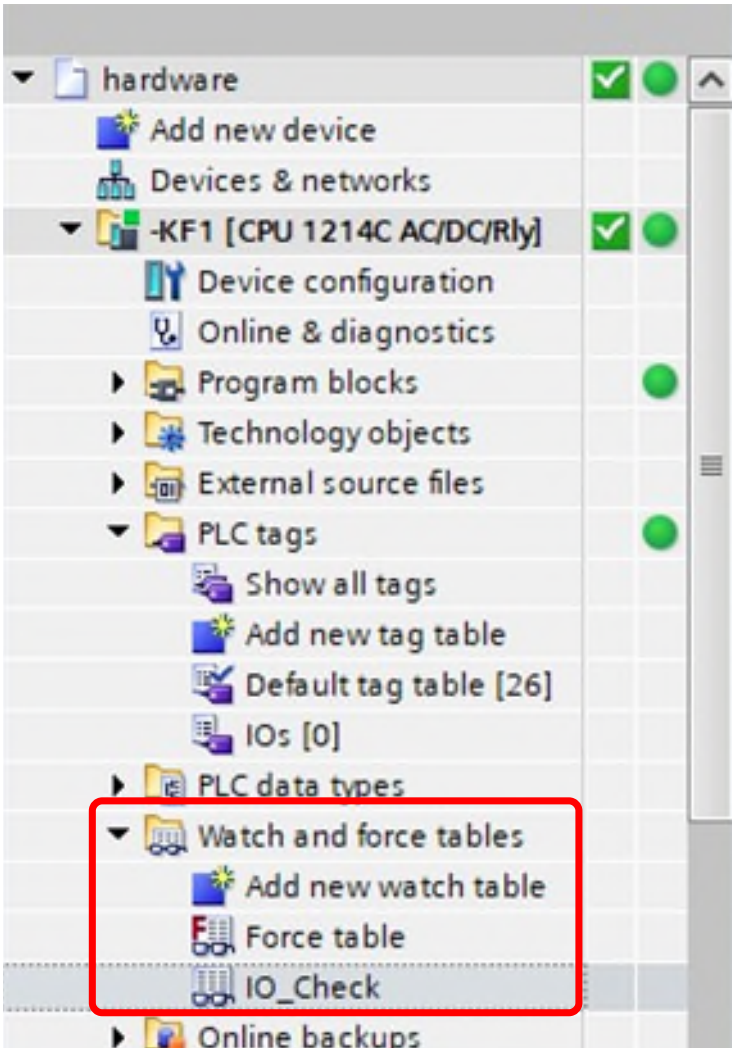
Inputs can be observed in the variable table, making the function suitable for testing the input assemblies and the encoder circuits. This makes it possible to check the status of inputs that are read in from the process image (PAE).
To observe, click the "Watch all" icon. The Observation Values column appears on it, where you can observe the values.

Check outputs

Outputs cannot be controlled or changed in the PLC variable table. These can only be observed here. To change the status of an output, the observation table must be used.

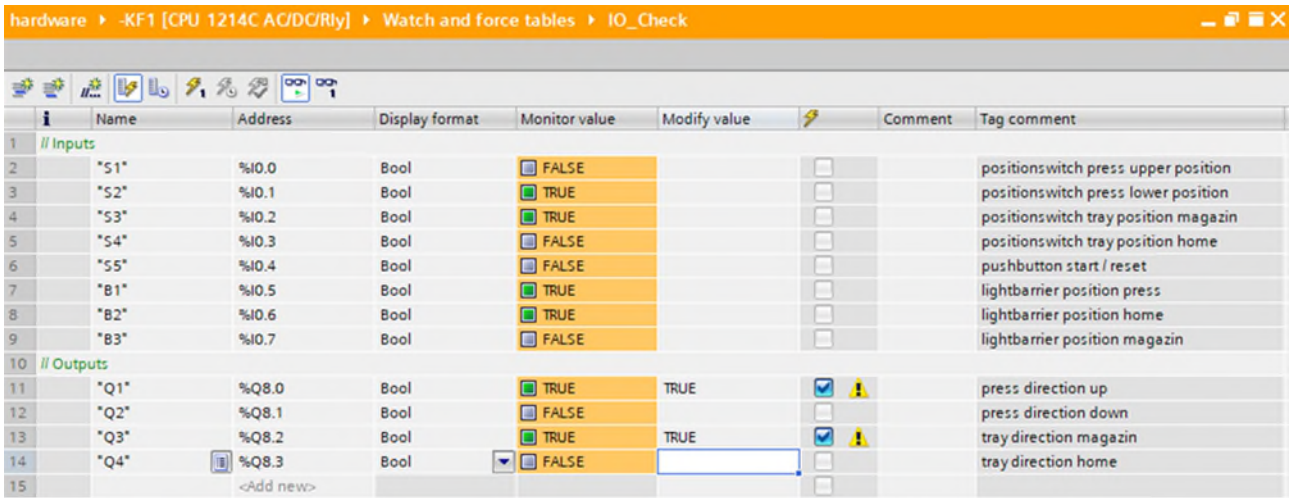
3.8.2 Observation table

In observation tables, you have the possibility to observe variables from different PLC variable tables in one place and also to control them.
To observe variables, there must be an online connection to the PLC. Once you have created an observation table, you can save, duplicate, print and use it again and again to observe and control variables.
You can find the observation tables in the "Observation and Force Tables" folder in the project navigation of your PLC. Multiple observation tables can be created. The names can be chosen freely.



Picture 13 Observation Table - Project Navigation

The following picture shows an open observation table. Some variables are already entered.



	Name	Address	Display format	Monitor value	Modify value		Comment	Tag comment
1	// Inputs							
2	"S1"	%I0.0	Bool	FALSE		☐		positionswitch press upper position
3	"S2"	%I0.1	Bool	TRUE		☐		positionswitch press lower position
4	"S3"	%I0.2	Bool	TRUE		☐		positionswitch tray position magazin
5	"S4"	%I0.3	Bool	FALSE		☐		positionswitch tray position home
6	"S5"	%I0.4	Bool	FALSE		☐		pushbutton start / reset
7	"B1"	%I0.5	Bool	TRUE		☐		lightbarrier position press
8	"B2"	%I0.6	Bool	TRUE		☐		lightbarrier position home
9	"B3"	%I0.7	Bool	FALSE		☐		lightbarrier position magazin
10	// Outputs							
11	"Q1"	%Q8.0	Bool	TRUE	TRUE	☑ ⚠		press direction up
12	"Q2"	%Q8.1	Bool	FALSE		☐		press direction down
13	"Q3"	%Q8.2	Bool	TRUE	TRUE	☑ ⚠		tray direction magazin
14	"Q4"	%Q8.3	Bool	FALSE		☐		tray direction home
15		<Add new>						

Picture 14 View Observation Table

The structure is very similar to the PLC variable table. However, the names of the variables cannot be changed.

Add Observation Table

To create an observation table, follow these steps:

1. In the project navigation, open the structure below the PLC for which you want to create an observation table.
2. Open the Observation and Force Tables folder.
3. Double-click the Add New Observation Table command.
4. A new observation table is added.

Different test cases

You can create multiple observation tables using Add New Observation Table and name them according to a specific test case. These observation tables are always part of the project.

Check receipts

Entrances can be observed in the observation table. This makes the function suitable for testing the input assemblies as well as the encoder circuits. This makes it possible to check the status of inputs that are read from the process image.

Control outputs

At the same time, individual outputs can be switched with the "Control" test function. The function of the connected actuators can thus be checked.

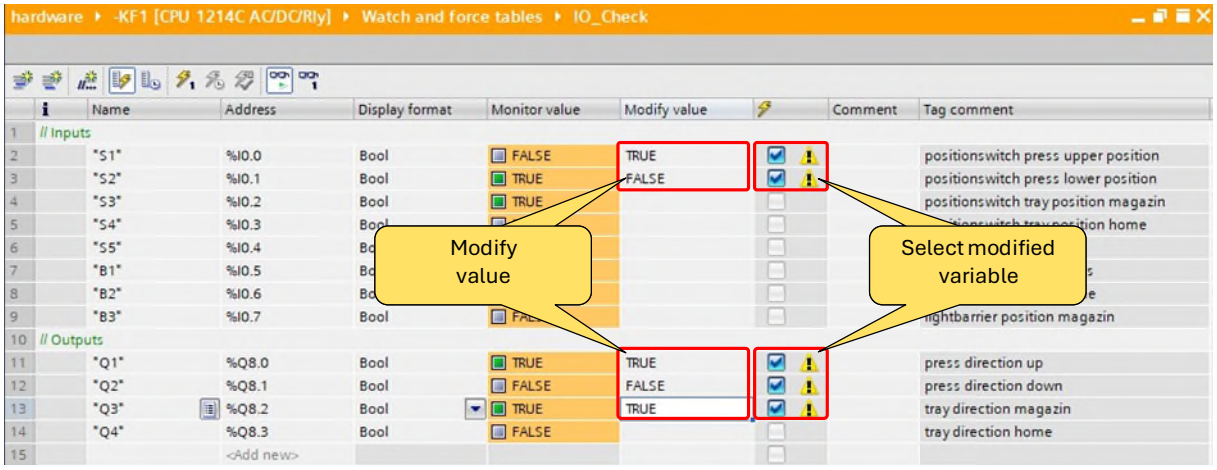
To observe or control, you will need the following controls:

Symbol	Meaning
	Show and hide the control columns
	Turning the observation function on and off
	One-time control of the selected PLC variable "Control Flash"

Table 2 Symbols Observation Table

Observe the procedure

1. Enter the name of the variable in the "Name" column.
2. Start the observation function (glasses with green triangle).



Picture 15 Controlling Variables

How to control

1. Enter the name of the variable in the "Name" column.
2. Start the observation function (glasses with green triangle).
3. Enable the control columns.
4. In the "Tax Value" column, enter the desired value.
5. For a binary signal, this will be 0 or "FALSE" or 1 or "TRUE".
6. Press the "Control Flash".

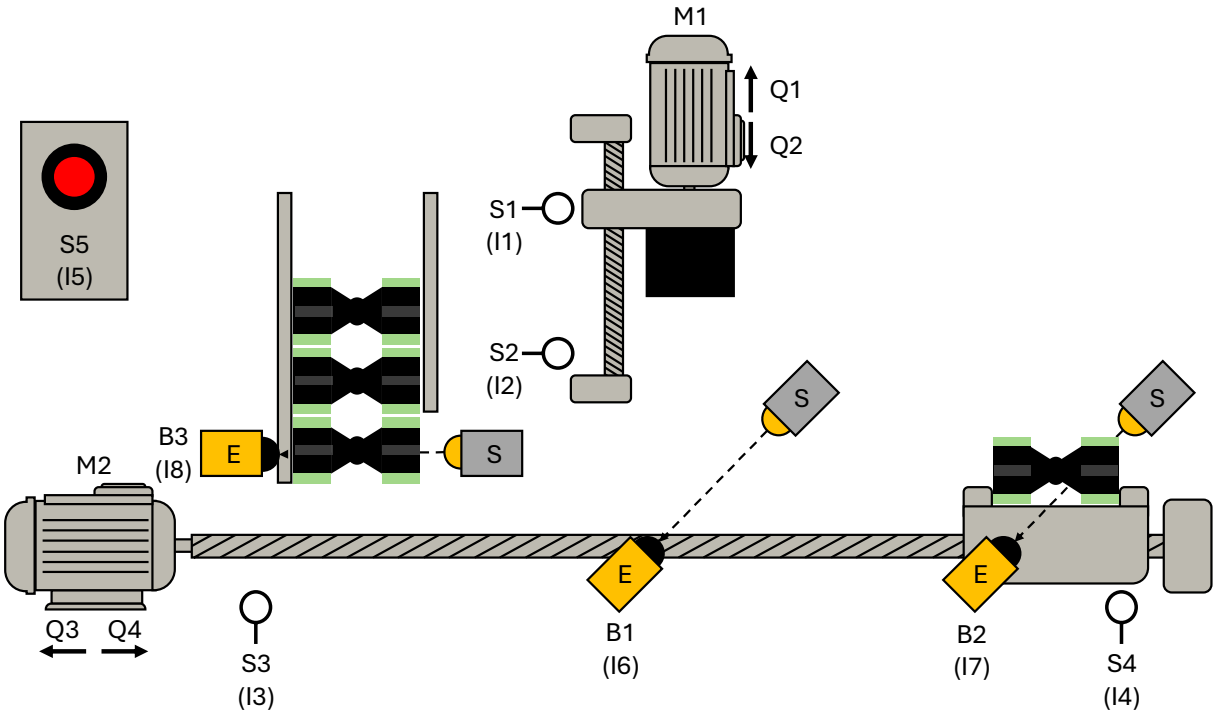
3.8.3 Exercise: Perform I/O Check

Goal:

I can check connected peripherals.

Task:

Check the correct wiring of the inputs and outputs of your PLC with the help of an observation table.

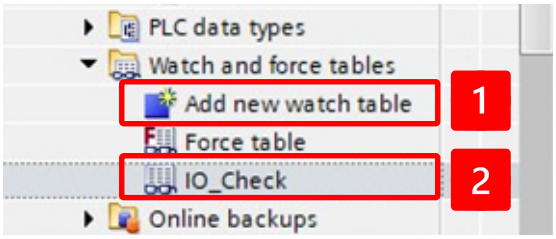


When controlling the motors, care must be taken that they do not drive into their final position, otherwise they will lock. If the motors run on block, this can lead to overloading.

A variable selected in the observation table can be immediately controlled to "TRUE" via the shortcut "Ctrl + F2" and to "FALSE" with "Ctrl + F3". This can be a helpful tool to avoid overrunning the end position.

Procedure:

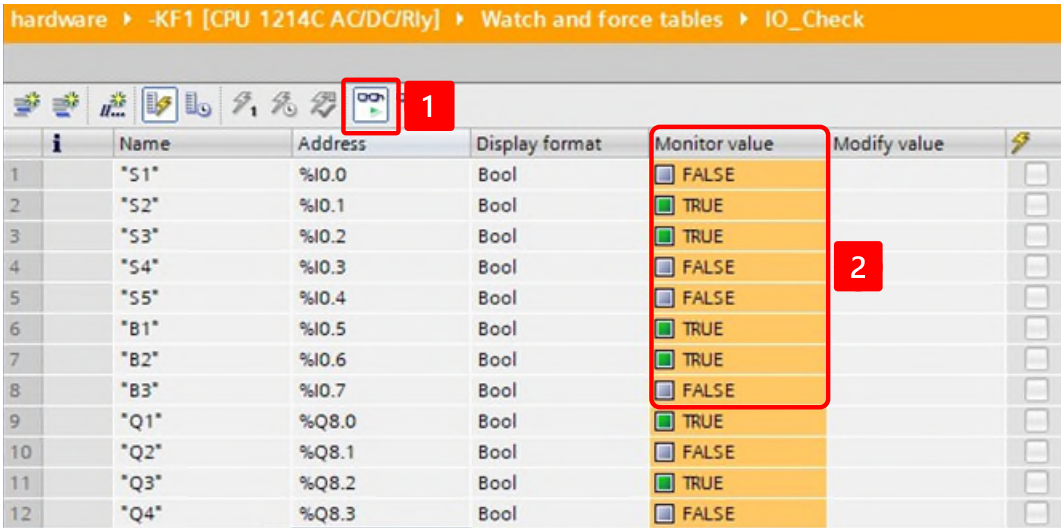
1. Add a new observation table using the "Add new observation table" button and assign a meaningful name (e.g. "IO-Check"):



2. Enter the variables from your PLC variable table:

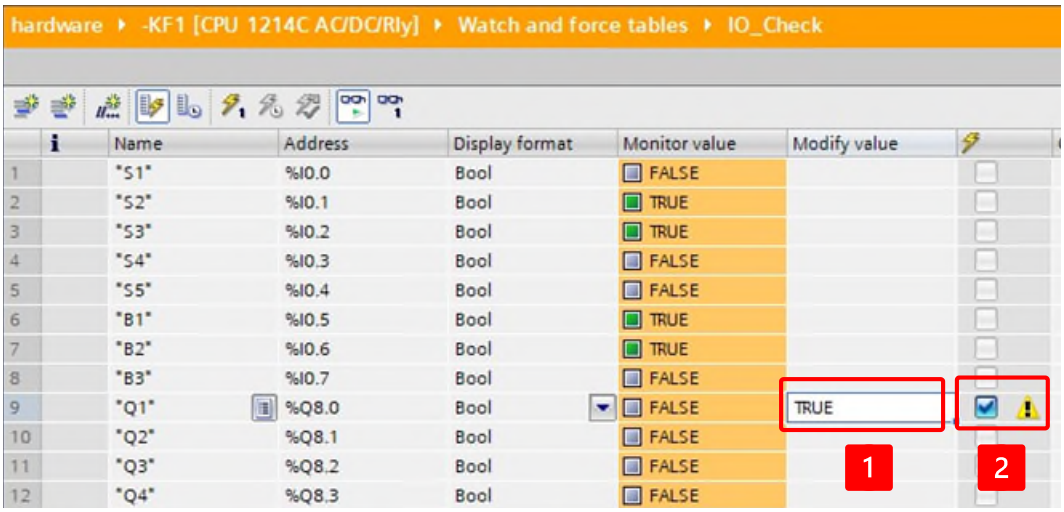
	Name	Address	Display format	Monitor value	Modify value	Comment	Tag comment
1	"S1"	%I0.0	Bool				positionswitch press upper position
2	"S2"	%I0.1	Bool				positionswitch press lower position
3	"S3"	%I0.2	Bool				positionswitch tray position magazin
4	"S4"	%I0.3	Bool				positionswitch tray position home
5	"S5"	%I0.4	Bool				pushbutton start / reset
6	"B1"	%I0.5	Bool				lightbarrier position press
7	"B2"	%I0.6	Bool				lightbarrier position home
8	"B3"	%I0.7	Bool				lightbarrier position magazin
9	"Q1"	%Q8.0	Bool				press direction up
10	"Q2"	%Q8.1	Bool				press direction down
11	"Q3"	%Q8.2	Bool				tray direction magazin
12	"Q4"	%Q8.3	Bool				tray direction home

3. Start the observation with the "glasses".  Manually operate all sensors and check them for correct wiring and function:



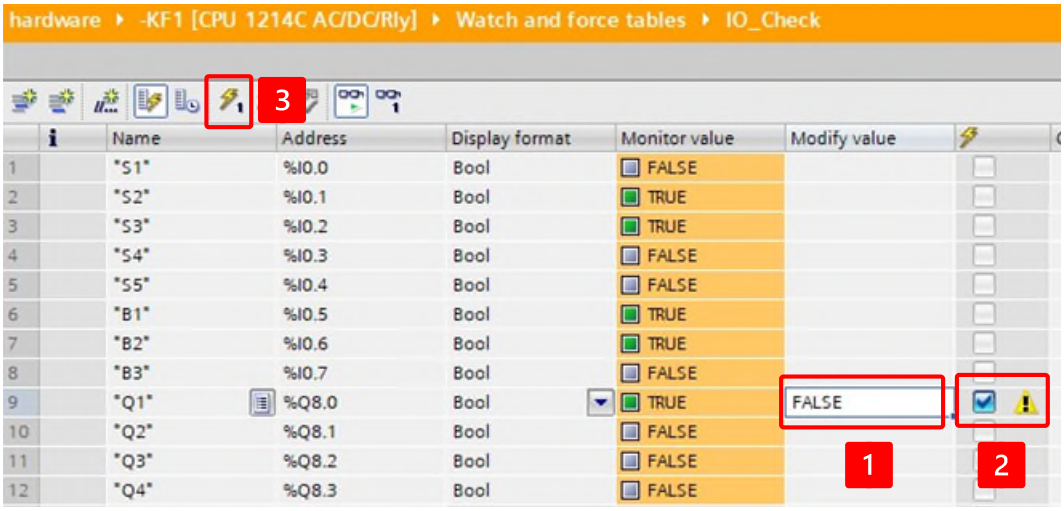
	Name	Address	Display format	Monitor value	Modify value
1	"S1"	%I0.0	Bool	FALSE	
2	"S2"	%I0.1	Bool	TRUE	
3	"S3"	%I0.2	Bool	TRUE	
4	"S4"	%I0.3	Bool	FALSE	
5	"S5"	%I0.4	Bool	FALSE	
6	"B1"	%I0.5	Bool	TRUE	
7	"B2"	%I0.6	Bool	TRUE	
8	"B3"	%I0.7	Bool	FALSE	
9	"Q1"	%Q8.0	Bool	TRUE	
10	"Q2"	%Q8.1	Bool	FALSE	
11	"Q3"	%Q8.2	Bool	TRUE	
12	"Q4"	%Q8.3	Bool	FALSE	

4. For the first output variable, enter "TRUE" or "1" in the column "Tax value". Make sure that the variable is also checked in the "Flash" column:



5. Press the button with the lightning bolt and the "1"  .

6. If the correct component is controlled, enter "FALSE" or "0" for the output in the "Control value" column and press the flash again  :



7. Perform procedure 4 – 6 for all outputs.