

# Learn-/Training Textbook

Siemens Automation Cooperates with Education (SCE)

TIA Portal Modules for Automation System SIMATIC S7-1200 from Version V14 SP1

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# SCE Learn-/Training Textbook

### Automation System SIMATIC S7-1200



TIA Portal Modules from Version V14 SP1

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# SCE Learn-/Training Textbook

# Automation System SIMATIC S7-1200



TIA Portal Modules from Version V14 SP1

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# **TIA Portal Module 011-001** 1 Firmware Update TIA Portal Module 011-100 Unspecified Hardware Configuration TIA Portal Module 011-101 Specified Hardware Configuration TIA Portal Module 020-100 Process description of sorting station TIA Portal Module 031-100 Basics of FC Programming TIA Portal Module 031-200 TIA Portal Module 031-300 IEC Timers and IEC Counters **TIA Portal Module 031-410 Basics of Diagnostics TIA Portal Module 031-420** Diagnostics via Web **TIA Portal Module 031-500** Analog Values **TIA Portal Module 031-600** Global Data Blocks TIA Portal Module 041-101 WinCC Basic with KTP700 TIA Portal Module 051-201 High-Level Language Programming with SCL **TIA Portal Module 051-300**

#### Matching SCE Trainer Packages for these Learn-/Training Document

- SIMATIC S7-1200 AC/DC/RELAY (set of 6) "TIA Portal" Order no.: 6ES7214-1BE30-4AB3
- SIMATIC S7-1200 DC/DC/DC (set of 6) "TIA Portal" Order no.: 6ES7214-1AE30-4AB3
- Upgrade SIMATIC STEP 7 BASIC V14 SP1 (for S7-1200) (set of 6) "TIA Portal" Order no.: 6ES7822-0AA04-4YE5

Please note that these trainer packages are replaced with successor packages when necessary. An overview of the currently available SCE packages is provided at: <u>siemens.com/sce/tp</u>

#### **Continued training**

For regional Siemens SCE continued training, contact your regional SCE representative: siemens.com/sce/contact

#### Additional information regarding SCE

siemens.com/sce

#### Information regarding use

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We wish to thank the TU Dresden, particularly Prof. Dr.-Ing. Leon Urbas and the Michael Dziallas Engineering Corporation and all other involved persons for their support during the preparation of this Learn-/Training Document.

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# Firmware Update with SIMATIC S7-1200

## 1 Goal

This chapter will show how the **firmware version of the CPU** of **SIMATIC S7-1200** can be checked and upgraded using the TIA Portal.

The SIMATIC S7 controllers listed in Chapter 3 can be used.

## 2 Requirement

No prerequisites have to be met for successful completion of this chapter.

### 3 Required hardware and software

- Engineering station: requirements for hardware and operating system (for additional information, see Readme on the TIA Portal Installation DVD)
- 2 STEP 7 Basic software in TIA Portal V14 SP1 or higher
- 3 SIMATIC S7-1200 controller, e.g. CPU 1214C DC/DC/DC Firmware V4.2.1 or higher
- 4 Ethernet connection between engineering station and controller

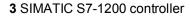


1 Engineering station





2 STEP 7 Basic (TIA Portal) V14 SP1 or higher



### 4 Theory

### 4.1 SIMATIC S7-1200 automation system

The SIMATIC S7-1200 automation system is a modular microcontroller system for the lower performance range.

A comprehensive range of modules is available to optimally adapt the system to the automation task.

The S7 controller consists of a power supply and a CPU with integrated inputs and outputs or additional input or output modules for digital and analog signals.

If necessary, communication processors and function modules for special tasks such as stepper motor control are also used.

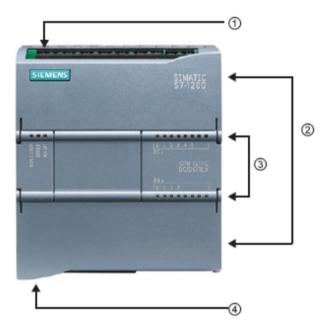
# 4.2 Operator controls and display elements of the CPU 1214C DC/DC/DC

#### 4.2.1 Front view of the CPU 1214C DC/DC/DC

With an integrated power supply (24 V connection) and integrated inputs and outputs, the CPU 1214C DC/DC/DC is ready for immediate use without additional components.

For communication with a programming device, the CPU has an integrated TCP/IP connection.

The CPU can thus communicate with HMI devices or other CPUs over an Ethernet network.



- ① 24 V connection
- 2 Plug-in terminal block for user wiring (behind the cover flaps)
- ③ Status LEDs for the integrated IO and the operating mode of the CPU
- ④ TCP/IP connection (on the bottom of the CPU)

#### 4.2.2 SIMATIC Memory Card (MC)

The optional **SIMATIC Memory Card (MC)** stores the program, data, system data, files and projects. It can be used for:

- Transfer of a program to multiple CPUs
- Firmware update of CPUs, signal modules (SM) and communication modules (CM)
- Simple CPU replacement



#### 4.2.3 Operating modes of the CPU

The CPU can have the following three operating modes:

- In STOP mode, the CPU is not executing the program and you can download a project.
- In **STARTUP** mode, the CPU is starting up.
- In RUN mode, the program is being executed cyclically.

The CPU does not have a physical switch for changing the operating mode.

You use the button on the operator panel of the STEP 7 Basic software to change the operating mode (**STOP** or **RUN**). The operator panel also contains an **MRES** button for performing a memory reset and displays the status LEDs of the CPU.

F	Press Control [CPU	1516-3 PN/DP
	RUN / STOP	RUN
	ERROR	STOP
	MAINT	MRES

#### 4.2.4 Status and error displays

The **Status LED RUN/STOP** on the front of the CPU indicates the current operating mode of the CPU by the color indicated.



- Yellow light indicates STOP mode.
- Green light indicates
   RUN mode.
- A flashing light indicates STARTUP mode.

In addition, there is an **ERROR** LED for indicating errors and a **MAINT** LED for indicating a maintenance requirement.

#### 4.3 STEP 7 Basic programming software (TIA Portal V14)

STEP 7 Basic V14 (TIA Portal V14) software is the programming tool for the following automation systems:

- SIMATIC S7-1200
- Basic Panels

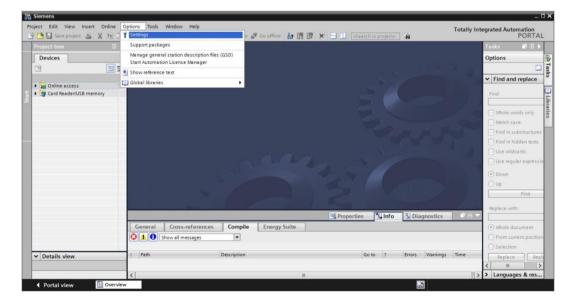
STEP 7 Basic V14 provides the following functions for plant automation:

- Configuration and parameter assignment of the hardware
- Specification of the communication
- Firmware update
- Programming
- Testing, commissioning and service with operational/diagnostic functions
- Documentation
- Creation of visualizations for SIMATIC Basic Panels with the integrated WinCC Basic software

Support is provided for all functions through detailed online help.

#### 4.3.1 Basic settings for the TIA Portal

→ Users can specify their own default settings for certain settings in the TIA Portal. A few important settings are shown here.



 $\rightarrow$  In the project view, select the  $\rightarrow$  "Options" menu and then  $\rightarrow$  "Settings".

- → One basic setting is the selection of the user interface language and the language for the program display. In the curriculums to follow, "English" will be used for both settings.
- → Under → "General" in "Settings", select "User interface language → English" and "Mnemonic → International".

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Settings      General     Hardware configuration     PLC programming     STEP 7 Safety	General		
Simulation     Online & diagnostics     PLC alarms     Visualization     Keyboard shortcuts     Password providers     Multiuser     CAx			Libraries

Note: These settings can always be changed.

#### 4.3.2 Setting the IP address on the programming device

You need a TCP/IP connection in order to upgrade the CPU of a SIMATIC S7-1200 controller from the PC, the programming device or a laptop.

It is important that the IP addresses of both devices match for the computer and SIMATIC S7-1200 to communicate with each other via TCP/IP.

First, we will show you how to set the IP address of a computer with the Windows 10 operating system.

 $\rightarrow$  Select the network icon in the taskbar at the bottom and click  $\rightarrow$  "Network settings".

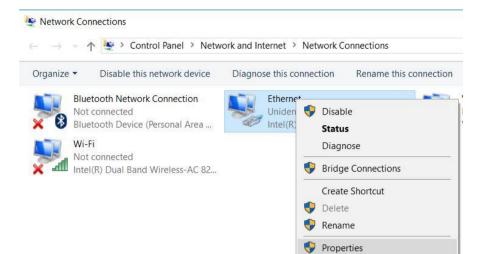


Settings

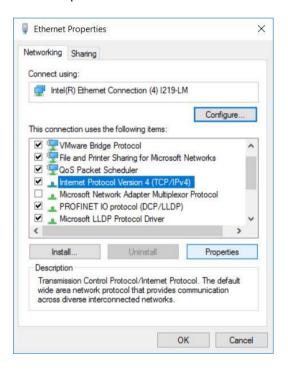
 $\rightarrow$  In the network settings window that opens, click  $\rightarrow$  "Ethernet" and then on  $\rightarrow$  "Change adapter options".

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Fir	Home And a setting work & Internet Status Wi-Fi Ethernet Dial-up VPN Airplane mode	VMware Network Adapter VMnet8   No Internet   VMware Network Adapter VMnet1   No Internet   Unidentified network   No Internet   Related settings Change adapter options Change advanced sharing options Network and Sharing Center
((j))	Mobile hotspot	HomeGroup
Ċ	Data usage	Windows Firewall
$\oplus$	Proxy	

→ Select the desired → "LAN Connection" that you want to use to connect to the controller and click → "Properties".



 $\rightarrow$  Select  $\rightarrow$  "Properties" for  $\rightarrow$  "Internet Protocol Version 4 (TCP/IPv4)".



→ You can now use the following IP address, for example → IP address: 192.168.0.99 and enter the following → subnet mask 255.255.255.0. Accept the settings. (→ "OK")

nternet Protocol Version 4 (TCP)	/IPv4) Properties ×
General	
	automatically if your network supports eed to ask your network administrator
Obtain an IP address autor	natically
• Use the following IP addres	is:
IP address:	192.168.0.99
Subnet mask:	255.255.255.0
Default gateway:	
Obtain DNS server address	automatically
• Use the following DNS serv	er addresses:
Preferred DNS server:	
Alternate DNS server:	
Validate settings upon exit	Advanced
	OK Cancel

#### 4.3.3 Setting the IP address in the CPU

Before a firmware update of the CPU can be performed, set the IP address of the SIMATIC S7-1200 correctly so that the programming device can reach the CPU via TCP (IP communication). The IP address of the SIMATIC S7-1200 is set as follows:

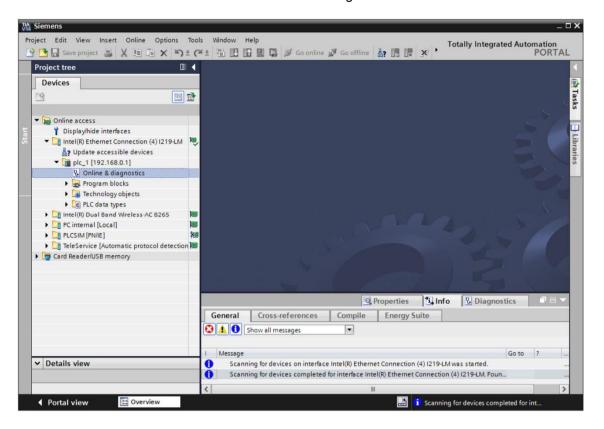
 $\rightarrow$  Double-click the Totally Integrated Automation Portal to select it. ( $\rightarrow$  TIA Portal V14)



 $\rightarrow$  Click  $\rightarrow$  "Online&Diagnostics" and open  $\rightarrow$  "Project view".

Start Pevices 8 Pevices 8 Pevices 8 Pevices 9 Pevices 9 Pev	TIA V14 Siemens		_ ¤ ×
<ul> <li>Devices &amp; networks</li> <li>Show all devices</li> <li>Chrive parameterization</li> <li>Orline &amp; Consiste devices</li> <li>Accessible devices</li> </ul>			Totally Integrated Automation PORTAL
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Online & Diagnostics		Accessible devices	
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▶ <u>Project view</u>	Project view		

→ In the project tree under → "Online access", select the network adapter that was set previously. If you click → "Update accessible devices", you will see the IP address (if previously set) or the MAC address (if IP address has not yet been assigned) of the connected SIMATIC S7-1200. Select → "Online&Diagnostics".



→ Under → "Functions", you now find the → "Assign IP address" item. Enter the following IP address here (example): → IP address: 192.168.0.1 → Subnet mask 255.255.255.0. Click → "Assign IP address" and this new address will be assigned to your SIMATIC S7-1200.

Project tree <ul> <li>access &gt; Intel(R) Ethernet Connection (4) [219:L4 &gt; pic_1 [192:168.0.1] &gt; Pic_1 [192:168.0.1] &gt; Pic_1 [192:168.0.1] = Pic</li> </ul> Devices <ul> <li>Displayhide interfaces</li> <li>Functions</li> <li>Assign IP address</li> <li>Functions</li> <li>Assign IP address to the device</li> <li>Functions</li> <li>Assign IP address costs to device to an enterprise network or directly to the internet must be application (4) [192:168.0.1]</li> <li>Displayhide interfaces</li> <li>Functions</li> <li>Assign IP address costs to device to an enterprise network or directly to the internet must be application (192:168.0.1]</li> <li>Devices connected to an enterprise network or directly to the internet must be application (192:168.0.1]</li> <li>Devices connected to an enterprise network or directly to the internet must be application about industrial security. please visit</li> <li>Pic_1 [192:168.0.1]</li> <li>Devices connected to an enterprise network or directly to the internet must be application about industrial security. please visit</li> <li>Pic_1 [192:168.0.1]</li> <li>Devices connected to an enterprise network or directly to the internet must be application about industrial security. Please visit</li> <li>Pic_1 [192:168.0.1]</li> <li>Pic_1 [192:168.0.1]</li> <li>Pic_2 [192:168.0.</li></ul>	V1	Siemens		×
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→ If the IP address was not successfully assigned, you will receive a message in the  $\rightarrow$  "Info" window under  $\rightarrow$  "General".

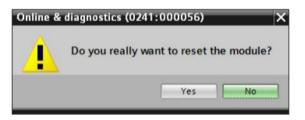
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#### 4.3.4 Restoring the factory settings of the CPU

→ If the IP address could not be assigned, the program data on the CPU must be deleted. This is done by resetting the CPU. To reset the controller, select the → "Reset to factory settings" function and then → "Delete IP address" and click → "Reset".

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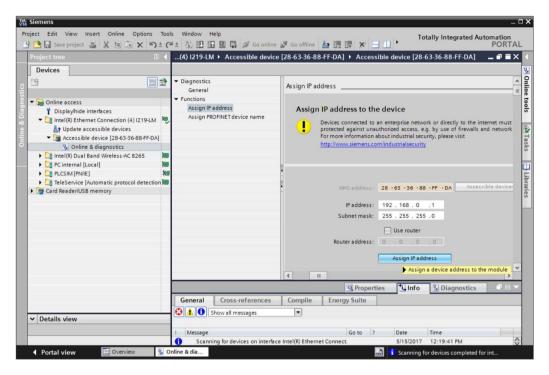
 $\rightarrow$  Confirm the prompt asking if you really want to reset the module with  $\rightarrow$  "Yes".



 $\rightarrow$  If necessary, stop the CPU. ( $\rightarrow$  "Yes")

Online &	diagnostics (0)	241:000020)	×
		only allowed in to stop the CPU	
		Yes	No

→ Once the CPU has been reset, click → "Update accessible devices" again. The MAC address of the connected SIMATIC S7-1200 can now be seen. Select → "Online&Diagnostics" again. Select → "Assign IP address" under → "Functions". Enter the following IP address here (example): IP address: 192.168.0.1 Subnet mask 255.255.255.0. Click "Assign IP address" and this new address will be assigned to your SIMATIC S7-1200.



→ You will receive a message regarding successful transfer of parameters in the → "Info" → "General" window.

				Q Prop	perties	1 Info	<b>B</b> Diagnostics	■■▼
General	Cross-references	Compile	Energ	y Suite				
	Show all messages	•						
! Message				Go to	?	Date	Time	
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📀 The pa	arameters were transferred	d successfully.				5/15/2017	12:24:56 PM	

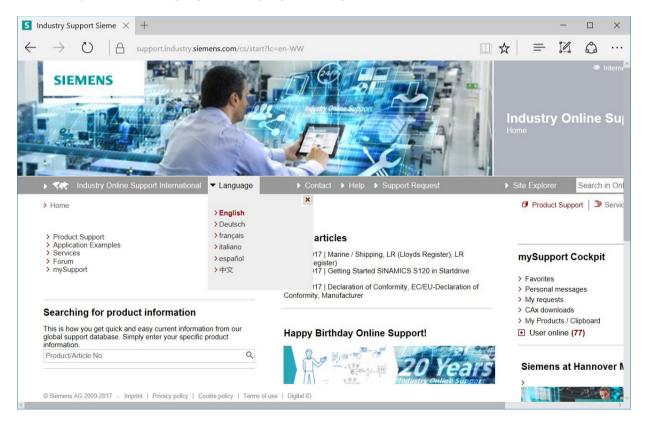
#### 4.3.5 Downloading a firmware update from the SIEMENS Support website

You can download current firmware updates free of charge from the Industry Online Support of SIEMENS AG.

 $\rightarrow$  Open your choice of Internet browser and enter the address

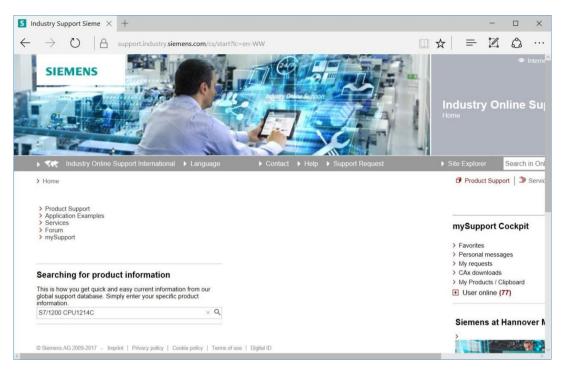
#### → support.automation.siemens.com





#### $\rightarrow$ Select your desired language $\rightarrow$ "Language" $\rightarrow$ "English".

→ In "Searching for product information", enter the CPU for which you need a firmware update. For example: → "S7-1200 CPU1214C"



→ Under "Filter criteria for entries" select the "Entry type" → "Download" and click the entry with firmware updates for your CPU in the selection list.

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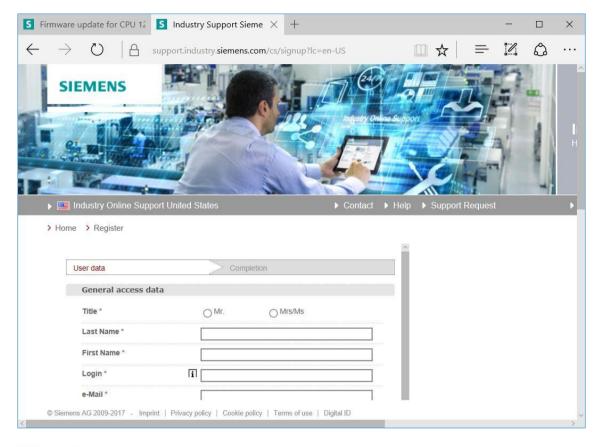
→ Various updates are offered in the next window. Select the update recommended for the upgrade.

				 •	
_	$ ightarrow$ O   $ m \Box$ sup	port.industry. <b>si</b>	emens.com/cs/document/10753!	0	•••
	be unable to change the operatin to the CPU to be able to change		to RUN mode. If this situation happens, you must cycle power lode.		
			f the CPU 1214C, DC/DC/DC, 14DI/10DO/2AI: download is only available to registered users.		
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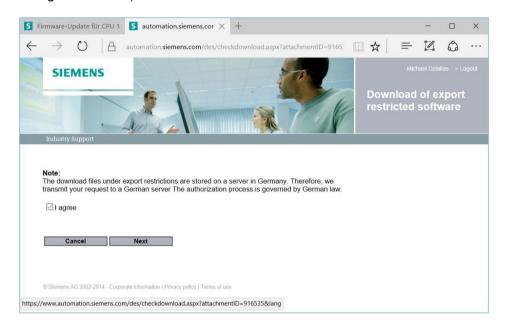
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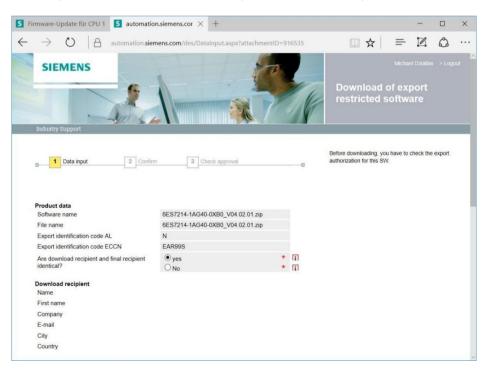
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#### 4.3.6 Firmware update of the CPU

The files with the firmware update can be imported into the "SIMATIC S7-1200" CPU as follows.

→ In the project tree under → "Online access", select the network adapter that was set previously. If you click → "Update accessible devices", you will see the IP address of the connected SIMATIC S7-1200. Select →"Online&Diagnostics". Under the "General" menu item, you can check the current firmware in your CPU in "Diagnostics".

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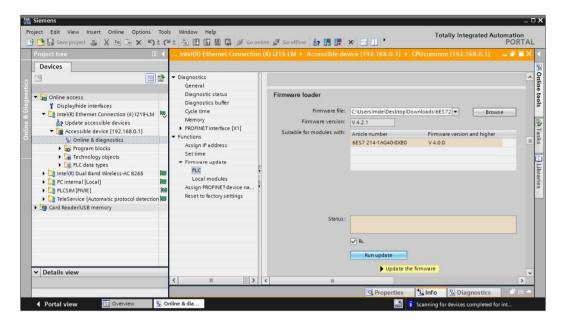
→ In the → "Functions" menu, change to → "Firmware update" → "PLC". In the → "Firmware loader" sub-item, click → "Browse".

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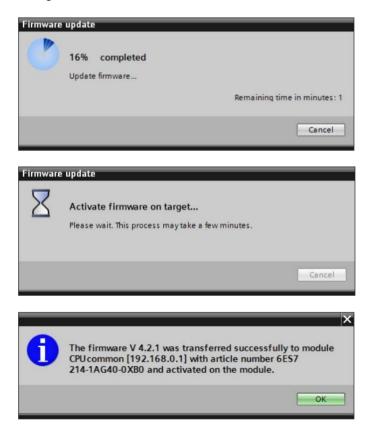
→ Select the previously downloaded and extracted firmware file → "6ES7 \*\*\*\_\*\*\*\*\*.upd" on your computer and click → "Open".

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→ The following dialog indicates whether your firmware file is compatible with your CPU. Now start the update. (→ "Run update")



→ The progress of the update and its successful completion are indicated with the following dialogs. Click → "OK" to confirm.



# 5 Additional information

You can find additional information as an orientation aid for initial and advanced training, for example, Getting Started, videos, tutorials, apps, manuals, programming guidelines and trial software/firmware, at the following link:

#### siemens.com/sce/s7-1200

#### Preview "Additional information"

Getting Started, Videos, Tutorials, Apps, Manuals, Trial-SW/Firmware

- ↗ TIA Portal Videos
- ↗ TIA Portal Tutorial Center
- > Getting Started
- ↗ Programming Guideline
- ↗ Easy Entry in SIMATIC S7-1200
- > Download Trial Software/Firmware
- Technical Documentation SIMATIC Controller
- ↗ Industry Online Support App
- TIA Portal, SIMATIC S7-1200/1500 Overview
- ↗ TIA Portal Website
- ↗ SIMATIC S7-1200 Website
- ↗ SIMATIC S7-1500 Website

### Notes

Notes		

## Notes

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# SCE Learn-/Training Textbook

# Automation System SIMATIC S7-1200



TIA Portal Modules from Version V14 SP1

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# TIA Portal Module 011-001 Firmware Update **TIA Portal Module 011-100** 2 Unspecified Hardware Configuration TIA Portal Module 011-101 Specified Hardware Configuration TIA Portal Module 020-100 Process description of sorting station TIA Portal Module 031-100 Basics of FC Programming TIA Portal Module 031-200 TIA Portal Module 031-300 IEC Timers and IEC Counters **TIA Portal Module 031-410 Basics of Diagnostics TIA Portal Module 031-420** Diagnostics via Web TIA Portal Module 031-500 Analog Values TIA Portal Module 031-600 Global Data Blocks TIA Portal Module 041-101 WinCC Basic with KTP700 TIA Portal Module 051-201 High-Level Language Programming with SCL

TIA Portal Module 051-300 PID Controller

## Matching SCE Trainer Packages for these Learn-/Training Document

- SIMATIC S7-1200 AC/DC/RELAY (set of 6) "TIA Portal" Order no.: 6ES7214-1BE30-4AB3
- SIMATIC S7-1200 DC/DC/DC (set of 6) "TIA Portal" Order no.: 6ES7214-1AE30-4AB3
- Upgrade SIMATIC STEP 7 BASIC V14 SP1 (for S7-1200) (set of 6) "TIA Portal" Order no.: 6ES7822-0AA04-4YE5

Note that these trainer packages are replaced with successor packages when necessary. An overview of the currently available SCE packages is available at: <u>siemens.com/sce/tp</u>

#### Continued training

For regional Siemens SCE continued training, get in touch with your regional SCE contact siemens.com/sce/contact

#### Additional information regarding SCE

siemens.com/sce

#### Information regarding use

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We wish to thank the TU Dresden, particularly Prof. Dr.-Ing. Leon Urbas and the Michael Dziallas Engineering Corporation and all other involved persons for their support during the preparation of this Learn-/Training Document.

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# Unspecified Hardware Configuration – for a SIMATIC S7-1200

# 1 Goal

In this chapter, you will first learn how to *create a project*. Next you will be shown how you can use the *TIA Portal* to detect *hardware* already installed and add it to a project. This hardware will then be configured.

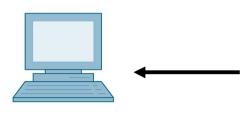
The SIMATIC S7 controllers listed in Chapter 3 can be used.

# 2 Prerequisite

You do not need any previous knowledge from other chapters to successfully complete this chapter. You only need an S7-1200 controller and a PC with the STEP 7 Basic V14 (TIA Portal V14) software.

# 3 Required hardware and software

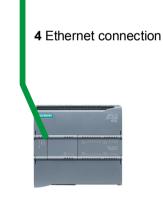
- 1 Engineering station: requirements include hardware and operating system (for additional information, see Readme on the TIA Portal Installation DVDs)
- 2 SIMATIC STEP 7 Basic software in TIA Portal as of V14 SP1
- 3 SIMATIC S7-1200 controller, e.g. CPU 1214C DC/DC/DC with ANALOG OUTPUT SB1232 signal board, 1 AO – Firmware as of V4.2.1
- 4 Ethernet connection between engineering station and controller



1 Engineering Station



2 SIMATIC STEP 7 Basic (TIA Portal) as of V14 SP1



3 SIMATIC S7-1200 controller

# 4 Theory

## 4.1 SIMATIC S7-1200 automation system

The SIMATIC S7-1200 automation system is a modular microcontroller system for the lower performance range.

A comprehensive range of modules is available to optimally adapt the system to the automation task.

The S7 controller consists of a power supply and a CPU with integrated inputs and outputs or additional input and output modules for digital and analog signals.

If necessary, communication processors and function modules are also used for special tasks such as stepper motor control.

The programmable logic controller (PLC) uses the S7 program to monitor and control a machine or process. In doing so, the IO modules are scanned in the S7 program using input addresses (%I) and addressed using output addresses (%Q).

The system is programmed with the TIA Portal Basic or Professional software.

## 4.1.1 Range of modules

The SIMATIC S7-1200 is a modular automation system and offers the following range of modules:

Central processing units (CPUs) with different performance, integrated inputs/outputs, and PROFINET interface (e.g. CPU 1214C)



Power supply module (PM) with input 120/230 V AC, 50 Hz / 60 Hz, 1.2 A / 0.7 A and output 24 V DC / 2.5 A



Signal boards (SBs) for adding analog or digital inputs/outputs, in which case the size of the CPU remains unchanged. (Signal boards can be used with CPUs 1211C / 1212C and 1214C.)



Signal modules (SMs) for digital and analog inputs and outputs (a maximum of 2 SMs can be used for CPU 1212C and a maximum of 8 SMs for CPU 1214C.)



Communication modules (CMs) for serial communication RS232 / RS 485 (Up to 3 CMs can be used for CPUs 1211C / 1212C and 1214C.)



Compact switch module (CSM) with 4x RJ45 sockets 10/100 Mbps



SIMATIC memory cards from 2 MB to 32 MB for storing program data and for easy exchange of CPUs during maintenance.



**Note:** Only a single CPU (any type) with integrated digital inputs and digital outputs is needed for this module.

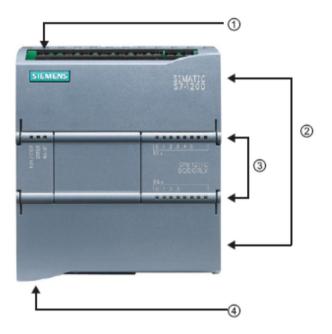
# 4.2 Operator control and display elements of the CPU 1214C DC/DC/DC

### 4.2.1 Front view of the CPU 1214C DC/DC/DC

With integrated power supply (24 V connection) and integrated inputs and outputs, the CPU 1214C DC/DC/DC is immediately ready for use without any other components.

The CPU has an integrated TCP/IP connection for communication with a programming device.

The CPU can thus communicate with HMI devices or other CPUs via an Ethernet network.



- ① 24 V connection
- 2 Plug-in terminal block for user wiring (behind the cover flaps)
- ③ Status LEDs for the integrated IO and the operating state of the CPU
- (4) TCP/IP connection (on the underside of the CPU)

### 4.2.2 SIMATIC memory card (MC)

The optional **SIMATIC memory card (MC)** stores a program as well as data, system data, files and projects. It can be used for:

- Transferring a program to multiple CPUs
- Firmware update of CPUs, signal modules (SMs) and communication modules (CMs)
- Easy replacement of the CPU



### 4.2.3 Operating states of the CPU

The CPU can have the following three operating states:

- In the STOP operating state, the CPU is not executing the program and you can download a project.
- In the **STARTUP** operating state, the CPU is starting up.
- In the **RUN** operating state, the program is cyclically executed.

The CPU does not have a physical switch for changing the operating state.

You use the button on the operator panel of the STEP 7 Basic software to change the operating state (**STOP** or **RUN**). The operator panel also contains an **MRES** button for performing a memory reset and displays the status LEDs of the CPU.

RUN / STOP	RUN
ERROR	STOP
MAINT	MRES

## 4.2.4 Status and error displays

The **RUN/STOP status LED** on the front side of the CPU indicates the current operating state of the CPU by the color of the display.



- Yellow light indicates STOP operating state.
- Green light indicates RUN operating state.
- A flashing light indicates
   STARTUP operating state.

There are two additional LEDs here: **ERROR** LED for indicating errors and **MAINT** LED for indicating that maintenance is required.

## 4.3 STEP 7 Basic V14 (TIA Portal V14) programming software

The STEP 7 Basic V14 (TIA Portal V14) software is the programming tool for the following automation systems:

- SIMATIC S7-1200
- Basic Panels

STEP 7 Basic V14 provides the following functions for automation of a system:

- Configuration and parameter assignment of the hardware
- Specification of the communication
- Programming
- Testing, commissioning and servicing with operational/diagnostic functions
- Documentation
- Creation of visualizations for SIMATIC Basic Panels using the integrated WinCC Basic software
- Support is provided for all functions through detailed online help.

#### 4.3.1 Project

To implement a solution for an automation and visualization task, you create a project in the TIA Portal. A project in the TIA Portal contains the configuration data for the configuration and internetworking of devices as well as the programs and the configuration of the visualization.

#### 4.3.2 Hardware configuration

The *hardware configuration* includes the configuration of the devices, consisting of the hardware of the automation system, the field devices on the PROFINET bus system and the hardware for visualization. The configuration of the networks specifies the communication between the various hardware components. Individual hardware components are *inserted in the hardware configuration* from catalogs.

The hardware of SIMATIC S7-1200 automation systems comprises the controller (CPU), the signal modules for input and output signals (SMs), the communication modules (CMs) and other special-purpose modules.

The signal modules and the field devices connect the input and output data of the process to be automated and visualized to the automation system.

The hardware configuration enables the downloading of automation and visualization solutions to the automation system and access to the connected signal modules by the controller.

#### 4.3.3 Planning the hardware

Before you can configure the hardware, you must plan it (hardware planning). In general, you begin by selecting which controllers are needed and how many. You then select the communication modules and signal modules. The selection of signal modules is based on the number and type of inputs and outputs needed. As the final step, a power supply that ensures the necessary power supply must be selected for each controller or field device.

The functionality required and the ambient conditions are of vital importance for planning the hardware configuration. For example, the temperature range in the application area sometimes limits which devices are available for selection. Fail-safe operation might be another requirement.

The <u>TIA Selection Tool</u> (Select automation technology  $\rightarrow$  TIA Selection Tool and follow the instructions) provides you support. Note: The TIA Selection Tool requires Java.

**Note for online research:** If more than one manual is available, you should look for the description "Device Manual", "Product Manual" or simply "Manual" (as opposed to "Function Manual", "List Manual", "System Manual", etc.) in order to find the device specifications.

#### 4.3.4 TIA Portal – Project view and portal view

The TIA Portal has two important views. When started, the TIA Portal displays the portal view by default. This view makes getting started easier, especially for beginning users.

The portal view provides a task-oriented view of the tools for working on the project. Here, you can quickly decide what you want to do and open the tool for the task at hand. If necessary, a change to the project view takes place automatically for the selected task.

Figure 1 shows the portal view. At the bottom left, there is an option to switch between this view and the project view.

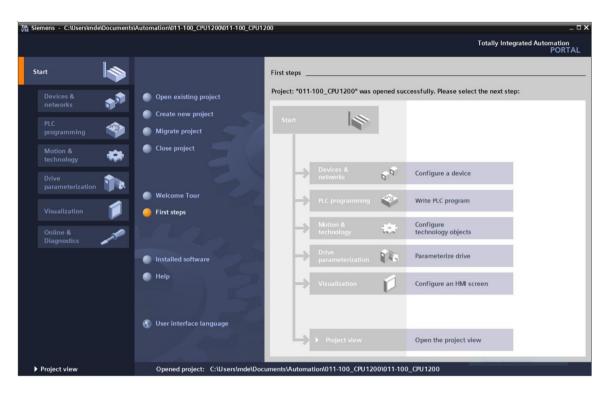


Figure 1: Portal view

The project view, as shown in Figure 2, is used for hardware configuration, programming, creation of the visualization and many other tasks.

By default, the project view displays the menu bar with the toolbars at the top, the project tree with all components of a project on the left and the so-called "task cards" with instructions and libraries, for example, on the right.

If an element (for example, the device configuration) is selected in the project tree, it is displayed in the center and can be worked on there.

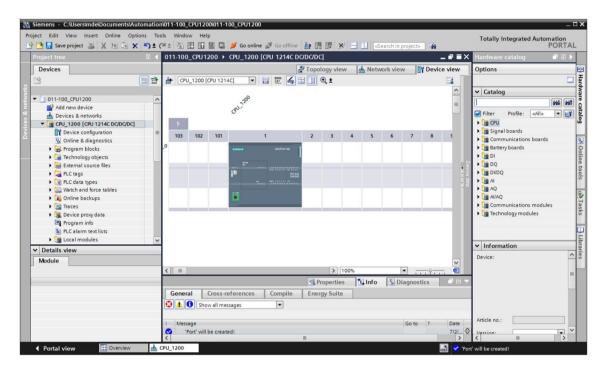


Figure 2: Project view

## 4.3.5 Basic settings for the TIA Portal

- → Users can specify their own default settings for certain settings in the TIA Portal. A few important settings are shown here.
- $\rightarrow$  In the project view, select the  $\rightarrow$  "Options" menu and then  $\rightarrow$  "Settings".

TIA Siemens			>
Project Edit View Insert Online	Options Tools Window Help		Totally Integrated Automation
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	Message     The project 011 100 \$71200	Ш	7/2/2017 4:23:51 PM
Portal view Dvervi	ew		😫 😴 The device was reset.

- → One basic setting is the selection of the user interface language and the language for the program display. In the curriculums to follow, "English" will be used for both settings.
- → Under "General" in "Settings", select → "User interface language → English" and "Mnemonic → International".

VI	Siemens		_ <sup>_</sup> X
		ne Options Tools Window Help 1 🗓 🗙 🥱 ± 🧭 🗄 🛄 🖬 🚆 🙀 🖉 Goonline 🖉 (	io offline 🏭 🖪 🕼 🗴 🖃 🛄 🔭 Totally Integrated Automation PORTAL
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	<ul> <li>Simulation</li> <li>Online &amp; diagnostics</li> <li>PLC alarms</li> <li>Visualization</li> <li>Keyboard shortcuts</li> </ul>	General settings User name: mde User interface language: English Mnemonic: International	Libraries
	<ul> <li>Password providers Multiuser CAx</li> </ul>	Show list of recently used projects:	ct during startup
		Tooltips: <table-cell> Show truncated texts o Show tooltips (context Open cascade automa Banner: 🔄 Show banners minimi</table-cell>	sensitive help is available) tically in tooltips

Note: These settings can always be changed.

### 4.3.6 Set the IP address on the programming device

To program the SIMATIC S7-1200 controller from the PC, the programming device or a laptop, you need a TCP/IP connection or an optional PROFIBUS connection.

For the PC and SIMATIC S7-1200 to communicate with each other via TCP/IP, it is important that the IP addresses of both devices match.

First, we show you how to set the IP address of a PC with Windows 7 operating system.

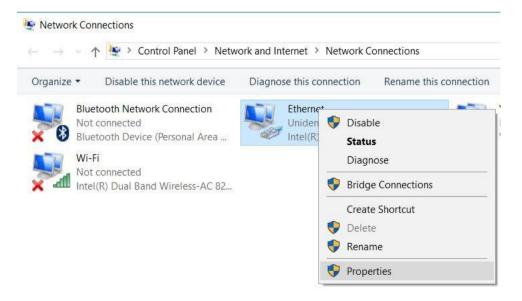
 $\rightarrow$  Locate the network icon in the taskbar at the bottom and click  $\rightarrow$  "Open Network and Sharing Center".

臣	VMwa No Int	re Network Adapter VMnet1 ernet	
(6	Wi-Fi Turned	d off	
Netv	vork set	<u>tings</u>	
(la		\$	
Wi-Fi		Airplane mode	

 $\rightarrow$  In the open Network and Sharing Center window, click  $\rightarrow$  "Change adapter settings".

ŝ	Home	Ethernet
Fi	nd a setting $\rho$	VMware Network Adapter VMnet8 No Internet
Netv	vork & Internet	VMware Network Adapter VMnet1
₽	Status	No Internet
(i.	Wi-Fi	Unidentified network
貯	Ethernet	
~		Related settings
()≡	Dial-up	Change adapter options
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	VPN	Change advanced sharing options
ŝ	Airplane mode	Network and Sharing Center
((j))	Mobile hotspot	HomeGroup
Ċ	Data usage	Windows Firewall
⊕	Proxy	

→ Select the desired → "Local Area Connection" that you want to use to connect to the controller and click → "Properties".



Settings

 $\rightarrow$  Next, select  $\rightarrow$  "Properties" for  $\rightarrow$  "Internet Protocol Version 4 (TCP/IP)".

Networking	Sharing			
Connect	using:			
🚽 Inte	el(R) Etheme	et Connection (4) 1219	-LM	
			Configure	e
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	QoS Packet			
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		O protocol (DCP/LLD		
1		DP Protocol Driver	.,	~
<				>
Ins	stall	Uninstall	Propertie	5
Descrip	tion			
		ol Protocol/Internet Pr		ult
		protocol that provides rconnected networks.		

→ You can use the following address, for example → IP address: 192.168.0.99 → Subnet mask 255.255.255.0 and accept the settings ( $\rightarrow$  "OK")

ternet Protocol Versior		. oper					
General							
You can get IP settings this capability. Otherwis for the appropriate IP se	e, you need to						
Obtain an IP addre	ss automatically	<i>(</i>					
• Use the following I	P address:						
IP address:	1	192 .	168	. 0		99	
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Obtain DNS server	address autom	atically					
Use the following D							
Preferred DNS server	:				•		
Alternate DNS server	:			•	÷		
Validate settings u	ipon exit				A	dvand	ed
		E.			_		Cancel
			(	DK 🛛			Cancel

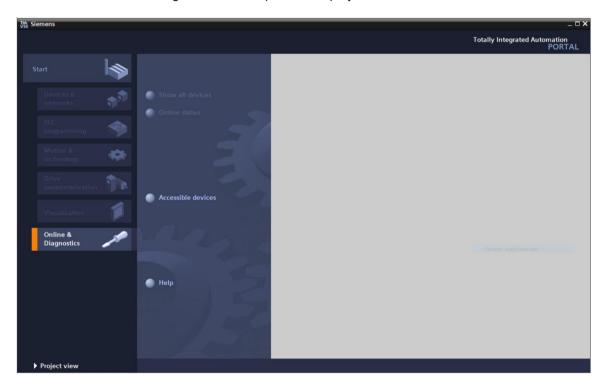
## 4.3.7 Set the IP address in the CPU

The IP address of SIMATIC S7-1200 is set as follows.

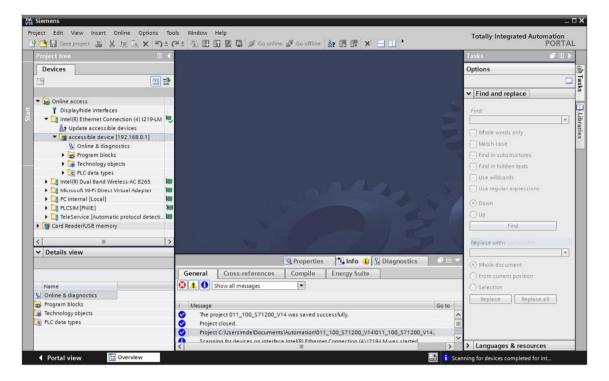
→ Select the Totally Integrated Automation Portal for this, which is opened here with a doubleclick (→ TIA Portal V14)



 $\rightarrow$  Select  $\rightarrow$  "Online & diagnostics", and open the  $\rightarrow$ "project view".



→ In the project tree under → "Online access", select the network adapter that was set previously. If you click → "Update accessible devices" here, you see the IP address (if previously set) or the MAC address (if IP address not yet assigned) of the connected SIMATIC S7-1200. Select → "Online & diagnostics" here.



→ Under→ "Functions", you now find the → "Assign IP address" item. Enter the following IP address here (example): → IP address: 192.168.0.1 → Subnet mask 255.255.255.0. Click → "Assign IP address" and this new address will be assigned to your SIMATIC S7-1200.

TIA Siemens	×
	w Help Totally Integrated Automation
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Devices	U.
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Comparation blocks     Setting     Setting     Comparation blocks     Setting     Setting     Comparation blocks     Setting     Se	
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1 S Th	ie project 011_100_S71200_V14 was saved successfully. 7/2/2017 4:23:51 PM
<	
<ul> <li>Portal view</li> <li>Overview</li> <li>Online &amp; dia.</li> </ul>	

→ If the IP address was not successfully assigned, you will receive a message in the  $\rightarrow$  "Info" window under  $\rightarrow$  "General".

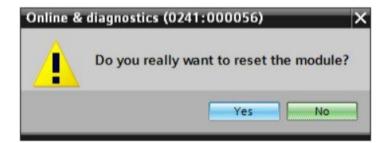
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General	Cross-references	Compile	Energy Suite					
<b>3</b>	Show all messages	•						
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🕄 The	e set command could not b	be executed.				7/2/2017	4:27:32 PM	
								=
								~
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### 4.3.8 Restore the factory settings of the CPU

→ If the IP address could not be assigned, the program data on the CPU must be deleted. This is done by resetting the CPU. To reset the controller, select the → "Reset to factory settings" function and click → "Reset".

A Siemens				_ 0
Project Edit View Insert Online Option			Totally Integrated Automatio	n
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<	>	<		
✓ Details view	_		🔍 Properties 🚺 Info 💟 Diagnostics 💷	
		General Cross-references Compile Ene	nergy Suite	
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		The set command could not be executed.	7/2/2017 4:27:32 PM	
				-
		e		>
Portal view     Overview	n .	line & dia	The set command could not be executed.	

 $\rightarrow$  Confirm the prompt asking if you really want to reset the module with  $\rightarrow$  "Yes".



 $\rightarrow$  If necessary, stop the CPU. ( $\rightarrow$  "Yes")

Online &	diagnostics (0241:000020)	×
	Resetting is only allowed in STOP mode Do you want to stop the CPU?	
	Yes	]

2

# 5 Task

Create a project and add the modules of the existing hardware (here: Trainer Package **SIMATIC S7-1200 with CPU 1214C)** by using the automatic hardware detection of the **TIA Portal**. The following modules must be detected:

- SIMATIC S7-1200, CPU 1214C DC/DC/DC (Order number: 6ES7 214-1AG40-0XB0)
- 1X SIMATIC S7-1200, signal board ANALOG OUTPUT SB1232, 1 AO (Order number: 6ES7 232-4HA30-0XB0)

# 6 Planning

Because this is a new system, a new project must be created.

The hardware for this project is already specified by the existing hardware (here: SIMATIC S7-1200 Trainer Package). Therefore, a selection does not have to be made. Instead, the listed modules of the Trainer Package are detected directly. The order numbers (see Task or Table 1) can be used for checking purposes.

The Ethernet interface must be set for the configuration of the CPU. For the digital and analog inputs and outputs, the address areas corresponding to Table 1 will be set.

Module	Order number	Slot	Address area
CPU 1214C DC/DC/DC	6ES7 214-1AG40-0XB0	1	DI 0.0 -1.5
			DQ 0.0 - 1.1
			AI 64 / 66
SB1232, 1 AO	6ES7 232-4HA30-0XB0		AO 64

Table 1: Overview of the planned configuration

As the final step, the hardware configuration must be compiled and downloaded. Any errors present can be detected during compiling and incorrect modules can be detected when the controller is started (*only possible when hardware is present and installed identically*).

The tested project must be saved and archived.

# 7 Structured step-by-step instructions

You can find instructions on how to carry out planning below. If you already have the relevant previous knowledge, it will be sufficient to focus on the numbered steps. Otherwise, simply follow the steps in the instructions.

# 7.1 Create a new project

→ Select the Totally Integrated Automation Portal for this, which is opened here with a doubleclick (→ TIA Portal V14)



 $\rightarrow$  In the portal view under the "Start" menu, select the command  $\rightarrow$  "Create new project".



 $\rightarrow$  Modify Project name, Path, Author and Comment as appropriate and click  $\rightarrow$  "Create".

Project name:	011-100_CPU1200	
Path	C:\Users\mde\Documents\Automation	
Version	V14 SP1	
Author	mde	
Comment:	: 1	1
		~

→ The project will be created and opened and the menu "Start", "First steps" will open automatically.

## 7.2 Read the hardware of SIMATIC S7-1200

→ In the → "Start" portal, select → "First steps" → "Devices & Networks" → "Configure a device".

Siemens - C:\Users\mde\Documents	Automation/011-100_CPU1200/011-100_CPU12	200	_ 🗆 X
		Totally Integrated A	Automation PORTAL
Start		First steps	
Devices & networks PLC programming	<ul> <li>Open existing project</li> <li>Create new project</li> <li>Migrate project</li> </ul>	Project: *011-100_CPU1200* was opened successfully. Please select the next step: Start	
Motion & technology Drive parameterization	Close project     Welcome Tour	Devices & Configure a device	
Visualization	🥚 First steps	Motion & Configure technology Configure	
	<ul> <li>Installed software</li> <li>Help</li> </ul>	Drive parameterization Rev Parameterize drive     Visualization Configure an HM screen	
	🛞 User interface language	Project view     Open the project view	
Project view	Opened project: C:\Users\mde\Doc	cuments\Automation\011-100_CPU1200\011-100_CPU1200	1.

- $\rightarrow$  The "Show all devices" menu opens in the "Devices & Networks" portal.
- $\rightarrow$  Switch to the "Add new device" menu.

Siemens - C:\Users\mde\Docur	ments/Automation/011-100_CPU1200/011-10	00_CPU1200			_ ¤ ×
				Totally Integrated A	utomation PORTAL
Start		Add new device			
Devices & 💦	🕤 🕘 Show all devices				^
PLC programming Motion & technology	Add new device	Controllers	Controllers     SIMATIC 57-1200     Im SIMATIC 57-1200     Im SIMATIC 57-1500     Im SIMATIC 57-1500     Im SIMATIC 57-300     Im SIMATIC 57-400     Im SIMATIC 57-400     Im SIMATIC ET 200 CPU	Device:	
Drive parameterization	Configure networks	нм	▶ C Device proxy	Article no.: Version: Description:	
Online & Diagnostics		PC systems			=
	Help	Drives			
		<			~
Project view	Opened project: C:\Users\n	nde\Documents\Automation\(	011-100_CPU1200\011-100_CPU120	0	

For unrestricted use in educational / R&D institutions. © Siemens AG 2017. All rights reserved. SCE\_EN\_011-100 Unspecific Hardware Configuration S7-1200\_R1709

- → Create a new CPU. Use an unspecified model of the S7-1200 CPU with order number 6ES7 2XX-XXXX-XXXX for this.
- → (Controllers → SIMATIC S7-1200 → CPU → Unspecified CPU 1200 → 6ES7 2XX-XXXX-XXXX → V4.2)

Siemens - C:\Users\mde\Document	s\Automation\011-100_CPU1200\011-100_CPU1	200					-	□×
						Totally Integrated Au	tomation PORTA	L
Start 🦓		Add new device _						
Devices &	Show all devices	Device name:						^
PLC programming	Add new device		✓ ☐ Controllers     ✓ ☐ SIMATIC S7-1200     ✓ ☐ CPU	^	Device:			
Drive parameterization		Controllers	[1] CPU 1211C ACIDCIRIy     [1] CPU 1211C DCIDCIDC     [1] CPU 1211C DCIDCIDC     [1] CPU 1211C DCIDCIRIy     [1] CPU 1212C ACIDCIRIy			Unspecified CPU 1200		
Visualization	Configure networks	нм	[iii CPU 1212C DC/DC/DC     [iii CPU 1212C DC/DC/Rly     [iii CPU 1214C AC/DC/Rly     [iiii CPU 1214C DC/DC/DC     [iiii CPU 1214C DC/DC/Rly	-	Article no.: Version: Description:	6ES7 2XX-XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX		
Online & Diagnostics			CPU 1215C AC/DC/Rly      CPU 1215C DC/DC/DC      CPU 1215C DC/DC/DC      CPU 1215C DC/DC/Rly		Unspecified C	PU 1200		
	🔵 Help	PC systems	[] CPU 1217C DC/DC/DC     [] CPU 1212FC DC/DC/DC     [] CPU 1212FC DC/DC/DC     [] CPU 1212FC DC/DC/Rly     [] CPU 1214FC DC/DC/DC					
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			CPU SIPLUS     SIMATIC S7-1500	~				~
Project view	Opened project: C:\Users\mde\Doc	uments\Automation\0	11-100_CPU1200\011-100_CPU1200					

 $\rightarrow$  Assign a device name (Device name  $\rightarrow$  "CPU\_1200").

Device name:	
CPU_1200	

 $\rightarrow\,$  Select "Open device view".



29

 $\rightarrow\,$  Click "Add".

						Totally Integrated Automatio POR
rt j	\$	Add new device				
Devices & networks	<ul> <li>Show all devices</li> <li>Add new device</li> </ul>		Controllers     SIMATIC \$7-1200     CPU	^	Device:	
		Controllers	CPU 1211C AC/DC/Rly     CPU 1211C DC/DC/DC     CPU 1211C DC/DC/DC     CPU 1211C DC/DC/Rly			
Motion & technology	* 2		CPU 1212C AC/DC/Rly      Tim CPU 1212C DC/DC/DC      Tim CPU 1212C DC/DC/DC      Tim CPU 1212C DC/DC/Rly		Article no.:	Unspecified CPU 1200 6ES7 2XX-XXXXX
Drive arameterization		нм	CPU 1214C AC/DC/Rly      GPU 1214C DC/DC/DC	=	Version: Description:	V4.2
	Configure networks		[]] CPU 1215C AC/DC/RY     []] CPU 1215C DC/DC/DC     []] CPU 1215C DC/DC/DC     []] CPU 1215C DC/DC/RIy		Unspecified C	PU 1200
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		Drives	[1] CPU 1214FC DC/DC/DC     [1] CPU 1214FC DC/DC/Rly     [1] CPU 1214FC DC/DC/Rly     [1] CPU 1215FC DC/DC/DC			
	💮 Help		CPU 1215FC DC/DC/Rly      Dispecified CPU 1200      GES7 2XX-XXXXXXXXXX      CPU SIPLUS			
			SIMATIC S7-1500	~		
		Open device view				Add

→ The TIA Portal now switches automatically to the project view and displays a notice there that this device is not specified. In order to have the hardware configuration automatically detected, start detection by clicking "detect" in the yellow information box (→ detect).

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	🍽 🗄 🗓 🗓 🔛 🔛 🕼 🖉 Goonline 🧬 Gooffline 👪 🖪 🕼 🧩 ⊟ 🛄	Search	in project>		
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Devices			Topology view	Network view	Device view
· · · · · · · · · · · · · · · · · · ·	🔐 CPU_1200 [Unspecific CPU 12 💌 🔛 🕎 💭 🛄 🔍 ± 📑	Devi	ice overview		Device view     Hardware     Q address     T
		<u> </u>	Module	Slot I addre	ss Q address T 2
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5				13	
Program blocks	1			1 16	01
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PLC tags		-		1 19	ē
PLC data types	Jugat Di sa	-		1 20	00
Watch and force tables		1		1 21	o l
Traces				1 32	-
Device proxy data				1 X1	(II) Tasks
Program info				1.41	as
E PLC alarm text lists					Ks.
Local modules					
Grand Antices	The device is not specified.				
🕨 🙀 Common data 🗸 🗸	→ Please use the Hardware catalog to specify the CPU,				F
✓ Details view	→ or <u>detect</u> the configuration of the connected device.				Libraries
Module		/			s,
	< III > 100% •	<			>
Name			<b>Properties</b>	🗓 Info 🔋 🗓 Diagno	stics
Device configuration	General Cross-references Compile Energy Suite			1	
Program blocks	1 37				
Technology objects	😢 🔔 🕦 Show all messages 💌				
External source files					
PLC tags	! Message		Go to ?	ate Time	
🕞 PLC data types	The project 011_100_S71200_V14 was saved successfully.		3	/2/2017 4:23:51 PM	^
Watch and force tables	Proiect closed.	_		/2/2017 4:23:53 PM	~
Portal view 🗄 Overview	CPU_1200			Project 011-100_CPU1200	created.

 $\rightarrow$  Select the type of your PG/PC interface ( $\rightarrow$  Type of the PG/PC interface: PN/IE).

Hardware detection fo	r CPU_1200				>
	Compatible access	Type of the PG/PC int PG/PC int ible nodes of the select	erface: Please sel PN/E TeleSe	ect	<ul> <li>•</li> /ul>
	Device	Device type	Interface type	Address	MAC address
Flash LED					<u>Start search</u>
Online status information	12			Display of	only error messages
					Detect <u>Cancel</u>

→ You can now select the network adapter you want to use to establish an Ethernet connection with the PLC ( $\rightarrow$  PG/PC interface: Intel(R) Ethernet Connection (4) I219-LM).

		Type of the PG/PC in	terface:	PN/IE			-
		PG/PC in	terface:	Please sel			- 🔊 🖸
	Compatible acce	ssible nodes of the selec	ted inte <mark>rf</mark> a	Intel/D	) Ethernet Connect	AC ROSE	
	Device	Device type		ace type	Address	MAC address	
Flash LED							
line status information					Dicplay	only error messages	Start search
inite status information					- Dispidy	only end messages	•

 $\rightarrow$  The search for devices in the network must be started by clicking the  $\rightarrow$  **Start search** button.

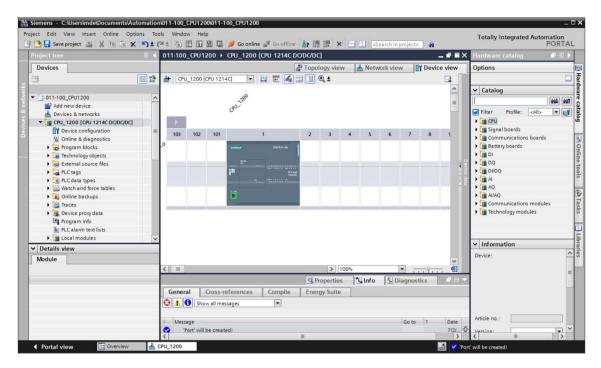
Hardware detection fo	r CPU_1200				×
		Type of the PG/PC int PG/PC int	and the second se	) Ethernet Connecti	on (4) 1219-LM
_	Compatible acces	ssible nodes of the selec	ted interface:		
	Device	Device type	Interface type	Address	MAC address
Flash LED					
					Start search
Online status information	1:			Display of	only error messages
					Detect <u>C</u> ancel

→ All accessible nodes are found and listed. If you have selected the correct CPU, the corresponding CPU and all the connected modules will be detected when you click "detect".

lardware detection fo	r CPU_1200				2
		Type of the PG/PC interface PG/PC interface e nodes of the selected inte	Intel(R) Eth	ernet Connection (4)	I219-LM 💌 🖲 💁
	Device	Device type	Interface type	Address	MAC address
	accessible device	CPU 1214C DC/DC/DC	PN/IE	192,168.0,1	28-63-36-88-FF-DA
Flash LED					
					<u>Start search</u>
Online status information				Display only er	
<ul> <li>Scan completed. 1 cr 2<sup>4</sup>? Retrieving device information</li> <li>Scan and information</li> </ul>	ormation	ccessible devices found.			
				D	etect <u>C</u> ancel

**Note:** If the list does not contain your CPU, ensure that you have selected the correct network adapter and have established a connection between the laptop and CPU.

→ The TIA Portal shows the complete device configuration of the selected CPU with signal board SB1232, 1 AO.



**Note:** You can now configure the CPU according to your specifications there. Possible settings include the PROFINET interface, startup characteristics, cycle, password protection, communication load and many more.

# 7.3 Configure the Ethernet interface of the CPU 1214C

- $\rightarrow$  Select the CPU with a double-click
- $\rightarrow$  Under  $\rightarrow$  "Properties", open the  $\rightarrow$  "PROFINET interface [X1]" menu and select the  $\rightarrow$  "Ethernet addresses" entry.

CPU_1200 [CPU 1214C DC/DC/DC]		🔍 Properties 🚺 Info 🗓 Diagnostics 💷 🗆
General IO tags System of	constants Texts	
General  ROFINET interface [X1]	Ethernet addresses	
General Ethernet addresses Time synchronization Operating mode	Interface networked with Subnet:	Not networked
<ul> <li>Advanced options</li> </ul>		
Web server access Hardware identifier	IP protocol	
DI 14/DQ 10		Set IP address in the project
▶ AI 2		
AQ1 signal board		IP address: 192 . 168 . 0 . 1
<ul> <li>High speed counters (HSC)</li> </ul>		Subnet mask: 255 . 255 . 0
<ul> <li>Pulse generators (PTO/PWM)</li> </ul>		Use router
Startup		Router address: 0 . 0 . 0 . 0
Cycle		IP address is set directly at the device
Communication load		O IP address is set directly at the device
System and clock memory		
Web server	PROFINET	
Multilingual support		
Time of day		PROFINET device name is set directly at the device
Protection & Security		Generate PROFINET device name automatically
Configuration control		
Connection resources	PROFINET device name:	cpu_1200
Overview of addresses	Converted name:	cpuxb120086d7
	Device number:	0 Rechteckiges Ausschneiden

- $\rightarrow$  Under "Interface networked with", only the "Not networked" entry is available.
- $\rightarrow$  Add an Ethernet subnet with the  $\rightarrow$  "Add new subnet" button.

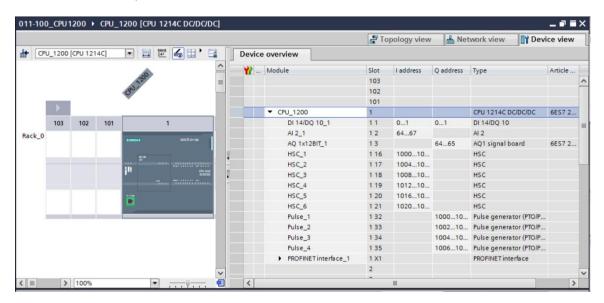
Ethernet addresses		
Interface networked with		
Subnet:	Not networked	•
	Add new subnet	

 $\rightarrow~$  Keep the preassigned "IP address" and "Subnet mask".

CPU_1200 [CPU 1214C DC/DC/DC	2]	🔍 Properties 🚺 Info 💟 Diagnostics 💷 🗆
General IO tags Syste	m constants Texts	
General  PROFINET interface [X1]	Ethernet addresses	
General Ethernet addresses	Interface networked with	
Time synchronization	Subnet:	PN/IE 1
Operating mode		Add new subnet
Advanced options		Add new subnet
Web server access	IP protocol	
Hardware identifier	ir protocoi	
DI 14/DQ 10		Set IP address in the project
► AI 2		
AQ1 signal board		IP address: 192 . 168 . 0 . 1
<ul> <li>High speed counters (HSC)</li> </ul>	•	Subnet mask: 255 . 255 . 0
<ul> <li>Pulse generators (PTO/PWM)</li> </ul>		Use router
Startup	•	Router address: 0 . 0 . 0 . 0
Cycle		
Communication load		O IP address is set directly at the device
System and clock memory		
Web server	PROFINET	
Multilingual support		_
Time of day		PROFINET device name is set directly at the device
Protection & Security		Generate PROFINET device name automatically
Configuration control	PROFINET device name:	cpu_1200
Connection resources		
Overview of addresses	Converted name:	cpuxb120086d7
	Device number:	0 Rechteckiges Ausschneiden 🕷

# 7.4 Configure the address areas

→ The next step is to check the address areas of the inputs and outputs and adapt them if necessary. DI/DO should have an address area of 0...1 and AI/AO should have an address area of 64...67 and 64...65, respectively. (→ Device overview → DI 14/DQ 10\_1 → I address: 0..1→ Q address: 0...1 → AI 2\_1 → I address: 64...67 → AQ 1x12BIT\_1 → Q address: 64...65)

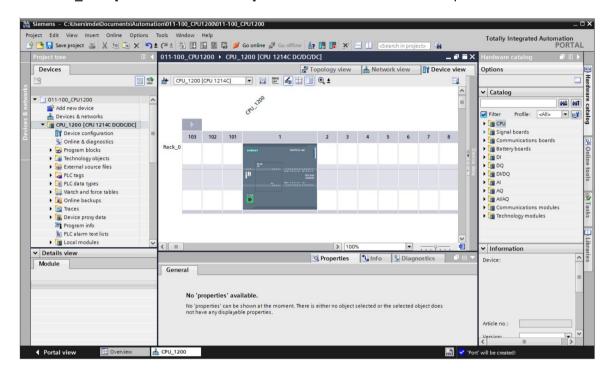


**Note:** To show and hide the Device overview, you need to click the small arrow next to "Device data" on the right side of the hardware configuration.

š.
ä
ata l

## 7.5 Save and compile the hardware configuration

→ Before you compile the configuration, you should save your project by clicking the → **Save project** button. To compile your CPU with the device configuration, first select the → "CPU\_1200 [CPU1214C DC/DC/DC]" folder and click the → <sup>I</sup> Compile" icon.



**Note:** "Save project" should be used again and again when working on a project since this does not happen automatically. A prompt to save the project only occurs when the TIA Portal is closed.

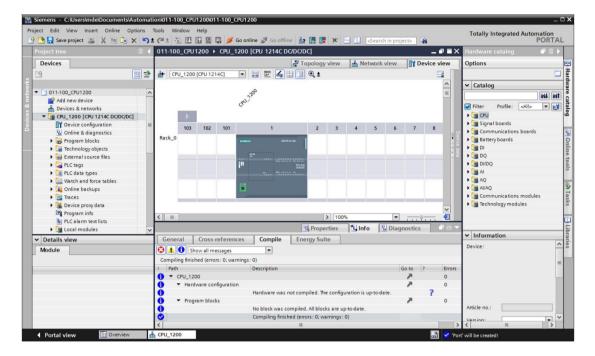
 $\rightarrow$  If the project was compiled without errors, you see the following screen.

					Q Pr	operti	es 🗓	Info 📱
General	Cross-references	Compile	Energy Suite					
3 🔺 🖯 [	Show all messages	-						
Compiling fir	nished (errors: 0; warnings	: 1)						
Path		Description			Go to	?	Errors	Warnings
4	CPU_1200				~		0	1
1	CPU_1200	CPU_1200 does	not contain a config	ured protection level	~			
🕗 🔻 Pr	ogram blocks				~		0	0
9	Main (OB1)	Block was succ	essfully compiled.		~			
1		Compiling finis	ned (errors: 0; warning	gs: 1)				

## 7.6 Download the hardware configuration to the device

 $\rightarrow$  To download your entire CPU, select the  $\rightarrow$  "CPU\_1200 [CPU1214C DC/DC/DC]" folder and

click the	$\rightarrow$	"Download"	icon.
-----------	---------------	------------	-------



 $\rightarrow$  The manager for configuring the connection properties (extended download) opens.

Device	Device type	Slot	Туре	Address	Subnet	
CPU_1200	CPU 1214C DC/D	1 X1	PN/IE	192.168.0.1	PN/IE_1	
	Type of the PG/PC inte	da car	Please select.			1
	PG/PC inte		Flease select.	16	*	1
	Connection to interface/su					
	Connection to interfaceist					
Device	Device type	Туре		Address	Target devi	ce
on:					<u>S</u> tart	search

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- $\rightarrow$  First, the interface must be correctly selected. This happens in three steps.
- $\rightarrow~$  Type of the PG/PC interface  $\rightarrow$  PN/IE

ended download		s nodes of "CPU_1200"				
	Device	Device type	Slot	Туре	Address	Subnet
	CPU_1200	CPU 1214C DC/D	1 X1	PN/IE	192.168.0.1	PN/IE_1
_						
				_		
		Type of the PG/PC inte		Please select		
		PG/PC inte	rface:	Please select.		
		Connection to interface/su	ubnet:	PN/IE	e	
		1st gat	eway:	_ releacivite		

 $\rightarrow$  PG/PC interface  $\rightarrow$  here: Intel(R) Ethernet Connection I217-LM

tended downloa	d to device					
-		s nodes of "CPU_1200"		-	1.2.2.2	1
	Device	Device type	Slot	Туре	Address	Subnet
	CPU_1200	CPU 1214C DC/D	1 X1	PN/IE	192.168.0.1	PN/IE_1
	·					
			1	Ten		
		Type of the PG/PC inte	erface:	PN/IE		
		Type of the PG/PC inte PG/PC inte		PN/IE Please select.		
		PG/PC inte	rface:			•
		PG/PC inte Connection to interface/se	rface: ubnet:	Please select. Please select		•
		PG/PC inte	rface: ubnet:	Please select. Please select Intel(R) Et	hernet Connection (4) I21	19-LM
		PG/PC inte Connection to interface/se	rface: ubnet:	Please select. Please select. Intel(R) Et Intel(R) Du	***	19-LM

 $\rightarrow$  Connection to interface/subnet  $\rightarrow$  "PN/IE\_1"

Extended download t		s nodes of "CPU_1200"				
	Device CPU_1200	Device type CPU 1214C DC/D	Slot 1 X1	Type PN/IE	Address 192.168.0.1	Subnet PN/IE_1
		Type of the PG/PC inte PG/PC inte Connection to interface/su	rface:	PN/IE Intel(R) Et Please select Please select		• • •

→ The → "Show all compatible devices" check box must be selected. The search for devices in the network is started by clicking the → Start search button.

Device	Device type	Slot	Туре	Address	Sub	net
CPU_1200	CPU 1214C DC/D		PN/IE	192.168.0.1	PN/I	
	Type of the PG/PC inter	face:	PN/IE			•
	PG/PC inter	face:	Intel(R)	Ethernet Connection (4) I	219-LM	-
	Connection to interface/sul	bnet:	Direct at s			-
	1st gate	510257				-
Select target dev Device	ice: Device type	Interfa	ice type	Show all compatib	ble devices Target d	levice
			ice type	NI		
Device	Device type		ice type	Address	Target d	
Device CPUcommon	Device type CPU 1214C DC/D	PN/IE	ice type	Address 192.168.0.1	Target d CPUcon	
Device CPUcommon 	Device type CPU 1214C DC/D	PN/IE	ice type	Address 192.168.0.1 Access address	Target d CPUcon 	nmon
Device CPUcommon	CPU 1214C DC/D 	PN/IE	ce type	Address 192.168.0.1	Target d CPUcon 	nmon
Pevice CPUcommon rmation: stablished to the device v	Device type CPU 1214C DC/D  ith address 192.168.0.1.	PN/IE PN/IE	ce type	Address 192.168.0.1 Access address	Target d CPUcon 	
Device CPUcommon	Device type CPU 1214C DC/D  ith address 192.168.0.1.	PN/IE PN/IE	ce type	Address 192.168.0.1 Access address	Target d CPUcon 	nmon

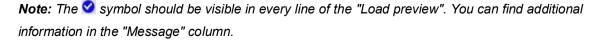
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→ If your CPU is shown in the "Compatible devices in target subnet" list, you must select it. The download can then be started ( $\rightarrow$  CPU 1214C DC/DC/DC  $\rightarrow$  "Load").

	Device	Device type	Slot	Туре	Address	Subnet
<b></b>	CPU_1200	CPU 1214C DC/D	1 X1	PN/IE	192.168.0.1	PN/IE_1
		Type of the PG/PC inter		PN/IE		•
		PG/PC inter			Ethernet Connection (4) I	
		Connection to interface/su		Direct at s	lot '1 X1'	•
		1st gate	eway:			
	Select target devi		Interd	ace type	Show all compatib	le devices Target device
	CPUcommon	CPU 1214C DC/D			192.168.0.1	CPUcommon
	-	-	PN/IE		Access address	-
Flash LED						
ne status informat	ion:				Display only erro	<u>S</u> tart sea
Connection estab	lished to the device wi	th address 192.168.0.1.			_ , , ,	
		of 1 accessible devices fou	nd.			
Retrieving device	information tion retrieval complete					

 $\rightarrow$  You first obtain a preview. Confirm the prompt  $\rightarrow$  "Overwrite all" and continue with  $\rightarrow$  "Load".

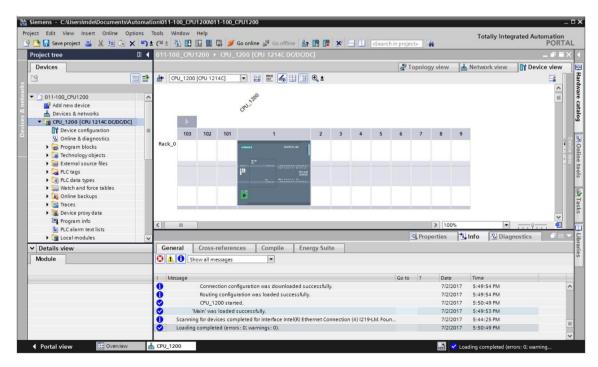
tus	1	Target	Message	Action
1	9	▼ CPU_1200	Ready for loading.	
	Δ	<ul> <li>Protection</li> </ul>	Protection from unauthorized access	
	4		Devices connected to an enterprise network or directly to the internet must be appropriately protected against unauthorized access, e.g. by use of firewalls and network segmentation. For more information about industrial security, please visit http://www.siemens.com/industrialsecurity	
	0	<ul> <li>Device configurati</li> </ul>	Delete and replace system data in target	Download to device
	0	<ul> <li>Software</li> </ul>	Download software to device	Consistent download
	0	Text libraries	Download all alarm texts and text list texts	Consistent download
	-		8	]
				Refresh



 $\rightarrow$  The  $\rightarrow$  "Start all" option will be selected next before the download operation can be completed with  $\rightarrow$  "Finish".

Status	1	Target	Message	Action
1	2	▼ CPU_1200	Downloading to device completed without error.	
	4	Start modules	Start modules after downloading to device.	Start all
¢			111	

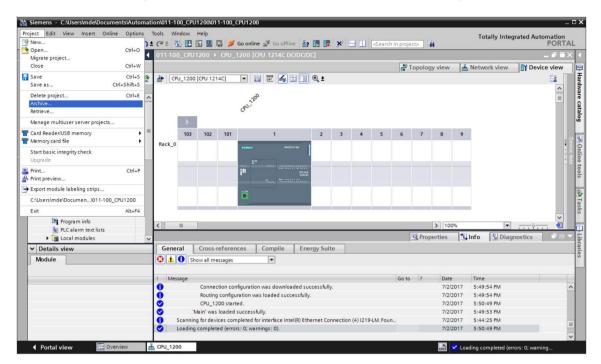
→ After a successful download, the project view will open again automatically. A loading report appears in the information field under "General". This can be helpful when troubleshooting an unsuccessful download.



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## 7.7 Archive the project

 $\rightarrow$  To archive the project, select the  $\rightarrow$  "Archive ..." command in the  $\rightarrow$  "Project" menu.



 $\rightarrow$  Confirm the prompt to save the project with  $\rightarrow$  "Yes".

Archive	project (0104:000006)	×
4	Save project? The last saved project is archived. Do you want to save the project before archiving to create a backup copy of the current changes?	
	Yes No	1

→ Select a folder where you want to archive your project and save it as file type "TIA Portal project archive" (→ "TIA Portal project archive" → "SCE\_EN\_011-100\_Unspecified hardware configuration\_S7-1200" → "Save").

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## 7.8 Checklist

No.	Description	Completed
1	Project was created	
2	Slot 1: CPU with correct order number	
3	Slot 1: CPU with correct firmware version	
4	Signal board: Analog module AQ 1x12BIT with correct order number	
5	Signal board: Analog module AQ 1x12BIT with correct firmware version	
6	Address areas correct	
7	Hardware configuration was compiled without error message	
8	Hardware configuration was downloaded without error message	
9	Project was successfully archived	

## 8 Additional information

More information for further practice and consolidation is available as orientation, for example: Getting Started, videos, tutorials, apps, manuals, programming guidelines and trial software / firmware, under the following link:

#### www.siemens.com/sce/s7-1200

#### Preview "Additional information"

- Getting Started, Videos, Tutorials, Apps, Manuals, Trial-SW/Firmware
  - ↗ TIA Portal Videos
  - TIA Portal Tutorial Center
  - > Getting Started
  - ↗ Programming Guideline
  - Easy Entry in SIMATIC S7-1200
  - > Download Trial Software/Firmware
  - 7 Technical Documentation SIMATIC Controller
  - ↗ Industry Online Support App
  - TIA Portal, SIMATIC S7-1200/1500 Overview
  - ↗ TIA Portal Website
  - ↗ SIMATIC S7-1200 Website
  - ↗ SIMATIC S7-1500 Website

## Notes

## SCE Learn-/Training Textbook

# Automation System SIMATIC S7-1200



TIA Portal Modules from Version V14 SP1

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## TIA Portal Module 011-001 Firmware Update TIA Portal Module 011-100 Unspecified Hardware Configuration TIA Portal Module 011-101 Specified Hardware Configuration TIA Portal Module 020-100 Process description of sorting station TIA Portal Module 031-100 Basics of FC Programming TIA Portal Module 031-200 TIA Portal Module 031-300 IEC Timers and IEC Counters **TIA Portal Module 031-410** Basics of Diagnostics

3

TIA Portal Module 031-420<br/>Diagnostics via Web9TIA Portal Module 031-500<br/>Analog Values10TIA Portal Module 031-600<br/>Global Data Blocks11TIA Portal Module 031-600<br/>Global Data Blocks11TIA Portal Module 041-101<br/>WinCC Basic with KTP70012TIA Portal Module 051-201<br/>High-Level Language Programming with SCL13TIA Portal Module 051-300<br/>PID Controllor14

## Matching SCE Trainer Packages for these Learn-/Training Document

- SIMATIC S7-1200 AC/DC/RELAY (set of 6) "TIA Portal" Order no.: 6ES7214-1BE30-4AB3
- SIMATIC S7-1200 DC/DC/DC (set of 6) "TIA Portal" Order no.: 6ES7214-1AE30-4AB3
- Upgrade SIMATIC STEP 7 BASIC V14 SP1 (for S7-1200) (set of 6) "TIA Portal" Order no.: 6ES7822-0AA04-4YE5

Note that these trainer packages are replaced with successor packages when necessary. An overview of the currently available SCE packages is available at: <u>siemens.com/sce/tp</u>

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#### Additional information regarding SCE

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We wish to thank the TU Dresden, particularly Prof. Dr.-Ing. Leon Urbas and the Michael Dziallas Engineering Corporation and all other involved persons for their support during the preparation of this Learn-/Training Document.

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# Specified Hardware Configuration – SIMATIC S7-1200

## 1 Goal

In this chapter, you will first learn how to *create a project*. You are then shown how the *hardware is configured*.

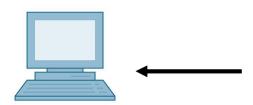
The SIMATIC S7 controllers listed in Chapter 3 can be used.

## 2 Prerequisite

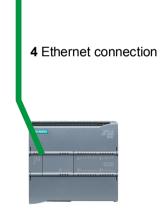
You do not need any previous knowledge from other chapters to successfully complete this chapter. You only need an S7-1200 controller and a PC with the STEP 7 Basic V14 (TIA Portal V14) software.

## 3 Required hardware and software

- 1 Engineering station: Requirements include hardware and operating system (for additional information, see Readme on the TIA Portal Installation DVDs)
- 2 SIMATIC STEP 7 Basic software in TIA Portal as of V14 SP1
- **3** SIMATIC S7-1200 controller, e.g. CPU 1214C DC/DC/DC with ANALOG OUTPUT SB1232 signal board, 1 AO Firmware as of V4.2.1
- 4 Ethernet connection between engineering station and controller



1 Engineering Station



3 SIMATIC S7-1200 controller



2 SIMATIC STEP 7 Basic (TIA Portal) as of V14 SP1

## 4 Theory

## 4.1 SIMATIC S7-1200 automation system

The SIMATIC S7-1200 automation system is a modular microcontroller system for the lower performance range.

A comprehensive range of modules is available to optimally adapt the system to the automation task. The S7 controller consists of a power supply and a CPU with integrated inputs and outputs or additional input and output modules for digital and analog signals.

If necessary, communication processors and function modules are also used for special tasks such as stepper motor control.

The programmable logic controller (PLC) uses the S7 program to monitor and control a machine or process. In doing so, the IO modules are scanned in the S7 program using input addresses (%I) and addressed using output addresses (%Q).

The system is programmed with the TIA Portal Basic or Professional software.

### 4.1.1 Range of modules

The SIMATIC S7-1200 is a modular automation system and offers the following range of modules:

Central processing units (CPUs) with different performance, integrated inputs/outputs, and PROFINET interface (e.g. CPU 1214C)



Power supply module (PM) with input 120/230 V AC, 50 Hz / 60 Hz, 1.2 A / 0.7 A and output 24 V DC / 2.5 A



Signal boards (SBs) for adding analog or digital inputs/outputs, in which case the size of the CPU remains unchanged. (Signal boards can be used with CPUs 1211C / 1212C and 1214C.)



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Signal modules (SMs) for digital and analog inputs and outputs (a maximum of 2 SMs can be used for CPU 1212C and a maximum of 8 SMs for CPU 1214C.)



Communication modules (CMs) for serial communication RS232 / RS 485 (Up to 3 CMs can be used for CPUs 1211C / 1212C and 1214C.)



Compact switch module (CSM) with 4x RJ45 sockets 10/100 Mbps



SIMATIC memory cards from 2 MB to 32 MB for storing program data and for easy exchange of CPUs during maintenance.



**Note:** Only a single CPU (any type) with integrated digital inputs and digital outputs is needed for this module.

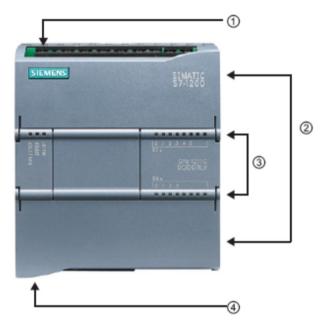
# 4.2 Operator control and display elements of the CPU 1214C DC/DC/DC

### 4.2.1 Front view of the CPU 1214C DC/DC/DC

With integrated power supply (24 V connection) and integrated inputs and outputs, the CPU 1214C DC/DC/DC is immediately ready for use without any other components.

The CPU has an integrated TCP/IP connection for communication with a programming device.

The CPU can thus communicate with HMI devices or other CPUs via an Ethernet network.



- 1 24 V connection
- 2 Plug-in terminal block for user wiring (behind the cover flaps)
- 3 Status LEDs for the integrated IO and the operating state of the CPU
- 4 TCP/IP connection (on the underside of the CPU)

## 4.2.2 SIMATIC memory card (MC)

The optional **SIMATIC memory card (MC)** stores a program as well as data, system data, files and projects. It can be used for:

- Transferring a program to multiple CPUs
- Firmware update of CPUs, signal modules (SMs) and communication modules (CMs)
- Easy replacement of the CPU



### 4.2.3 Operating states of the CPU

The CPU can have the following three operating states:

- In the STOP operating state, the CPU is not executing the program and you can download a project.
- In the **STARTUP** operating state, the CPU is starting up.
- In the **RUN** operating state, the program is cyclically executed.

The CPU does not have a physical switch for changing the operating state.

You use the button on the operator panel of the STEP 7 Basic software to change the operating state (**STOP** or **RUN**). The operator panel also contains an **MRES** button for performing a memory reset and displays the status LEDs of the CPU.

RUN / STOP	RUN
ERROR	STOP
MAINT	MRES

3

## 4.2.4 Status and error displays

The **RUN/STOP status LED** on the front side of the CPU indicates the current operating state of the CPU by the color of the display.



- Yellow light indicates STOP operating state.
- Green light indicates RUN operating state.
- A flashing light indicates
   STARTUP operating state.

There are two additional LEDs here: **ERROR** LED for indicating errors and **MAINT** LED for indicating that maintenance is required.

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## 4.3 STEP 7 Basic V14 (TIA Portal V14) programming software

The STEP 7 Basic V14 (TIA Portal V14) software is the programming tool for the following automation systems:

- SIMATIC S7-1200
- Basic Panels

STEP 7 Basic V14 provides the following functions for automation of a system:

- Configuration and parameter assignment of the hardware
- Specification of the communication
- Programming
- Testing, commissioning and servicing with operational/diagnostic functions
- Documentation
- Creation of visualizations for SIMATIC Basic Panels using the integrated WinCC Basic software

Support is provided for all functions through detailed online help.

#### 4.3.1 Project

To implement a solution for an automation and visualization task, you create a project in the TIA Portal. A project in the TIA Portal contains the configuration data for the configuration and internetworking of devices as well as the programs and the configuration of the visualization.

#### 4.3.2 Hardware configuration

The *hardware configuration* includes the configuration of the devices, consisting of the hardware of the automation system, the field devices on the PROFINET bus system and the hardware for visualization. The configuration of the networks specifies the communication between the various hardware components. Individual hardware components are *inserted in the hardware configuration* from catalogs.

The hardware of SIMATIC S7-1200 automation systems comprises the controller (CPU), the signal modules for input and output signals (SMs), the communication modules (CMs) and other special-purpose modules.

The signal modules and the field devices connect the input and output data of the process to be automated and visualized to the automation system.

The hardware configuration enables the downloading of automation and visualization solutions to the automation system and access to the connected signal modules by the controller.

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#### 4.3.3 Planning the hardware

Before you can configure the hardware, you must plan it (hardware planning). In general, you begin by selecting which controllers are needed and how many. You then select the communication modules and signal modules. The selection of signal modules is based on the number and type of inputs and outputs needed. As the final step, a power supply that ensures the necessary power supply must be selected for each controller or field device.

The functionality required and the ambient conditions are of vital importance for planning the hardware configuration. For example, the temperature range in the application area sometimes limits which devices are available for selection. Fail-safe operation might be another requirement.

The <u>TIA Selection Tool</u> (Select automation technology  $\rightarrow$  TIA Selection Tool and follow the instructions) provides you support. Note: The TIA Selection Tool requires Java.

**Note for online research:** If more than one manual is available, you should look for the description "Device Manual", "Product Manual" or simply "Manual" (as opposed to "Function Manual", "List Manual", "System Manual", etc.) in order to find the device specifications.

## 4.3.4 TIA Portal – Project view and portal view

The TIA Portal has two important views. When started, the TIA Portal displays the portal view by default. This view makes getting started easier, especially for beginning users.

The portal view provides a task-oriented view of the tools for working on the project. Here, you can quickly decide what you want to do and open the tool for the task at hand. If necessary, a change to the project view takes place automatically for the selected task.

Figure 1 shows the portal view. At the bottom left, there is an option to switch between this view and the project view.

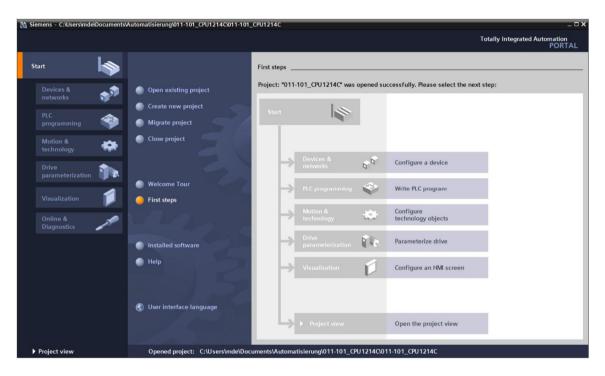


Figure 1: Portal view

The project view, as shown in Figure 2, is used for hardware configuration, programming, creation of the visualization and many other tasks.

By default, the project view displays the menu bar with the toolbars at the top, the project tree with all components of a project on the left and the so-called "task cards" with instructions and libraries, for example, on the right.

If an element (for example, the device configuration) is selected in the project tree, it is displayed in the center and can be worked on there.

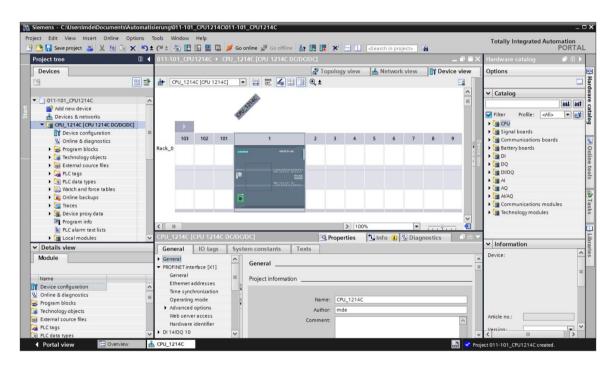


Figure 2: Project view

3

## 4.3.5 Basic settings for the TIA Portal

- → Users can specify their own default settings for certain settings in the TIA Portal. A few important settings are shown here.
- $\rightarrow$  In the project view, select the  $\rightarrow$  "Options" menu and then  $\rightarrow$  "Settings".

TIA Siemens			_ ¤ ×
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	anage general station description files (GSD) art Automation License Manager		
T\$2	now reference text		Tas Tas
	lobal libraries		🕀 Tasks
Online access			
L Card Reader/USB memory			Hubraries
			Changes St
	and a standard standa		
✓ Details view			
Name		Reperties	Linfo Diagnostics
Y Display/hide interfaces	General Cross-references Compile	Energy Suite	
	Show all messages		
	! Message	Go	to ? Date Time
	The project 011 100 S71200 V14 was saved :		7/2/2017 4:23:51 PM
Portal view 🔛 Overview		the second s	The device was reset.

- → One basic setting is the selection of the user interface language and the language for the program display. In the curriculums to follow, "English" will be used for both settings.
- → Under "General" in "Settings", select → "User interface language → English" and "Mnemonic → International".

	line Options Tools Window Help		Totally Integrated Automation
📑 🎦 🔚 Save project 📑 🐰	■ 〒 X り ± C* ± ℡ Ш Ш 里	🕼 🖉 Go online 🖉 Go offline 🛔 🖪 🖪 🗶 🖃 🛄 📩	PORTAL
Settings			_ # = ×
General     Hardware configuration     PLC programming     STEP 7 Safety	General		
Simulation     Online & diagnostics     PLC alarms	General settings User name:	mde	
Visualization     Keyboard shortcuts     Password providers	User interface language: Mnemonic:	English International	× •
Multiuser CAx		8 🔷 elements Load last opened project during startup	
		Show truncated texts completely Show tooltips (context-sensitive help is available) Open cascade automatically in tooltips	
		Show banners minimized	

Note: These settings can always be changed.

## 4.3.6 Set the IP address on the programming device

To program the SIMATIC S7-1200 controller from the PC, the programming device or a laptop, you need a TCP/IP connection or an optional PROFIBUS connection.

For the PC and SIMATIC S7-1200 to communicate with each other via TCP/IP, it is important that the IP addresses of both devices match.

First, we show you how to set the IP address of a PC with Windows 7 operating system.

 $\rightarrow$  Locate the network icon in the taskbar at the bottom and click  $\rightarrow$  "Open Network and Sharing Center".

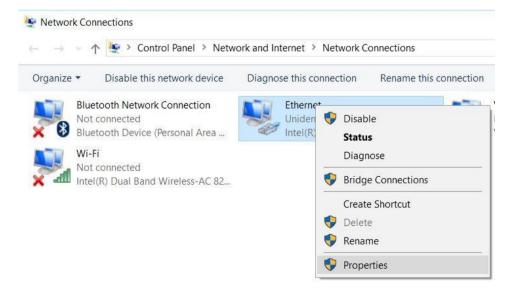
臣	VMwa No Int	re Network Ad ernet	lapter VMnet1				
Wi-Fi Turned off							
Network settings							
(la		ц)-					
Wi-Fi		Airplane mode					

 $\rightarrow$  In the open Network and Sharing Center window, click  $\rightarrow$  "Change adapter settings".

```
Settings
```

<u>نې</u>	Home	Ethernet
Fi	nd a setting	VMware Network Adapter VMnet8 No Internet
Net	work & Internet	
₽	Status	VMware Network Adapter VMnet1 No Internet
ſ.	Wi-Fi	Unidentified network No Internet
臣	Ethernet	- 1 - 1 - 1
0	Dial us	Related settings
(	Dial-up	Change adapter options
<u>%</u>	VPN	Change advanced sharing options
÷	Airplane mode	Network and Sharing Center
(q))	Mobile hotspot	HomeGroup
Ċ	Data usage	Windows Firewall
	Proxv	

→ Select the desired → "Local Area Connection" that you want to use to connect to the controller and click → "Properties".



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 $\rightarrow$  Next, select  $\rightarrow$  "Properties" for  $\rightarrow$  "Internet Protocol Version 4 (TCP/IP)".

Networking	Sharing			
Connect u	sing:			
🚽 Inte	I(R) Ethemet C	Connection (4) 1219-	LM	
			Config	jure
This conne	ection uses the	e following items:	-	
The second se	/Mware Bridge	Protocol	- and the second se	^
700		Sharing for Microso	ft Networks	
	oS Packet Sc		4	
	a destination of the second second second	ol Version 4 (TCP/IF ork Adapter Multiple	and the second se	
the second s		protocol (DCP/LLD)		
V . P				
				~
		Protocol Driver		>
<			Proper	
<	Aicrosoft LLDP	Protocol Driver	Proper	
Inst Descripti Transmi	Aicrosoft LLDP	Protocol Driver Uninstall Protocol/Internet Pr	otocol. The de	ties
Inst Descripti Transmi wide are	Aicrosoft LLDP all ion ission Control F ea network pro	Protocol Driver Uninstall	otocol. The de	ties
Inst Descripti Transmi wide are	Aicrosoft LLDP all ion ission Control F ea network pro	Protocol Driver Uninstall Protocol/Internet Protocol that provides	otocol. The de	ties

→ You can use the following address, for example → IP address: 192.168.0.99 → Subnet mask 255.255.255.0 and accept the settings ( $\rightarrow$  "OK")

Seneral	
	automatically if your network supports eed to ask your network administrator
Obtain an IP address autom	natically
• Use the following IP address	s:
IP address:	192.168.0.99
Subnet mask:	255.255.255.0
Default gateway:	
Obtain DNS server address	automatically
Use the following DNS serve	er addresses:
Preferred DNS server:	
Alternate DNS server:	
Validate settings upon exit	Advanced

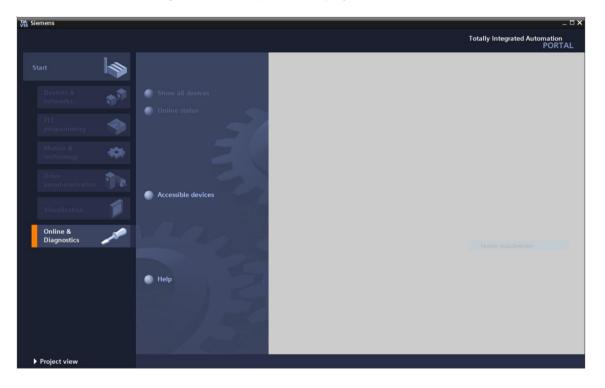
## 4.3.7 Set the IP address in the CPU

The IP address of SIMATIC S7-1200 is set as follows.

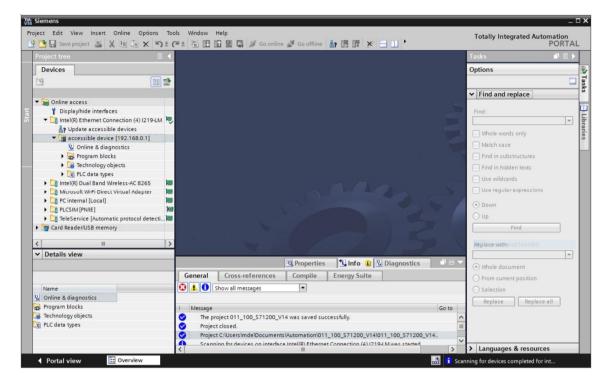
→ Select the Totally Integrated Automation Portal for this, which is opened here with a doubleclick (→ TIA Portal V14)



 $\rightarrow$  Select  $\rightarrow$  "Online&Diagnostics", and open the  $\rightarrow$ "project view".



→ In the project tree under → "Online access", select the network adapter that was set previously. If you click → "Update accessible devices" here, you see the IP address (if previously set) or the MAC address (if IP address not yet assigned) of the connected SIMATIC S7-1200. Select → "Online&Diagnostics" here.



→ Under→ "Functions", you now find the → "Assign IP address" item. Enter the following IP address here (example): → IP address: 192.168.0.1 → Subnet mask 255.255.255.0. Click → "Assign IP address" and this new address will be assigned to your SIMATIC S7-1200.

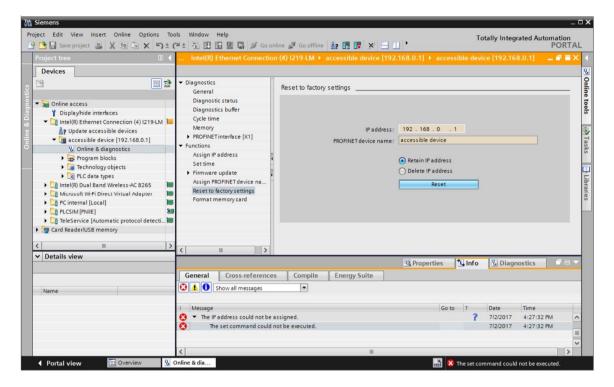
Project tree		ine 🖉 Go offline 🛔 🖪 🖪 🗶 = 🛄 🎽 PORTA (4)  219-LM → accessible device [192.168.0.1] → accessible device [192.168.0.1] 🗕 🖬 🗮
Devices		
	Diagnostics     General     Diagnostic status     Diagnostics buffer     Cycle time     Memory     PROFINET interface [X1]     Functions     Assign IP address     Set time	Assign IP address  Assign IP address to the device Devices connected to an enterprise network or directly to the internet must be appropriately protected against unauthorized access. e.g. by use of firewalls and network segmentation. For more information about industrial security, please visit http://www.siemens.com/industrialsecurity
All Recharge objects     Card ta types     All Intel(R) Dual Band Wireless-AC 8265     Macrosoft Wirf Direct Virual Adapter     Card Reader/USB memory     Card Reader/USB memory     Details view	Firmware update     Assign PROFINET device na Reset to factory settings     Format memory card	MAC address: 28 -63 -36 -88 -FF -DA Accessible devices IP address: 192 . 168 . 0 . 1 Subnet mask: 255 . 255 . 0 Use router Router address: 0 . 0 . 0 Accessible devices Use router Router address: 0 . 0 . 0
Name	General Cross-references	Compile Energy Suite
	Show all messages	Go to 7 Date Time U14 was saved successfully. 7/2/2017 4:23:51 PM

→ If the IP address was not successfully assigned, you will receive a message in the  $\rightarrow$  "Info" window under  $\rightarrow$  "General".

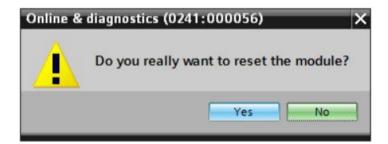
				Q Properties	<u>*1</u>	Info	🛚 🖁 Diagr	ostics	<b>•</b> • •
General	Cross-references	Compile	Energy Suite						
	Show all messages	•							
! Message				Go	to	?	Date	Time	
	address could not be assi	gned.				?	7/2/2017	4:27:32 PM	^
😧 Th	e set command could not l	be executed.					7/2/2017	4:27:32 PM	
									=
									~
<									>

### 4.3.8 Restore the factory settings of the CPU

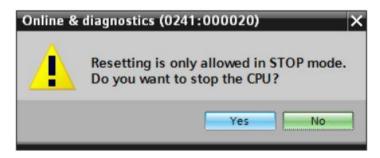
→ If the IP address could not be assigned, the program data on the CPU must be deleted. This is done by resetting the CPU. To reset the controller, select the → "Reset to factory settings" function and click → "Reset".



 $\rightarrow$  Confirm the prompt asking if you really want to reset the module with  $\rightarrow$  "Yes".



 $\rightarrow$  If necessary, stop the CPU. ( $\rightarrow$  "Yes")



## 5 Task

Create a project und configure the compact CPU of your hardware, which corresponds to one part of the **SIMATIC S7-1200 with CPU 1214C** DC/DC/DC Trainer Package.

 SIMATIC S7-1200, CPU 1214C DC/DC/DC (Order number: 6ES7 214-1AG40-0XB0)

## 6 Planning

Because this is a new system, a new project must be created.

The hardware for this project is already specified with the SIMATIC S7-1200, CPU 1214C DC/DC/DC Trainer Package, Therefore, a selection does not have to be made. Instead, the listed CPU of the Trainer Package only has to be inserted in the project. To ensure that the correct module is inserted, the order number from the Task should be checked again directly on the installed device (see Table 1).

The Ethernet interface must be set for the configuration of the CPU. For the digital and analog inputs and outputs, the address areas corresponding to Table 1 will be set.

Module	Order number	Slot	Address area
CPU 1214C DC/DC/DC	6ES7 214-1AG40-0XB0	1	DI 0.0 -1.5
			DQ 0.0 - 1.1
			AI 64 / 66

Table 1: Overview of the planned configuration

As the final step, the hardware configuration must be compiled and downloaded. Any errors present can be detected during compiling and incorrect modules can be detected when the controller is started *(only possible when hardware is present and installed identically)*.

The tested project must be saved and archived.

## 7 Structured step-by-step instructions

You can find instructions on how to carry out planning below. If you already have the relevant previous knowledge, it will be sufficient to focus on the numbered steps. Otherwise, simply follow the detailed steps in the instructions.

### 7.1 Create a new project

→ Select the Totally Integrated Automation Portal for this, which is opened here with a doubleclick (→ TIA Portal V14)



 $\rightarrow$  In the portal view under the "Start" menu, select the command  $\rightarrow$  "Create new project".

Via Si	emens		
s	tart		
		1	Open existing project
			<ul> <li>Create new project</li> <li>Migrate project</li> </ul>
		-	
			Welcome Tour
			First steps
	Online & Diagnostics	10	

 $\rightarrow$  Modify Project name, Path, Author and Comment as appropriate and click  $\rightarrow$  "Create".

Project name:	011-101_CPU1214C	
Path:	C:\Users\mde\Documents\Automatisierung	
Version:	V14 SP1	-
Author:	mde	
Comment:		^
		~

→ The project will be created and opened and the "Start" menu, "First steps" will open automatically.

### 7.2 Insert the CPU 1214C DC/DC/DC

→ In the → "Start" portal, select → "First steps" → "Devices & Networks" → "Configure a device".

mens - C:\Users\mde	Documents	Automatisierung\011-101_CPU1214C\011	-101_CPU1214C				
						То	tally Integra
art			First steps				
	*	Open existing project	Project: "01	I-101_CPU1214C" was	opened su	ccessfully. Please select the next st	ep:
	<b>W</b> .	Create new project	Start				
	-	Migrate project					
Motion & technology	-	Close project					
					Q Q	Configure a device	
		Welcome Tour		PLC programming	٢	Write PLC program	
		🥚 First steps		Motion &		Configure	
Online & Diagnostics	1			technology	105	technology objects	
		Installed software		Drive parameterization	10	Parameterize drive	
		🔵 Help		Visualization	Ø	Configure an HMI screen	
		🚱 User interface language					
			4	Project view		Open the project view	
			_				
Project view		Opened project: C:\Users\mde	Documents\Autom	atisierung\011-101_CF	U1214C10	11-101_CPU1214C	

- $\rightarrow$  The "Show all devices" menu opens in the "Devices & Networks" portal.
- $\rightarrow$  Switch to the "Add new device" menu.

Siemens - C:\Users\mde\Documents\	Automatisierung\011-101_CPU1214C\011-101	1_CPU1214C			- <b>-</b> ×
				Totally Integrated Automation PORT	<b>AL</b>
Start		Add new device			
Devices & anterior of the second seco	Show all devices Add new device	Device name:			^
PLC programming	Add new device		Controllers     SIMATIC \$7-1200	Device:	
Motion & technology		Controllers	[]] SIMATIC \$7-1500     []] SIMATIC \$7-300     []] SIMATIC \$7-300     []] SIMATIC \$7-400		
Drive parameterization	Configure networks		Ima SIMATIC ET 200 CPU     Ima Device proxy	Article no.:	
Visualization 📁	Compute networks	HMI		Version:	=
Online & Diagnostics	1 1 2 2 4				
		PC systems			
	e Help	Drives			
					~
Project view	Opened project: C:\Users\mde\Do	cuments\Automatisierun	ng\011-101_CPU1214C\011-101_CPU1214	4C	

- $\rightarrow$  The specified model of the CPU will now be added as a new device.
- → (Controllers → SIMATIC S7-1200 → CPU → CPU 1214C DC/DC/DC → 6ES7214-1AG40-0XB0 → V4.2)

							Totally Integrated Automation POR
			Add new device				
Devices &		Show all devices	Device name:				
networks	<b>W</b> .	Add new device	CPU_1214C				
PLC programming Motion &	۲			←	^	Device:	P
technology			Controllers	CPU 1211C AC/DC/Rly      Gamma CPU 1211C DC/DC/DC      Gamma CPU 1211C DC/DC/DC			ē
				CPU 1211C DC/DC/Rly      CPU 1212C AC/DC/Rly      CPU 1212C DC/DC/DC      CPU 1212C DC/DC/DC			CPU 1214C DC/DC/DC
		Configure networks		CPU 1212C DC/DC/Rly		Article no.:	6ES7 214-1AG40-0XB0
			HM	<ul> <li>▶ □ CPU 1214C AC/DC/Rly</li> <li>▼ □ CPU 1214C DC/DC/DC</li> <li>■ 6557 214-1AE30-0X80</li> </ul>	=	Version: Description:	V4.2
Online & Diagnostics	~			6ES7 214-1AG31-0X80 6ES7 214-1AG40-0X80		DI14 x 24VDC	y 100 KB; 24VDC power supply with SINK/SOURCE, DQ10 x 24VDC and ; 6 high-speed counters and 4 pulse
			PC systems	CPU 1214C DC/DC/Rly      CPU 1215C AC/DC/Rly      CPU 1215C AC/DC/Rly      CPU 1215C DC/DC/DC		board I/O; up serial commu	oard; signal board expands on- to 3 communication modules for unication; up to 8 signal modules sion; 0.04 ms/1000 instructions;
				CPU 1215C DC/DC/Rly		PROFINET inte	erface for programming, HMI and
		Help		CPU 1217C DC/DC/DC		PLC to PLC co	mmunication
			Law.	CPU 1212FC DC/DC/DC     CPU 1212FC DC/DC/Rly			
			Drives	CPU 1212FC DCDCRiy      CPU 1214FC DC/DC/DC			
				CPU 1214FC DC/DC/Rly			
				CPU 1215FC DC/DC/DC			
				CPU 1215FC DC/DC/Rly			
				Unspecified CPU 1200	~		

 $\rightarrow$  Assign a device name (Device name  $\rightarrow$  "CPU\_1214C").

Add new device	
Device name:	
CPU_1214C	

 $\rightarrow$  Select "Open device view".



iemens - C:\Users\mde\Documents\Automatisierung\011-101\_CPU1214C\011-101\_CPU1214C Totally Integrated Automation Add new device ^ 22 Devices & networks Add new device Controllers ۲ CPU 1214C DC/DC/DC CPU 1212C AC/DC/Rly Motion & -6ES7 214-1AG40-0X80 Article no.: CPU 1212C DC/DC/Rly CPU 1212C DC/DC/Ry
 CPU 1214C AC/DC/Ry
 CPU 1214C AC/DC/DC/
 GE57 214-1AE30-0XB0
 GE57 214-1AE30-0XB0
 GE57 214-1AG31-0XB0
 GE57 214-1AG31-0XB0
 GE57 214-1AG40-0XB0
 GE57 214
 GE57
 GE57 214
 GE57
 GE57 214
 GE57 HM -Version: 1 Description Werk memory 100 KB: 24VDC power supply with D14 x 24VDC SINK/SOUREZ, DQ10 x 24VDC and A12 on board, 5 high-speed counters and 4 public outputs on board: signal board expands on-board liO; up to 3 communication modules for lor liO expansion. Od m sh1000 instructions; PROHIGE Interface for programming. Mile and PLC of RLC communication PC systems CPU 1215C AC/DC/Rly CPU 1215C DC/DC/Rlv CPU 1217C DC/DC/DC CPU 1212FC DC/DC/DC CPU 1212FC DC/DC/Rly Drives CPU 1214FC DC/DC/DC Help CPU 1215FC DC/DC/DC CPU 1215FC DC/DC/Rly

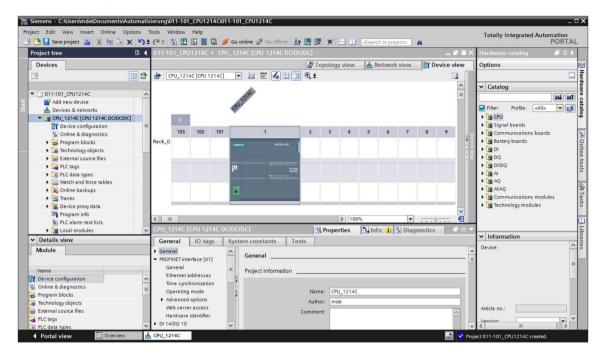
Unspecified CPU 1200

CPU 1215FC DC/DC/Rly > < Open device view Add Opened project: C:\Users\mde\Documents\Automatisierung\011-101\_CPU1214C\011-101\_CPU1214C Project view

**Note:** The desired CPU may have multiple versions that differ in functionality (work memory, integrated memory, technology functions, etc.). In this case, you should ensure that the selected CPU meets the requirements placed on it.

30

The TIA Portal now switches automatically to the project view and displays the selected CPU in the device configuration on slot 1 of a rail.



**Note:** You can now configure the CPU according to your specifications there. Possible settings include the PROFINET interface, startup characteristics, cycle, password protection, communication load and many more.

### 7.3 Configure the Ethernet interface of the CPU 1214C DC/DC/DC

- $\rightarrow$  Select the CPU with a double-click
- → Under → "Properties", open the → "PROFINET interface [X1]" menu and select the → "Ethernet addresses" entry.

CPU_1214C	[CPU 1214C	DC/DC/DC]	9	Properties	🗓 Info 🔇	i 🗓 Diagnostics	1
General	IO tags	System constants	Texts				
Time syno Operating Advanced Web serv	addresses chronization g mode	Ethemet addres Interface ne IP protocol	tworked with		orked I new subnet		×
<ul> <li>DI 14/DQ 10</li> <li>AI 2</li> <li>High speed</li> <li>Pulse generic Startup Cycle Communica System and</li> </ul>	counters (HSC) ators (PTO/PWM	•		I Sub Use rou Route	net mask:	project 192 . 168 . 0 . 1 255 . 255 . 255 . 0 0 . 0 . 0 . 0 tly at the device	]
<ul> <li>Web server Multilingual Time of day</li> <li>Protection &amp; Configuratio Connection Overview of</li> </ul>	Security n control resources	PROFINET	NET device name Converted name Device numbe	Genera cpu_1214 cpuxb1214	te PROFINET de c	e is set directly at the d evice name automatica	

- $\rightarrow$  Under "Interface networked with", only the "Not networked" entry is available.
- $\rightarrow~$  Add an Ethernet subnet with the  $\rightarrow$  "Add new subnet" button.

Ethernet addresses		
Interface networked with		
Subnet:	Not networked	•
	Add new subnet	

 $\rightarrow~$  Keep the preassigned "IP address" and "Subnet mask".

CPU_1214C	[CPU 1214C	DC/DC/DC]	9	Properties	🗓 Info 🔒 🗓 Diagnostics	
General	IO tags	System constants	Texts			
3	addresses chronization g mode	Ethemet addre	sses tworked with		l new subnet	
<ul> <li>DI 14/DQ 10</li> <li>AI 2</li> <li>High speed</li> <li>Pulse generic Startup Cycle Communica System and</li> </ul>	e identifier counters (HSC) ators (PTO/PWM	IP protocol		I Sub Use rou Route	ddress in the project Paddress: 192.168.0.1 inet mask: 255.255.255.0 iter raddress: 0.0.0.0 ess is set directly at the device	
<ul> <li>Web server Multilingual Time of day</li> <li>Protection &amp; Configuratio Connection Overview of</li> </ul>	Security n control resources	PROFINET	INET device name Converted name Device number	Generat cpu_12140		

## 7.4 Configure the address areas

→ The next step is to check the address areas of the inputs and outputs and adapt them if necessary. DI/DO should have an address area of 0...1 and AI should have an address area of 64...67. (→ Device overview → DI 14/DQ 10\_1 → I address: 0..1 → Q address: 0...1 → AI 2\_1 → I address: 64...67)

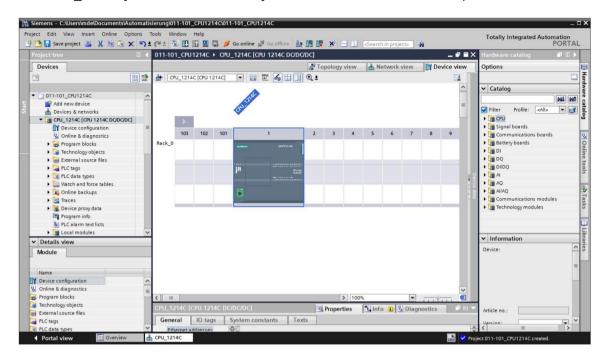
												Topology view	Network view	Device	view
• 0	PU_12140	[CPU 12	14C]	•	1 🖾 📲 ,		Devic	ce overview							
				4		^	¥ .	Module	Slot	I address	Q address	Туре	Article no.	Firmware	Co
				2740					103						
				CPU-224C		=			102						
	_			V					101						
								▼ CPU_1214C	1			CPU 1214C DC/DC/DC	6ES7 214-1AG40-0XB0	V4.2	
	103	102	101	1	1			DI 14/DQ 10_1	11	01	01	DI 14/DQ 10			
		102	101		1			AI 2_1	12	6467		AI 2			
ck_0									13						
								HSC_1	1 16	10001003		HSC			
								HSC_2	1 17	10041007		HSC			
				11	CPU 0000			HSC_3	1 18	10081011		HSC			
								HSC_4	1 19	10121015		HSC			
								HSC_5	1 20	10161019		HSC			
								HSC_6	1 21	10201023		HSC			
						- 11		Pulse_1	1 32		10001001	Pulse generator (PTO/P.			
								Pulse_2	1 33		10021003	Pulse generator (PTO/P.			
								Pulse_3	1 34		10041005	Pulse generator (PTO/P.			
								Pulse_4	1 35		10061007	Pulse generator (PTO/P.			
								PROFINET interface_	1 1 X1			PROFINET interface			
									2						
									3						
									4						
									5						
									6						
									7						
Ш		100%							8						

**Note:** To show and hide the Device overview, you need to click the small arrow next to "Device data" on the right side of the hardware configuration.



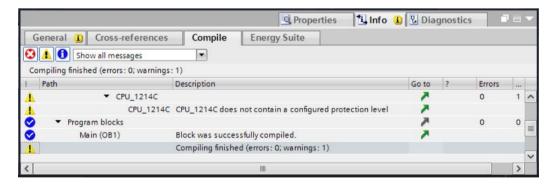
### 7.5 Save and compile the hardware configuration

→ Before you compile the configuration, you should save your project by clicking the → **Save project** button. To compile your CPU with the device configuration, first select the → "CPU\_1214C [CPU1214C DC/DC/DC]" folder and click the → <sup>[III]</sup> "Compile" icon.



**Note:** "Save project" should be used again and again when working on a project since this does not happen automatically. A prompt to save the project only occurs when the TIA Portal is closed.

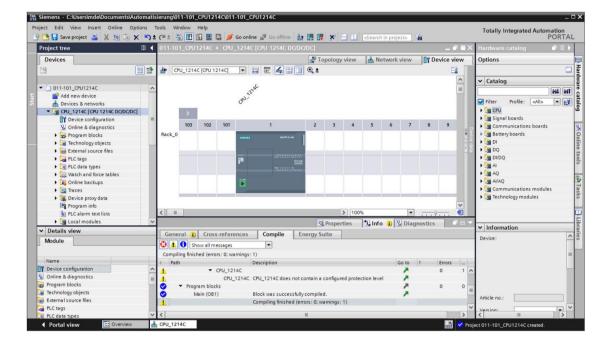
 $\rightarrow$  If the project was compiled without errors, you see the following screen.



### 7.6 **Download the hardware configuration to the device**

 $\rightarrow~$  To download your complete CPU, select the  $\rightarrow$  "CPU\_1214C [CPU1214C DC/DC/DC]" folder

and click the  $\blacksquare \rightarrow$  "Download" icon.



 $\rightarrow$  The manager for configuring the connection properties (extended download) opens.

	Device	Device type	Slot	Туре	Address	Subnet
	CPU_1214C	CPU 1214C DC/D		PN/IE	192.168.0.1	PN/IE_1
		Type of the PG/PC inte PG/PC inte		Please select		· · · · · · · · · · · · · · · · · · ·
		Connection to interface/su	bnet.	[		
		1st gat		E		
	Select target devi	ce:			Show devices with	the same address
	Device	Device type	Interfa	ace type	Address	Target device
Flash LED	Device	Device type	Interfa	sce type		
		Device type	Interfe	sce type	Address	Target device
		Device type	Interfa	sce type	Address	Target device
Flash LED		Device type	Interfa	sce type	Address	Target device

- $\rightarrow$  First, the interface must be correctly selected. This happens in three steps.
- $\rightarrow~$  Type of the PG/PC interface  $\rightarrow$  PN/IE

 Configured access nodes of "CPU_1200"								
Device	Device type	Slot	Туре	Address	Subnet			
CPU_1200	CPU 1214C DC/D	1 X1	PN/IE	192.168.0.1	PN/IE_1			
	Type of the PG/PC inte	erface:	Please select					
	PG/PC inte	rface:	Please select.	P.				
	Connection to interface/st	ubnet:	PN/IE	A	C			
	Connection to interface/su	ubnet:						

 $\rightarrow$  PG/PC interface  $\rightarrow$  here: Intel(R) Ethernet Connection (4) I219-LM

Configured acces	is nodes of "CPU_1200"					
Device	Device type	Slot	Туре	Address	Subnet	
CPU_1200	CPU 1214C DC/D	1 X1	PN/IE	192.168.0.1	PN/IE_1	1
	Type of the PG/PC inte	rface:	PN/IE		-	]
	Type of the PG/PC inte PG/PC inte		PN/IE Please select.	n	▼  ▼	-

 $\rightarrow$  Connection to interface/subnet  $\rightarrow$  "PN/IE\_1"

 Configured acces	s nodes of *CPU_1200*				
Device	Device type	Slot	Туре	Address	Subnet
CPU_1200	CPU 1214C DC/D	1 X1	PN/IE	192.168.0.1	PN/IE_1
	Type of the PG/PC inte	erface:	PN/IE		•
	PG/PC inte	rface:	Intel(R) Et	nernet Connection (4) I21	9-LM
	PG/PC inte Connection to interface/su		Please selec		9-LM 🔹 🕅

→ The → "Show all compatible devices" check box must be selected. The search for devices in the network is started by clicking the →  $\boxed{\text{Start search}}$  button.

	Configured access not Device	Device type	Slot	Туре	Address	Subnet	
	CPU_1200			PN/IE	192.168.0.1	PN/IE_1	
		Type of the PG/PC inte	rface:	PN/IE			
		PG/PC inte		and a second sec	Ethernet Connection (4) I21		
	Conn	ection to interface/su	bnet:	Direct at s			
		1st gat	ewav:		A990-11/09-342/0		
	Select target device:				Show all compatible	devices	1
	Device	Device type	Interfa	ce type	Address	Target devic	e
	-	-	PN/IE		Access address	-	
P							
5							
Flash LED							
						<u>Start</u> s	earch
ne status information	:				Display only error	messages	▶ St
						07.	

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→ If your CPU is shown in the "Compatible devices in target subnet" list, you must select it. The download can then be started ( $\rightarrow$  CPU 1214C DC/DC/DC  $\rightarrow$  "Load").

	Device	Device type	Slot T	ype	Address	Subnet	
	CPU_1200	CPU 1214C DC/D	1 X1 P	N/IE	192.168.0.1	PN/IE_1	
		Type of the PG/PC inte PG/PC inte	100 C	PN/IE		▼ 219-LM	
		For Cinte		ect at slot '1 X1	Connection (4) 12	219-LM	0
	(			ectatsiot 1 X1	<u>.</u>		
		1st gat	evvay:			*	V
	Select target devic	:e:		s	how all compatib	le devices	0
	Device	Device type	Interface ty	pe Addre	255	Target devic	e
	CPUcommon	CPU 1214C DC/D.	PN/IE	192.1	68.0.1	CPUcommo	n
and the second second second second	-	-	PN/IE	Acces	s address	-	
<u>  </u>							
Flash LED							
Flash LED						<u>Start</u> s	earch
	n:				Display only erro	L	earch
Flash LED		:h address 192.168.0.1.			Display only erro	L	
ine status information Connection establis	hed to the device wit	th address 192.168.0.1. f 1 accessible devices for	und.		Display only erro	L	-
ine status information Connection establis	hed to the device wit compatible devices o		und.		Display only erro	L	

 $\rightarrow$  You first obtain a preview. Confirm the prompt  $\rightarrow$  "Overwrite all" and continue with  $\rightarrow$  "Load".

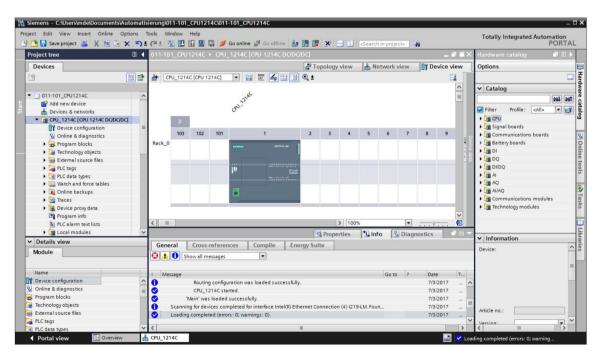
Status	1	Target	Message	Action
1]	9	▼ CPU_1200	Ready for loading.	
	4	<ul> <li>Protection</li> </ul>	Protection from unauthorized access	
	A		Devices connected to an enterprise network or directly to the internet must be appropriately protected against unauthorized access, e.g. by use of firewalls and network segmentation. For more information about industrial security, please visit http://www.siemens.com/industrialsecurity	
	0	Device configurati	Delete and replace system data in target	Download to device
	0	Software	Download software to device	Consistent download
	0	Text libraries	Download all alarm texts and text list texts	Consistent download
<			10	

*Note:* The Symbol should be visible in every line of the "Load preview". You can find additional information in the "Message" column.

The  $\rightarrow$  "Start all" option will be selected next before the download operation can be completed with  $\rightarrow$  "Finish".

Load res	sults			>
3	Status	and actions after downloa	ding to device	
Status	1	Target	Message A	ction
1	2	▼ CPU_1200	Downloading to device completed without error.	
	4	Start modules	Start modules after downloading to device.	Start all
<				
<				>
			Finish	Load Cancel

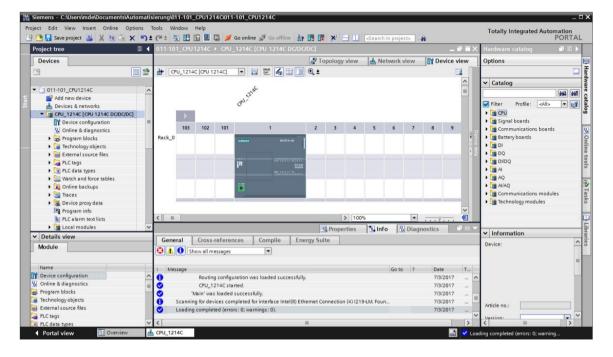
→ After a successful download, the project view will open again automatically. A loading report appears in the information field under "General". This can be helpful when troubleshooting an unsuccessful download.



# 7.7 Download the hardware configuration to the PLCSIM simulation (optional)

If no hardware is present, the hardware configuration can **alternatively** be downloaded to a PLC simulation (S7-PLCSIM).

→ To do so, you must first start the simulation by selecting the  $\rightarrow$  "CPU\_1214C [CPU1214C DC/DC/DC]" folder and clicking the  $\blacksquare$   $\rightarrow$  "Start simulation" icon.



 $\rightarrow$  The prompt that all other online interfaces will be disabled is confirmed with  $\rightarrow$  "OK".

Recreate	the cross-reference information (0626	×
	Starting simulation will disable all other online interfaces.	
	Do not show this message again.	
	OK Cancel	

3

42

 $\rightarrow$  The "S7 PLCSIM" software is started in a separate window in the compact view.



→ The manager for configuring the connection properties (extended download) opens shortly thereafter.

	Device	Device type	Slot	Туре	Address	Subnet
	CPU_1214C	CPU 1214C DC/D	1 X1	PN/IE	192.168.0.1	PN/IE_1
	Co	Type of the PG/PC interfac PG/PC interfac nnection to interface/subne 1st gatewa	e: Pl	_PN/IE ease select _PN/IE		
	Select target dev		9. L		Show devices with	
	Device	Device type	Interf	ace type	Address	Target device
Flash LED						
ne status information	1:				Display only error	<u>Start sea</u> messages

First, the interface must be correctly selected. This happens in three steps.

 $\rightarrow~$  Type of the PG/PC interface  $\rightarrow$  PN/IE

tended downloa						
	Configured acces	s nodes of "CPU_1214C"				
	Device	Device type	Slot	Туре	Address	Subnet
	CPU_1214C	CPU 1214C DC/D	1 X1	PN/IE	192.168.0.1	PN/IE_1
		Type of the PG/PC interfac	e: 🖳	PN/IE		-
		PG/PC interfac	te: Ple	ease select		1 🐨 🖳 🚺
	<b>C</b>	nection to interface/subn		PN/IE		
	Con	inection to interface/subn	et:	ebse select		
		1st gatewa	av:			- 💎

 $\rightarrow$  PG/PC interface  $\rightarrow$  PLCSIM

 Configured access	s nodes of "CPU_1214C"				
Device	Device type	Slot	Туре	Address	Subnet
CPU_1214C	CPU 1214C DC/D	1 X1	PN/IE	192.168.0.1	PN/IE_1
	Type of the PG/PC interfac	:e: 🖳	PN/IE		
	Type of the PG/PC interface PG/PC interface	-	PN/IE PLCSIM		
Con		:e: 🔊			

 $\rightarrow$  Connection to interface/subnet  $\rightarrow$  "PN/IE\_1"

xtended download		s nodes of *CPU_1214C*				
	Device	Device type	Slot	Туре	Address	Subnet
	CPU_1214C	CPU 1214C DC/D	1 X1	PN/IE	192.168.0.1	PN/IE_1
		Type of the PG/PC interfac PG/PC interfac	and the second	.PN/IE PLCSIM		 ▼ ♥ 盟 Q
	Con	nection to interface/subne 1st gatewa	y: Plo	ease select ease select rect at slot '1 I/IE_1	x1'	· (*)

→ The → "Show all compatible devices" check box must be selected. The search for devices in the network is started by clicking the → start search button.

	Device	Device type	Slot T	ype	Address	Subnet
	CPU_1214C	CPU 1214C DC/D	1 X1 P	PN/IE	192.168.0.1	PN/IE_1
		Type of the PG/PC interfac				
	C	PG/PC interfac				- © - ()
	Cor	1st gatewa		.!		• •
	Device 	Device type —	Interface ty PN/IE	уре	Address Access address	Target device —
	Device 			уре		
Flash LED	Device —			уре		
Flash LED	Device —			ype		
Flash LED	-			ype		
	-			ype	Access address	
	-			ype	Access address	

→ If the simulation is shown in the "Compatible devices in target subnet" list, it must be selected before the download can be started (→ "CPU-1200 Simulation" → "Load")

	Device	Device type	Slot Type	Address	Subnet
	CPU_1214C	CPU 1214C DC/D		192.168.0.1	PN/IE_1
	Con	Type of the PG/PC interfac PG/PC interfac nection to interface/subne 1st gatewa	e: PLCSIM		
	Select target devi	ce:		Show devices with	the same address
	Device	Device type	Interface type	Address	Target device
	CPUcommon	CPU-1200 Simula.	and the second se	192.168.0.1	CPUcommon
			PN/IE	Access address	-
Flash LED					
Flash LED	stion:			Display only erro	<u>Start search</u> r messages
iline status informa		of 1 accessible devices fou	nd.	Display only error	

 $\rightarrow$  You first obtain a preview. Continue with  $\rightarrow$  "Load".

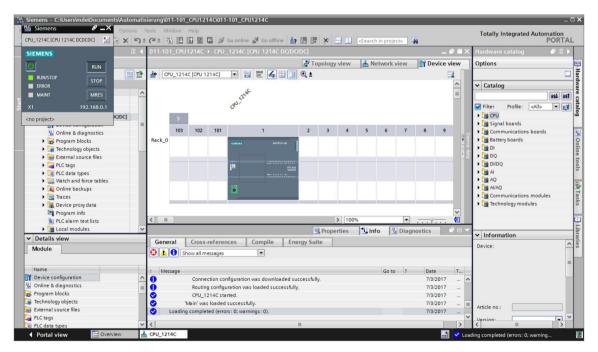
atus	1	Target	Message	Action
10	0	▼ CPU_1214C	Ready for loading.	
	0	Simulated module	The download will be performed to a simulated PLC.	
	0	Device configurati	Delete and replace system data in target	Download to device
	0	<ul> <li>Software</li> </ul>	Download software to device	Consistent download
	0	Text libraries	Download all alarm texts and text list texts	Consistent download
			III	

*Note:* The Symbol should be visible in every line of the "Load preview". You can find additional information in the "Message" column.

 $\rightarrow$  The  $\rightarrow$  "Start all" option will be selected next before the download operation can be completed with  $\rightarrow$  "Finish".

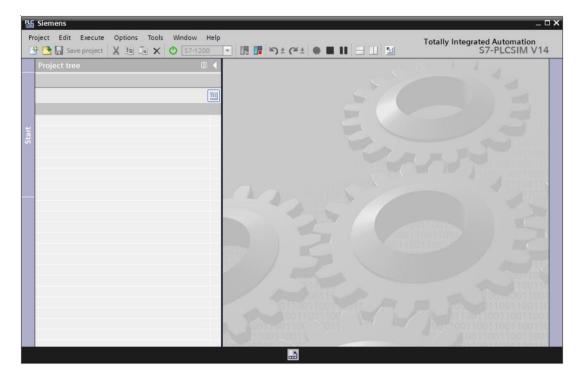
Status	1	Target	Message	Action
1	-	▼ CPU_1214C	Downloading to device completed without error.	
	4	Start modules	Start modules after downloading to device.	Start all
(				

→ After a successful download, the project view will open again automatically. A loading report appears in the information field under "General". This can be helpful when troubleshooting an unsuccessful download.



 $\rightarrow$  The PLCSIM simulation has the following appearance in the project view. You can switch to

the compact view of the simulation by clicking the  $\rightarrow$   $\stackrel{[]}{\longrightarrow}$  icon in the menu bar.

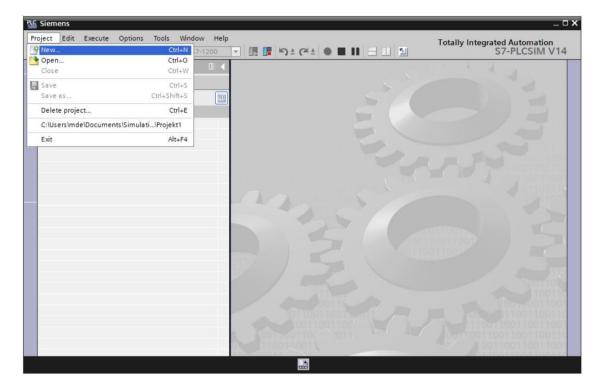


→ The compact view of the PLCSIM simulation has the following appearance. You can switch



back to the project view by clicking the  $\rightarrow$  icon.

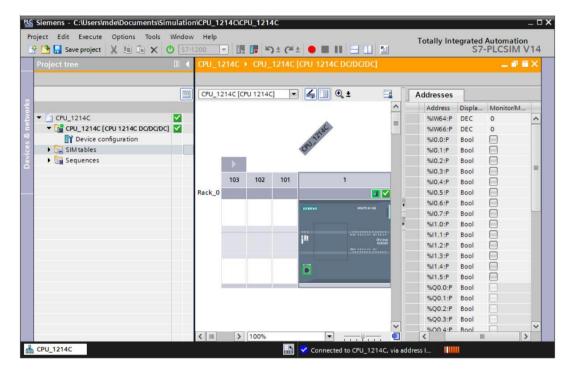
→ In the project view you have to create a new simulation project by clicking → "Project" → "New".



→ Assign a "Project name" → "CPU\_1214C" and select a → "Path" where you want to create your project. Then click → "Create".

Create a new project		×
Project name:	CPU_1214C	
Path:	C:\Users\mde\Documents\Simulation	
Version:	V14 SP1	-
Author:	mde	
Comment:		< >
	Create Cancel	

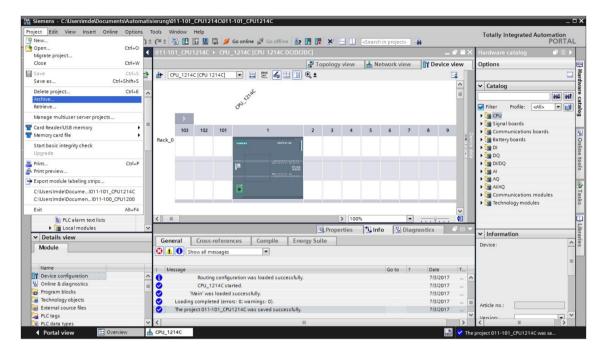
→ You can see the downloaded configuration with the status of all inputs and outputs in the project view by double-clicking → "Device configuration". Here you can also create your own
 → "Sim tables" with selected input and output signals. You can modify the input signals used in your program to test the program in the PLCSIM simulation.



**Note:** Because this is a simulation, you cannot detect errors in the hardware configuration in this case.

### 7.8 Archive the project

 $\rightarrow$  To archive the project, select the  $\rightarrow$  "Archive ..." command in the  $\rightarrow$  "Project" menu.



 $\rightarrow$  Confirm the prompt to save the project with  $\rightarrow$  "Yes".

Archive p	project (0104:000006) ×
<u> </u>	Save project? The last saved project is archived. Do you want to save the project before archiving to create a backup copy of the current changes?
	Yes No

→ Select a folder where you want to archive your project and save it as file type "TIA Portal project archive" (→ "TIA Portal project archive" → "SCE\_EN\_011-101\_Hardware configuration\_S7-1214C..." → "Save").

## 7.9 Checklist

No.	Description	Completed
1	Project was created	
2	Slot 1: CPU with correct order number	
3	Slot 1: CPU with correct firmware version	
4	Address area of the digital inputs correct	
5	Address area of the digital outputs correct	
6	Address area of the analog inputs correct	
7	Hardware configuration was compiled without error message	
8	Hardware configuration was downloaded without error message	
9	Project was successfully archived	

# 8 Exercise

### 8.1 Task – Exercise

The hardware configuration of the SIMATIC CPU 1214C DC/DC/DC Trainer Package is not quite complete. Insert the following missing signal board. Use the address area starting from 64 for the analog output.

1X SIMATIC S7-1200, signal board ANALOG OUTPUT SB1232, 1 AO (Order number: 6ES7 232-4HA30-0XB0)

## 8.2 Planning

Plan the implementation of the task on your own.

## 8.3 Checklist – Exercise

No.	Description	Completed
1	Signal board with correct order number	
2	Signal board with correct firmware version	
3	Signal board address area of analog output correct	
4	Hardware configuration was compiled without error message	
5	Hardware configuration was downloaded without error message	
6	Project was successfully archived	

## 9 Additional information

More information for further practice and consolidation is available as orientation, for example: Getting Started, videos, tutorials, apps, manuals, programming guidelines and trial software / firmware, under the following link:

www.siemens.com/sce/s7-1200

Preview "Additional information"

Getting Started, Videos, Tutorials, Apps, Manuals, Trial-SW/Firmware

- ↗ TIA Portal Videos
- TIA Portal Tutorial Center
- > Getting Started
- ↗ Programming Guideline
- Easy Entry in SIMATIC S7-1200
- > Download Trial Software/Firmware
- 7 Technical Documentation SIMATIC Controller
- ↗ Industry Online Support App
- TIA Portal, SIMATIC S7-1200/1500 Overview
- ↗ TIA Portal Website
- ↗ SIMATIC S7-1200 Website
- SIMATIC S7-1500 Website

# Notes

# SCE Learn-/Training Textbook

# Automation System SIMATIC S7-1200



TIA Portal Modules from Version V14 SP1

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<b>TIA Portal Module 011-001</b> Firmware Update	1
TIA Portal Module 011-100 Unspecified Hardware Configuration	2
<b>TIA Portal Module 011-101</b> Specified Hardware Configuration	3
<b>TIA Portal Module 020-100</b> Process description of sorting station	4
TIA Portal Module 031-100 Basics of FC Programming	
TIA Portal Module 031-200 Basics of FB Programming	6
TIA Portal Module 031-300 IEC Timers and IEC Counters	7
<b>TIA Portal Module 031-410</b> Basics of Diagnostics	8
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### Additional information regarding SCE

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We wish to thank the TU Dresden, particularly Prof. Dr.-Ing. Leon Urbas and the Michael Dziallas Engineering Corporation and all other involved persons for their support during the preparation of this Learn-/Training Document.

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# **Process Description - Sorting Station**

The "Sorting station" example process is described in the following.

## **1** Description of functions

### 1.1 Brief description

The automated sorting station (see Figure 1) is used to separate plastic and metal components. A component is fed to the conveyor via a chute. The conveyor starts as soon as the component has been detected. If a component made of metal is on the conveyor, it is detected, transported up to the height of the metal magazine and pushed by a cylinder into the metal magazine. If no metal is detected, the component is made of plastic. The plastic component is transported to the end of the belt, where it falls into the plastic magazine. As soon as a component is sorted, the next component can be fed.

### 1.2 Technology diagram

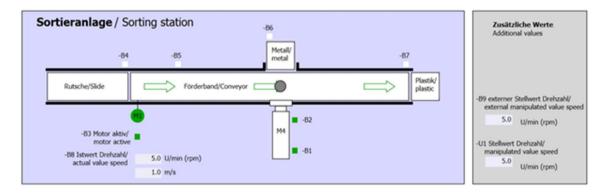


Figure 1: Technology diagram

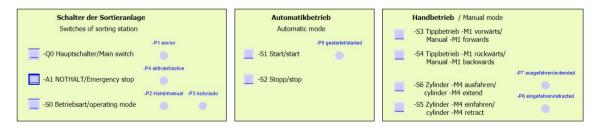


Figure 2: Control panel

### 1.3 Switching on

The station is switched on with the main switch Q0. Relay K0 (main switch "ON") is energized and provides the supply voltage for the sensors and actuators.

This operating state is indicated by indicator light P1 (main switch on)

### 1.4 Operating mode selection

Once the station has been switched on, two operating modes are possible: manual mode or automatic mode. The operating mode is selected using switch S0.

The selected operating mode is indicated by indicator lights P2 (manual mode) and P3 (automatic mode).

### 1.5 EMERGENCY STOP

In the absence of feedback from the EMERGENCY STOP (A1), all drives must be stopped immediately.

When feedback from the EMERGENCY STOP function is present again, the station may only start up again after another start signal.

Activation of the EMERGENCY STOP is indicated by indicator lights P4 (EMERGENCY STOP activated).

### 1.6 Manual mode

The station is set up in manual mode.

### 1.6.1 Retracting and extending the cylinder

After pushbutton S5 (cylinder M4 extend) is pressed, cylinder M4 is extended. When the front end position is reached (extended position), the cylinder pauses in this position. After pushbutton S4 is pressed, the cylinder retracts. A change of direction is to be possible at any time. When the two pushbuttons are pressed simultaneously, no motion should take place.

### 1.6.2 Conveyor motor in manual mode

With pushbutton S3 (pushbutton manual mode conveyor M1 forwards), motor Q1 (conveyor motor M1 forwards fixed speed) is moved forward in manual mode. With pushbutton S4 (pushbutton manual mode conveyor M1 backwards), motor Q2 (conveyor motor M1 backwards fixed speed) is moved backward in manual mode. When the two pushbuttons are pressed simultaneously, no motion should take place.

For safety reasons, only the preset speed may be used here. Output Q3 (conveyor motor M1 variable speed) must therefore be deactivated.

#### 1.6.3 Initial state

At station start or after release of EMERGENCY STOP, the station must be moved in manual mode to a defined operating state (initial state). In the initial state, the conveyor is empty and stopped and the cylinder is retracted.

## 1.7 Automatic mode

In automatic mode, the station executes the process (see also Brief description).

#### 1.7.1 Starting and stopping

If the station is in the initial state, automatic mode starts when pushbutton S1 (automatic start) is pressed. When pushbutton S2 (automatic stop) is pressed, automatic mode is ended again as soon as the initial state has been reached.

If EMERGENCY STOP has been tripped or the operating mode changed, automatic mode is ended immediately (without return to the initial state).

The current state is indicated by indicator light P6 (automatic mode started).

#### 1.7.2 Conveyor control

If light sensor B4 (chute occupied) detects a component, the conveyor motor starts. The component slides onto the transport conveyor and is further conveyed.

If inductive sensor B5 detected a metal component, this is transported up to light sensor B6 (part in front of cylinder M4). The conveyor is then switched off. As soon as B3 (sensor motor M1 active) no longer supplies a signal, the Cylinder control (see below) is activated and moves the component into the metal magazine. As soon as the cylinder is retracted again, the sorting station is back in the initial state.

If a metal component was not detected by sensor B5, this is recognized when light sensor B6 (part in front of cylinder M4) is reached. The plastic component is then transported to the end of the conveyor. It is detected there by light sensor B7 and conveyed after a delay time into the plastic magazine at the end of the conveyor.

#### 1.7.3 Cylinder control

If a metal component reaches light sensor B6 (part in front of cylinder M4) and the conveyor has stopped, cylinder M4 moves to the front end position B2 (cylinder M4 extended), thereby pushing the metal component from the conveyor into the metal magazine. Cylinder M4 then moves to the rear end position B1 (cylinder M4 retracted).

#### 1.7.4 Speed control (conveyor speed)

In automatic mode, the motor can be moved at a fixed or variable speed.

Fixed speed requires signal "1" at Q1 "Conveyor motor M1 forwards fixed speed" or Q2 "Conveyor motor M1 backwards fixed speed". For variable speed, Q3 "Conveyor motor M1 variable speed" must be activated and a "manipulated value for motor speed" (analog value +/-10 V corresponds to +/- 50 rpm or 10 m/s) must be specified at U1. Signal "1" must not be present at Q1 "Conveyor motor M1 forwards fixed speed" or Q2 "Conveyor motor M1 backwards fixed speed". Otherwise, U1 has no effect on the speed of the conveyor.

#### 1.7.5 Speed control

A speed control can be integrated for control of the conveyor speed. This uses the speed sensor for evaluating the current speed. A speed of 5 rpm corresponds to a conveyor belt speed of 1 m/s.

## 1.8 Indicator lights

As soon as relay K0 (main switch "ON") becomes energized, indicator light P1 (main switch on) lights up.

If switch S0 (mode selector manual/automatic) is set to Manual, the indicator light P2 (manual mode) lights up. If switch S0 is set to Automatic, the indicator light P3 (automatic mode) lights up.

If the EMERGENCY STOP function has tripped, P4 (EMERGENCY STOP activated) lights up.

If automatic mode has been selected and the station is in the initial state, P5 (automatic mode started) flashes to signal that automatic mode can be started. As soon as automatic mode has been started, P5 lights up.

Indicator light P6 (cylinder M4 retracted) lights up as soon as end position sensor B1 (sensor cylinder M4 retracted) has been reached. Indicator light P7 (cylinder M4 extended) lights up as soon as cylinder M4 has reached the front end position sensor B2 (sensor cylinder M4 extended). Indicator lights P6 and P7 are not lit if the cylinder is located in neither of the two end positions.

# 2 Reference list

By default, the S7-1200 has only 14 digital Inputs, 10 digital outputs, 2 analog inputs und 1 analog output. Therefore, the signals shown in the list with blue text are not available for it.

DI	Туре	Identifier	Function	NC/NO
10.0	BOOL	A1	Return signal emergency stop OK	NC
I 0.1	BOOL	K0	Main switch "ON"	NO
10.2	BOOL	S0	Mode selector manual (0)/ automatic (1)	Manual = 0 Auto = 1
10.3	BOOL	S1	Pushbutton automatic start	NO
10.4	BOOL	S2	Pushbutton automatic stop	NC
10.5	BOOL	B1	Sensor cylinder M4 retracted	NO
10.6	BOOL	B2	Sensor cylinder M4 extended	NC
10.7	BOOL	B3	Sensor motor M1 active (pulse signal also suitable for positioning)	NO
I 1.0	BOOL	B4	Sensor at chute occupied	NO
I 1.1	BOOL	B5	Sensor metal part	NO
I 1.2	BOOL	B6	Sensor part in front of cylinder M4	NO
I 1.3	BOOL	B7	Sensor part at end of conveyor	NO
I 1.4	BOOL	S3	Pushbutton manual mode conveyor M1 forwards	NO
I 1.5	BOOL	S4	Pushbutton manual mode conveyor M1 backwards	NO
I 1.6	BOOL	S5	Pushbutton manual mode cylinder M4 retract	NO
I 1.7	BOOL	S6	Pushbutton manual mode cylinder M4 extend	NO

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DO	Туре	Identifier	Function	
Q 0.0	BOOL	Q1	Conveyor motor M1 forwards fixed speed	
Q 0.1	BOOL	Q2	Conveyor motor M1 backwards fixed speed	
Q 0.2	BOOL	Q3	Conveyor motor M1 variable speed	
Q 0.3	BOOL	M2	Cylinder M4 retract	
Q 0.4	BOOL	M3	Cylinder M4 extend	
Q 0.5	BOOL	P1	Display "main switch on"	
Q 0.6	BOOL	P2	Display "MANUAL" mode	
Q 0.7	BOOL	P3	Display "AUTOMATIC" mode	
Q 1.0	BOOL	P4	Display "emergency stop activated"	
Q 1.1	BOOL	P5	Display "automatic mode started"	
Q 1.2	BOOL	P6	Display "cylinder M4 retracted"	
Q 1.3	BOOL	P7	Display "cylinder M4 extended"	
AI	Туре	Identifier	Function	
IW 64	INT	B8	Sensor actual value speed of motor +/- 10V	
IW 66	INT	B9	Setpoint specification via potentiometer	
			+/- 10V	
AO	Туре	Identifier	Function	
QW 64	INT	U1	Manipulated value speed of motor in 2 directions +/- 10V	

## Legend for reference list

- DIDigital InputDODigital OutputAIAnalog InputAOAnalog Output
- I Input
- NC Normally Closed
- NO Normally Open
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Output

Q

# **3** Description of components of the station

# 3.1 Manual operation

#### 3.1.1 Pushbuttons

The utilized pushbuttons can supply either a "0" or "1" signal. Depending on whether you have planned them as normally-closed or normally-open contacts (see Reference list), they supply a "1" or "0" signal when not actuated. The signal changes to "0" or "1" only while the pushbutton is being pressed.

#### 3.1.2 Switches

The utilized switches can also supply either a "0" or "1" signal. Depending on whether you have planned them as normally-closed or normally-open contacts (see Reference list), they supply a "1" or "0" signal when not actuated. The signal changes to "0" or "1" when the switch is actuated. This signal is present as long as the switch is not actuated again.

#### 3.1.3 Feedback from EMERGENCY STOP pushbutton

EMERGENCY STOP pushbuttons are pushbuttons with an additional mechanical lock and are connected to a safety relay. They thus behave like a switch. The EMERGENCY STOP feedback from the safety relay is planned as a normally closed contact for safety reasons. If a wire break occurs, therefore, this feedback is no longer present and the station responds as if an EMERGENCY STOP has tripped.

## 3.2 Sensors

#### 3.2.1 Position switches

A main switch is actuated to switch on the station. This energizes a relay and supplies the power to the station. A position switch provides feedback on the operation of the relay.

#### 3.2.2 Limit switches

The limit switches supply a signal when the cylinder is either fully retracted or extended. The limit switches are implemented as normally-closed or normally-open contacts.

#### 3.2.3 Light barriers / optical sensors

The light barriers supply a "1" signal as soon as an object is in the sensing range.

#### 3.2.4 Metal detection / Inductive sensor

The inductive sensor supplies a "1" signal as soon as a metallic object enters its sensing range. In the case of non-metallic objects, the signal remains at "0".

#### 3.2.5 Motor speed

The motor speed is recorded by an incremental encoder at the conveyor motor and provided as an analog value via a transducer. The speed falls within the range from -50 rpm to 50 rpm. That corresponds to a conveyor belt speed of -10 m/s to +10 m/s.

In addition, pulses are received at "Sensor conveyor motor M1 active" that can also be used for positioning. The resolution is 20 pulses per total conveyor belt length (10 m).

### 3.3 Actuators

#### 3.3.1 Conveyor motor

The conveyor motor drives the conveyor belt. It has multiple signal combinations so that the conveyor belt can be moved at fixed or variable speed in both directions.

Fixed speed requires signal "1" at Q1 "Conveyor motor M1 forwards fixed speed" or Q2 "Conveyor motor M1 backwards fixed speed". For variable speed, Q3 "Conveyor motor M1 variable speed" must be activated and a "manipulated value for motor speed" (analog value +/-10 V corresponds to +/- 50 rpm or 10 m/s) must be specified at U1. Signal "1" must not be present at Q1 "Conveyor motor M1 forwards fixed speed" or Q2 "Conveyor motor M1 backwards fixed speed". Otherwise, U1 has no effect. Simultaneous activation of signals Q1 and Q2 causes the conveyor to stop and must be prevented by the control program.

#### 3.3.2 Cylinders

Cylinder M4 is controlled using two separate signals. Activation of one signal (M3) causes the cylinder to extend and activation of the other signal (M2) causes the cylinder to retract. The signals must not be activated simultaneously, otherwise an undefined state occurs and the cylinder pauses at its position. This must be prevented by the control program.

#### 3.3.3 Displays

All indicator lights are located on the control panel. If signal "1" is present, these indicator lights illuminate.

# 4 Brief description of the simulation

The simulation of the sorting station consists of 9 diagrams. The 01\_Operating screen diagram is important for operation (see Figure 3), which contains the control panel and a representation of the station.

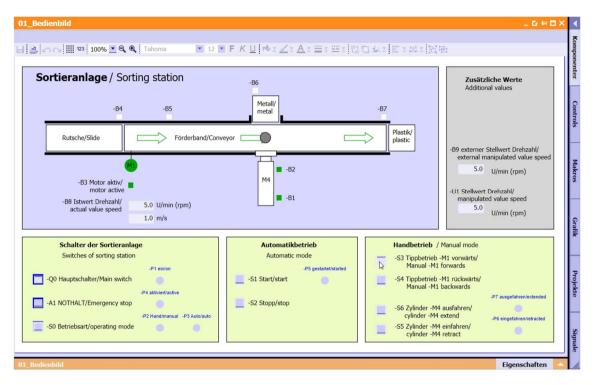


Figure 3: The operating screen

Figure 4 shows the 02\_SimControl diagram. It allows important simulation settings to be made. The first settings affect the creation of the components. Here, you can select between automatic and manual creation of components. With automatic creation of components, a new component is always created and sent to the station when the previous component has been sorted. A single component is created with manual creation of components. The next settings allow you to specify whether a metal component or plastic component will be created. The following selections are available: Produce only metal components, Produce only plastic components and Randomly produce metal or plastic components Only one of the three options should be selected.

🗠 😋 🏢 123 100% 🔽 🔍 🍭 Tahoma	💌 12 💌 F K U 🗆 1 🗹 1 🗛 1 🚍 1 🖽 1 🖓 1 🕰 1
eile erzeugen/ Create components	Nur eine Option pro Feld auswählen!/ Choose only one option per field!
Automatisch oder manuell/ Automatic or manual	
Automatisch Bauteile erzeugen/ Automatic creation of components	
	=1 New component
Manuell 1 Bauteil erzeugen/Manual creation of 1 component	
nur Metallbauteile erzeugen/ Produce only metal cor	nponents
Metallbauteile/ Metal components	
Metal_comp	
nur Plastikbauteile erzeugen/ Produce only plastic co	omonents
Plastikbauteile/ plastic components	in porterio
Plastic comp	
zufällig Metall- oder Plastikbauteile erzeugen/ Rand zufällig/randomly	omly produce metal or plastic components
Construction of the second second	
Rand_comp	
elle Vorgabe eines analogen Wertes/ Manual -B9 externer Stellwert Drehzahl/ external manipula	
	B9 nicht benötigt wird, kann dieser analoge Wert für andere
5.0 > Zwecke	wiederverwendet werden.
1t -B9 is	not used the analogue value may be reuse for other purpose.
setzen der Bauteilposition/ Reset of compone	nt position
Manuelles Rücksetzen/ Manual reset	
manual_reset	

In the "Manual specification of an analog value" area, a value between -50 and +50 can be set for input word IW 66 (see Reference list). This corresponds to an input voltage of -/+10 V. This value is then converted to a digital value between -27648 and +27648 and is thus available as an analog input value.

The last setting concerns the manual resetting of the current component. This resets the position of the component and a new component can be created.

Figure 4: Simulation control

# 5 Additional information

More information for further practice and consolidation is available as orientation, for example: Getting Started, videos, tutorials, apps, manuals, programming guidelines and trial software / firmware, under the following link:

www.siemens.com/sce/s7-1200

#### Preview "Additional information"

- Getting Started, Videos, Tutorials, Apps, Manuals, Trial-SW/Firmware
  - TIA Portal Videos
  - ↗ TIA Portal Tutorial Center
  - > Getting Started
  - ↗ Programming Guideline
  - Easy Entry in SIMATIC S7-1200
  - > Download Trial Software/Firmware
  - 7 Technical Documentation SIMATIC Controller
  - ↗ Industry Online Support App
  - TIA Portal, SIMATIC S7-1200/1500 Overview
  - ↗ TIA Portal Website
  - ↗ SIMATIC S7-1200 Website
  - ↗ SIMATIC S7-1500 Website

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# Notes

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# SCE Learn-/Training Textbook

# Automation System SIMATIC S7-1200



TIA Portal Modules from Version V14 SP1

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<b>TIA Portal Module 011-001</b> Firmware Update	1
TIA Portal Module 011-100 Unspecified Hardware Configuration	2
TIA Portal Module 011-101 Specified Hardware Configuration	
<b>TIA Portal Module 020-100</b> Process description of sorting station	4
TIA Portal Module 031-100 Basics of FC Programming	5
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<b>TIA Portal Module 051-300</b> PID Controller	14

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- SIMATIC S7-1200 AC/DC/RELAY (set of 6) "TIA Portal" Order no.: 6ES7214-1BE30-4AB3
- SIMATIC S7-1200 DC/DC/DC (set of 6) "TIA Portal" Order no.: 6ES7214-1AE30-4AB3
- Upgrade SIMATIC STEP 7 BASIC V14 SP1 (for S7-1200) (set of 6) "TIA Portal" Order no.: 6ES7822-0AA04-4YE5

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We wish to thank the TU Dresden, particularly Prof. Dr.-Ing. Leon Urbas and the Michael Dziallas Engineering Corporation and all other involved persons for their support during the preparation of this Learn-/Training Document.

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# **Basics of FC Programming**

# 1 Goal

In this chapter, you will get to know the basic elements of a control program – the **organization blocks (OBs), functions (FCs)**, function blocks (FBs) and data blocks (DBs). In addition, you will be introduced to **library-compatible** function und function block programming. You will get to know the **Function Block Diagram (FBD)** programming language and use it to program a function (FC1) and an organization block (OB1).

The SIMATIC S7 controllers listed in Chapter 3 can be used.

# 2 Prerequisite

This chapter builds on the hardware configuration of SIMATIC S7 CPU1214C. However, other hardware configurations that have digital input and output cards can be used. For this chapter, you can use the following project, for example:

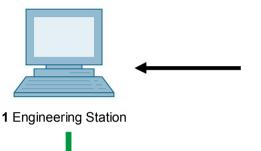
SCE\_EN\_011\_101\_Hardware\_Configuration\_CPU1214C.zap14

# 3 Required hardware and software

- 1 Engineering station: requirements include hardware and operating system (for additional information, see Readme on the TIA Portal Installation DVDs)
- 2 SIMATIC STEP 7 Basic software in TIA Portal as of V14 SP1
- 3 SIMATIC S7-1200 controller, e.g. CPU 1214C DC/DC/DC with ANALOG OUTPUT SB1232 signal board, 1 AO Firmware as of V4.2.1

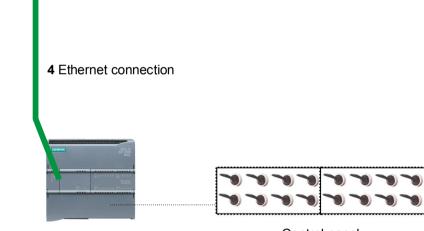
Note: The digital inputs should be fed out to a control panel.

4 Ethernet connection between engineering station and controller





2 SIMATIC STEP 7 Basic (TIA Portal) as of V14 SP1



3 SIMATIC S7-1200 controller

Control panel

# 4 Theory

## 4.1 **Operating system and application program**

Every controller (CPU) contains an **operating system**, which organizes all functions and sequences of the CPU that are not associated with a specific control task. The tasks of the operating system include the following:

- Performing a warm restart
- Updating the process image of the inputs and output
- Cyclically calling the user program
- Detecting interrupts and calling interrupt OBs
- Detecting and handling errors
- Managing memory areas

The operating system is an integral component of the CPU and comes pre-installed.

The **user program** contains all functions that are necessary for executing your specific automation task. The tasks of the user program include the following:

- Checking the basic requirements for a warm restart using startup OBs
- Processing of process data, i.e. activation of output signals as a function of the input signal states
- Reaction to interrupts and interrupt inputs
- Error handling during normal program execution

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# 4.2 Organization blocks

Organization blocks (OBs) form the interface between the operating system of the controller (CPU) and the application program. They are called from the operating system and control the following operations:

- Cyclic program processing (e.g. OB1)
- Startup characteristics of the controller
- Interrupt-driven program processing
- Error handling

A project must have, at a minimum, *an organization block for cyclic program processing*. An OB is called by a *start event* as shown in Figure 1. In addition, the individual OBs have defined priorities so that, for example, an OB82 for error handling can interrupt the cyclic OB1.

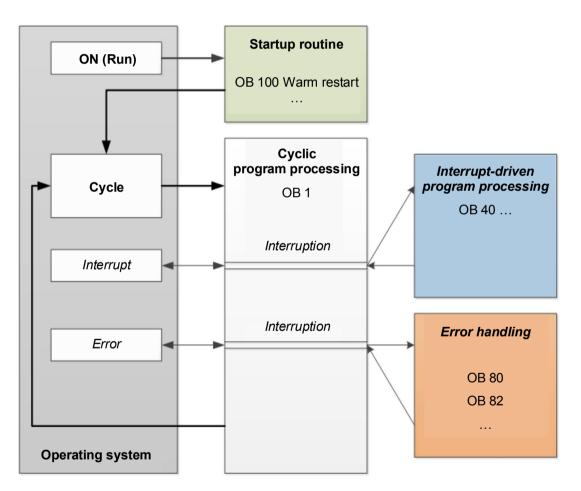


Figure 1: Start events in the operating system and OB call

When a start event occurs, the following reactions are possible:

- If an OB has been assigned to the event, this event triggers the execution of the assigned OB. If the priority of the assigned OB is greater than the priority of the OB that is currently being executed, it is executed immediately (interrupt). If not, the assigned OB waits until the higher-priority OB has been completely executed
- If you have not assigned an OB to the event, the default system reaction is performed.

Table 1 shows examples for various start events for a SIMATIC S7-1200. Also shown are the possible OB number(s) and the default system reactions that occur when the respective organization block (OB) is not present in the controller.

Start event	Possible OB numbers	Default system reaction
Startup	100, ≥ 123	Ignore
Cyclic program	1, ≥ 123	Ignore
Time-of-day interrupt	10 to 11	-
Update interrupt	56	Ignore
Scan cycle monitoring time exceeded once	80	Ignore
Scan cycle monitoring time exceeded twice	80	STOP
Diagnostic interrupt	82	Ignore

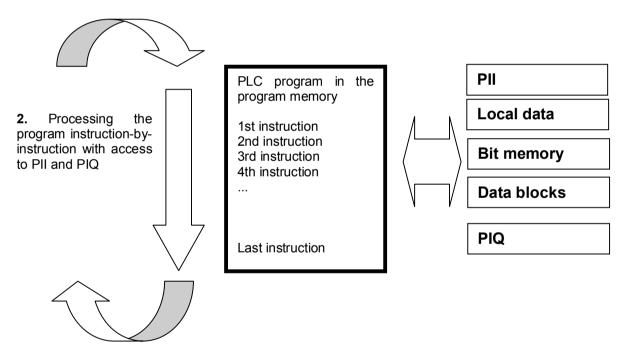
Table 1: OB numbers for various start events

# 4.3 **Process image and cyclic program processing**

When the cyclic user program addresses the inputs (I) and outputs (O), it does not query the signal states directly from the input/output modules. Instead, it accesses a memory area of the CPU. This memory area contains an image of the signal states and is called the **process image**.

The cyclic program processing sequence is as follows:

- At the start of the cyclic program, a query is sent to determine whether or not the individual inputs are energized. This status of the inputs is stored in the process image of the inputs (PII). In doing so, the information 1 or "High" is stored for energized inputs and the information 0 or "Low" for de-energized inputs.
- The CPU then executes the program stored in the cyclic organization block. For the required input information, the CPU accesses the previously read process image of the inputs (PII) and the results of logic operation (RLOs) are written to a so-called process image of the outputs (PIQ).
- 3. At the end of the cycle, the **process image of the outputs** (**PIQ**) is transferred as the signal state to the output modules and these are energized or de-energized. The sequence then continues again with Item 1.
  - 1. Save status of inputs in PII.



3. Transfer status from the PIQ to the outputs.

Figure 2: Cyclic program processing

**Note:** The time the CPU needs for this sequence is called cycle time. This depends, in turn, on the number and type of instructions and the processor performance of the controller.

## 4.4 Functions

Functions (FCs) are logic blocks without memory. They *have no data memory* in which values of block parameters can be stored. Therefore, all interface parameters must be connected when a function is called. To store data permanently, global data blocks must be created beforehand.

A function contains a program that is executed whenever the function is called from another logic block.

Functions can be used, for example, for the following purposes:

- Math functions that return a result dependent on input values.
- Technological functions such as individual controls with binary logic operations.

A function can also be called several times at different points within a program.

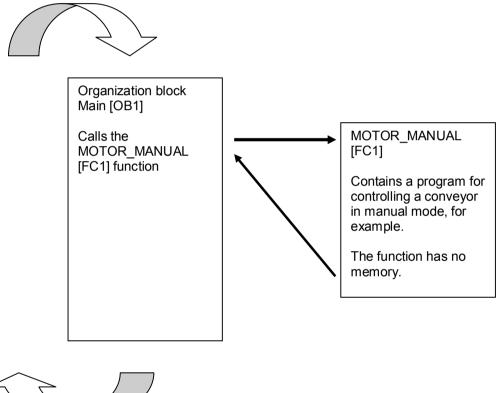




Figure 3: Function with call from organization block Main [OB1]

## 4.5 Function blocks and instance data blocks

Function blocks are logic blocks that store their input, output and in-out tags as well as static tags permanently in instance data blocks, so that they **are available after the block has been executed**. For this reason, they are also referred to as blocks with "memory".

Function blocks can also operate with temporary tags. Temporary tags are not stored in the instance DB, however. Instead, they are only available for one cycle.

Function blocks are used for tasks that cannot be implemented with functions:

- Whenever timers and counters are required in the blocks, or
- When information must be stored in the program, such as preselection of the operating mode with a button.

Function blocks are always executed when called from another logic block. A function block can also be called several times at different points within a program. This facilitates the programming of frequently recurring complex functions.

A call of a function block is referred to as an instance. Each instance of a function block is assigned a memory area that contains the data that the function block uses. This memory is made available by data blocks created automatically by the software.

It is also possible to provide memory for multiple instances in one data block in the form of a **multi-instance**. The maximum size of instance data blocks varies depending on the CPU. The tags declared in the function block determine the structure of the instance data block.

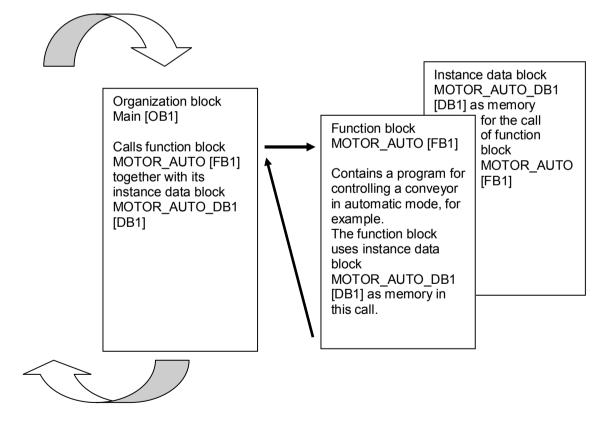


Figure 4: Function block and instance with call from organization block Main [OB1]

## 4.6 Global data blocks

In contrast to logic blocks, data blocks contain no instructions. Rather, they serve as memory for user data.

Data blocks thus contain variable data that is used by the user program. You can define the structure of global data blocks as required.

Global data blocks store data that can be used **by all other blocks** (see Figure 5). Only the associated function block should access instance data blocks. The maximum size of data blocks varies depending on the CPU.

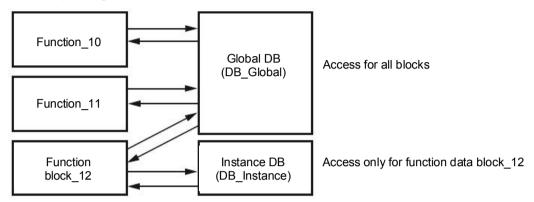


Figure 5: Difference between global DB and instance DB.

Application examples for global data blocks are:

- Saving of information about a storage system. "Which product is located where?"
- Saving of recipes for particular products.

## 4.7 Library-compatible logic blocks

A user program can be created with linear or structured programming. *Linear programming* writes the entire user program in the cycle OB, but is only suitable for very simple programs for which other less expensive control systems, such as LOGO!, can now be used.

For more complex programs, *structured programming* is always recommended. Here, the overall automation task can be broken down into small sub-tasks in order to implement a solution for them in functions and function blocks.

In this case, library-compatible logic blocks should be created preferentially. This means that the input and output parameters of a function or function block are defined generally and only supplied with the current global tags (inputs/outputs) when the block is used.

Name       Data type       Default value       Comment         Manual_mode_active       Bool       Nanual mode activated         Manual_mode_active       Bool       Pushbutton manual mode conveyor on         All enable_OK       Bool       All enable control of the conveyor motor in manual mode         Conveyor_motor_manual_mode       Bool       Control of the conveyor motor in manual mode         Conveyor_motor_inanual_mode       Conveyor_motor in manual mode       Conveyor_motor in manual mode         Conveyor_motor_inanual_mode       Econveyor_motor_inanual_mode       Conveyor_motor in manual mode         Conveyor_motor_inanual_mode       Safey_shutoff is not activated the output         Conveyor_motor_manual_mode       Safey_shutoff is not activated the output         Conveyor_motor_manual_mode		
2       •       Manual_mode_active       Bool       Bool       Pushbutton manual mode       Pushbutton manual mode       Pushbutton manual mode       Conveyor         3       •       •       Safety_shutoff_active       Bool       All enable conditions OK         3       •       •       Safety_shutoff_active       Bool       Safety shutoff active e.g. emergency stop ope         4       •       •       •       •       •       •       •         4       •       •       •       •       •       •       •         5       •       •       •       •       •       •       •         5       •       •       •       •       •       •       •       •         6       •       •       •       •       •       •       •       •         6       •       •       •       •       •       •       •       •       •       •       •       •       •       •       •       •       •       •       •       •       •       •       •       •       •       •       •       •       •       •       •       •       •       •	Data type Default value Comment	
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Figure 6: Library-compatible function with call in OB1

## 4.8 **Programming languages**

For SIMATIC S7-1200, the available programming languages for programming functions and function blocks are Function Block Diagram (FBD), Ladder Logic (LAD) and Structured Control Language (SCL).

The Function Block Diagram (FBD) programming language will be presented in the following.

FBD is a graphical programming language. The representation is based on electronic switching systems. The program is mapped in networks. A network contains one or more logic operation paths. Binary and analog signals are linked together by boxes. The graphical logic symbols known from Boolean algebra are used to represent the binary logic.

You can use binary functions to query binary operands and to logically combine their signal states. The following instructions are examples of binary functions: "AND operation", "OR operation" and "EXCLUSIVE OR operation". These are shown in Figure 7.

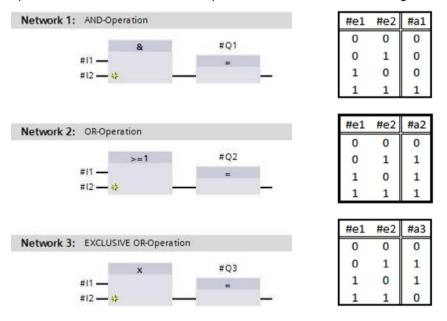


Figure 7: Binary functions in FBD and associated logic table

You can thus use simple instructions, for example, to control binary outputs, evaluate edges and execute jump functions in the program.

Program elements such as IEC timers and IEC counters provide complex instructions.

The empty box serves as a placeholder in which you can select the required instruction.

Enable input EN (enable) / Enable output ENO (enable output) mechanism:

- An instruction without EN/ENO mechanism is executed independent of the signal state at the box inputs.
- Instructions with EN/ENO mechanism are only executed if enable input "EN input has signal state "1". When the box is processed correctly, enable output "ENO" has signal state "1". If an error occurs during processing, the enable output "ENO" is reset. If enable input EN is not connected, the box is always executed.

# 5 Task

The following functions of the sorting station process description will be planned, programmed and tested in this chapter:

- Manual mode - Control of conveyor tracking forwards in manual/jog mode

# 6 Planning

The programming of all functions in OB1 is not recommended for reasons of clarity and reusability. The majority of the program code will therefore be moved into functions (FCs) and function blocks (FBs). The decision on which functions is to be moved to FCs and which is to run in OB 1 is planned below.

### 6.1 EMERGENCY STOP

The EMERGENCY STOP does not require a separate function. Just like the operating mode, the current state of the EMERGENCY STOP relay can be used directly at the blocks.

## 6.2 Manual mode – Conveyor motor in manual mode

Manual mode of the conveyor motor is to be encapsulated in a function (FC) "MOTOR\_MANUAL". On the one hand, this preserves the clarity of OB1. On the other hand, it enables reuse if another conveyor belt is added to the station. Table 2 lists the planned parameters.

Input	Data type	Comment
Manual_mode_active	BOOL	Manual mode activated
Pushbutton_manual_mode	BOOL	Pushbutton to switch on conveyor in manual mode
Enable_OK	BOOL	All enable conditions OK
Safety_shutoff_active	BOOL	Safety shutoff active e.g. emergency stop operated
Output		
Conveyor_motor_manual_mode	BOOL	Control of the conveyor motor in manual mode

Table 2: Parameters for FC "MOTOR\_MANUAL"

Output Conveyor\_motor\_manual\_mode is ON as long as Pushbutton\_manual\_mode is pressed, manual mode is activated, the enable conditions are met and the safety shutoff is not active.

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# 6.3 Technology diagram

Here, you see the technology diagram for the task.

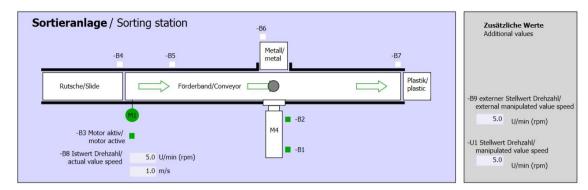


Figure 8: Technology diagram

Schalter der Sortieranlage Switches of sorting station -P1 einion	Automatikbetrieb Automatic mode -P5 gestartel/started	Handbetrieb / Manual mode -S3 Tippbetrieb -M1 vorwarts/ Manual -M1 forwards
-Q0 Hauptschalter/Main switch     -P4 aktivert/active     -P4 aktivert/active     -P4 aktivert/active     -P4 Hand/manual -P3 Auto/auto     -P3 Hand/manual -P3 Auto/auto     -S0 Betriebsart/operating mode	-S1 Start/start -S2 Stopp/stop	-S4 Tippbetrieb -M1 rückwärts/ Manual -M1 backwards -P7 ausgefahren/extended -S6 Zylinder -M4 ausfahren/ cylinder -M4 extend -S5 Zylinder -M4 einfahren/ cylinder -M4 retract

Figure 9: Control panel

# 6.4 Reference list

The following signals are needed as operands for this task.

DI	Туре	Identifier	Function	NC/NO
I	BOOL	-A1	Return signal emergency stop ok	NC
I	BOOL	-K0	Main switch "ON"	NO
І 0.2	BOOL	-S0	Mode selector manual (0)/ automatic (1)	Manual = 0 Auto = 1
I	BOOL	-B1	Sensor cylinder M4 retracted	NO
І 1.4	BOOL	-S3	Pushbutton manual mode conveyor M1 forward	NO
І 1.5	BOOL	-S4	Pushbutton manual mode conveyor M1 reverse	NO

DO	Туре	Identifier	Function	
Q	BOOL	-Q1	Conveyor motor M1 forwards fixed speed	

#### Legend for reference list

DI	Digital Input	DO	Digital Output
AI	Analog Input	AO	Analog Output
I	Input	Q	Output

NC Normally Closed

NO Normally Open

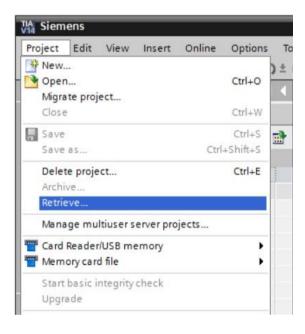
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# 7 Structured step-by-step instructions

You can find instructions on how to carry out planning below. If you already have a good understanding of everything, it is sufficient to focus on the numbered steps. Otherwise, simply follow the detailed steps in the instructions.

## 7.1 Retrieve an existing project

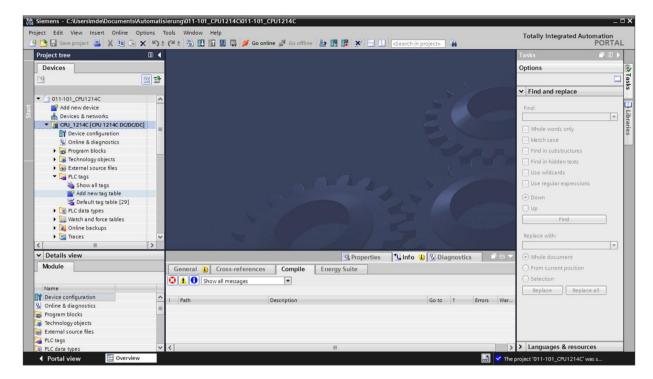
→ Before we can start programming the function (FC) "MOTOR\_MANUAL", we need a project with a hardware configuration (e.g. SCE\_EN\_011\_101\_Hardware\_Configuration\_CPU1214C.zap14). To retrieve an existing project that has been archived, you must select the relevant archive with → Project → Retrieve in the project view. Confirm your selection with Open. (→ Project → Retrieve → Select a .zap archive → Open).



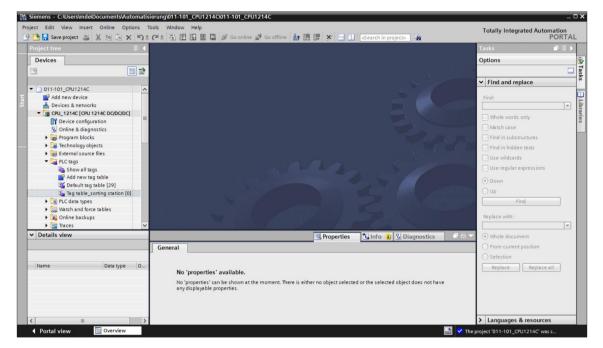
→ The next step is to select the target directory where the retrieved project will be stored. Confirm your selection with "OK". (→ Target directory  $\rightarrow$  OK)

# 7.2 Create a new tag table

→ In the project view, navigate to the → PLC tags of your controller and create a new tag table by double-clicking → Add new tag table.



→ Rename the tag table you just created as "Tag\_table\_sorting\_station" (→ right-click "Tag\_table\_1" → "Rename" → Tag\_table\_sorting\_station).



 $\rightarrow$  Open this tag table with a double-click. ( $\rightarrow$  Tag\_table\_sorting\_station)

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## 7.3 Create new tags within a tag table

→ Add the name Q1 and confirm the entry with the Enter key. If you have not yet created additional tags, TIA Portal now automatically assigns data type "Bool" and address %I0.0 (I 0.0) (→ <Add> → Q1 → Enter).

						- Tags	El	Jser constants
i 👬	🖻 🖻 🖤 🛍							
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-	Q1		%10.0					

→ Change the address to %Q0.0 (Q 0.0) by entering this directly or by clicking the drop-down arrow to open the Addressing menu. Change the operand identifier to Q and confirm with Enter or by clicking the check mark ( $\rightarrow$  %I0.0  $\rightarrow$  Operand identifier  $\rightarrow$  Q  $\rightarrow$   $\blacksquare$ )

-31 E			- Tags		lser const					
1 ( )										Ę
Tag tab	le_sorting_station									
Na	me	Data type	Address		Retain	Acces	Writa	Visibl	Comment	
-	Q1	Bool	%10.0	-						
	<add new=""></add>			1.1	nd ident perand t Addr Bit num	type: Q ress: M			·	

 $\rightarrow$  Enter the "Conveyor motor M1 forwards fixed speed" comment for the tag.

										Tags	User constant
1	lag t		ting statio	n							
	lag t	Name	Data type	n	Address	Retain	Acces	Writa	Visibl	Comment	
1	Fag t				Address %Q0.0	Retain	Acces	Writa	Visibl		-M1 forwards fixed speed

→ Add a new Q2 tag in line 2. TIA Portal has automatically assigned the same data type as the one in line 1 and has incremented the address by 1 to %Q0.1 (Q0.1). Enter the comment "Conveyor motor M1 backwards fixed speed".

 $(\rightarrow < Add > \rightarrow Q2 \rightarrow Enter \rightarrow Comment \rightarrow Conveyor motor M1 backwards fixed speed)$ 

<b>1</b>			ng station						- Tags	User constants
	-	Name 🔺	Data type	Address	Retain	Acces	Writa	Visible in	Comment	
1	-0	-Q1	Bool	%Q0.0					conveyor motor -M1 f	forwards fixed speed
2		-Q2	Bool	%Q0.1					conveyor motor -M1	backwards fixed speed

# 7.4 Import "Tag\_table\_sorting\_station"

 → To insert an existing symbol table, right-click on an empty field of the created "Tag\_table\_sorting\_station". Select "Import file" in the shortcut menu.
 (→ Right-click in an empty field of the tag table → Import file)

									🕣 Tags	User constants
*	💉 [	• • • •	11							<b>=</b>
1	ag ta	ble_sorting_	_station							
	1	Name	Data type	Address	Retain	Acces	Writa	Visibl	Comment	
		Q1	Bool	%10.0					conveyor motor -	M1 forwards fixed speed
		Q2		%10.1					conveyor motor -	M1 backwards fixed speed
			률ᢪ Insert row 률ᢪ Add row				<b>V</b>	1		
			🔏 Cut		Ctrl+					
		1	Copy Paste		Ctrl+ Ctrl+	-				
			X Delete Rename		D	2				
		1	Cross-refe	rences rence information	F1	1				
			Monitor al	1						
			Import file							
		-	Export file							
	<		🔍 Properties			101				1

- → Select the desired symbol table (e.g. in .xlsx format) and confirm the selection with "Open". ( $\rightarrow$  SCE\_EN\_020-100\_Tag\_table\_sorting\_station...  $\rightarrow$  Open)
- $\rightarrow$  When the import is finished, you will see a confirmation window and have an opportunity to view the log file for the import. Click  $\rightarrow$  OK.

Import co	ompleted. (0032:000001) ×
	Import completed successfully.
	Detailed information is shown in the import log file.
	Click here to view the log file.
	ОК

- → You can see that some addresses have been highlighted in orange. These are duplicate addresses and the names of the associated tags have been numbered automatically to avoid confusion.
- → Delete the duplicate tags by selecting the lines and pressing the Del key on your keyboard or selecting "Delete" in the shortcut menu. (→ Right-click on selected tags → Delete)

*	3ě	<b>&gt;</b> •	°° 🛍						
Ta	ag ta	able_so	rting station						
	1	Name	Data type	Address	Retain	Acces	Writa	Visibl	Comment
		Q1	Bool	%Q0.0					conveyor motor -M1 forwards fixed speed
		Q2	Bool	%Q0.1					conveyor motor -M1 forwards fixed speed
	-	-A1	Bool 🔳	%10.0	-				return signal emergency stop ok (nc)
	-	-K0	Bool	%IO.1					main switch "ON" (no)
		-50	Bool	%10.2		<b></b>			mode selector manual(0) / automatic(1)
		-51	Bool	%10.3					pushbutton automatic start (no)
		-52	Bool	%10.4					pushbutton automatic stop (nc)
	-	-B1	Bool	%10.5					sensor cylinder -M4 retracted (no)
		-B2	Bool	%10.6					sensor cylinder -M4 extended (nc)
D		-B3	Bool	%10.7					sensor motor -M1 actice (pulse signal for
1	-	-B4	Bool	%11.0					sensor part at slide (no)
2	-	-85	Bool	%11.1					sensor metal part (no)
3	-	-B6	Bool	%11.2					sensor part in front of cylinder -M4 (no)
4		-B7	Bool	%11.3					sensor part at end of conveyor (no)
5	-	-53	Bool	%11.4					pushbutton manual mode conveyor -M1
5	-00	-54	Bool	%11.5					pushbutton manual mode conveyor -M1
7	-	-55	Bool	%11.6					pushbutton manual mode cylinder -M4 re
3		-56	Bool	%11.7					pushbutton manual mode cylinder -M4 ex.
9	-	-Q1	Bool	%Q0.0					conveyor motor -M1 forwards fixed speed
)	-	-Q2	Bool	%Q0.1					conveyor motor -M1 backwards fixed speed
1	-	-Q3	Bool	%Q0.2					conveyor motor -M1 variable speed
2		-M2	Bool	%Q0.3					cylinder -M4 retract
3	-	-MB	Bool	%Q0.4	Ā				cylinder -M4 extend
1		-P1	Bool	%Q0.5					display "main switch on"
5	-	-P2	Bool	%Q0.6					display "manual mode"
5	-	-P3	Bool	%Q0.7					display "automatic mode"

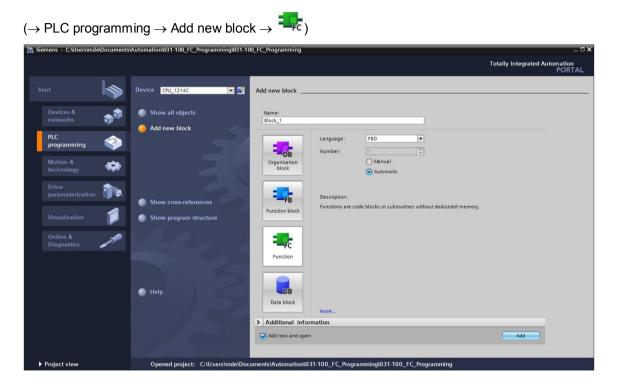
→ You now have a complete symbol table of the digital inputs and outputs in front of you. Save your project under the name 031-100\_FC Programming.

 $(\rightarrow \text{Project} \rightarrow \text{Save as } \dots \rightarrow 031\text{-}100\text{_FC Programming} \rightarrow \text{Save})$ 

🕒 🔚 Save project 昌	XIIIX	5 ±	C			i 🖪 🗔 🔎	🛙 Go online 🖉 🛛	So offline	2 🖪 🕞	×		Search in project>	Totally Int	tegrated Automation PORT
Project tree	A		011	-101_	CPU 12	14C + CPL	J_1214C [CPU 1	1214C DC/D	C/DC] •	PLC tag	s ▶ Tag	g table_sorting station [28]		_ # =
Devices													🕣 Tags	User constants
	1	•	\$	1	•	···								-
			1	Tag ta	ble so	orting static	n							
011-101_CPU1214C		^			lame	Data type	Address	Retain	Acces.	Writa	Visibl	Comment		
Add new device			1	-01	-A1	Bool	B %0.0	-				return signal emergency stop ok (nc)		
A Devices & netwo	rks		2	-	-K0	Bool	%0.1					main switch _ON" (no)		
- CPU_1214C [CPU	1214C DC/DC/DC]		3	-0	-50	Bool	%10.2					mode selector manual(0) / automatic(1)		
Device config	uration		4	-0	-51	Bool	%10.3					pushbutton automatic start (no)		
V Online & diag	nostics		5	-0	-52	Bool	%10.4					pushbutton automatic stop (nc)		
Program block	s		6	-0	-B1	Bool	%10.5					sensor cylinder -M4 retracted (no)		
Technology ol	jects		7	-0	-B2	Bool	%10.6					sensor cylinder -M4 extended (nc)		
External source	e files		8	-0	-83	Bool	%10.7					sensor motor -M1 actice (pulse signal for		
PLC tags			9	-0	-84	Bool	%11.0					sensor part at slide (no)		
Show all ta	gs		10	-0	-85	Bool	%11.1					sensor metal part (no)		
Add new t	g table		11	-00	-86	Bool	%11.2					sensor part in front of cylinder -M4 (no)		
😼 Default tag	table [29]		12	-00	-87	Bool	%11.3					sensor part at end of conveyor (no)		
🐫 Tag table_	sorting station [28		13	-00	-53	Bool	%11.4					pushbutton manual mode conveyor -M1		
PLC data type	5		14	-03	-54	Bool	%11.5					pushbutton manual mode conveyor -M1		
Watch and for	ce tables		15	-00	-55	Bool	%11.6					pushbutton manual mode cylinder -M4 re		
Online backu	os		16	-00	-56	Bool	%11.7					pushbutton manual mode cylinder -M4 ex		
🕨 🔄 Traces		~	17	-00	-Q1	Bool	%Q0.0					conveyor motor -M1 forwards fixed speed		
Details view		_	18	-00	-Q2	Bool	%Q0.1					conveyor motor -M1 backwards fixed speed		
		_	19	-00	-Q3	Bool	%Q0.2					conveyor motor -M1 variable speed		
			20	-0	-M2	Bool	%Q0.3					cylinder -M4 retract		
			21	-0	-MB	Bool	%Q0.4					cylinder -M4 extend		
Name	Data type		22	-	-P1	Bool	%Q0.5					display "main switch on"		
-Q1	Bool	91~	23	-0	-P2	Bool	%Q0.6					display "manual mode"		
-Q2	Bool	91	24	-0	-P3	Bool	%Q0.7					display "automatic mode"		
-Q3	Bool	%	25	-00	-P4	Bool	%Q1.0					display "emergency stop activated"		
-SO	Bool	9(≡	26	-0	-P5	Bool	%Q1.1					display "automatic mode started"		
-S1	Bool	9	27	-0	-P6	Bool	%Q1.2					display cylinder -M4 "retracted"		
-52	Bool	91~		-								Properties	nfo 🔒 🖏 Dia	

# 7.5 Create function FC1 "MOTOR\_MANUAL" for the conveyor motor in manual mode

→ In the PLC programming section of the portal view, click "Add new block" to create a new function.



→ Rename your new block to: "MOTOR\_MANUAL", set the language to FBD and keep automatic assignment of the number. Select the "Add new and open" check box. You will thus be taken automatically to your created function block in the project view.Click "Add".
 (→ Name: MOTOR\_MANUAL→ Language: FBD → Number: Automatic → Add new and open → Add)

MOTOR_MANUAL			
Organization block	Language: Number:	FBD	
E FB	Description:		
Function block	Functions are c	code blocks or subroutines without dedicated memory.	
Function block	Functions are c	code blocks or subroutines without dedicated memory.	

### 7.6 Define the Interface of function FC1 "MOTOR\_MANUAL"

If you selected "Add new and open", the project view opens with a window for creating the block you just added.

→ You can find the interface description of your function in the upper section of your programming view.

			¢ ⊵∕ DR MA				9:	8 ± 2 ± \$	ä ± 😑	😰 ¢° 6° 6	<b>≣ 6∄ ₹</b>	≱ ⊊≡	"≡ <sup>"</sup> "	<b>6</b>	<b>(1</b> 6	
			me					Data type		Default value	Comm	ent				
1	-	•	Input													
2			<ad< td=""><td>ld new&gt;</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></ad<>	ld new>												
		•	Output	t												
4			<ad< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></ad<>													
5	-	•	InOut													
6			<ad< td=""><td>ld new&gt;</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></ad<>	ld new>												
7	-	¥	Temp													
8			<ad< td=""><td>ld new&gt;</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></ad<>	ld new>												
9		•	Consta	nt												
10			<ad< td=""><td>ld new&gt;</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></ad<>	ld new>												
11	-	•	Return													
12	-		MO	TOR_MA	NUAL			Void								
	<	-														>
		-														
8		> = 1	??	н	-01	↦	-[=]									
•	Blo	ck	title:													^
10	om															=
•	1	Vet	work 1	:												
	C	om	ment													
																~
												100%			•	

→ A binary output signal is needed for controlling the conveyor motor. For this reason, we first create local output tag #Conveyor\_motor\_manual\_mode of the "Bool" type. Enter comment "Control of the conveyor motor in manual mode" for the parameter.
 (→ Output: Conveyor\_motor\_manual\_mode → Bool → Control of the conveyor motor in manual mode)

?	C_F	ro	gramming + CPU_1214C [CPU 1	214C DC/DC/DC] >	Program block	s ▶ MOTOR_MANUAL [FC1] 📃 🖬 🖬 🗙
iố	13	{ 3	0 🔮 🐛 🖿 🗖 🚍 🕾 😫 ±	2 ± 🕲 ± 🖃 😥	¢° ६₀ 🦛 🖷	"■◆「●●●●=================================
	MC	T	DR_MANUAL			
		Na	me	Data type	Default value	Comment
1	-	-	Input			
2			<add new=""></add>			
3	-	•	Output			
4	-		Conveyor_motor_manual_mode	Bool		Control of the conveyor motor in manual mode
5			<add new=""></add>			
6	-	•	InOut			
7			<add new=""></add>			
8	-	•	Temp			
9			<add new=""></add>			
10	-	•	Constant			
11			<add new=""></add>			
12	-	•	Return			
13	-		MOTOR_MANUAL	Void		

→ Add parameter #Manual\_mode\_active as the input interface under Input and confirm the entry with the Enter key or by exiting the entry field. Data type "Bool" is assigned automatically. This will be retained. Next, enter the associated comment "Manual mode activated".

 $(\rightarrow Manual\_mode\_active \rightarrow Enter \rightarrow Bool \rightarrow Manual mode activated)$ 

→ Continue by adding parameters #Pushbutton\_manual\_mode, #Enable\_OK and #Safety\_shutoff\_active as additional binary input parameters and check their data types. Add descriptive comments.

	IVIC		DR_MANUAL				
		Na	me	Data type	Defau	Comment	
1	-	•	Input				1
2	-		Manual_mode_active	Bool		Manual mode activated	
3	-		Pushbutton_manual_mode	Bool		Pushbutton manual mode conveyor on	
4	-		Enable_OK	Bool		All enable conditions OK	
5	-		Safety_shutoff_active	Bool	]	Safety shutoff active e.g. emergency stop operated	=
6			<add new=""></add>				
7		•	Output				
В	-		Conveyor_motor_manual_mode	Bool		Control of the conveyor motor in manual mode	
9			<add new=""></add>				
0	-	•	InOut				
11			<add new=""></add>				
12	-	•	Temp				
13			<add new=""></add>				
14	-	•	Constant				
15			<add new=""></add>				
16	-	-	Return				1

→ For purposes of program documentation, assign the block title, a block comment and a helpful network title for Network 1.

( $\rightarrow$  Block title: Motor control in manual mode  $\rightarrow$  Network 1: Control of the conveyor motor in manual mode)

		Nar	me					Data type	Default value	Comment	T
	-	-	Input								
			Ma	nual_r	mode_	active		Bool		Manual mode activated	
			Pus	hbutt	on_ma	nual_	mode	Bool		Pushbutton manual mode conveyor on	l
	-		Ena	ble_0	ж			Bool		All enable conditions OK	
			Saf	ety_sh	nutoff_	active		Bool		Safety shutoff active e.g. emergency stop operated	
	-	•	Output	t							
	-		Cor	iveyor	_moto	r_mar	nual_mode	Bool		Control of the conveyor motor in manual mode	1
	<									][:	•
2			[??]	- 4	-01	4.8	7.1		has and has and	1976 	
		> = 1	111	7	-01	-	-[=]				
	Blo	ckt	title:	Motor	contro	l in m	anual mode				
c	ond	itio	ns are g	rante	d and	the sa			al_mode is ope ed the output	rated, the enable	
	1	let	work 1	: Co	ontrol o	of the o	conveyor mo	tor in manua	al mode		
			ment								

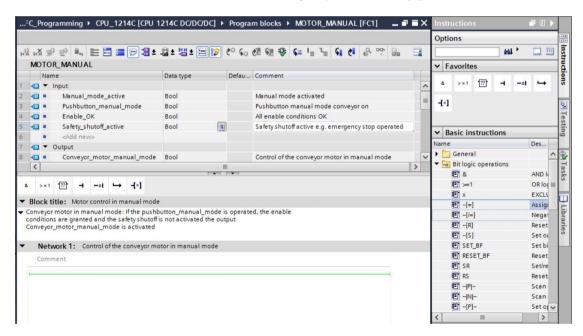
#### 7.7 Program FC1: MOTOR\_MANUAL

→ Below the interface description, you see a toolbar in the programming window with various logic functions and below that an area with networks. We have already specified the block title and the title for the first network there. Programming is performed within the networks using individual logic blocks. Distribution among multiple networks helps to preserve the clarity of the program. In the following, you will get to know the various ways you can insert logic blocks.



→ On the right side of your programming window is a list of instructions you can use in the program. Under → Basic instructions → Bit logic operations, find function –[=] (Assignment) and use a drag & drop operation to move it to Network 1 (green line appears, mouse pointer with + symbol).

 $(\rightarrow \text{Instructions} \rightarrow \text{Basic instructions} \rightarrow \text{Bit logic operations} \rightarrow -[=])$ 



→ Now use drag & drop to move your output parameter #Conveyor\_motor\_manual\_mode onto <??.?> above the block you just inserted. The best way to select a parameter in the interface description is by "grabbing" it at the blue symbol <a>[]</a>.

 $(\rightarrow \textcircled{all Conveyor_motor_manual_mode})$ 

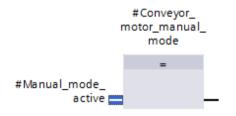
	Na	me	Data type	Defau	Comment				
	•	Input							
		Manual_mode_active	Bool		Manual mode activated				
	•	Pushbutton_manual_mode	Bool		Pushbutton manual mode conveyor on				
	•	Enable_OK	Bool		All enable conditions OK				
	•	Safety_shutoff_active	Bool		Safety shutoff active e.g. emergency stop operated				
	•	<add new=""></add>							
	•	Output							
		Conveyor_motor_manual_mode	Bool		Control of the conveyor motor in manual mode				
<	_								
- D1		and a second s							
Con con Con	veyd litio veyd	title: Motor control in manual mode or motor in manual mode: If the push ins are granted and the safety shutoff or_motor_manual_mode is activated twork 1: Control of the conveyor mo	utton_manual_mode is not activated the o		d, the enable				

5

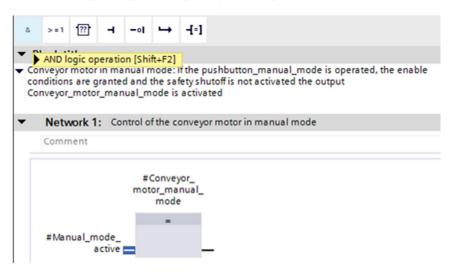
- → This determines that the #Conveyor\_motor\_manual\_mode parameter is written by this block. Still missing, however, are the input conditions so that this actually happens. For this, use drag & drop to move input parameter #Manual\_mode\_active to the left side of the assignment block.
  - $(\rightarrow \blacksquare Manual_mode_active)$

-	Name		Data type	Defau	Comment	
-	<ul> <li>Input</li> </ul>					
	<ul> <li>Manu</li> </ul>	ual_mode_active	Bool		Manual mode activated	
-	Push	button_manual_mode	Bool		Pushbutton manual mode conveyor on	
-	Enab	le_OK	Bool		All enable conditions OK	
-	<ul> <li>Safet</li> </ul>	y_shutoff_active	Bool		Safety shutoff active e.g. emergency stop operated	
	Add	new>				
	<ul> <li>Output</li> </ul>					
-	Conv	eyor_motor_manual_mode	Bool		Control of the conveyor motor in manual mode	
<			1	Ш		
	itions are gra	n manual mode: If the pushb anted and the safety shutoff manual_mode is activated				
Conve						
Conve		Control of the conveyor mo	otor in manual mode			
Conve N		Control of the conveyor mo	otor in manual mode			

→ The input of the assignment block will also be logically combined with other parameters by an AND logic operation. To do this, first click the input of the block to which #Manual\_mode\_active is already connected, so that the input line has a blue background.



→ Click the ♣ icon in your logic toolbar to insert an AND logic operation between the #Manual\_mode\_active tag and your assignment block.



→ Double-click the second input of the & logic operation <??.?> and enter the letter "P" in the field that appears in order to see a list of available tags starting with "P". Click the #Pushbutton\_manual\_mode tag and apply with → Enter.

 $(\rightarrow \& block \rightarrow <??? \rightarrow P \rightarrow #Pushbutton_manual_mode \rightarrow Enter)$ 

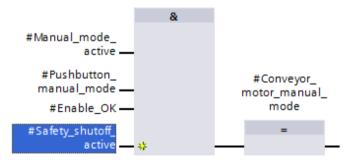
		Na	ame	Data type	Defau	Comment	-	
		-	Input					-
•			Manual_mode_active	Bool	]	Manual mode activated		
		•	Pushbutton_manual_mode	Bool		Pushbutton manual mode conveyor on		Ľ
			Enable_OK	Bool		All enable conditions OK		
1	-		Safety_shutoff_active	Bool		Safety shutoff active e.g. emergency stop operated		
			<add new=""></add>					
1		•	Output					
	-	•	Conveyor_motor_manual_mode	Bool		Control of the conveyor motor in manual mode		
							10	-
	ond		ons are granted and the safety shutoff is	s not activated the out	-		>	
Co	ond	litic /eyd		s not activated the out	-		)>	

**Note:** When assigning tags in this way, there is a risk of a mix-up with the global tags from the tag table. The previously presented procedure using drag & drop from the interface description should therefore be used preferentially.

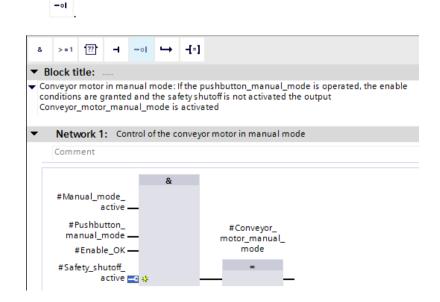
→ To ensure that the output can only be controlled when the enable conditions are met and the safety shutoff is not active, the #Enable\_OK and #Safety\_shutoff\_active input tags are logically combined with the AND logic operation. To do this, click twice on the yellow star so f your AND block to add two additional inputs.

8	> = 1	??	٦	-01	↦	-[=]												
▼ BI	lock ti	tle:																
cor	dition	motor s are g _moto	rante	d and t	the sat	fety sh	utof	fis n						erate	ed, tl	he er	habl	e
•	Netv	vork 1	: Co	ntrol of	f the co	onvey	or m	otor	in m	anua	al m	ode						
	Comn	nent																
	# F	ual_m a ushbu nual_r	active	- ***	&					eyor_ anua le								

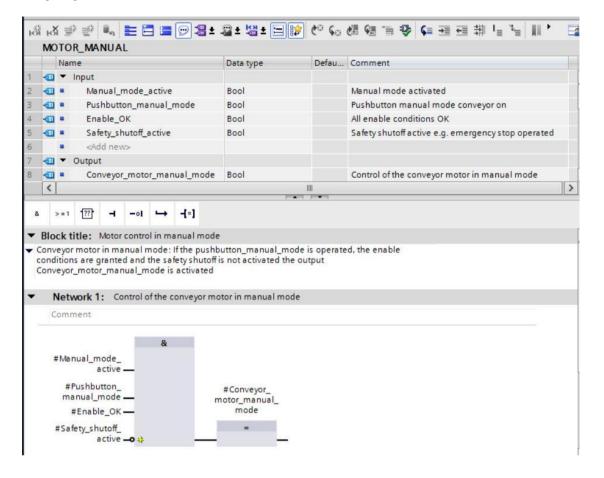
→ Add input tags #Enable\_OK and #Safety\_shutoff\_active to your newly created inputs of the AND block.



→ Negate the input connected to parameter #Safety\_shutoff\_active by selecting it and clicking



→ Do not forget to click Save project regularly. The finished function "MOTOR\_MANUAL" [FC1] in FBD is shown below.



→ Under "General" in the properties of the block, you can change the "Language" to LAD (Ladder Logic) (→Properties → General → Language: LAD)

MOTOR_MANUAL [FC1]		S. Pr	operties	1 Info	i Diagnostics	
General						
General Information	General					
Time stamps Compilation Protection		Name: Type:	MOTOR_MAI	NUAL		
Attributes	-	Language:	FBD LAD FBD			-
			Manual Automat	ic		

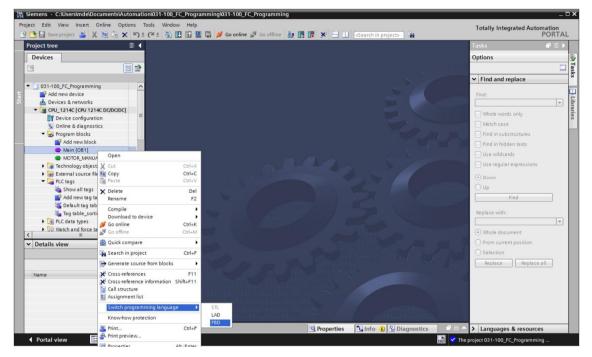
 $\rightarrow$  The program has the following appearance in LAD.

	DTOR_MANUAL	Data type	Defau Co				
-	Name ▼ Input	Data type	Derau Co	mment		_	
		Bool		nual mode activate			-
					5		=
				shbutton manual mo			-
		Bool		enable conditions C			
-		Bool	Sa	fety shutoff active e.	g. emergency stop operated	d	
	Add new>						
	<ul> <li>Output</li> </ul>						
	Conveyor_motor_manual_	mode Bool	Co	ntrol of the conveyor	r motor in manual mode		~
<			III			>	
			<b>™</b> 10 <b>•</b> 10				-
 Blo	ock title: Motor control in manua	l mode pushbutton_manual_mo	ode is operated, t	ne enable			-
 Blo onv ond onv	ock title: Motor control in manua	I mode pushbutton_manual_mo hutoff is not activated the vated	ode is operated, t e output	ne enable			~

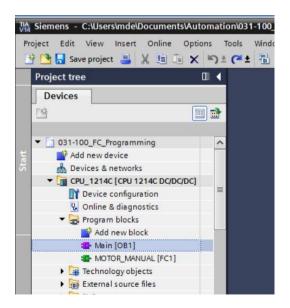
## 7.8 **Program the organization block OB1 – Control conveyor** tracking forwards in manual mode

→ Before programming organization block "Main [OB1]", we switch the programming language to FBD (Function Block Diagram). To do so, first click on "Main [OB1]" in the "Program blocks" folder.

 $(\rightarrow$  CPU\_1214C [CPU 1214C DC/DC/DC  $\rightarrow$  Program blocks  $\rightarrow$  Main [OB1]  $\rightarrow$  Switch programming language  $\rightarrow$  FBD)



 $\rightarrow$  Open the "Main [OB1]" organization block with a double-click.



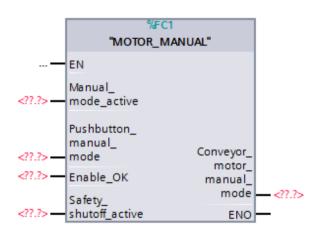
→ Assign Network 1 the name "Control conveyor tracking forwards in manual/jog mode" (→ Network 1:... →Control conveyor tracking forwards in manual/jog mode)

		lain		- 1 - 4		_	-			de de le le le de de de de les	
	IV		lan					Data type	Default value	Comment	
1	4			Input				Data type	Derbuit voide	comment	
	4			Initial Ca	11			Bool		Initial call of this OB	
5				Remanen				Bool		=True, if remanent data are available	
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											_
•		Ne	etv	work 1: Co	ntrol c	onvey	or mo	otor forwards in n	nanual mode		
		Cor	mr	nent							

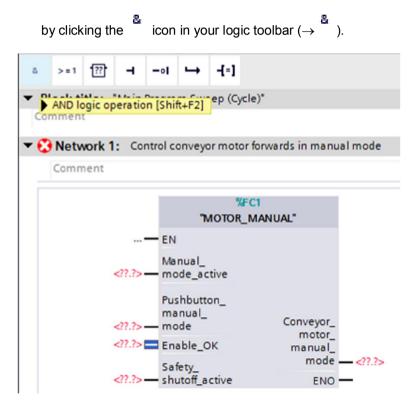
→ Use drag & drop to move your "MOTOR\_MANUAL [FC1]" function onto the green line in Network 1.

Project tree		03	31-1		_FC_P			ng 🕨	CPU_	_1214	4C [C	PU 1.	214C	DC/D	C/DC	
Devices																
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			Ma													
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Devices & networks		2	-		Init	tial_Ca	all			Bool						
CPU_1214C [CPU 1214C DC/DC/DC]		3	-00		Rei	mane	nce			Bool						
Device configuration	=	4	-0	-	Temp											
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- Main [OB1]			<											11	1	
MOTOR_MANUAL [FC1]						1	1		1					•	•	
Technology objects		8	i i	> = 1	??	-	-0	$\rightarrow$	-[=]							
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PLC tags		<ul> <li>Block title: "Main Program So Comment</li> </ul>							ceb (	-Jeie)						
PLC data types		11	com	inc.												
Watch and force tables		-		Net	work 1	1: 0	ontrol	convey	or mo	tor fo	rwa rd	s in m	anual	mode		
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Device proxy data	~		-													
✓ Details view		1						-00.1	MOTO			EC11				
								-64"	1010	n_1401	tont (	101				

→ A block with the interface you defined and connections EN and ENO are inserted in Network 1.



 $\rightarrow$  To insert an AND before input parameter "Enable\_OK", select this input and insert the AND



 $\rightarrow$  Click the yellow star  $\stackrel{\text{\tiny{\$}}}{\rightarrow}$  of the AND block to add another input ( $\rightarrow$  $\stackrel{\text{\scriptsize{\$}}}{\rightarrow}$ ).

≥ >=1 [??] → -ol → -[=]		
<ul> <li>Block title: "Main Program Sweep (Cycle)"</li> </ul>		
Comment		
▼ 🕄 Network 1: Control conveyor motor forwards in manual mo	ode	
Comment		
	%FC1 "MOTOR_MANUAL"	
	EN	
?.	Manual_ mode_active	
	Enable_OK manual_	?.?
?.?	shutoff_active ENO	_

- → To connect the block to the global tags from "Tag\_table\_sorting\_station", we have two options:
- → Either select the "Tag\_table\_sorting\_station" in the project tree and use drag & drop to move the desired global tag from the Details view to the interface of FC1

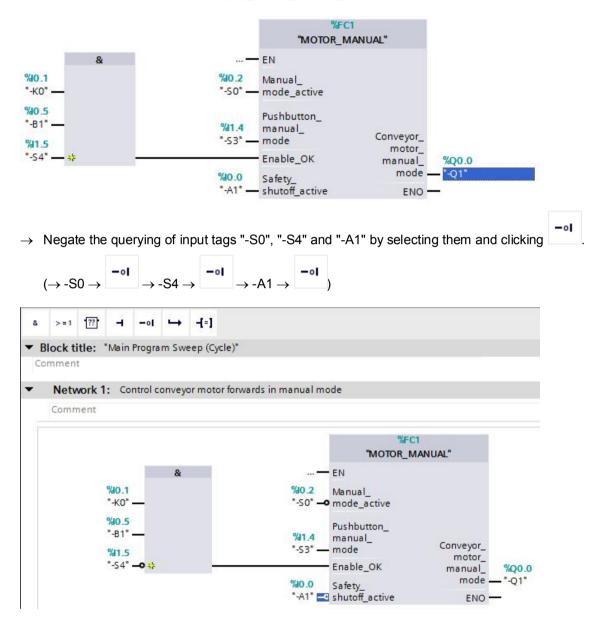
 $(\rightarrow Tag\_table\_sorting\_station \rightarrow Details view. \rightarrow -S0 \rightarrow Manual\_mode\_active)$ 

		ew tag table			Comment			
		lt tag table [28] ble_sorting station [28	1	~			%FC "MOTOR_M	
- 1	Details view		_			— e	EN Manual_	
N	lame	Data type				N <11.3 - r	mode_active	
_	lame -Q1	Data type Bool		^	&	<77.3> — r		
			1	^	?.?		mode_active Pushbutton_ manual_	Conveyor
1	-Q1	Bool		^	<11.7>	??.? — r └── F ??.? — r	mode_active Pushbutton_ manual_ mode	Conveyor_ motor_
1	-Q1 -Q2	Bool Bool Bool		^	?.?	??.? — r └── F ??.? — r	mode_active Pushbutton_ manual_	motor_ manual_
	-Q1 -Q2 -Q3	Bool Bool Bool		~	<11.7>	<11.75 — r <11.75 — r <11.75 — r	mode_active Pushbutton_ manual_ mode	motor_

→ Or, enter the starting letters (e.g. "-S") of the desired global tag for <??.?> and select the global input tag "-S0" (%I0.2) from the displayed list (→ Manual\_mode\_active → -S → -S0).

>=1	??	-	-01	-→	-[=]					
Block	title:	"Main I	Progra	m Swe	ep (Cycle)*					
omme	nt									
No.	a served at		strole		r motor forwards	in manual made				
-		1: 00	TUDIC	onveyo	r motor lorwards	in manual mode				
Com	ment									
								FC1		
								MANUAL"		
						— EN		_		
							nual			
					-5		de_active			
				&	-cu "-so"	N Bool	%10.2	mode selector n	nanual(0) / auto	
		?.?	-		*S1*	Bool	%10.3	pushbutton auto	omatic start (no)	
		?.	-		****	Bool	%10.4	pushbutton auto	omatic stop (nc)	
		?.	*			Bool	%11.4	pushbutton mar	ual mode conv	l
					-S4"	Bool	%11.5	pushbutton mar	ual mode conv	
					-S5"	Bool	%11.6	auchbutton man	ual mode cylind	- [

→ Insert the other input tags "-S3", "-K0", "-B1", "-S4" and "-A1" and then insert output tag "-Q1" (%Q0.0) at output "Conveyor\_motor\_manual\_mode".

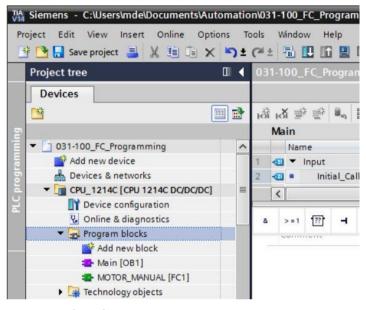


5

### 7.9 Save and compile the program

→ To save your project, select the **Save project** button in the menu. To compile all blocks,

click the "Program blocks" folder and select the  $\boxed{1}$  icon for compiling in the menu ( $\rightarrow$   $\boxed{1}$  Save project  $\rightarrow$  Program blocks  $\rightarrow$   $\boxed{1}$ ).



 $\rightarrow$  The "Info", "Compile" area shows which blocks were successfully compiled.

		S. Prope	rties 🚺	nfo 追 🗓 D	agnosti	cs	<u>א א</u> י
General (1) Cross-reference	s Compile	Energy Suite	Syntax				
🕽 🚹 🚺 Show all messages			1970-				
Compiling finished (errors: 0; warnin	gs: 0)						
Path	Description			Go te	?	Errors	Wa
▼ CPU_1214C				7	E.	0	0
<ul> <li>Program blocks</li> </ul>				7	l.	0	0
MOTOR_MANUAL (FC1)	Block was success	fully compiled.		1			
Main (OB1)	Block was success	fully compiled.		/			
	Compiling finished	(errors: 0; warnings	: 0)				

## 7.10 Download the program

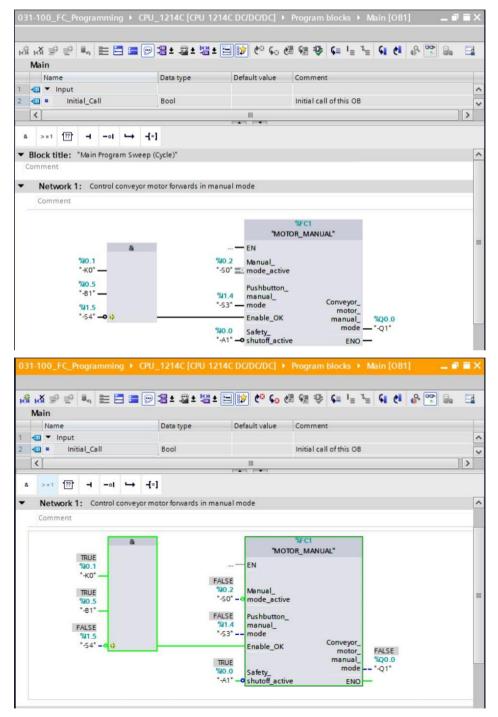
→ After successful compilation, the complete controller with the created program, as previously described in the modules for hardware configuration, can be downloaded  $(\rightarrow \square)$ .

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Add new device	1 📲 🔻 Input	& >=1 ??? -1 -01 → 0
Devices & networks	2 📵 = Initial_Call Bool Initial call of this OB	-[-]
CPU_1214C [CPU 1214C DC/DC/DC]	K	111
Configuration	a >=1 1777 → -01 → -[=]	-f*) Testing
Program blocks		
Add new block	▼ Block title: "Main Program Sweep (Cycle)"	
Hain [OB1]	Comment	Basic instructions
MOTOR_MANUAL [FC1]	Network 1: Control conveyor motor forwards in manual mode	Name Descri
Technology objects	Comment	) General
External source files     Dectags		Bit logic operations
Show all tags	%FC1	O Timer operations     Gounter operations     Comparator operations     Math functions
Add new tag table	"MOTOR_MANUAL"	Counter operations     Comparator operations
😽 Default tag table [29]	&— EN	Comparator operations     Math functions
✓ Details view	%0.1 %0.2 Manual_ *K0*— *50* ₩ mode_active	Move operations
	Store F	Conversion operations
	*-81*	Program control operati
	"-S3" mode Conveyor_	Word logic operations
Name Details	*-54* —•• + Enable_OK manual_ %Q0.0	Shift and rotate
Add new block	%0.0 Safety_ mode *-Q1*	
MOTOR MANUAL FC1	"-A1" — shutoff_active ENO —	
		< III >
	▼ Network 2:	> Extended instructions
	Comment	> Technology
	K 100%	> Communication
	🖾 Properties 🚺 🗓 Diagnostics 💷 🗕 🗠	> Optional packages
Portal view	Main (OB1) 📩 🗸 The	project 031-100_FC_Programming

### 7.11 Monitor program blocks

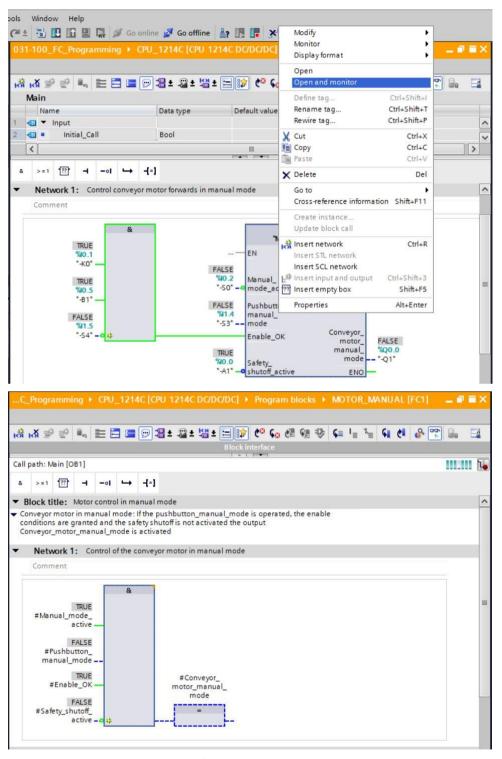
 $\rightarrow$  The desired block must be open for monitoring the downloaded program. The monitoring can

now be activated/deactivated by clicking the  $\square$  icon ( $\rightarrow$  Main [OB1]  $\rightarrow$   $\square$ ).



**Note:** The monitoring here is signal-related and controller-dependent. The signal states at the terminals are indicated with TRUE or FALSE.

→ The "MOTOR\_MANUAL" [FC1] function called in the "Main [OB1]" organization block can be selected directly for "Open and monitor" after right-clicking (→ "MOTOR\_MANUAL" [FC1] → Open and monitor).



**Note:** The monitoring here is function-related and controller-independent. The actuation of sensors and the station status are shown here with TRUE or FALSE.

→ If a particular point of use of the "MOTOR\_MANUAL" [FC1] function is to be monitored, the call environment can be selected using the  $\boxed{10}$  icon (→  $\boxed{10}$  → Call environment → OK)

) Call	environment		
	Dependency structure	! Address	Details
1	🎦 Main	OB1	@Main > NW1 (Control conveyor motor forwards in manual mod
2			
-			
-			
	-		
			Transfer to "adjusted manually"

### 7.12 Archive the project

→ As the final step, we want to archive the complete project. Select the → "Archive ..." command in the → "Project" menu. Select a folder where you want to archive your project and save it with the file type "TIA Portal project archive". (→ Project → Archive → TIA Portal project archive → 031-100\_FC Programming.... → Save)

🙀 Siemens - C:\Users\mde\DocumentsV	Automati	n\031-100_FC_Programming\031-100_FC_Programming	_ = ×
Project Edit View Insert Online O	ptions .	ols Window Help	Totally Integrated Automation
1 New	) ±	(# 🗄 🗓 🗓 🖳 🖉 🕼 💋 Go online 🖉 Go offline 🛔 🕼 🖟 🗶 🔚 🛄 <earch in="" project=""> 🔒</earch>	PORTAL
	trl+0	031-100_FC_Programming   CPU_1214C [CPU 1214C DC/DC/DC]   Program blocks  Main [OB1]	X Instructions
Migrate project Close C	trl+W		Options
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		Main	✓ Favorites
Delete project C Archive	trl+E	Name Data type Default value Comment	
Betrieve		1 🕢 🔻 Input	
		2 CI = Initial_Call Bool Initial call of this OB	✓ -[-]
Manage multiuser server projects	=	<ul> <li>( )</li> </ul>	
Card Reader/USB memory	•	a >=1 [??] → -ol ↦ -[=]	- (*)
Themory card file	•		len
Start basic integrity check		<ul> <li>Network 1: Control conveyor motor forwards in manual mode</li> </ul>	<u>^</u>
Upgrade		Comment	✓ Basic instructions
	Etrl+P		Name Descri
A Print preview		%£C1	General G
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C:lUsersImdelDocumel011-101_CPU121	14C	& EN	
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	lt+F4	"-K0" "-S0" mode_active	Comparator operations
опше вискора	~	"40.5 "-B1" Pushbutton	= + 1 Math functions
✓ Details view		Milia manual Conveyor	Move operations
		91.5 motor_	Conversion operations
			Program control operati
		*40.0 Safety *-A1* shutoff.active ENO	Word logic operations
Name		AT - STILLEDI_BELIVE ENO	Shift and rotate
Add new device			
Devices & networks		Network 2:	
CPU_1214C		Comment	< III >
Common data			> Extended instructions
Documentation settings		K III > 100%	> Technology
Languages & resources			
		🖸 Properties 🚺 Info 🚺 Diagnostics 💷 –	
		General Cross-references Compile Energy Suite Syntax	Optional packages
Portal view  Overview		Main (OB1) 🔝 😪 🖸	Connection to CPU_1214C terminated.

# 7.13 Checklist

No.	Description	Completed
1	Compiling successful and without error message	
2	Download successful and without error message	
3	Switch on station (-K0 = 1) Cylinder retracted / Feedback activated (-B1 = 1) EMERGENCY OFF (-A1 = 1) not activated MANUAL mode (-S0 = 0) Activate manual mode conveyor forwards (-S3 = 1) Conveyor motor forwards fixed speed (-Q1 = 1)	
4	Same as 3 but activate EMERGENCY OFF (-A1 = 0) $\rightarrow$ -Q1 = 0	
5	Same as 3 but AUTO mode (-S0 = 1) $\rightarrow$ -Q1 = 0	
6	Same as 3 but switch off station (-K0 = 0) $\rightarrow$ -Q1 = 0	
7	Same as 3 but cylinder not retracted (-B1 = 0) $\rightarrow$ -Q1 = 0	
8	Same as 8 but also activate manual mode conveyor backwards (-S4 = 1) $\rightarrow$ -Q1 = 0	
9	Project successfully archived	

# 8 Exercise

#### 8.1 Task – Exercise

The following functions of the sorting station process description will be planned, programmed and tested in this chapter:

- Manual mode - Control of conveyor tracking backwards in manual/jog mode

### 8.2 Technology diagram

Here, you see the technology diagram for the task.

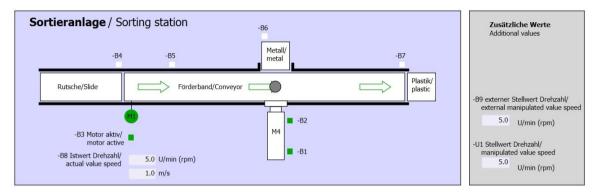


Figure 10: Technology diagram

Schalter der Sortieranlage	Automatikbetrieb	Handbetrieb / Manual mode
Switches of sorting station	Automatic mode	-S3 Tippbetrieb -M1 vorwärts/
-Pt ein/on	-P5 gestartel/started	Manual -M1 forwards
-Q0 Hauptschalter/Main switch -P4 aktivier/lactive -A1 NOTHALT/Emergency stop -P2 Hand/manual -P3 Auto/auto -P3 Auto/auto	-S1 Start/start  -S2 Stopp/stop	-S4 Tippbetrieb -M1 rückwärts/ Manual -M1 backwards -S6 Zylinder -M4 ausfahren/ cylinder -M4 extend -S5 Zylinder -M4 einfahren/ cylinder -M4 retract

Figure 11: Control panel

# 8.3 Reference list

The following	signals are	e needed a	as operands	for this task.

DI	Туре	Identifier	Function	NC/NO
10.0	BOOL	-A1	Return signal emergency stop ok	NC
I 0.1	BOOL	-K0	Main switch "ON"	NO
10.2	BOOL	-S0	Mode selector manual (0)/ automatic (1)	Manual = 0 Auto = 1
10.5	BOOL	-B1	Sensor cylinder M4 retracted	NO
I 1.4	BOOL	-S3	Pushbutton manual mode conveyor M1 forward	NO
I 1.5	BOOL	-S4	Pushbutton manual mode conveyor M1 reverse	NO

DO	Туре	Identifier	Function	
Q 0.1	BOOL	-Q2	Conveyor motor M1 backwards fixed speed	

#### Legend for reference list

DI Digital Input DO D	Digital Output
-----------------------	----------------

- AI Analog Input AO Analog Output
- I Input Q Output
- NC Normally Closed
- NO Normally Open

## 8.4 Planning

Plan the implementation of the task on your own.

# 8.5 Checklist – Exercise

No.	Description	Completed
1	Compiling successful and without error message	
2	Download successful and without error message	
3	Switch on station (-K0 = 1) Cylinder retracted / Feedback activated (-B1 = 1) EMERGENCY OFF (-A1 = 1) not activated MANUAL mode (-S0 = 0) Activate manual mode conveyor backwards (-S4 = 1) Conveyor motor backwards fixed speed (-Q2 = 1)	
4	Same as 8 but activate EMERGENCY OFF (-A1 = 0) $\rightarrow$ -Q2 = 0	
5	Same as 8 but AUTO mode (-S0 = 1) $\rightarrow$ -Q2 = 0	
6	Same as 8 but switch off station (-K0 = 0) $\rightarrow$ -Q2 = 0	
7	Same as 8 but cylinder not retracted (-B1 = 0) $\rightarrow$ -Q2 = 0	
8	Same as 8 but also activate manual mode conveyor forwards $(-S3 = 1) \rightarrow -Q1 = 0$ and $-Q2 = 0$	
9	Project successfully archived	

# 9 Additional information

More information for further practice and consolidation is available as orientation, for example: Getting Started, videos, tutorials, apps, manuals, programming guidelines and trial software / firmware, under the following link:

#### www.siemens.com/sce/s7-1200

#### Preview "Additional information"

- Getting Started, Videos, Tutorials, Apps, Manuals, Trial-SW/Firmware
  - ↗ TIA Portal Videos
  - TIA Portal Tutorial Center
  - > Getting Started
  - ↗ Programming Guideline
  - ↗ Easy Entry in SIMATIC S7-1200
  - > Download Trial Software/Firmware
  - ↗ Technical Documentation SIMATIC Controller
  - Industry Online Support App
  - TIA Portal, SIMATIC S7-1200/1500 Overview
  - ↗ TIA Portal Website
  - ↗ SIMATIC S7-1200 Website
  - ↗ SIMATIC S7-1500 Website

# Notes

# SCE Learn-/Training Textbook

# Automation System SIMATIC S7-1200



TIA Portal Modules from Version V14 SP1

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# TIA Portal Module 011-001 Firmware Update TIA Portal Module 011-100 Unspecified Hardware Configuration TIA Portal Module 011-101 Specified Hardware Configuration TIA Portal Module 020-100 Process description of sorting station TIA Portal Module 031-100 Basics of FC Programming TIA Portal Module 031-200 6 Basics of FB Programming TIA Portal Module 031-300 IEC Timers and IEC Counters **TIA Portal Module 031-410 Basics of Diagnostics TIA Portal Module 031-420** Diagnostics via Web **TIA Portal Module 031-500** Analog Values TIA Portal Module 031-600 Global Data Blocks TIA Portal Module 041-101 WinCC Basic with KTP700 TIA Portal Module 051-201 High-Level Language Programming with SCL **TIA Portal Module 051-300**

### Matching SCE Trainer Packages for these Learn-/Training Document

- SIMATIC S7-1200 AC/DC/RELAY (set of 6) "TIA Portal" Order no.: 6ES7214-1BE30-4AB3
- SIMATIC S7-1200 DC/DC/DC (set of 6) "TIA Portal" Order no.: 6ES7214-1AE30-4AB3
- Upgrade SIMATIC STEP 7 BASIC V14 SP1 (for S7-1200) (set of 6) "TIA Portal" Order no.: 6ES7822-0AA04-4YE5

Note that these trainer packages are replaced with successor packages when necessary. An overview of the currently available SCE packages is available at: <u>siemens.com/sce/tp</u>

#### **Continued training**

For regional Siemens SCE continued training, get in touch with your regional SCE contact siemens.com/sce/contact

#### Additional information regarding SCE

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We wish to thank the TU Dresden, particularly Prof. Dr.-Ing. Leon Urbas and the Michael Dziallas Engineering Corporation and all other involved persons for their support during the preparation of this Learn-/Training Document.

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# **Basics of FB Programming**

# 1 Goal

In this chapter, you will get to know the basic elements of a control program – the *organization blocks (OBs), functions (FCs)*, function blocks (FBs) and data blocks (DBs). In addition, you will be introduced to *library-compatible* function und function block programming. You will get to know the *Function Block Diagram (FBD)* programming language and use it to program a function block (FB1) and an organization block (OB1).

The SIMATIC S7 controllers listed in Chapter 3 can be used.

# 2 Prerequisite

This chapter builds on the hardware configuration of SIMATIC S7 CPU1214C. However, other hardware configurations that has digital input and output board be used. For this chapter, you can use the following project, for example:

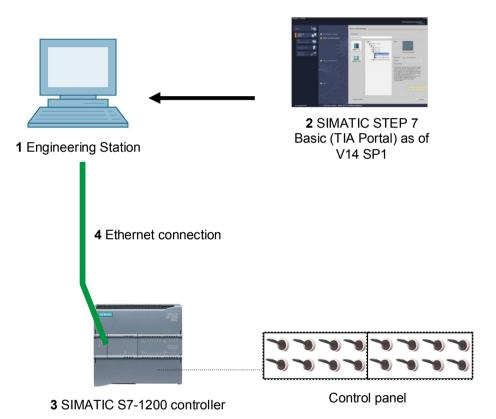
SCE\_EN\_011\_101\_Hardware\_Configuration\_CPU1214C.zap14

# 3 Required hardware and software

- 1 Engineering station: requirements include hardware and operating system (for additional information, see Readme on the TIA Portal Installation DVDs)
- 2 SIMATIC STEP 7 Basic software in TIA Portal as of V14 SP1
- 3 SIMATIC S7-1200 controller, e.g. CPU 1214C DC/DC/DC with ANALOG OUTPUT SB1232 signal board, 1 AO Firmware as of V4.2.1

Note: The digital inputs should be fed out to a control panel.

4 Ethernet connection between engineering station and controller



# 4 Theory

### 4.1 **Operating system and application program**

Every controller (CPU) contains an **operating system**, which organizes all functions and sequences of the CPU that are not associated with a specific control task.

The tasks of the operating system include the following:

- Performing a warm restart
- Updating the process image of the inputs and output
- Cyclically calling the user program
- Detecting interrupts and calling interrupt OBs
- Detecting and handling errors
- Managing memory areas

The operating system is an integral component of the CPU and comes pre-installed.

The **user program** contains all functions that are necessary for executing your specific automation task. The tasks of the user program include the following:

- Checking the basic requirements for a warm restart using startup OBs
- Processing of process data, i.e. activation of output signals as a function of the input signal states
- Reaction to interrupts and interrupt inputs
- Error handling during normal program execution

#### 4.2 Organization blocks

Organization blocks (OBs) form the interface between the operating system of the controller (CPU) and the application program. They are called from the operating system and control the following operations:

- Cyclic program processing (e.g. OB1)
- Startup characteristics of the controller
- Interrupt-driven program processing
- Error handling

A project must have, at a minimum, *an organization block for cyclic program processing*. An OB is called by a *start event* as shown in Figure 1. In addition, the individual OBs have defined priorities so that, for example, an OB82 for error handling can interrupt the cyclic OB1.

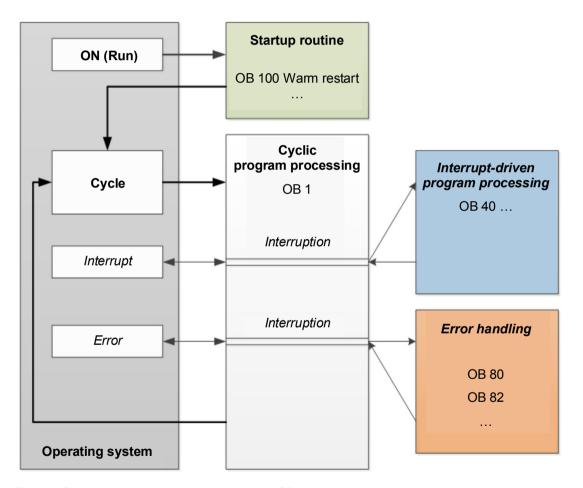


Figure 1: Start events in the operating system and OB calls

When a start event occurs, the following reactions are possible:

- If an OB has been assigned to the event, this event triggers the execution of the assigned OB. If the priority of the assigned OB is greater than the priority of the OB that is currently being executed, it is executed immediately (interrupt). If not, the assigned OB waits until the higher-priority OB has been completely executed
- If you have not assigned an OB to the event, the default system reaction is performed.

Table 1 shows examples for various start events for a SIMATIC S7-1200. Also shown are the possible OB number(s) and the default system reactions that occur when the respective organization block (OB) is not present in the controller.

Start event	Possible OB numbers	Default system reaction	
Startup	100, ≥ 123	Ignore	
Cyclic program	1, ≥ 123	Ignore	
Time-of-day interrupt	10 to 11	-	
Update interrupt	56	Ignore	
Scan cycle monitoring time exceeded once	80	Ignore	
Scan cycle monitoring time exceeded twice	80	STOP	
Diagnostic interrupt	82	Ignore	

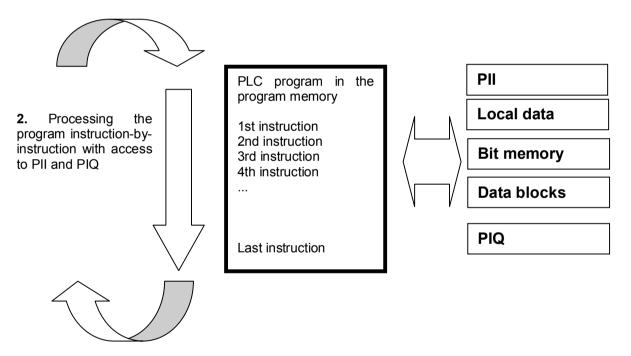
Table 1: OB numbers for various start events

# 4.3 **Process image and cyclic program processing**

When the cyclic user program addresses the inputs (I) and outputs (O), it does not query the signal states directly from the input/output modules. Instead, it accesses a memory area of the CPU. This memory area contains an image of the signal states and is called the **process image**.

The cyclic program processing sequence is as follows:

- At the start of the cyclic program, a query is sent to determine whether or not the individual inputs are energized. This status of the inputs is stored in the process image of the inputs (PII). In doing so, the information 1 or "High" is stored for energized inputs and the information 0 or "Low" for de-energized inputs.
- The CPU then executes the program stored in the cyclic organization block. For the required input information, the CPU accesses the previously read process image of the inputs (PII) and the results of logic operation (RLOs) are written to a so-called process image of the outputs (PIQ).
- 3. At the end of the cycle, the **process image of the outputs** (**PIQ**) is transferred as the signal state to the output modules and these are energized or de-energized. The sequence then continues again with Item 1.
  - 1. Save status of inputs in PII.



3. Transfer status from the PIQ to the outputs.

Figure 2: Cyclic program processing

**Note:** The time the CPU needs for this sequence is called cycle time. This depends, in turn, on the number and type of instructions and the processor performance of the controller.

## 4.4 Functions

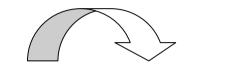
Functions (FCs) are logic blocks without memory. They **have no data memory** in which values of block parameters can be stored. Therefore, all interface parameters must be connected when a function is called. To store data permanently, global data blocks must be created beforehand.

A function contains a program that is executed whenever the function is called from another logic block.

Functions can be used, for example, for the following purposes:

- Math functions that return a result dependent on input values.
- Technological functions such as individual controls with binary logic operations.

A function can also be called several times at different points within a program.



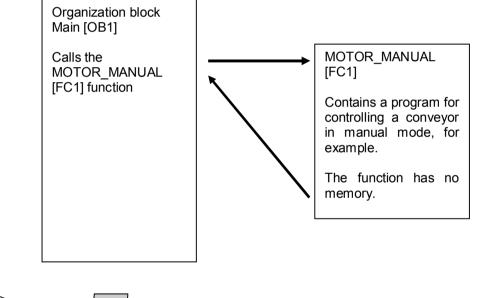


Figure 3: Function with call from organization block Main [OB1]

6

## 4.5 Function blocks and instance data blocks

Function blocks are logic blocks that store their input, output and in-out tags as well as static tags permanently in instance data blocks, so that they **are available after the block has been executed**. For this reason, they are also referred to as blocks with "memory".

Function blocks can also operate with temporary tags. Temporary tags are not stored in the instance DB, however. Instead, they are only available for one cycle.

Function blocks are used for tasks that cannot be implemented with functions:

- Whenever timers and counters are required in the blocks, or
- When information must be stored in the program, such as preselection of the operating mode with a button.

Function blocks are always executed when called from another logic block. A function block can also be called several times at different points within a program. This facilitates the programming of frequently recurring complex functions.

A call of a function block is referred to as an instance. Each instance of a function block is assigned a memory area that contains the data that the function block uses. This memory is made available by data blocks created automatically by the software.

It is also possible to provide memory for multiple instances in one data block in the form of a **multi-instance**. The maximum size of instance data blocks varies depending on the CPU. The tags declared in the function block determine the structure of the instance data block.

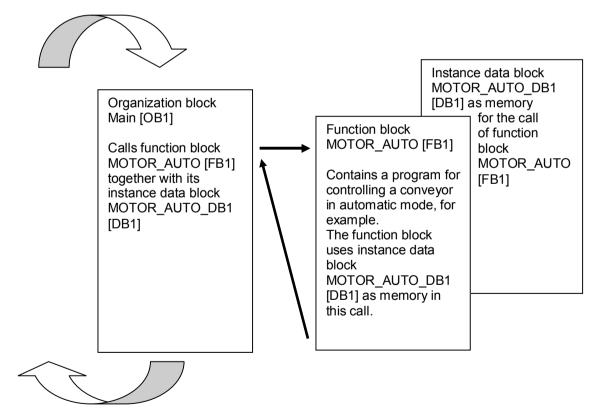


Figure 4: Function block and instance with call from organization block Main [OB1]

# 4.6 Global data blocks

In contrast to logic blocks, data blocks contain no instructions. Rather, they serve as memory for user data.

Data blocks thus contain variable data that is used by the user program. You can define the structure of global data blocks as required.

Global data blocks store data that can be used **by all other blocks** (see Figure 5). Only the associated function block should access instance data blocks. The maximum size of data blocks varies depending on the CPU.

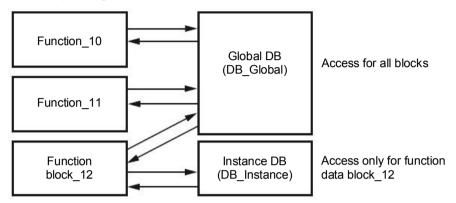


Figure 5: Difference between global DB and instance DB.

Application examples for global data blocks are:

- Saving of information about a storage system. "Which product is located where?"
- Saving of recipes for particular products.

# 4.7 Library-compatible logic blocks

A user program can be created with linear or structured programming. *Linear programming* writes the entire user program in the cycle OB, but is only suitable for very simple programs for which other less expensive control systems, such as LOGO!, can now be used.

For more complex programs, *structured programming* is always recommended. Here, the overall automation task can be broken down into small sub-tasks in order to implement a solution for them in functions and function blocks.

In this case, library-compatible logic blocks should be created preferentially. This means that the input and output parameters of a function or function block are defined generally and only supplied with the current global tags (inputs/outputs) when the block is used.

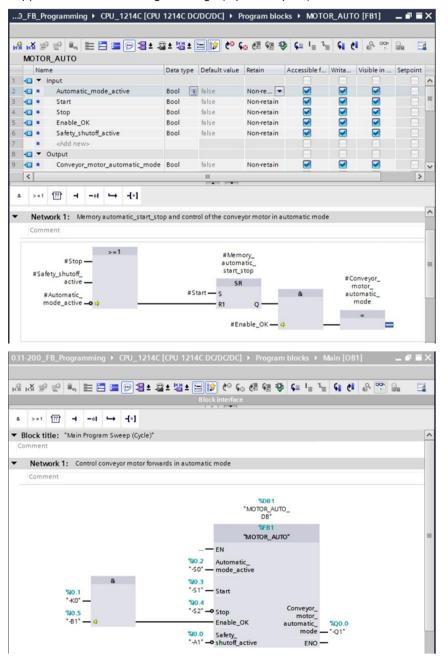


Figure 6: Library-compatible function bock with call in OB1

### 4.8 **Programming languages**

For SIMATIC S7-1200 controller, the available programming languages for programming functions and function blocks are Function Block Diagram (FBD), Ladder Logic (LAD) and Structured Control Language (SCL).

The Function Block Diagram (FBD) programming language will be presented in the following.

FBD is a graphical programming language. The representation is based on electronic switching systems. The program is mapped in networks. A network contains one or more logic operation paths. Binary and analog signals are linked together by boxes. The graphical logic symbols known from Boolean algebra are used to represent the binary logic.

You can use binary functions to query binary operands and to logically combine their signal states. The following instructions are examples of binary functions: "AND operation", "OR operation" and "EXCLUSIVE OR operation". These are shown in Figure 7.

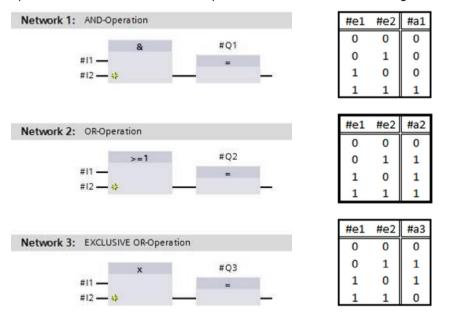


Figure 7: Binary functions in FBD and associated logic table

You can thus use simple instructions, for example, to control binary outputs, evaluate edges and execute jump functions in the program.

Program elements such as IEC timers and IEC counters provide complex instructions.

The empty box serves as a placeholder in which you can select the required instruction.

Enable input EN (enable)/ Enable output ENO (enable output) mechanism:

- An instruction without EN/ENO mechanism is executed independent of the signal state at the box inputs.
- Instructions with EN/ENO mechanism are only executed if enable input "EN input has signal state "1". When the box is processed correctly, enable output "ENO" has signal state "1". If an error occurs during processing, the enable output "ENO" is reset. If enable input EN is not connected, the box is always executed.

# 5 Task

The following functions of the sorting station process description will be planned, programmed and tested in this chapter:

Automatic mode - Conveyor motor

# 6 Planning

The programming of all functions in OB1 is not recommended for reasons of clarity and reusability. The majority of the program code will therefore be moved into functions (FCs) and function blocks (FBs). The decision on which functions are to be moved to the FB and which is to run in OB 1 is planned below.

#### 6.1 EMERGENCY STOP

The EMERGENCY STOP does not require a separate function. Just like the operating mode, the current state of the EMERGENCY STOP relay can be used directly at the blocks.

## 6.2 Automatic mode - Conveyor motor

Automatic mode of the conveyor motor is to be encapsulated in a function block (FB) "MOTOR\_AUTO". On the one hand, this preserves the clarity of OB1. On the other hand, it enables reuse if another conveyor belt is added to the station. Table 2 lists the planned parameters.

Input	Data	Comment
Automatic_mode_active	BOOL	Automatic mode activated
Start	BOOL	Pushbutton automatic start
Stop	BOOL	Pushbutton automatic stop
Enable_OK	BOOL	All enable conditions OK
Safety_shutoff_active	BOOL	Safety shutoff active e.g. emergency stop
Output		
Conveyor_motor_automatic_mode	BOOL	Control of the conveyor motor in automatic mode
Static		
Memory_automatic_start_stop	BOOL	Memory used for start/stop automatic mode

Table 2: Parameters for FB "MOTOR\_AUTO"

The Memory\_automatic\_start\_stop is latched with Start but only if the reset conditions are not present.

The Memory\_automatic\_start\_stop is reset if Stop is present or safety shutoff is active or automatic mode is not activated (manual mode).

The Conveyor\_motor\_automatic\_mode output is controlled when Memory\_automatic\_start\_stop is set and the enable conditions are met.

# 6.3 Technology diagram

Here, you see the technology diagram for the task.

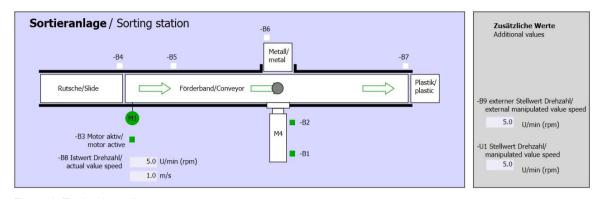


Figure 8: Technology diagram

Schalter der Sortieranlage Switches of sorting station -P1 ein/on	Automatikbetrieb Automatic mode -P5 gestartet/started	Handbetrieb / Manual mode -S3 Tippbetrieb -M1 vorwarts/ Manual -M1 forwards
-Q0 Hauptschalter/Main switch -P4 aktivier/active	-S1 Start/start	-S4 Tippbetrieb -M1 rückwärts/ Manual -M1 backwards -P7 ausgefahren/extended
-A1 NOTHALT/Emergency stop	-S2 Stopp/stop	-S6 Zylinder -M4 ausfahren/ cylinder -M4 extend -P6 eingefahren/retracted
S0 Betriebsart/operating mode		-S5 Zylinder -M4 einfahren/ cylinder -M4 retract

Figure 9: Control panel

# 6.4 Reference list

The following signals are needed as operands for this task.

DI	Туре	ldentifier	Function	NC/NO
10.0	BOOL	-A1	Return signal emergency stop ok	NC
I 0.1	BOOL	-K0	Main switch "ON"	NO
10.2	BOOL	-S0	Mode selector manual (0)/ automatic (1)	Manual = 0 Auto = 1
10.3	BOOL	-S1	Pushbutton automatic start	NO
10.4	BOOL	-S2	Pushbutton automatic stop	NC
I 0.5	BOOL	-B1	Sensor cylinder M4 retracted	NO

DO	Туре	Identifier	Function	
Q 0.0	BOOL	-Q1	Conveyor motor M1 forwards fixed speed	

#### Legend for reference list

DI	Digital Input	DO	Digital Output
AI	Analog Input	AO	Analog Output
I	Input	Q	Output

NC Normally Closed

NO Normally Open

# 7 Structured step-by-step instructions

You can find instructions on how to carry out planning below. If you already have a good understanding of everything, it will be sufficient to focus on the numbered steps. Otherwise, simply follow the detailed steps in the instructions.

## 7.1 Retrieve an existing project

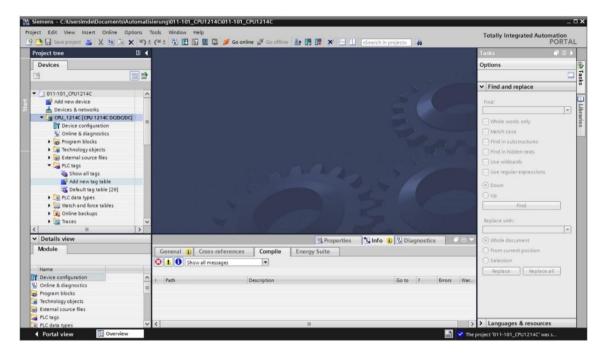
→ Before we can start programming the function block (FB) "MOTOR\_AUTO", we need a project with a hardware configuration (e.g. SCE\_EN\_011\_101\_Hardware\_Configuration\_S7-CPU1214C....zap). To retrieve an existing project that has been archived, you must select the relevant archive with → Project → Retrieve in the project view. Confirm your selection with Open (→ Project → Retrieve → Select a .zap archive → Open).

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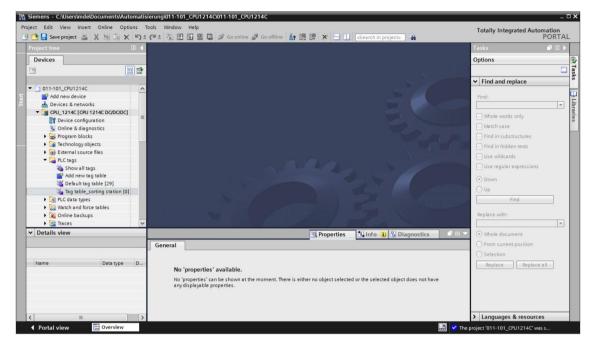
→ The next step is to select the target directory where the retrieved project will be stored. Confirm your selection with "OK". (→ Target directory  $\rightarrow$  OK) 6

# 7.2 Create a new tag table

 $\rightarrow$  In the project view, navigate to the  $\rightarrow$  PLC tags of your controller and create a new tag table by double-clicking  $\rightarrow$  Add new tag table.



→ Rename the tag table you just created as "Tag\_table\_sorting\_station" (→ right-click "Tag\_table\_1" → "Rename" → Tag\_table\_sorting\_station).



 $\rightarrow$  Open this tag table with a double-click. ( $\rightarrow$  Tag table sorting station)

Siemens - C:\Users\mde\Documents\Automati	rung\011-101_CPU1214C\01	1-101_CPU1214C				×
Project Edit View Insert Online Options		🖡 Go online 🖉 Go offline 🖁 🛔		≪earch in project>	34	Totally Integrated Automation PORTAL
Project tree 🛛 🖉 🖣	011-101_CPU1214C → CPU	J_1214C [CPU 1214C DC/DC/D	C] 🕨 PLC tags 🕨 Ta	g table_sorting st	ation [0] 🛛 🗖 🖬 🗙	Tasks 📑 🗈 🕨
Devices				- Tags	User constants	Options
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2	Tag table_sorting statio	n				✓ Find and replace
011-101_CPU1214C	Name	Data type A	dress Retain	Acces Writa \	/isibl Comment	
Add new device	<add new=""></add>			<ul> <li>Image: Image: Ima</li></ul>		Find:
Devices & networks						Whole words only
CPU_1214C [CPU 1214C DC/DC/DC]						Whole words only
Device configuration						
😧 Online & diagnostics						Match case
Program blocks						Find in substructures
Technology objects						Find in hidden texts
External source files						Use wildcards
- PLC tags						Use regular expressions
a Show all tags Add new tag table						use regular expressions
Sefault tag table [29]						O Down
Tag table_sorting station [0]						Oup
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Watch and force tables						
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	ag table_so					project '011-101_CPU1214C' was s

# 7.3 Create new tags within a tag table

→ Add the name Q1 and confirm the entry with the Enter key. If you have not yet created additional tags, TIA Portal now automatically assigns data type "Bool" and address %I0.0 (I 0.0) (→ <Add> → Q1 → Enter).

								📶 Tags		Jser constants
2	# E	) 🕆 🕆 🖞								
		ble_sorting_station								
	N	lame	Data type	Address		Retain	Acces	Writa	Visibl	Comment
		Q1	Bool	%10.0	•					
		<add new=""></add>								

→ Change the address to %Q0.0 (Q 0.0) by entering this directly or by clicking the drop-down arrow to open the Addressing menu. Change the operand identifier to Q and confirm with Enter or by clicking the check mark ( $\rightarrow$  %I0.0  $\rightarrow$  Operand identifier  $\rightarrow$  Q  $\rightarrow$   $\blacksquare$ )

								Tage		Jser const	ants
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1	-	ble_sorting_station									
	N	lame	Data type	 Address		Retain	Acces	Writa	Visibl	Comment	
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 $\rightarrow$  Enter the "Conveyor motor M1 forwards fixed speed" comment for the tag.

											🕣 Tags	User constants
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	Tag t	table_so	rting statio	n								
		Name	Data type		Address		Retain	Acces	Writa	Visibl	Comment	
1	-	Name Q1	Data type Bool		Address %Q0.0	-	Retain	Acces	Writa	Visibl		1 forwards fixed speed

→ Add a new Q2 tag in line 2. TIA Portal has automatically assigned the same data type as the one in line 1 and has incremented the address by 1 to %Q0.1 (Q0.1). Enter the comment "Conveyor motor M1 backwards fixed speed".

 $(\rightarrow < Add > \rightarrow Q2 \rightarrow Enter \rightarrow Comment \rightarrow Conveyor motor M1 backwards fixed speed)$ 

									Tags	User constants
ý			ri (*							
	Tag t	table_sort	ting station							
		Name 🔺	Data type	Address	Retain	Acces	Writa	Visible in	Comment	
1	-	-Q1	Bool	%Q0.0					conveyor motor -M1 for	rwards fixed speed
2	-	-Q2	Bool	%Q0.1					conveyor motor -M1 ba	ckwards fixed speed

# 7.4 Import "Tag\_table\_sorting\_station"

- → To insert an existing symbol table, right-click on an empty field of the created "Tag\_table\_sorting\_station". Select "Import file" in the shortcut menu.
  - $(\rightarrow \text{Right-click in an empty field of the tag table} \rightarrow \text{Import file})$

									Tags	User constants
#	*	<b>* *</b> (	11							
٦	ag ta	able_sorting	_station							
		Name	Data type	Address	Retain	Acces	Writa	Visibl	Comment	
	-	Q1	Bool	%10.0					conveyor motor -	M1 forwards fixed speed
	-	Q2	Bool	%10.1					conveyor motor -	W1 backwards fixed speed
		<add news<="" td=""><td>🚔 Insert row 🛃 Add row</td><td></td><td></td><td></td><td>1</td><td><b>V</b></td><td></td><td></td></add>	🚔 Insert row 🛃 Add row				1	<b>V</b>		
			Cut		Ctrl+ Ctrl+					
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			Monitor al	I						
			Import file							
			Export file			_				

- → Select the desired symbol table (e.g. in .xlsx format) and confirm the selection with "Open". ( $\rightarrow$  SCE\_EN\_020-100\_Tag\_table\_sorting\_station...  $\rightarrow$  Open)
- $\rightarrow$  When the import is finished, you will see a confirmation window and have an opportunity to view the log file for the import. Click  $\rightarrow$  OK.

Import co	mpleted. (0032:000001) X
	Import completed successfully.
	Detailed information is shown in the import log file.
	Click here to view the log file.
	ОК

You can see that some addresses have been highlighted in orange. These are duplicate addresses and the names of the associated tags have been numbered automatically to avoid confusion.

→ Delete the duplicate tags by selecting the lines and pressing the Del key on your keyboard or selecting "Delete" in the shortcut menu.

		1							Tags [	User constants	
-	1		°° 🗊								2
1	lag t	able_so	orting station								
		Name	Data type	Address	Retain	Acces	Writa	Visibl	Comment		
1	-	Q1	Bool	%Q0.0					conveyor motor -M1 fe	orwards fixed speed	
2	-	Q2	Bool	%Q0.1					conveyor motor -M1 fe	orwards fixed speed	
3	-00	-A1	Bool 🔳	%10.0					return signal emerge	ncy stop ok (nc)	
2	-	-K0	Bool	%10.1		<b></b>			main switch "ON" (no	)	
ō	-0	-50	Bool	%10.2		Image: A start and a start			mode selector manua	al(0) / automatic(1)	
ke -	-	-S1	Bool	%10.3					pushbutton automati	ic start (no)	
7	-00	-S2	Bool	%10.4					pushbutton automati	ic stop (nc)	
5	-00	-B1	Bool	%10.5					sensor cylinder -M4 re	etracted (no)	
<u> </u>		-B2	Bool	%10.6					sensor cylinder -M4 e:	xtended (nc)	
0	-00	-83	Bool	%10.7					sensor motor -M1 act	ice (pulse signal for .	
1	-0	<b>-</b> B4	Bool	%11.0					sensor part at slide (r	no)	
2		-85	Bool	%11.1					sensor metal part (no	))	i
3	-00	-86	Bool	%11.2					sensor part in front of	f cylinder -M4 (no)	
4		<b>-</b> B7	Bool	%11.3					sensor part at end of	conveyor (no)	
5	-	-53	Bool	%11.4					pushbutton manual r	node conveyor –M1	
6	-00	-54	Bool	%11.5					pushbutton manual r	mode conveyor -M1	
7	-00	-55	Bool	%11.6					pushbutton manual r	node cylinder -M4 re.	
8	-	-56	Bool	%11.7					pushbutton manual r	node cylinder -M4 ex.	
9	-00	-Q1	Bool	%Q0.0					conveyor motor -M1 f	orwards fixed speed	
0	-00	-Q2	Bool	%Q0.1					conveyor motor -M1 b	ackwards fixed spee	d
1	-	-Q3	Bool	%Q0.2					conveyor motor -M1 v	ariable speed	
2		-M2	Bool	%Q0.3					cylinder -M4 retract		
3	-00	-MB	Bool	%Q0.4					cylinder -M4 extend		
4	-	-P1	Bool	%Q0.5					display "main switch	on"	
25	-0	-P2	Bool	%Q0.6					display "manual mod	e"	
6	-00	-P3	Bool	%Q0.7					display automatic m	ode"	

 $(\rightarrow$  Right-click on selected tags  $\rightarrow$  Delete)

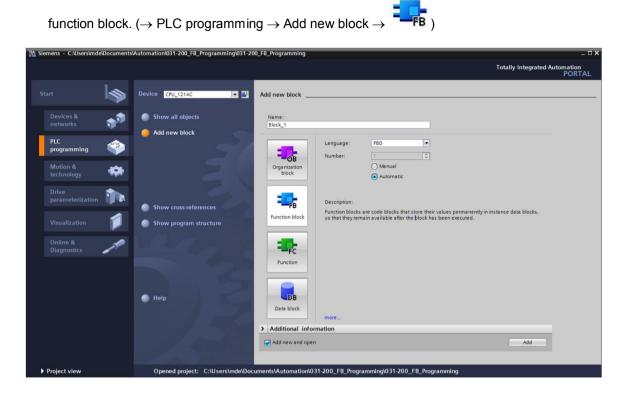
→ You now have a complete symbol table of the digital inputs and outputs in front of you. Save your project under the name 031-200\_FB\_Programming.

roject tree	□ 4	011	-101_	CPU 12	14C + CPL	J_1214C [CPU 1	214C	DC/DC/	DC] 🕨	PLC tage	⊧ • Ta	g table_sorting station [28]		_ # # #
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3	•	1	<b>*</b> 5	•	···									
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011-101_CPU1214C	^			lame	Data type	Address		Retain	Acces	Writa	Visibl	Comment		
Add new device		1	-	-A1	Bool	(iii) %IO.0	-					return signal emergency stop ok (nc)		
A Devices & networks		2		-K0	Bool	%10.1						main switch _ON" (no)		
- CPU_1214C [CPU 1214C DC/DC/DC	]	3	-0	-50	Bool	%10.2						mode selector manual(0) / automatic(1)		
Device configuration	=	4	-0	-51	Bool	%10.3						pushbutton automatic start (no)		
Q Online & diagnostics		5	-0	-52	Bool	%10.4						pushbutton automatic stop (nc)		
Program blocks		6	-03	-B1	Bool	%10.5						sensor cylinder -M4 retracted (no)		
Technology objects		7	-0	-B2	Bool	%10.6						sensor cylinder -M4 extended (nc)		
External source files		8	-0	-83	Bool	%10.7						sensor motor -M1 actice (pulse signal for		
🕶 🌄 PLC tags		9	-0	-84	Bool	%11.0						sensor part at slide (no)		
Show all tags		10	-0	-85	Bool	9611.1						sensor metal part (no)		
Add new tag table		11	-0	-B6	Bool	%11.2						sensor part in front of cylinder -M4 (no)		
🜿 Default tag table [29]		12	-01	-87	Bool	%11.3						sensor part at end of conveyor (no)		
🖳 Tag table_sorting station [.	8	13	-0	-53	Bool	9611.4						pushbutton manual mode conveyor -M1		
PLC data types		14	-03	-54	Bool	%11.5						pushbutton manual mode conveyor -M1		
Watch and force tables		15	-	-55	Bool	%11.6						pushbutton manual mode cylinder -M4 re		
Online backups		16	-	-56	Bool	%11.7						pushbutton manual mode cylinder -M4 ex		
🕨 🔯 Traces	~	17	-	-Q1	Bool	%Q0.0						conveyor motor -M1 forwards fixed speed		
Details view	_	18	-	-Q2	Bool	%Q0.1						conveyor motor -M1 backwards fixed speed		
		19	-0	-Q3	Bool	%Q0.2						conveyor motor -M1 variable speed		
		20	-0	-M2	Bool	%Q0.3						cylinder -M4 retract		
		21	-0	-M3	Bool	%Q0.4						cylinder -M4 extend		
Name Data type		22	-	-P1	Bool	%Q0.5						display main switch on"		
Q1 Bool	21	23	-	-P2	Bool	%Q0.6						display "manual mode"		
Q2 Bool	%	24	-	-P3	Bool	%Q0.7						display "automatic mode"		
-Q3 Bool	%	25	-	-P4	Bool	%Q1.0						display "emergency stop activated"		
-SO Bool	%≡	26	-	-P5	Bool	%Q1.1						display "automatic mode started"		
S1 Bool	9/	27	-	-P6	Bool	%Q1.2						display cylinder -M4 "retracted"		
-52 Bool	91~		-	_			_		-	-			Info 追 🖏 Di	

 $(\rightarrow \text{Project} \rightarrow \text{Save as } ... \rightarrow 031-200\_\text{FB}\_\text{Programming} \rightarrow \text{Save})$ 

# 7.5 Create function block FB1 "MOTOR\_AUTO" for the conveyor motor in automatic mode

ightarrow In the PLC programming section of the portal view, click "Add new block" to create a new



→ Rename your new block to: "MOTOR\_AUTO", set the language to FBD and keep automatic assignment of the number. Select the "Add new and open" check box. You will thus be taken automatically to your created function block in the project view.Click "Add".
 (→ Name: MOTOR\_AUTO→Language: FBD → Number: Automatic → Add new and open → Add)

MOTOR_AUTO				
	Language: Number:	FBD	•	
Organization block		O Manual O Automatic		
	Description: Function block	s are code blocks that s	tore their values permanently in instance data bl block has been executed.	ocks
	so that they re		block has been executed.	
Function	30 that they re		DIOCK HISS DEET EXECUTED.	
FC.	30 that they re		under nus been executed.	

# 7.6 **Define the interface of FB1 "MOTOR\_AUTO"**

- → If you selected "Add new and open", the project view opens with a window for creating the block you just added.
- → You can find the interface description of your function block in the upper section of your programming view.

0	_F	B_1	Programming   CPU_12	214C [CPU 1214C D	C/DC/DC] • Pro	gram blo	cks	MOTOR	_AUTO	[FB1] .	₋∎≡×
R	Ы	٤ :	0 e 🛰 🖿 🚍 🗖	🗩 📲 ± 📲 ± 📲 ±	= 😥 🥙 💊	<del>ر</del> ا ا	₽	<b>¢</b> ≡ <sup>1</sup> ≡ <sup>3</sup> ≡	<b>61 (1</b>	0° 00	ie 📑
	MC	T	OR_AUTO								
		Na	ime	Data type	Default value	Retain		Accessible f	Writa	Visible in	. Setp
1	-	-	Input								~
2 3 4 5			<add new=""></add>				-				
З	-0	•	Output								
4			<add new=""></add>								_ =
5		•	InOut								
6			<add new=""></add>								
6 7 8	-	•	Static								
8			<add new=""></add>								
	-	•	Temp								
10			<add new=""></add>								
	-	•	Constant								
12		=	<add new=""></add>								~
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	1				hard hard at						
2		>=1	· '??' → -ol →	-1=1							
-	Blo	ck	title:								^
C	om	me	nt								
•	1	Vet	twork 1:								
	C	om	iment								
											=
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→ A binary output signal is needed for controlling the conveyor motor. For this reason, we first create local output tag #Conveyor\_motor\_automatic\_mode of the "Bool" type. Enter the comment "Control of the conveyor motor in automatic mode" for the parameter.
 (→ Output→ Conveyor\_motor\_automatic\_mode → Bool → Control of the conveyor motor in automatic mode)

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			🖗 🖗 🖿 🚍 💬 🕮 ± 🎗	≝± ≝±E	∃ 🌮 ¢∞ ६⊕			1 # 1	: *≡      9	H (H ) 64		4
	MC	OTO	DR_AUTO									
		Na	ime	Data type	Default value	Retain	Accessible f	Writa	Visible in	Setpoint	Comment	ł
1	-	•	Input									
2			<add new=""></add>									ſ
3	-	•	Output									1
4	-		Conveyor_motor_automatic_mode	Bool	false	Non-retain 💌					Control of the conveyor motor in automatic mode	
5			<add new=""></add>									
6	-	•	InOut									l
7			<add new=""></add>									
8	-	•	Static									
9			<add new=""></add>									
10	-	•	Temp									
11			<add new=""></add>									
		-	Constant				0					16

→ Add parameter #Automatic\_mode\_active as the input interface under Input and confirm the entry with the Enter key or by exiting the entry field. Data type "Bool" is assigned automatically. This will be retained. Next, enter the associated comment "Automatic mode activated".

 $(\rightarrow \text{Input} \rightarrow \text{Automatic_mode_active} \rightarrow \text{Bool} \rightarrow \text{Automatic mode activated})$ 

→ Continue by adding parameters #Start, #Stop, #Enable\_OK and #Safety\_shutoff\_active as additional binary input parameters and check their data types. Add descriptive comments.

26		×	# # •, E 🖻 🖻 🗩 🖁 ± 🌡	Э <b>. ю .</b> Г	- 1842 AG C-	AR Co	th ( = at		L. 3. 11	6 AL .S	1. 00 O	
					∃ 8₽'  C~ %©	(	₩ <b>9</b> = 22	<u>28 48</u>	. = . =   MI	41 CH 0	* >   WB	-
			OR_AUTO	Data type	Default value	Retain	Accessible f	Writa	Visible in	Setpoint	Comment	
			Input		,							1
			Automatic_mode_active	Bool	false	Non-retain					Automatic mode activated	
		1 -	Start	Bool	false	Non-retain					Pushbutton automatic start	
			Stop	Bool	false	Non-retain					Pushbutton automatic stop	
	-		Enable_OK	Bool	false	Non-retain					All enable conditions OK	
	-	1 -	Safety_shutoff_active	Bool	false	Non-retain					Safety shutoff active e.g. emergency stop operated	J
		-	<add new=""></add>									
		•	Output									
		1 =	Conveyor_motor_automatic_mode	Bool	false	Non-retain					Control of the conveyor motor in automatic mode	
0			<add new=""></add>									
1		•	InOut									
2			<add new=""></add>									
3		•	Static									
4			<add new=""></add>									
5	-	•	Temp									

→ The conveyor is started and stopped with pushbuttons. We therefore need a "Static" tag as a memory. Under Static, add tag #Memory\_automatic\_start\_stop and confirm the entry with the Enter key or by exiting the entry field. Data type "Bool" is assigned automatically. This will be retained. Enter the associated comment "Memory used for start\_stop automatic mode".
(→ Static → Memory\_automatic\_start\_stop → Bool → Memory used for start/stop automatic mode".

(c)	1	ă	( 🛫 🛫 🐛 🖿 🚍 💬 📲 ± 🍇	2 ± 😫 ± 🗄	🛊 🕫 😡	🖑 🕼 🗎	⊉ ⊊ -≣	書業	I≣ <sup>1</sup> ≣ ∭	SI CI 6	2, oor <u>∎</u>	E
	N	01	TOR_AUTO									
		1	Name	Data type	Default value	Retain	Accessible f	Writa	Visible in	Setpoint	Comment	
	-	•	<ul> <li>Input</li> </ul>									
	-		Automatic_mode_active	Bool	false	Non-retain					Automatic mode activated	
			<ul> <li>Start</li> </ul>	Bool	false	Non-retain					Pushbutton automatic start	
	-	•	<ul> <li>Stop</li> </ul>	Bool	false	Non-retain					Pushbutton automatic stop	
	-		Enable_OK	Bool	false	Non-retain					All enable conditions OK	
	-		Safety_shutoff_active	Bool	false	Non-retain					Safety shutoff active e.g. emergency stop operated	
	1		Add new>									
	-	•	▼ Output									
			Conveyor_motor_automatic_mode	Bool	false	Non-retain					Control of the conveyor motor in automatic mode	
			Add new>									
	-	•	▼ InOut									
			Add new>									
3	-	•	▼ Static									
4	-		Memory_automatic_start_stop	Bool	false	Non-retain					Memory used for start/ stop automatic mode	
5			Add new>									
5	-	•	▼ Temp									
7	1		Add new>									
В	-	1	<ul> <li>Constant</li> </ul>									
9	Ľ		Add new>	6		*						ļ

→ For purposes of program documentation, assign the block title, a block comment and a helpful network title for Network 1.

( $\rightarrow$  Block title: Motor control in automatic mode  $\rightarrow$  Network 1: Memory\_automatic\_start\_stop and control of the conveyor motor in automatic mode)

			) 🔮 🐛 🖿 🚍 🗩 🗃 🗲 🕾 4	a z va z E	3 8 <b>2</b> (* <b>%</b> 3	(1) 11 1	<b>♦</b> = , ≡ , ≡	41 Cx	0. 2	8	E
N		Nam	R_AUTO	Data type	Default value	Retain	Accessible f	Writa	Visible in	Setpoint	Comment
-		-	Input	1 7/							
-			Automatic_mode_active	Bool	false	Non-retain					Automatic mode activated
*	01		Start	Bool	false	Non-retain					Pushbutton automatic start
4	01		Stop	Bool	false	Non-retain					Pushbutton automatic stop
-	01		Enable_OK	Bool	false	Non-retain					All enable conditions OK
*	01		Safety_shutoff_active	Bool	false	Non-retain					Safety shutoff active e.g. emergency stop operated
1			<add new=""></add>								
*	0	•	Output								
4	01		Conveyor_motor_automatic_mode	Bool	false	Non-retain					Control of the conveyor motor in automatic mode
Ľ			<add new=""></add>								
-	01	•	InOut								
L			<add new=""></add>								
*	0	•	Static								
			Memory_automatic_start_stop	Bool	false	Non-retain					Memory used for start/ stop automatic mode
ŀ	٢	_									
-		>=1	1??? → → → -[=]				hard hered				
R		ck ti	itle: Motor control in automatic mod	e							
	-		motor in automatic mode:								
0		it M	lemory_automatic_start_stop is set wit	th the input S	tart, but only if th	ne reset condi	tions				
16		ot fu	ufilled. lemory_automatic_start_stop is reset v	Add at a factor of							
re				with the input		lety shuton is					
he	b		or if the automatic mode is not activa								

# 7.7 Program FB1: MOTOR\_AUTO

→ Below the interface description, you see a toolbar in the programming window with various logic functions and below that an area with networks. We have already specified the block title and the title for the first network there. Programming is performed within the networks using individual logic blocks. Distribution among multiple networks helps to preserve the clarity of the program. In the following, you will get to know the various ways you can insert logic blocks.



→ On the right side of your programming window is a list of instructions you can use in the program. Under → Basic instructions → Bit logic operations, find function (Assignment) and use a drag & drop operation to move it to Network 1 (green line appears, mouse pointer with + symbol).

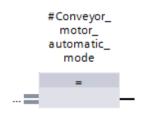
 $(\rightarrow \text{Instructions} \rightarrow \text{Basic instructions} \rightarrow \text{Bit logic operations} \rightarrow \blacksquare --=]$ 

.J_FB_Pro	gramming      CPU_1214C [CPU	1214C DO	DODC] • Pro	gram block	S MOTOR	_AUTO	[FB1]		Instructions	• 1
									Options	
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MOTOR	AUTO								> Favorites	
Name		Data type	Default value	Retain	Accessible f	Writa	Visible in	Setp	✓ Basic instructions	
🕣 🔻 Ir	iput							^		Des
	Automatic_mode_active	Bool	false	Non-retain					General	Des
	Start	Bool	false	Non-retain					▼ ☐ Bit logic operations	
-0	Stop	Bool	false	Non-retain						AND I
	Enable_OK	Bool	false	Non-retain					E >=1	OR loc
	Safety_shutoff_active	Bool	false	Non-retain						EXCLU
	<add new=""></add>								E -[=]	Assign
	utput									Negat
- III-	Conveyor_motor_automatic_mode	Bool	false	Non-retain				~	E -[R]	Reset
<								>	E -[S]	Set ou
5 >=1	[??] → → → → +[=]								E SET BF	Set bi
5 >=1									RESET_BF	Reset
Block tit	le: Motor control in automatic mode	2							E SR	Set/re
Conveyor n	notor in automatic mode:								E RS	Reset
									E - P -	Scan
Netw	ork 1: Memory automatic_start_sto	p and contro	ol of the conveyo	motor in aut	omatic mode					Scan
Comm	ent								E -[P]-	Set or
									E -[N]-	Set or
-									P_TRIG	Scanl
									IN_TRIG	Scanl
									R_TRIG	Detec
									F_TRIG	Detec

Now use drag & drop to move your output parameter #Conveyor\_motor\_automatic\_mode onto <??.?> above the block you just inserted. The best way to select a parameter in the interface description is by "grabbing" it at the blue symbol  $\triangleleft$ . ( $\rightarrow$   $\triangleleft$  Conveyor\_motor\_automatic\_mode)

	Name	Data type	Default value	Retain	Accessible f	Writa	Visible in	Setp
	<ul> <li>Input</li> </ul>							
	Automatic_mode_active	Bool	false	Non-retain				
	Start	Bool	false	Non-retain				
-	<ul> <li>Stop</li> </ul>	Bool	false	Non-retain				
	Enable_OK	Bool	false	Non-retain				
	<ul> <li>Safety_shutoff_active</li> </ul>	Bool	false	Non-retain				
	Add new>							
- <b>- - - -</b>	<ul> <li>Output</li> </ul>							-
- 🖸 🛛		Bool	false	Non-re 💌				
<	<ul> <li>Add second</li> </ul>							>
	= 1 [??] → -ol → -[=] :k title: Motor control in automatic mode							
	eyor motor in automatic mode: letwork 1: Memory automatic_start_stop	and control	of the conveyor	motor in auto	omatic mode			
	omment							

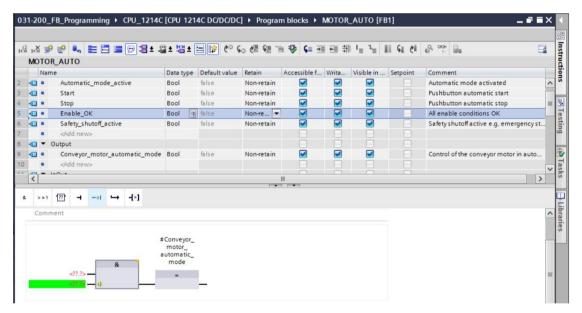
→ This determines that the #Conveyor\_motor\_automatic\_mode parameter is written by this block. Still missing, however, are the input conditions so that this actually happens. An SR flip-flop and #Enable\_OK parameter are logically combined with an AND logic operation at the input of the assignment block. To do this, first click the input of the block so that the input line has a blue background.



→ Click the <sup>a</sup> icon in your logic toolbar to insert an AND logic operation before your assignment block.

8	> = 1	??	۰	-01	↦	-[*]
•	Nota AND loc	nic ope	Me	norva (Shift	+F21	atic_start_stop and control of the conveyor motor in automatic mode
	Comm					
					Convey motor utoma mode	r tic
					=	
						-

→ Use drag & drop to move input parameter #Enable\_OK onto the second input of the & logic operation <??.?>. (→ 
Enable\_OK)



→ Use drag & drop to move the Set/reset flip-flop function ISR from the list of instructions under → Basic instructions → Bit logic operations onto the first input of the & operation I.
 (→ Instructions → Basic instructions → Bit logic operations → ISR → I)

FB_Proc	pramming      CPU_1214C [CPU	1214C DU	DODC] • P	rogram bloc	ks MOTO	K_AUT		_ # #×	Instructions	
									Options	
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MOTOR	AUTO								> Favorites	
Name		Data type	Default value	Retain	Accessible f	Writa	Visible in	Setpoint	✓ Basic instructions	
	Automatic_mode_active	Bool	false	Non-retain						Des
-51 =	Start	Bool	false	Non-retain					General	Des
	Stop	Bool	false	Non-retain						
	Enable_OK	Bool	false	Non-re 💌						AN
	Safety_shutoff_active	Bool	false	Non-retain					€ >1	OR
	<add new=""></add>								E x	EXC.
🕣 🔻 Ou	itput									Ass.
- 🗠 -	Conveyor_motor_automatic_mode	Bool	false	Non-retain						Ne
•	<add new=""></add>								THE CONTRACT OF CONTRACT.	Res
<	<b>.</b>	12						>	E -[S]	Set
	1 1 1 1 1 1		have been						E SET BF	Set .
& >=1	??] ⊣ –이 ↦ -[=]								E RESET BF	Res
Comme									E SR	Set/
Comme	nt							-	E RS	Res
									E - P -	Sca.
	#	Conveyor_							E - N -	Sca.
	-	motor_ utomatic							E -[P]-	Set.
	8	mode							E -[N]-	Set.
	?.? -	-						=	P_TRIG	Sca.
#Fi	nable OK - *	-						-	N_TRIG	Sca.
									R_TRIG	Det.
									F_TRIG	Det

→ The SR flip-flop requires a memory tag. For this, use drag & drop to move static parameter #Memory\_automatic\_start\_stop onto the <??.?> above the SR flip-flop.

 $(\rightarrow \blacksquare Memory\_automatic\_start\_stop)$ 

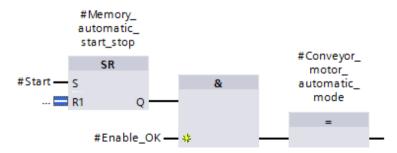
-	1000			Data ty	pe	Default value	Retain	Accessible f	writa	visible in	Setpoint	1
			Conveyor_motor_automatic_mode	Bool		false	Non-retain					1
0			<add new=""></add>									
1		•	InOut									
2		=	<add new=""></add>									1
3 ┥	0	•	Static									1
4	0		Memory_automatic_start_stop	Bool		false	Non-re 💌					
5			<add new=""></add>									
6	0	•	Temp									
7			<add new=""></add>									
1	<	-	C	12		101					>	-
_		-			_							
2	>	= 1	'???' ⊣ -0  ↦ -[=]									
	Co	omn	nent									-
			<22.2×									
			SR			#Conve	eyor_					10

For unrestricted use in educational and R&D institutions. © Siemens AG 2017. All rights reserved. SCE\_EN\_031-200 FB-Programming S7-1200\_R1709 → The #Memory\_automatic\_start\_stop will be set with input tag #Start. Click twice on the S input of the SR flip-flop <??.?> and enter "Start" in the field that appears in order to see a list of available tags starting with "Start".Click the #Start tag and apply with → Enter.
(→ SR flip-flop → <??.?> → Start → #Start → Enter)

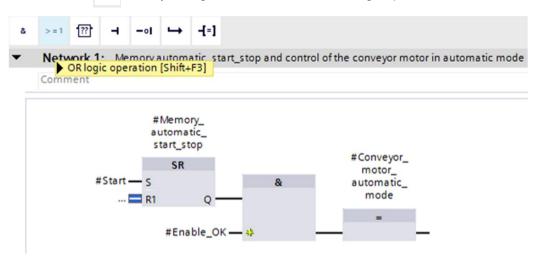
			R_AU						🗆 😰 🥙 🤇						4
		Nar	ne					Data type	Default value	Retain	Accessible f	Writa	Visible in	Setpoint	1
	-	•	Input												1
			Aut	omati	ic_mod	le_act	ive	Bool	false	Non-retain					
	-		Star	rt				Bool	false	Non-retain					
	-		Sto	р				Bool	false	Non-retain					ł
	-0		Ena	ble_0	ОК			Bool	false	Non-retain					
	-		Safe	ety_sh	nutoff_a	active		Bool	false	Non-retain					
			<ad< td=""><td>d nev</td><td>N&gt;</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></ad<>	d nev	N>										
	-	•	Output												
	-		Con	iveyor	r_moto	r_auto	matic_mode	Bool	false	Non-retain					
~	<	-												>	
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2	>	= 1	??	-	-01	$\mapsto$	-[=]								
					au	Memo utoma tart_st	tic_		#Conve	evor					
ł	-	-				SR			moto	or_					
	Star	t			1 5			&	autom	atic_					

**Note:** When assigning tags in this way, there is a risk of a mix-up with the global tags from the tag table. The previously presented procedure using drag & drop from the interface description should therefore be used preferentially.

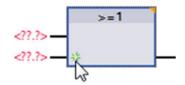
→ Multiple conditions are to be able to stop the conveyor. An OR block is therefore needed at the R1 input of the SR flip-flop. First, click the R1 input of the SR flip-flop so that the input line has a blue background.



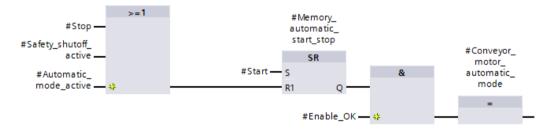
 $\rightarrow$  Click the >=1 con in your logic toolbar to insert an OR logic operation.



→ The OR block has 2 inputs initially. In order to logically combine an additional input tag, click the yellow star <sup>3</sup>/<sub>2</sub> of your OR block.



→ Add input tags #Stop, #Safety\_shutoff\_active and #Automatic\_mode\_active to the 3 inputs of the OR block.



→ Negate the input connected to parameter #Automatic\_mode\_active by selecting it and clicking -•1

>=1 ???	• → -[=]			
Network 1: Memo	Invert RLO [Ctrl+Shift-	eand control of the conveyor mot	or in automatic mode	1
#Stop — #Safety_shutoff_ active — #Automatic_ mode_active —	>=1 *	#Memory_ automatic_ start_stop #Start — S R1 0	&	#Conveyor_ motor_ automatic_ mode

→ Do not forget to click Save project regularly. The finished function block "MOTOR\_AUTO" [FB1] in FBD is shown below.

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			ame						Data ty	pe	Default value	Retain	Accessible f	Writa	Visible in	Setpoir	2
				put					100000	-							
	- 3	•				c_mod	de_act	ive	Bool			Non-re 💌					
		•		Sta					Bool		false	Non-retain					
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5		•			able_0				Bool		false	Non-retain				_	
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		•			ld nev	V>											
3		•		utpu													
	1			Cor	iveyo	_moto	or_auto	omatic_mode	Bool		false	Non-retain					
		٤															>
•			etw	ork 1	: M	emory	autom	atic_start_sto	p and c	ontr	ol of the conve	yor motor in au	utomatic mode	:			
		#5	# A	ty_sh a utom	#Stop utoff_ active natic_		>=1			#St	#Mem autom start_s sart — s R1	atic_ top	&	au	onveyor_ notor_ tomatic_ mode		

For unrestricted use in educational and R&D institutions. © Siemens AG 2017. All rights reserved. SCE\_EN\_031-200 FB-Programming S7-1200\_R1709 → Under "General" in the properties of the block, you can change the "Language" to LAD (Ladder Logic) (→Properties → General → Language: LAD)

MOTOR_AUTO [FB1]			roperties 🗓 Info 追 🗓 Diag	nostics
General FB supervisio	n definitions			
General Information	General			
Time stamps				
Compilation		Name:	MOTOR_AUTO	
Protection	•	Type:	FB	
Attributes Download without reinitializati		Language:	FBD	<b>•</b>
Download without reinitializati		Number:	LAD FBD	
			() Manual	
			Automatic	

 $\rightarrow$  The program has the following appearance in LAD.

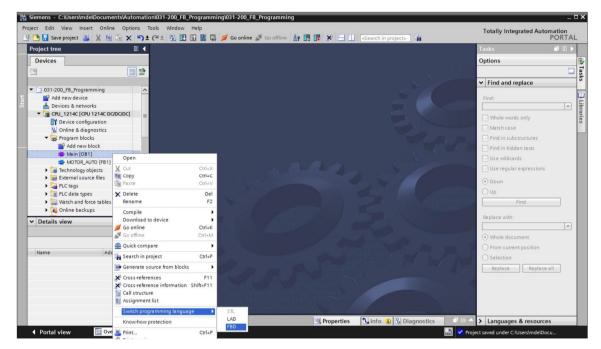
Imput       Imput <td< th=""><th>MO</th><th>Ma</th><th>ime</th><th>Data tune</th><th>Default value</th><th>Retain</th><th>Accessible f</th><th>Write</th><th>Visible in</th><th>Setnoin</th><th>4</th></td<>	MO	Ma	ime	Data tune	Default value	Retain	Accessible f	Write	Visible in	Setnoin	4
Automatic_mode_active Bool is false Non-ret     Automatic_mode_active Bool is false Non-retain     Automatic_mode_active Bool false Non-retain     Automatic_start_stop     Bool false Non-retain     Automatic_mode Bool false Non-retain     Automatic_start_stop Bool false Non-retain     Automatic_start_stop Bool false Non-retain     Automatic_start_stop Bool false Non-retain     Automatic_start_stop is set with the input Start, but only if the reset conditions     the bit Memory_automatic_start_stop is reset with the input Start, but only if the reset conditions     the bit Memory_automatic_start_stop is reset with the input Start, but only if the reset conditions     the bit Memory_automatic_start_stop is set with the input Start, but only if the reset conditions     tort saltad     tort saltad				Dote type	Deladit volue	Netoni				Seepon	Î
■ Start       Bool       false       Non-retain       Image: Conveyor in the start in the input Start, but only if the reset conditions regranted and emory. Sutomatic_start_stop is set with the input Start, but only if the safety shutoff is the enable control of the conveyor motor in automatic_start_stop is set with the input Start, but only if the safety shutoff is the enable conditions are granted and emory. Sutomatic_start_stop is set with the input Start, but only if the safety shutoff is this the enable conditions are granted and emory. Sutomatic_start_stop is set with the input Start, but only if the safety shutoff is this the end to false emory. Sutomatic_start_stop is set with the input Start, but only if the safety shutoff is this the automatic to be is not activated (manual mode).         Network 1:       Memory_automatic_start_stop and control of the conveyor motor in automatic mode         Start       SR       #Enable_OK       #Conveyor_motor in automatic mode         mode       start.       SR       #Enable_OK       mode	_			Bool 🗐	false	Non-re					
■ Stop       Bool       false       Non-retain       ✓       ✓         ■ Enable_OK       Bool       false       Non-retain       ✓       ✓       ✓         ■ Safety_shutoff_active       Bool       false       Non-retain       ✓       ✓       ✓         ■ Add news       ■       ■       ■       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓       ✓					,			-			
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■ Safety_shutoff_active       Bool       false       Non-retain       Image: Conveyor_motor_automatic_mode         ■ Conveyor_motor_automatic_mode       Bool       false       Non-retain       Image: Conveyor_motor_automatic_mode         ■ Conveyor_motor_automatic_mode       Bool       false       Non-retain       Image: Conveyor_motor_automatic_star_stop         ■ Nemory_automatic_star_stop       Bool       false       Non-retain       Image: Conveyor_motor_automatic_star_stop         ■ Memory_automatic_star_stop is set with the input Start, but only if the reset conditions       Image: Conveyor_automatic_star_stop is set with the input Start, but only if the reset conditions       Image: Conveyor_automatic_star_stop is set with the input Start, but only if the reset conditions         ■ bit Memory_automatic_start_stop is not activated (manual mode).       Image: Conveyor_automatic_star_stop is reset with the input Start, but only if the reset conditions         Wemory_automatic_start_stop is set the output Conveyor_motor_automatic_mode is activated.         Network 1:       Memory_automatic_start_stop and control of the conveyor motor in automatic mode         Comment       #Memory_automatic_start_stop and control of the conveyor motor in automatic mode         #Start       SR       #Enable_OK       Image: Conveyor_motor_automatic_mode         #Start       SR       #Enable_OK       Image: Conveyor_motor_automatic_mode         #Start       SR	_						-	-		- H	
<ul> <li>Add news</li> <li>Conveyor_motor_automatic_mode</li> <li>Conveyor_motor_automatic_mode</li> <li>Add news</li> <li>Add news</li> <li>Add news</li> <li>Static</li> <li>Memory_automatic_start_stop</li> <li>Bool</li>     &lt;</ul>	_										
Output Conveyor_motor_automatic_mode Bool false Non-retain Non-			57								
Conveyor_motor_automatic_mode Bool false Non-retain     Add news     Add news     Add news     Add news     Add news     Static     Memory_automatic_start_stop Bool false Non-retain     Memory_automatic_start_stop Bool false Non-retain     Memory_automatic_start_stop is set with the input Start, but only if the reset conditions e not Milled. e bit Memory_automatic_start_stop is reset with the input Start, but only if the reset conditions e not Milled. be bit Memory_automatic_start_stop is reset with the input Start, but only if the reset conditions e not Milled. be bit Memory_automatic_start_stop is reset with the input Stop or if the safety shutoff is tivated or if the automatic mode is not activated (manual mode). Memory_automatic_start_stop is set, the enable conditions are granted and emory_conveyor_start_stop is set the output Conveyor_motor_automatic_mode is activated.  Network 1: Memory automatic_start_stop and control of the conveyor motor in automatic mode comment     #Memory_automatic_start_stop and control of the conveyor motor in automatic mode     start_stop     #Start     SR     #Enable_OK     mode     mode	•	-					Ä	Ä			
Add news <td></td> <td></td> <td></td> <td>Bool</td> <td>false</td> <td>Non-retain</td> <td></td> <td></td> <td></td> <td></td> <td></td>				Bool	false	Non-retain					
Inout Add news Add news Static Memory_automatic_start_stop Bool Bool False Non-retain Non-retain Non-retain Image: Static Non-retain Image: Static							- A				
<ul> <li>Add news</li> <li>Static</li> <li>Memory_automatic_start_stop</li> <li>Bool</li> <li>Block</li> <li>Hemory_automatic_start_stop</li> <li>Hemory_automatic_start_stop is set with the input Start, but only if the reset conditions</li> <li>e bit Memory_automatic_start_stop is set with the input Start, but only if the reset conditions</li> <li>e bit Memory_automatic_start_stop is set with the input Start, but only if the reset conditions</li> <li>e bit Memory_automatic_start_stop is set with the input Start, but only if the reset conditions</li> <li>e bit Memory_automatic_start_stop is set with the input Start, but only if the safety shutoff is</li> <li>trivated or if the automatic mode is not activated (manual mode).</li> <li>Memory_automatic_start_stop is set, the enable conditions are granted and</li> <li>emory_conveyor_start_stop is set the output Conveyor_motor_automatic_mode is activated.</li> </ul> Network 1: Memory automatic_start_stop and control of the conveyor motor in automatic mode Comment           # Memory	•	•					- A				
Memory_automatic_start_stop          Bool       false       Non-retain       Image: Construct of the start_stop         All							- A		Ä		
★ Conveyor_ automatic_start_stop is set with the input Start, but only if the reset conditions e not fulled. e bit Memory_automatic_start_stop is reset with the input Start, but only if the reset conditions e not fulled. e bit Memory_automatic_start_stop is reset with the input Stop or if the safety shutoff is trivated or if the automatic mode is not activated (manual mode). Memory_automatic_start_stop is set, the enable conditions are granted and emory_conveyor_start_stop is set the output Conveyor_motor_automatic_mode is activated.          Network 1:       Memory_automatic_start_stop and control of the conveyor motor in automatic mode comment         # Memory_automatic_start_stop       # Conveyor_motor_ automatic_ start_stop         # Start       SR         # Stop       # Enable_OK	•	•	Static				i i				
Image:			Memory_automatic_start_stop	Bool	false	Non-retain					i
Image: Start_stop       Image: Start_stop         #Start       SR         #Stop       #Enable_OK	1		- 1.1		100				-	13	į
#Memory_ automatic_ start_stop #Start SR #Enable_OK mode #Stop #Stop	e b e b e b tiva	eyo it I ot f it I ate	title: Motor control in automatic mode or motor in automatic mode: Memory_automatic_start_stop is set with fufiled. Memory_automatic_start_stop is reset w d or if the automatic mode is not activat ry_automatic_start_stop is set, the enab	n the input s ith the inpu ed ( manua le condition	it Stop or if the I mode). Ins are granted i	safety shutoff and	is				
#Stop	Bioc onve e b e no e b triva Mer emo	ck eyd it I ot f it I ate mo ory	title: Motor control in automatic mode or motor in automatic mode: Memory_automatic_start_stop is set with fufiled. Memory_automatic_start_stop is reset w do rif the automatic mode is not activat ry_automatic_start_stop is set, the enab _conveyor_start_stop is set the output C	n the input s ith the inpu ed ( manua le condition onveyor_mo	at Stop or if the I mode). Is are granted a otor_automatic	safetyshutoff and _mode is acti	is vated.	e			
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For unrestricted use in educational and R&D institutions. © Siemens AG 2017. All rights reserved. SCE\_EN\_031-200 FB-Programming S7-1200\_R1709

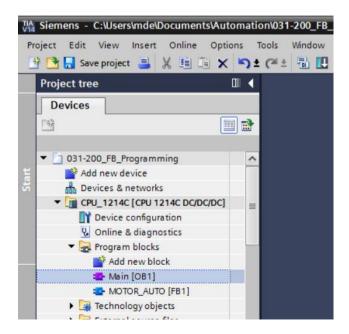
# 7.8 Program the organization block OB1 – Control conveyor tracking forwards in automatic mode

→ Before programming organization block "Main [OB1]", we switch the programming language to FBD (Function Block Diagram). To do so, first click on "Main [OB1]" in the "Program blocks" folder.

(→ CPU\_1214C [CPU 1214C DC/DC/DC] → Program blocks → Main [OB1] → Switch programming language → FBD)



 $\rightarrow$  Open the "Main [OB1]" organization block with a double-click.



→ Assign Network 1 the name "Control conveyor tracking forwards in automatic mode" (→ Network 1:... →Control conveyor tracking forwards in automatic mode)

		× ≞ ∋in		J-010101 -		생생왕 두너날 두 아이 아이 아이들 글
			me	Data type	Default value	Comment
i		-	Input			
2			Initial_Call	Bool		Initial call of this OB
3	-		Remanence	Bool		=True, if remanent data are available
4		-	Temp			
5			<add new=""></add>			
5		-	Constant			
7			<add new=""></add>			
	<	1			111	
	Blo	>=1	title: "Main Program Sweep	<u>.</u>		
•		Net	work 1: Control conveyor m	notor forwards in au	utomatic mode	
			ment			

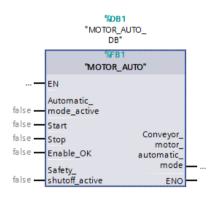
→ Use drag & drop to move your "MOTOR\_AUTO [FB1]" function block onto the green line in Network 1.

Siemens - C:\Users\mde\Documents\Automati		_rb_rrogramming				- 0
Project Edit View Insert Online Options		ne 🖉 Go offline 🕌 🖪 🖪	🗶 🖃 🛄 - Search in project> 🖬		Totally Integrated Automa P(	tion ORTAL
Project tree 🛛 🕄 🗸	031-200_FB_Programming + CPU	_1214C [CPU 1214C DC/DC/	DC] ▶ Program blocks ▶ Main [OB1]	_ # = ×	Instructions	
Devices					Options	
19 E	B B 2 2 2 4 1 1 2 2 2 2 3 4 1 2 2 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 1 2 3 4 1 1 2 3 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	8: 2: 8: 5 0 e	°େ ੴ ∰ ♥ ⊊ I= I= I= 61 01 0° ??		ini *	
	Main				> Favorites	
O31-200_FB_Programming	Name	Data type Default v	alue Comment		Basic instructions	_
Add new device	1 📲 🕶 Input					Descri
🚠 Devices & networks	2 - Initial_Call	Bool	Initial call of this OB		General	
CPU_1214C [CPU 1214C DC/DC/DC] =	3 🕣 🔹 Remanence	Bool	=True, if remanent data are available		General     General     General     General     General	
Device configuration	4 🕣 🕶 Temp				G Timer operations	
😓 Online & diagnostics	5 Add news				Inner operations     Inner operations	
<ul> <li>Program blocks</li> </ul>	6 🔄 🕶 Constant				Comparator operations	
Add new block	7 • <add new=""></add>				Math functions	-
🖀 Mein [OB1]	<			>		
MOTOR_AUTO [FB1]		hard her	• 0]		Conversion operations	
Technology objects	& >=1 [??] -I -oI → -[=]	1			Program control operati	
External source files					Word logic operations	
PLC tags	<ul> <li>Block title: "Main Program Sweep (</li> </ul>	Cycle)*			Shift and rotate	
PLC data types	Comment				· H shint and rotate	
Watch and force tables	<ul> <li>Network 1: Control conveyor mo</li> </ul>	tor forwards in automatic mode				
🕨 🙀 Online backups		tor ionverus in eutomatic moor				i
✓ Details view	Comment					
	- MOTOR_AUTO [	F81]				
Name Address						
					< =	>
					> Extended instructions	
					> Technology	
			100%		> Communication	
		9	Properties 1 Info 1 Diagnostics	- B -	> Optional packages	
Portal view	Main (OB1)			📑 i The	programming language of the sele	

 $\rightarrow$  The instance data block for this call of FB1 is created automatically. Assign a name and apply it with OK. ( $\rightarrow$  MOTOR\_AUTO\_DB1  $\rightarrow$  OK)



→ A block with the interface you defined, the instance data block and connections EN and ENO are inserted in Network 1.



→ To insert an AND before input parameter "Enable\_OK", select this input and insert the AND

).

by clicking th	ne icon ir	n your logic to	colbar ( $\rightarrow$
AND logic operation [S Comment	••I → -[=] hift+F2] veep (Cycle)*		node
	%DB1 *MOTOR_AI DB* %FB1 *MOTOR_A	-	
false false false	Automatic_ mode_active Start	Conveyor_ motor_ automatic_ mode — ENO —	

→ To connect the block to the global tags from "Tag\_table\_sorting\_station", we have two options:

Either select the "Tag\_table\_sorting\_station" in the project tree and use drag & drop to move the desired global tag from the Details view to the interface of FC1 ( $\rightarrow$  Tag\_table\_sorting\_station  $\rightarrow$  Details view  $\rightarrow$  -S0  $\rightarrow$  Automatic\_mode\_active)

	😽 Defau	all tags ew tag table It tag table [28] ble_sorting station [28	31	•	Comment				%DE	
~ 1	Details view	·							*MOTOR DB %FE	31
N	Name	Data type	Details						"MOTOR	_AUTO
01	-Q2	Bool	%Q0.1	^						
01	-Q3	Bool	%Q0.2					falca	Automatic_ mode_active	
01	-50	Bool	%IO.2	·			2			
01	-51	Bool	%10.3		?.?</td <td>&amp;</td> <td></td> <td>false -</td> <td></td> <td>Conveyor_</td>	&		false -		Conveyor_
01	-52	Bool	%10.4					false -		motor_
01	-53	Bool	%11.4		!.!</td <td>&gt; *</td> <td></td> <td></td> <td>Enable_OK</td> <td>automatic_ mode</td>	> *			Enable_OK	automatic_ mode
01	-54	Bool	%11.5	=				6100	Safety_	
01	-55	Bool	%11.6					taise -	shutoff_active	ENO
01	-56	Bool	%11.7							

 $\rightarrow$  Or, enter the starting letters (e.g. "-S") of the desired global tag for <???> and select the global input tag "-S0" (%I0.2) from the displayed list

 $(\rightarrow Automatic\_mode\_active \rightarrow -S \rightarrow -S0).$ 

& >=1 [??] ⊢ −oI ↦ ⊢[=]

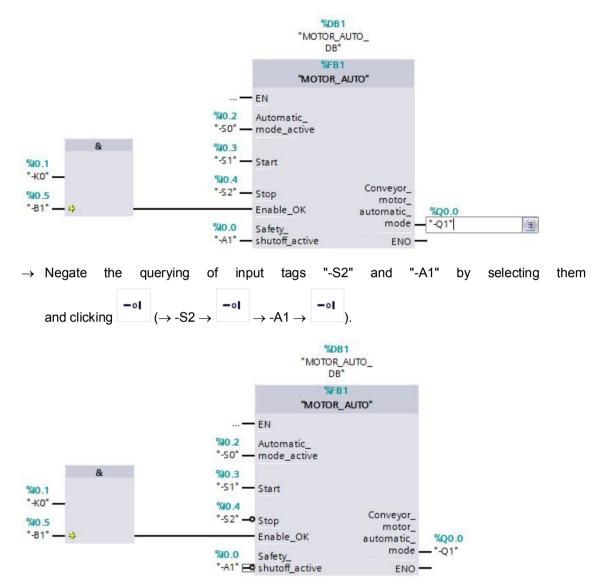
Block title: "Main Program Sweep (Cycle)"

Comment

🕶 🔀 Network 1: 🛛 Control conveyor motor forwards in automatic mode

		%DB1 "MOTOR_AUTO DB"	_		
		%FB1 "MOTOR_AUTO	-		
	EN				
s	🔳 mode	_active			
s 	N	_active Bool	%10.2	mode selector	1
·	iii mode		%I0.2 %I0.3	mode selector pushbutton aut	-
· *-S0*	N	Bool			H

→ Insert the other input tags "-S1", "-S2", "-K0", "-B1" and "-A1" and then insert output tag "-Q1" (%Q0.0) at output "Conveyor\_motor\_automatic\_mode".



### 7.9 Result in the LAD (Ladder Logic) programming language

The result in the LAD (Ladder Logic) programming language has the following appearance.

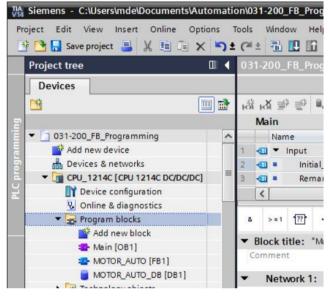
031-200_FB_Programming      CPU_121	4C [CPU 1214C DC/DC/DC	[] 🕨 Program blocks 🕨 Ma	in [OB1] 🛛 🗕 🖬 🗮 🗙
🚜 🥩 👻 💺 🖿 🚍 💬 🕾 ±	a ± 별 ± 🖃 😥 🥙 🤇	🛛 🖑 🐨 🤣 📢 🖏 🖏	위 한 😵 📽 🔒 📑
	Block interfac		
⊣⊢⊣/⊢−)⊢ ഈ ↦ ᅼ			
<ul> <li>Network 1: Control conveyor motor for</li> </ul>	rwards in automatic mode		^
Comment			
	%DB1		
	"MOTOR_AUTO_ DB"		
	%FB1		
	"MOTOR_AUTO"		
	EN	ENO	
%0.2	Automatic	nveyor_ motor_	=
-50 <b>-</b> %0.3	mode_active auto	matic_ %Q0.0 mode	
*-S1*	Start		
%40.4			
*-52*			
<del>  - И</del>	Stop		
940.1 940.5			
"-КО" "-В1"			
	Enable_OK		
%40.0 "-A1"			
	Safety_ shutoff_active		
		100%	×
		100%	▼

### 7.10 Save and compile the program

 $\rightarrow$  To save your project, select the  $\square$  Save project button in the menu. To compile all blocks,

click the "Program blocks" folder and select the 🛅 icon for compiling in the menu

 $(\rightarrow \square$  Save project  $\rightarrow$  Program blocks  $\rightarrow \square$ ).



 $\rightarrow$  The "Info", "Compile" area shows which blocks were successfully compiled.

General (1) Cross-refere	ences Compile	Energy Suite	Syntax				
3 🚹 🜖 Show all messages							
Compiling finished (errors: 0; wa	arnings: 0)						
Path	Description		Go to	?	Errors	Warnings	Time
CPU_1214C			7		0	0	2:52:35 PM
<ul> <li>Program blocks</li> </ul>			7		0	0	2:52:35 PI
MOTOR_AUTO (FB1	) Block was succes	sfully compiled.	~				2:52:35 PM
Main (OB1)	Block was succes	sfully compiled.	~				2:52:36 PI

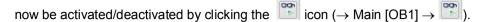
### 7.11 Download the program

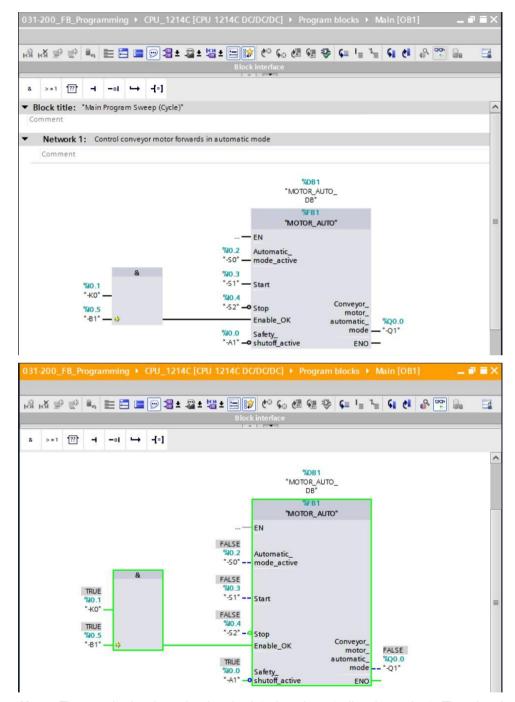
→ After successful compilation, the complete controller with the created program, as previously described in the modules for hardware configuration, can be downloaded
 (→ □).

Ma Siemens - C:\Users\mde\Documents\Automation	\031-200_FB_Programming\031-200_FB_Programming	_ ¤ ×
Project Edit View Insert Online Options Too	ols Window Help	Totally Integrated Automation
📑 🎦 🔜 Save project 🚢 💥 🗐 🗐 🗙 🍤 ± (	🝽 🗄 🔃 🕼 🔡 📪 💋 Go online 🖉 Go offline 🎄 🖪 🧗 🛠 🚽 🔢	PORTAL
	)31-200_FB_Programming → CPU_1214C [CPU 1214C DC/DC/DC] → Program blocks → Main [OB1] 🛛 🗕 🖬 🚍 🏷	Instructions
Devices		Options
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### 7.12 Monitor program blocks

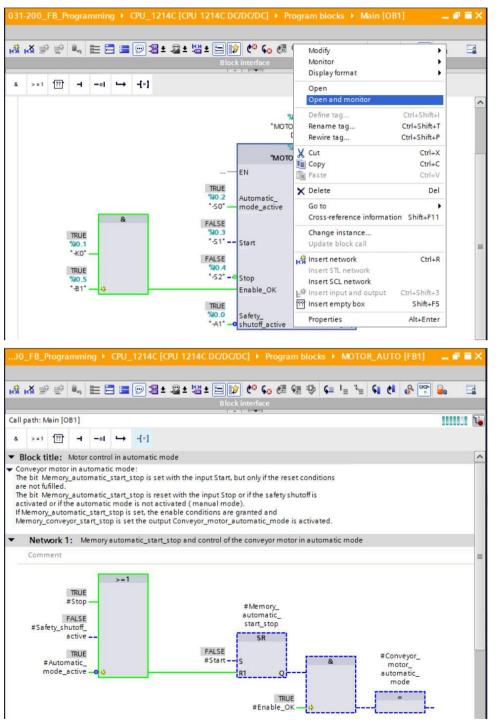
 $\rightarrow$  The desired block must be open for monitoring the downloaded program. The monitoring can





**Note:** The monitoring here is signal-related and controller-dependent. The signal states at the terminals are indicated with TRUE or FALSE.

→ The "MOTOR\_AUTO" [FB1] function block called in the "Main [OB1]" organization block can be selected directly for "Open and monitor" after right-clicking (→ "MOTOR\_AUTO" [FB1] → Open and monitor).



**Note:** The monitoring here is function-related and controller-independent. The actuation of sensors and the station status are shown here with TRUE or FALSE.

→ If a particular point of use of a "MOTOR\_AUTO" [FB1] function block that is called multiple times is to be monitored, this can be performed using the icon. There are two alternatives available for specifying the call environment: using the call environment or the instance data block (→ → Instance data block → MOTOR\_AUTO\_DB1 [DB1] → Call environment → Address: OB1 → Details: Main NW1 → OK).

) Non	-		
Inst	ance data block		
M	DTOR_AUTO_DB [DB1]		
) Call	environment		
E	Dependency structure	! Address	Details
1	Main ("MOTOR_AUTO_DB")	OB1	@Main > NW1 (Control conveyor motor forwards in automatic mo
2			
-			
			Transfer to "adjusted manually"
Man	ually adjusted call environment		
			OK Canc
	vironment of block	_	OK Cance
Non		-	OK Cance
) Non ) Insti	e		OK Cance
Non Insta	e ance data block		OK Cance
Non Insta	e ance data block DTOR_AUTO_DB [DB1]	1 Address	OK Cence Details
) Non ) Instr MC ) Call	e ance data block otoR_AUTO_D8 [D81] environment	I Address OB1	Details
) Non ) Instr MC ) Call	e ance data block DTOR_AUTO_DB [DB1] environment Dependency structure		Details
) Non ) Instr MC ) Call	e ance data block DTOR_AUTO_DB [DB1] environment Dependency structure		Details
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) Non ) Instr MC ) Call	e ance data block DTOR_AUTO_DB [DB1] environment Dependency structure		Details @Main ► NW1 (Control conveyor motor forwards in automatic mo
) Non ) Instr Call	e ance data block DTOR_AUTO_D8 [DB1] environment Dependency structure at Main ("MOTOR_AUTO_D8")		Details
) Non ) Instr (MC Call 1 2	e ance data block DTOR_AUTO_DB [DB1] environment Dependency structure		Details @Main ► NW1 (Control conveyor motor forwards in automatic mo
) Non ) Instr Call	e ance data block DTOR_AUTO_D8 [DB1] environment Dependency structure at Main ("MOTOR_AUTO_D8")		Details @Main ► NW1 (Control conveyor motor forwards in automatic mo
) Non ) Instr (MC Call 1 2	e ance data block DTOR_AUTO_D8 [DB1] environment Dependency structure at Main ("MOTOR_AUTO_D8")		Details @Main ► NW1 (Control conveyor motor forwards in automatic mot

### 7.13 Archive the project

→ As the final step, we want to archive the complete project. Select the → "Archive ..." command in the → "Project" menu. Select a folder where you want to archive your project and save it with the file type "TIA Portal project archive". (→ Project → Archive → TIA Portal project archive → 031-200\_FB Programming.... → Save)

Siemens - C:\Users\mde\Documents\Autor	ation\031-200_FB_Programming\031-200_FB_Programming	×
Project Edit View Insert Online Option	Tools Window Help ) ± C <sup>all</sup> ± 🗓 🔃 🔛 🔛 💋 Goonline 🖉 Gooffine 🎎 🆪 🕞 🗱 🛠 😑 🕕 ( <earch in="" projects)="" td="" 👍<=""><td>Totally Integrated Automation PORTAL</td></earch>	Totally Integrated Automation PORTAL
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Portal view     Overview	🖀 Main (OB1) 🔛 😴 Con	nection to CPU 1214C terminated.

### 7.14 Checklist

No.	Description	Completed
1	Compiling successful and without error message	
2	Download successful and without error message	
3	Switch on station (-K0 = 1) Cylinder retracted / Feedback activated (-B1 = 1) EMERGENCY OFF (-A1 = 1) not activated AUTOMATIC mode (-S0 = 1) Pushbutton automatic stop not actuated (-S2 = 1) Briefly press the automatic start pushbutton (-S1 = 1) Conveyor motor forwards fixed speed then switches on (-Q1 = 1) switches on and stays on.	
4	Briefly press the automatic stop pushbutton (-S2 = 0) $\rightarrow$ -Q1 = 0	
5	Activate EMERGENCY OFF (-A1 = 0) $\rightarrow$ -Q1 = 0	
6	Manual mode (-S0 = 0) $\rightarrow$ -Q1 = 0	
7	Switch off station (-K0 = 0) $\rightarrow$ -Q1 = 0	
8	Cylinder not retracted (-B1 = 0) $\rightarrow$ -Q1 = 0	
9	Project successfully archived	

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### 8 Exercise

### 8.1 Task – Exercise

In this exercise, an energy saving function is to be added to the MOTOR\_AUTO [FB1] function block. The expanded function block will be planned, programmed and tested:

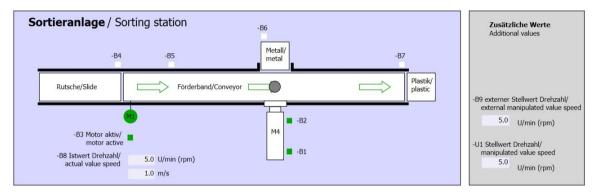
To save energy, the conveyor should only run when a part is present.

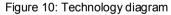
The Conveyor\_motor\_automatic\_mode output is therefore only activated when Memory\_automatic\_start\_stop is set, the enable conditions are met and Memory conveyor start stop is set.

The Memory\_conveyor\_start\_stop is set when Sensor\_chute\_occupied signals a part and is reset when Sensor\_end\_of\_conveyor produces a negative edge or safety shutoff is active or automatic mode is not activated (manual mode).

### 8.2 **Technology diagram**

Here, you see the technology diagram for the task.





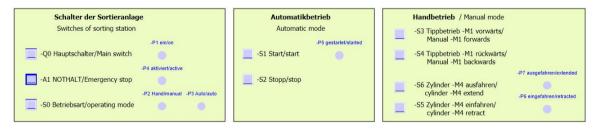


Figure 11: Control panel

### 8.3 Reference list

DI	Туре	Identifier	Function	NC/NO
I 0.0	BOOL	-A1	Return signal emergency stop ok	NC
I 0.1	BOOL	-K0	Main switch "ON"	NO
10.2	BOOL	-S0	Mode selector manual (0)/ automatic (1)	Manual = 0 Auto = 1
10.3	BOOL	-S1	Pushbutton automatic start	NO
10.4	BOOL	-S2	Pushbutton automatic stop	NC
10.5	BOOL	-B1	Sensor cylinder M4 retracted	NO
I 1.0	BOOL	-B4	Sensor at chute occupied	NO
I 1.3	BOOL	-B7	Sensor part at end of conveyor	NO

The following signals are needed as global operands for this task.

DC	)	Туре	Identifier	Function	
Q 0.	.0	BOOL	-Q1	Conveyor motor M1 forwards fixed speed	

#### Legend for reference list

DI	Digital Input	DO	Digital Output
AI	Analog Input	AO	Analog Output
I	Input	Q	Output
NC	Normally Closed		

NO Normally Open

### 8.4 Planning

Plan the implementation of the task on your own.

Note: Learn about the use of the negative edge in SIMATIC S7-1200 in the online help.

### 8.5 Checklist – Exercise

No.	Description	Completed
1	Compiling successful and without error message	
2	Download successful and without error message	
3	Switch on station (-K0 = 1) Cylinder retracted / Feedback activated (-B1 = 1) EMERGENCY OFF (-A1 = 1) not activated AUTOMATIC mode (-S0 = 1) Pushbutton automatic stop not actuated (-S2 = 1) Briefly press the automatic start pushbutton (-S1 = 1) Sensor at chute activated (-B4 = 1) Conveyor motor forwards fixed speed then switches on (-Q1 = 1) switches on and stays on.	
4	Sensor at end of conveyor activated (-B7 = 1) $\rightarrow$ -Q1 = 0	
5	Briefly press the automatic stop pushbutton (-S2 = 0) $\rightarrow$ -Q1 = 0	
6	Activate EMERGENCY OFF (-A1 = 0) $\rightarrow$ -Q1 = 0	
7	Manual mode (-S0 = 0) $\rightarrow$ -Q1 = 0	
8	Switch off station (-K0 = 0) $\rightarrow$ -Q1 = 0	
9	Cylinder not retracted (-B1 = 0) $\rightarrow$ -Q1 = 0	
10	Project successfully archived	

6

### 9 Additional information

More information for further practice and consolidation is available as orientation, for example: Getting Started, videos, tutorials, apps, manuals, programming guidelines and trial software / firmware, under the following link:

#### www.siemens.com/sce/s7-1200

#### Preview "Additional information"

- Getting Started, Videos, Tutorials, Apps, Manuals, Trial-SW/Firmware
  - ↗ TIA Portal Videos
  - TIA Portal Tutorial Center
  - > Getting Started
  - ↗ Programming Guideline
  - ↗ Easy Entry in SIMATIC S7-1200
  - > Download Trial Software/Firmware
  - ↗ Technical Documentation SIMATIC Controller
  - ↗ Industry Online Support App
  - TIA Portal, SIMATIC S7-1200/1500 Overview
  - ↗ TIA Portal Website
  - ↗ SIMATIC S7-1200 Website
  - ↗ SIMATIC S7-1500 Website

### Notes

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### Notes

# SCE Learn-/Training Textbook

# Automation System SIMATIC S7-1200



#### TIA Portal Modules from Version V14 SP1

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TIA Portal Module 011-001	
Firmware Update	
<b>TIA Portal Module 011-100</b> Unspecified Hardware Configuration	
<b>TIA Portal Module 011-101</b> Specified Hardware Configuration	
<b>TIA Portal Module 020-100</b> Process description of sorting station	4
TIA Portal Module 031-100 Basics of FC Programming	
TIA Portal Module 031-200 Basics of FB Programming	
TIA Portal Module 031-300 IEC Timers and IEC Counters	7
TIA Portal Module 031-410 Basics of Diagnostics	8
	8 9
Basics of Diagnostics TIA Portal Module 031-420	
Basics of Diagnostics TIA Portal Module 031-420 Diagnostics via Web TIA Portal Module 031-500	
Basics of Diagnostics TIA Portal Module 031-420 Diagnostics via Web TIA Portal Module 031-500 Analog Values TIA Portal Module 031-600	
Basics of Diagnostics         TIA Portal Module 031-420         Diagnostics via Web         TIA Portal Module 031-500         Analog Values         TIA Portal Module 031-600         Global Data Blocks         TIA Portal Module 041-101	

### Matching SCE Trainer Packages for these Learn-/Training Document

- SIMATIC S7-1200 AC/DC/RELAY (set of 6) "TIA Portal" Order no.: 6ES7214-1BE30-4AB3
- SIMATIC S7-1200 DC/DC/DC (set of 6) "TIA Portal" Order no.: 6ES7214-1AE30-4AB3
- Upgrade SIMATIC STEP 7 BASIC V14 SP1 (for S7-1200) (set of 6) "TIA Portal" Order no.: 6ES7822-0AA04-4YE5

Note that these trainer packages are replaced with successor packages when necessary. An overview of the currently available SCE packages is available at: <u>siemens.com/sce/tp</u>

#### **Continued training**

For regional Siemens SCE continued training, get in touch with your regional SCE contact siemens.com/sce/contact

#### Additional information regarding SCE

siemens.com/sce

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We wish to thank the TU Dresden, particularly Prof. Dr.-Ing. Leon Urbas and the Michael Dziallas Engineering Corporation and all other involved persons for their support during the preparation of

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## IEC Timers and IEC Counters Multiinstances for SIMATIC S7-1200

### 1 Goal

In this chapter, you will become acquainted with the use of single instances and multi-instances for programming of SIMATIC S7-1200 with the TIA Portal programming tool.

The module explains the various types of instance data blocks and shows step-by-step how to add IEC timers and IEC counters to a program block.

The SIMATIC S7 controllers listed in Chapter 3 can be used.

### 2 Prerequisite

This chapter builds on the FB programming for SIMATIC S7 CPU1214C. For this chapter, you can use the following project, for example:

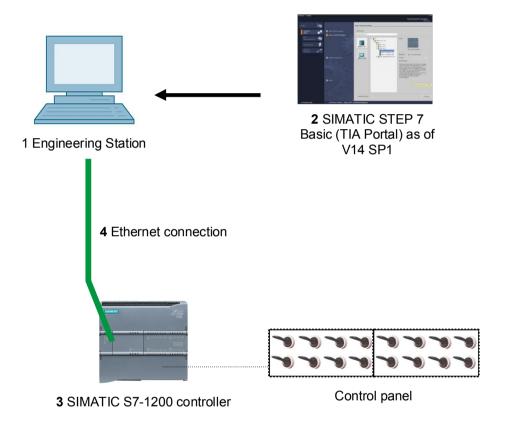
031-200\_FB-Programming\_S7-1200....zap14

### 3 Required hardware and software

- 1 Engineering station: requirements include hardware and operating system (for additional information, see Readme on the TIA Portal Installation DVDs)
- 2 SIMATIC STEP 7 Basic software in TIA Portal as of V14 SP1
- 3 SIMATIC S7-1200 controller, e.g. CPU 1214C DC/DC/DC with ANALOG OUTPUT SB1232 signal board, 1 AO Firmware as of V4.2.1

Note: The digital inputs should be fed out to a control panel.

4 Ethernet connection between engineering station and controller



### 4 Theory

### 4.1 Instances and multi-instances in SIMATIC S7-1200

The call of a function block is referred to as an **instance**. An **instance** is assigned to every call of a function block and serves as a data memory. It stores the actual parameters and the static data of the function block.

The tags declared in the function block determine the structure of the instance data block.

#### Use of single instances and multi-instances

You can assign instances as follows:

#### Call as a single instance:

- A separate instance data block for each instance of a function block

#### Call as a multi-instance:

- One instance data block for several instances of one or more function blocks

#### 4.1.1 Instance data blocks / Single instances

The call of a function block that is assigned its own instance data block is called a **single instance**.

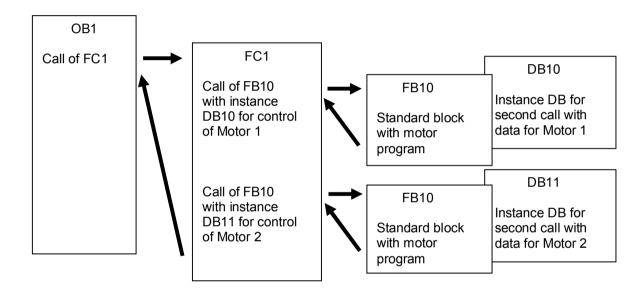
If the function block was created according to the rules for library-compatible standard blocks, it can also be called multiple times.

However, you must assign another instance data block for each call as a single instance.

#### Example of single instances:

The following figure shows the control of two motors using one function block FB10 and two different data blocks:

The different data for the individual motors, such as speed, acceleration time and total operating time, are saved in the instance data blocks DB10 and DB11.



**Note:** Some commands, such as timers and counters, behave like function blocks. When these are called, they also require an assigned memory area, e.g., in the form of an instance data block.

#### 4.1.2 Multi-instances

You may want to limit the number of data blocks used for instances or this may be necessary due to lack of memory in the utilized CPU.

If other function blocks, timers, counters, etc. that already exist are to be called in a function block in your user program, you can call these other function blocks without separate (i.e. additional) instance DBs.

Simply select 'Multi-instance' for the call options:

Call options	×
Single instance	Multiple instance         Name in the interface         The called function block saves its data in the instance data block of the calling function block and not in its own instance data block. This allows you to concentrate the instance data blocks in a single block and to get by with fewer instance data blocks in your program.         More
	OK Cancel

**Notes:** Multi-instances enable a called function block to store its data in the instance data block of the calling function block.

In this case, the calling block must always be a function block.

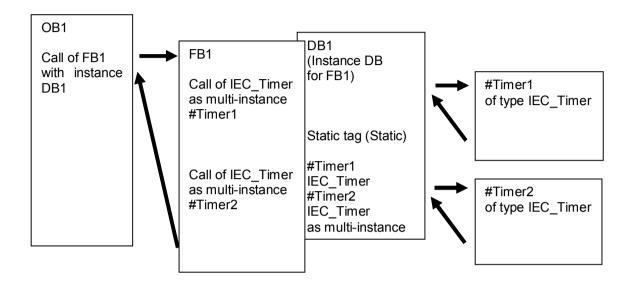
This allows you to concentrate the instance data in one instance data block and thus make better use of the number of DBs available.

Incidentally, this is always required when the calling block is to remain available for reuse as a standard block.

#### Example of multi-instances:

The following figure shows two calls of an IEC timer of type TP (pulse) within a function block.

The different data for the two counters is stored as different **multi-instances** in the instance data block DB1 of the calling function block FB1.



### 5 Task

In this chapter, an IEC timer will be added to the function block from chapter "SCE\_EN\_031-200 FB Programming S7-1200".

### 6 Planning

The IEC timer is programmed as an addition to the MOTOR\_AUTO [FB1] function block from the "031-200\_FB-Programming\_S7-1200.zap13" project. This project must be retrieved in order to now add the IEC timer TP (latching pulse). A multi-instance will be created as a memory for the timer.

### 6.1 Automatic mode - Conveyor motor with time function

The Memory\_automatic\_start\_stop is latched with Start but only if the reset conditions are not present.

The Memory\_automatic\_start\_stop is reset if Stop is present or safety shutoff is active or automatic mode is not activated (manual mode).

The Conveyor\_motor\_automatic\_mode output is activated when Memory\_automatic\_start\_stop is set, the enable conditions are met and Memory\_conveyor\_start\_stop is set.

To save energy, the conveyor should only run when a part is present.

For this reason, the Memory\_conveyor\_start\_stop is set when Sensor\_chute\_occupied signals a part and reset when Sensor\_end\_of\_conveyor produces a negative edge or safety shutoff is active or automatic mode is not activated (manual mode).

#### Addition of time function:

Because the Sensor\_end\_of\_conveyor is not able to be mounted directly at the end of the conveyor, the Sensor\_end\_of\_conveyor signal must be stretched.

To achieve this, a latching pulse will be inserted between Sensor\_end\_of\_conveyor and the negative edge detection.

### 6.2 Technology diagram

Here, you see the technology diagram for the task.

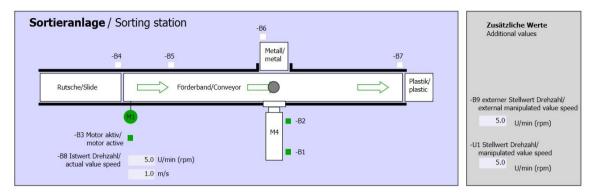


Figure 1: Technology diagram

Schalter der Sortieranlage Switches of sorting station	Automatikbetrieb Automatic mode	Handbetrieb / Manual mode -53 Tippbetrieb -M1 vorwärts/ Manual -M1 forwards
-Pt einfon -Q0 Hauptschalter/Main switch -P4 aktiviet/active -A1 NOTHALT/Emergency stop	-P5 gestarte/started -S1 Start/start	-S4 Tippbetrieb -M1 rückwärts/ Manual -M1 backwards -P7 ausgefahren/extended
-P2 Hand/manual -P3 Auto/auto		

Figure 2: Control panel

### 6.3 Reference list

DI	Туре	Identifier	Function	NC/NO
I 0.0	BOOL	-A1	Return signal emergency stop ok	NC
I 0.1	BOOL	-K0	Main switch "ON"	NO
I 0.2	BOOL	-S0	Mode selector manual (0)/ automatic (1)	Manual = 0 Auto = 1
1 0.3	BOOL	-S1	Pushbutton automatic start	NO
I 0.4	BOOL	-S2	Pushbutton automatic stop	NC
I 0.5	BOOL	-B1	Sensor cylinder M4 retracted	NO
I 1.0	BOOL	-B4	Sensor at chute occupied	NO
l 1.3	BOOL	-B7	Sensor part at end of conveyor	NO

The following signals are needed as global operands for this task.

DO	Туре	Identifier	Function	
Q 0.0	BOOL	-Q1	Conveyor motor M1 forwards fixed speed	

#### Legend for reference list

DI	Digital Input	DO	Digital Output
AI	Analog Input	AO	Analog Output
I	Input	Q	Output
NC	Normally Closed		

NO Normally Open

### 7 Structured step-by-step instructions

You can find instructions on how to carry out planning below. If you already have a good understanding of everything, it will be sufficient to focus on the numbered steps. Otherwise, simply follow the detailed steps in the instructions.

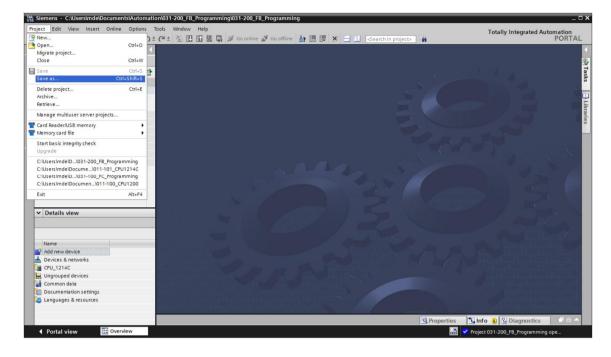
### 7.1 Retrieve an existing project

→ Before we can expand the "MOTOR\_AUTO [FB1]" function block, we must retrieve the "031-200\_FB-Programming\_S7-1200.zap14" project from chapter "SCE\_EN\_031-200 FB Programming S7-1200". To retrieve an existing project that has been archived, you must select the relevant archive with → Project → Retrieve in the project view. Confirm your selection with Open (→ Project → Retrieve → Select a .zap archive → 031-200\_FB-Programming\_S7-1200.zap14 → Open).

Project	Edit	View	Insert	Online	Options	1
New Open.		- itema			Ctrl+O	1
Close	e proj	ect			Ctrl+W	
Save					Ctrl+S	1
Savea	BS			Ctrl	+Shift+S	
Delete	e proje	ct			Ctrl+E	
Retrie	ve					
Manag	ge mul	tiuser s	erver pro	jects		
T Card F	leader	USB me	emory		•	
🍟 Memo	rycard	l file			•	
Start	oasic ii	ntegrity	check			
Upgra	de					

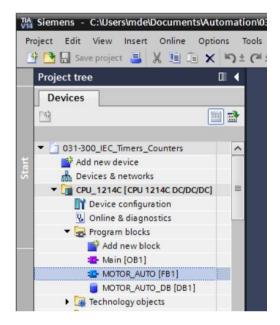
→ The next step is to select the target directory where the retrieved project will be stored. Confirm your selection with "OK".

→ Save the opened project under the name 031-300\_IEC\_Timers\_Counters  $(\rightarrow \text{Project} \rightarrow \text{Save as } ... \rightarrow 031-300\_IEC_Timers_Counters \rightarrow \text{Save})$ 

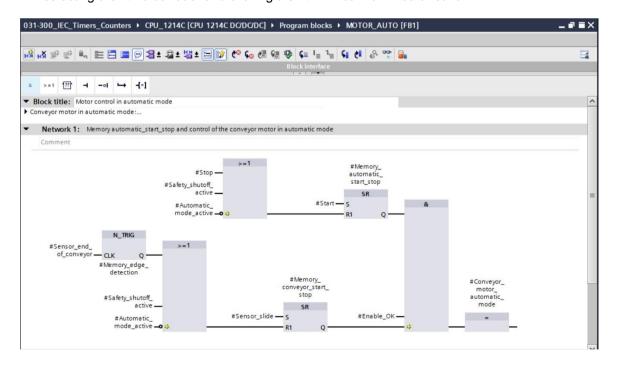


### 7.2 Addition of an IEC timer TP to function block FB1 "MOTOR\_AUTO"

 $\rightarrow$  First, open the "MOTOR\_AUTO [FB1]" function block with a double-click.



→ Insert another network at the beginning of the "MOTOR\_AUTO [FB1]" function block by selecting the  $\rightarrow$  "block title" and clicking the  $\rightarrow$   $\overrightarrow{\mathbb{M}}$  icon for "Insert network".



 $\rightarrow$  Add helpful information to the block comment and the network title of "Network 1:".



→ On the right side of your programming window, you will see the timer functions in the list of instructions. Under → Basic instructions → Timer operations, find function <sup>■</sup>TP (Generate pulse) and use a drag & drop operation to move it to Network 1 (green line appears, mouse pointer with + symbol).

 $(\rightarrow \text{Instructions} \rightarrow \text{Basic instructions} \rightarrow \text{Timer operations} \rightarrow \textcircled{} \rightarrow \textcircled{}$ 

EC	_1 mer	s_Counters      CPU_1	214C [CPU 1214C		rogram blo	ocks	S MOTOR		[וישיו]		~	Instructions	
												Options	
ăř	ι¥ ≣ <sup>3</sup>	🔊 🔍 🗮 🚍 🚍 🖗	🖻 📲 ± 📲 ± 📲 ±	🖃 🎲 🍄 🦕	. 🔠 🖼 🖣	3	<b>⊊</b> <sup>1</sup> ≣ <sup>3</sup> ≣	SI (1	0 00 ×	<b>e</b> E	4	· 10	
1	NOTOR	AUTO										> Favorites	
	Name	2	Data type	Default value	Retain		Accessible f	Writa	Visible in	Setp		✓ Basic instructions	
-	🗊 🔻 Ir	iput									^	Name	Descr.
-	<b>•</b>	Automatic_mode_act	Bool	false	Non-ret	•						General	Desci.
-	<b>•</b>	Start	Bool	false	Non-retain						=	Bit logic operations	
-	• D	Stop	Bool	false	Non-retain							Timer operations	
-		Enable_OK	Bool	false	Non-retain							TP	Gener
-		Safety_shutoff_active	Bool	false	Non-retain						]	TON	Gener
-		Sensor_slide	Bool	false	Non-retain						]	TOF	Gener
-	•	Sensor_end_of_conve	Bool	false	Non-retain						]	TONR	Time
1	<b>0</b> - 0	utput									}	[TP]-	Start .
0 4	•	Conveyor_motor_aut	Bool	false	Non-retain						~	[TON]-	Start .
	<			1111						>		[TOF]-	Start .
_	1		P 5								-	E -[TONR]-	Time .
2	> = 1	1??? • - →	-[=]									E -[RT]-	Reset
B	lock tit	le: Motor control in auto	matic mode								~	[PT]-	Load .
		notor in automatic mode:									-	Fi Counter operations	
											=	Comparator operations	
	Netw	ork 1: Overrun time en	d of conveyor pulse 2	seconds								The the second sec	
	Comm		2 1									Move operations	
	comm											Conversion operations	
۲						_						Program control operati	
												Word logic operations	
												Shift and rotate	

→ The timer function requires a memory. This memory is provided in this case within the instance data block of the function block without creating a new instance data block. Select the →"Multi-instance" option for this. Enter a name for the multi-instance and confirm with → "OK". (→ Multi-instance → IEC\_Timer\_overrun → OK)

	Multiple instance	
Single instance	Name in the interface	of the calling function block an ck. This allows you to n a single block and to get by
Parameter instance	more	
		OK Cancel

→ As a result, a tag structure of "Static" type suitable for TP Timer will be created in the interface description.

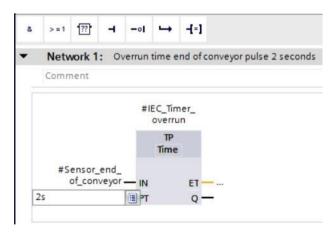
ool fai ool fai ool fai ool fai ime T#	lse No No No	ain A n-retain n-retain n-retain n-retain		Writa	Visible in	Setpoint	Comment Memory used for start' stop automatic Memory used for start' stop of convey
ool fal ool fal P_TIME T#	lse No No No	n-retain n-retain					
ool fal ool fal P_TIME T#	lse No No No	n-retain n-retain					
ool fal	lse No No	n-retain	<b></b>				Memory used for start/ stop of convey
P_TIME ime T#	No						
ime T#		n-retain					Memory used for edge detection
	Ome No						
ime T#	01115 110	n-retain		<ul> <li>Image: A start of the start of</li></ul>	Image: A start and a start		
inte in	Oms No	n-retain					
ool fa	lse No	n-retain	Image: A start and a start	<b>V</b>			
ool fa	lse No	n-retain					
		A 1					
de							
yor pulse 2 sec	onds						
d	e		e	e	e	e	e

**Note:** A multi-instance can only be used for programming within a function block because static tags are only available there.

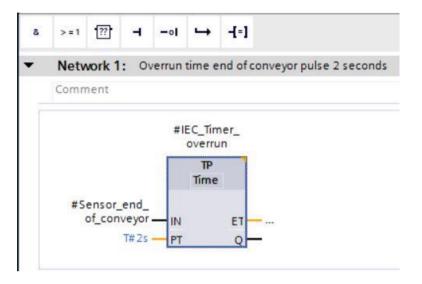
→ Use drag & drop to move input parameter #Sensor\_end\_of\_conveyor to <??.?> in front of parameter "IN" of TP Timer so that this will be started at a positive edge at input #Sensor\_end\_of\_conveyor. The best way to select a parameter in the interface description is by "grabbing" it at the blue symbol <=> (→ <=> Sensor\_end\_of\_conveyor).

M	отс	R_AUTO								
	Na	ne	Data type	Default value	Retain	Accessible f	Writa	Visible in	Setpoint	Comment
	•	Input								
	1 •	Automatic_mode_active	Bool	false	Non-retain					Automatic mode activated
-	1 =	Start	Bool	false	Non-retain					Pushbutton automatic start
	1 =	Stop	Bool	false	Non-retain					Pushbutton automatic stop
	1 =	Enable_OK	Bool	false	Non-retain					All enable conditions OK
	1 •	Safety_shutoff_active	Bool	false	Non-retain					Safety shutoff active e.g. emergency st.
	1 =	Sensor_slide	Bool	false	Non-retain					Sensor part at slide
	1 =	Sensor_end_of_conveyor	Bool	false	Non-ret					Sensor part at end of conveyor
	1 -	Output								
	1 =	Conveyor_motor_automatic	Bool	false	Non-retain					Control of the conveyor motor in auto
<										>
Blo	veyo	1     -•I     →     -[=]       title:     Motor control in automatic n       r     motor in automatic mode:								
•		work 1: Overrun time end of con ment	veyor pulse 2	2 seconds						
		#IEC_Timer_ overrun								

 $\rightarrow$  Enter the required pulse duration of 2 seconds in front of parameter "PT" ( $\rightarrow$ 2s ).

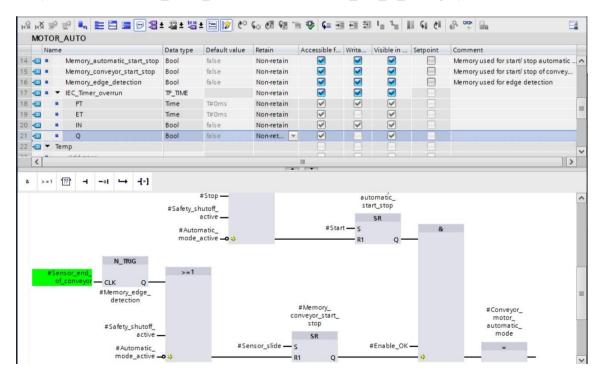


→ The entry of 2s is converted automatically to the IEC-Time format suitable for the IEC timer and is shown as constant "T#2s".



→ Now move output "Q" from tag structure "IEC\_Timer\_overrun" onto input "CLK" of negative edge "N\_TRIG" in Network 2. This will replace the #Sensor\_end\_of\_conveyor input tag previously entered there and the conveyor will be stopped by a negative edge of the IEC\_Timer\_overrun pulse.

 $(\rightarrow \text{Network } 2 \rightarrow \text{IEC}_\text{Timer}_\text{overrun} \rightarrow \text{Q} \rightarrow \text{\#Sensor}_\text{end}_\text{of}_\text{conveyor})$ 



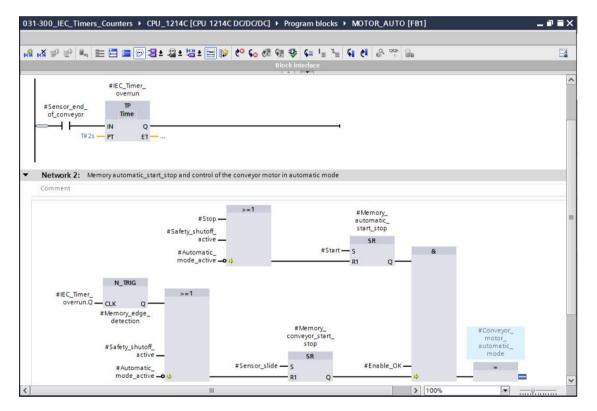
 $\rightarrow$  Do not forget to click Save project regularly. The finished function block "MOTOR\_AUTO" [FB1] with the timer is shown in FBD below.

	1	Name		Data type	Default value	Retain	Accessible f	Writa	Visible in	Setpoint	Comment
	•	<ul> <li>Input</li> </ul>									
		Au	tomatic_mode_active	Bool	false	Non-retain					Automatic mode activated
-		Sta	irt	Bool	false	Non-retain					Pushbutton automatic start
ŀ		Sto	p	Bool	false	Non-retain					Pushbutton automatic stop
		En En	able_OK	Bool	false	Non-retain					All enable conditions OK
		sa Sa	fety_shutoff_active	Bool	false	Non-retain					Safety shutoff active e.g. emergency st
			nsor_slide	Bool	false	Non-retain					Sensor part at slide
		se Se	nsor_end_of_conveyor	Bool	false	Non-retain					Sensor part at end of conveyor
,		· Outpu	t								
		Co	nveyor_motor_automatic	Bool	false	Non-retain					Control of the conveyor motor in auto
•		<ul> <li>InOut</li> </ul>									
		< <a< td=""><td>dd new&gt;</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></a<>	dd new>								
•		· Static									
			mory_automatic_start_stop	Bool	false	Non-retain					Memory used for start/ stop automatic
			mory_conveyor_start_stop	Bool	false	Non-retain				Ä	Memory used for start/ stop of convey
			mory_edge_detection	Bool	false	Non-retain				Ä	Memory used for edge detection
			_Timer_overrun	TP_TIME		Non-retain					
			PT	Time	T#Oms	Non-retain					
			ET	Time	T#Oms	Non-retain	<ul> <li>Image: A start of the start of</li></ul>				
			IN	Bool	false	Non-retain	<ul> <li>Image: A start of the start of</li></ul>				
			0	Bool	false	Non-ret 👻					
		<ul> <li>Temp.</li> </ul>	Y	0001	1013 C	Nonec					
	<						111				
			r in automatic mode: I: Overrun time end of con #IEC_Timer_ overrun TP Time		2 seconds						
	N	etwork 1	#IEC_Timer_ overrun TP Time _end	weyor pulse :							
	N	etwork 1	#IEC_Timer_ overrun TP Time _end_ iveyor _ IN ET	weyor pulse :	ontrol of the conv		utomatic mod				
	N	etwork 1 #Sensor of_cor	#IEC_Timer_ overrun TP Time _end	veyor pulse :  t_stop and ci #Safety_s #Auto	#Stop —	eyor motor in a	utomatic mod	#M au st	Vermory_ tomatic_ ar_stop SR Q —		
	N	#Sensor of_cor etwork 1 #IEC_	I: Overrun time end of con #IEC_Timer_ overrun TP Time end_ nveyor IN ET T# 25 PT Q  2: Memory automatic_star N_TRIG	veyor pulse :  t_stop and ci #Safety_s #Auto	#Stop	-1		#1 au st rt — s	tomatic_ art_stop SR		#Conveyor_ motor_ automatic_

→ Under "General" in the properties of the block, you can change the "Language" to LAD (Ladder Logic) ( $\rightarrow$ Properties  $\rightarrow$  General  $\rightarrow$  Language: LAD)

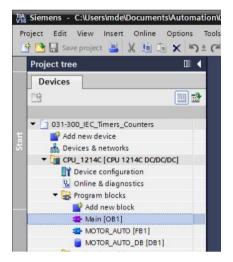
C I 50 11	1. 61. 141			
General FB supervisio	n definitions			
General	General			
Information	General			
Time stamps				
Compilation		Name:	MOTOR_AUTO	
Protection		Type:	FB	
Attributes	-			
Download without reinitializati.		Language:	FBD	•
	-	Number:	LAD FBD	
			() Manual	]
			Automatic	

 $\rightarrow$  This is what networks 1 and 2 look like in LAD.



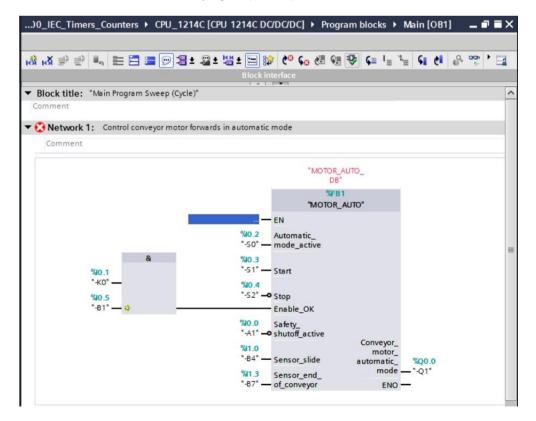
### 7.3 Update the block call in the organization block

 $\rightarrow$  Open the "Main [OB1]" organization block with a double-click.



→ In Network 1 of the "Main [OB1" organization block, instance data block "MOTOR\_AUTO\_DB1" for the "MOTOR\_AUTO [FB1]" function block appears incorrect, because the additional memory for the TP Timer has not yet been added there. Click the → "

 <sup>1</sup> icon for "Update inconsistent block calls". This will add the "MOTOR\_AUTO\_DB1" instance data block correctly again (→ <sup>1</sup>).



## 7.4 Save and compile the program

→ To save your project, select the Save project button in the menu. To compile all blocks, click

the	"Program	blocks"	folder	and	select	the	icon	for	compiling	in	the	menu
(→	🔜 Save project	$\rightarrow$ Prog	ram blo	cks $ ightarrow$	<b>D</b> ).							

Siemens - C:\Users\mde\Documents\Autom	nation \031-300_IEC_Timers_Counters \031-300_	IEC_Timers_Counters		
ject Edit View Insert Online Options				Totally Integrated Automation
		🛿 Go offline  🋔 🖪 🖉 🚽 🛄 <earch in="" project=""> 🖓</earch>		PORT
Project tree		4C [CPU 1214C DC/DC/DC] 🕨 Program blocks 🕨 Main [OB1] 🛛 💻 🖬	= X Ir	nstructions 🗖 🗊
Devices			0	Options
🖼 🔲 🖬	* BC 🐨 🖶 🖿 🚍 🐨 🕾	:월:월:도글 😥 🕫 🕼 🕼 🖓 💶 노 노 🖬 🖬 🔗 🙄 '	Ed [	est tes 🕨 🗖
		Block interface		Favorites
O31-300_IEC_Timers_Counters				
Add new device	<ul> <li>Block title: "Main Program Sweep (Cycle)</li> </ul>	)"		Basic instructions
A Devices & networks	Comment		10.00	ame Description
- CPU_1214C [CPU 1214C DC/DC/DC]	<ul> <li>Network 1: Control conveyor motor for</li> </ul>	orwards in automatic mode		General General
Device configuration				Bit logic operations
Q Online & diagnostics	Comment			Timer operations
Program blocks				E Counter operations
Add new block		%DB1		Comparator operations
Main [OB1]		"MOTOR_AUTO_ DB"		± Math functions
MOTOR_AUTO [FB1]		%F81		Move operations
MOTOR_AUTO_DB [DB1]		"MOTOR AUTO"		Conversion operations
Technology objects	-	_		Program control operati
External source files		— EN		Word logic operations
PLC tags		%0.2 Automatic_ *-50* — mode_active	= •	Shift and rotate
Compared by the second se				
Watch and force tables	&	%0.3 *-51* — Start		
Online backups	%40.1 *-K0*			
Traces		\$40.4 *-52* —● Stop		
Device proxy data	%40.5 *-81* +}			
Program info	-81 - 4	Enable_OK		
PLC alarm text lists		%40.0 Safety		
Local modules		"-A1" - o shutoff_active Conveyor_		
E Ungrouped devices		%1.0 motor_		
Common data		*-B4* — Sensor_slide automatic_ %Q0.0 %11.2 mode — *-Q1*		
Documentation settings		Sensor_end_		
Languages & resources		"-87" — of_conveyor ENO —		
Online access				
Card Reader/USB memory	Network 2:		<	III
	Comment		>	Extended instructions
	Comment		~ >	Technology
	<	> 100%	. >	Communication
Details view		Properties Tunfo (1) Diagnostics		Optional packages
Portal view     Overview	- Main (OB1)			e project 031-300_IEC_Timers_Coun

 $\rightarrow$  The "Info", "Compile" area shows which blocks were successfully compiled.

	ferences Compi	e Energy Suite	Syntax					
3 🛕 🚯 Show all messa	ges 💌							
Compiling finished (errors: (	); warnings: 0)							
Path	Description			Go to	?	Errors	Warnings	Time
CPU_1214C				7		0	0	4:48:34 PN
Program blocks				~		0	0	4:48:34 PM
MOTOR_AUTO	(FB1) Block was si	accessfully compiled.		~				4:48:34 PN
Main (OB1)	Block was st	accessfully compiled.		~				4:48:37 PN
8	Compiling fi	hished (errors: 0; warning:	s: 0)					4:48:37 PM

# 7.5 **Download the program**

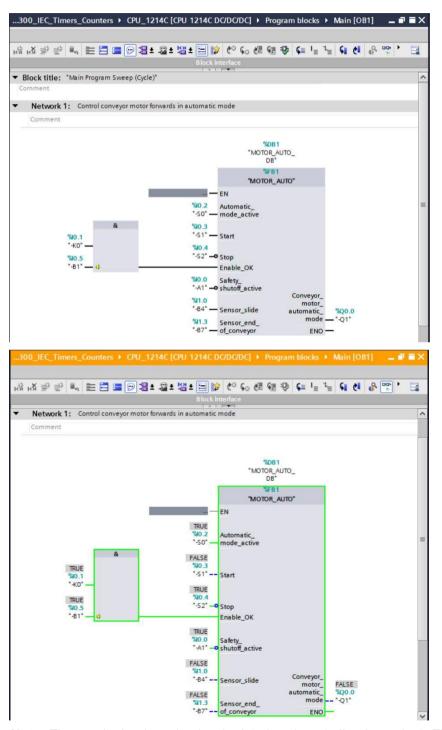
 $\rightarrow$  After successful compilation, the complete controller with the created program including the hardware configuration, as previously described in the modules, can be downloaded ( $\rightarrow$   $\square$ ).

ect Edit View Insert Online Options 🎦 🔚 Save project 昌 🐰 🗐 📻 🗙 🌍		🖉 Go offline 🛔 🖪 📑 🗱 🥌 💷 🛹	Totally Integrated A	PORT
roject tree 🛛 🔳 🖣	031-300_IEC_Timers_Counters   CP	PU_1214C [CPU 1214C DC/DC/DC]  Program blocks  Main [OB1]	_ ■ ■ X Instructions	
Devices			Options	
1 🔤 🖻	i 🖧 🖉 👻 🐛 🗮 🚍 💬 🕿	] # 월 19 1월 1월 19 10 10 10 10 10 10 10 10 10 10 10 10 10		M , 🗖 🛛
		Block interface	> Favorites	
031-300_IEC_Timers_Counters	▼ Block title: "Main Program Sweep (Cyc		^   ✓ Basic instruction	s
Add new device	Comment		Name	De
📩 Devices & networks			General	0
CPU_1214C [CPU 1214C DC/DC/DC]	<ul> <li>Network 1: Control conveyor moto</li> </ul>	or forwards in automatic mode	Hit logic operation	ns
Device configuration	Comment		O Timer operations	
Q Online & diagnostics			HI Counter operation	
<ul> <li>Brogram blocks</li> </ul>		%DB1	Comparator oper	
Add new block		"MOTOR_AUTO_	▶ 王 Math functions	
Main [OB1]		DB"	Move operations	
MOTOR_AUTO [FB1]		%FB1	Conversion opera	
MOTOR_AUTO_DB [DB1]		"MOTOR_AUTO"	Program control o	operati
Technology objects		— EN	Word logic operat	
External source files		%0.2 Automatic	E Shift and rotate	
PLC tags		"-S0" - mode_active		
Log PLC data types	&	%40.3		
Watch and force tables	%40.1	"-51" Start		
Online backups	*-ко* —	%0.4		
🕨 🚰 Traces	%40.5	"-52" - • Stop		
Device proxy data	"-B1" — #	Enable_OK		
Program info		%40.0 Safety_		
PLC alarm text lists		"-A1" - o shutoff_active		
Local modules		%1.0 Conveyor_		
La Ungrouped devices		"-84" — Sensor_slide automatic %Q0.0		
Common data	1	%1.3 Sensor_end_ mode — "-Q1"		
Documentation settings	1	"-B7" — of_conveyor ENO —		
Languages & resources				
🖬 Online access			<	_
🕎 Card Reader/USB memory	<ul> <li>Network 2:</li> </ul>		> Extended instruct	tions
	Comment			uons
			V > Technology	
	۲	> 100%	> Communication	
Details view	1	🔍 Properties 🚺 Info 👔 🗓 Diagnostics	Detional package	es

## 7.6 Monitor program blocks

 $\rightarrow$  The desired block must be open for monitoring the downloaded program. Monitoring can now

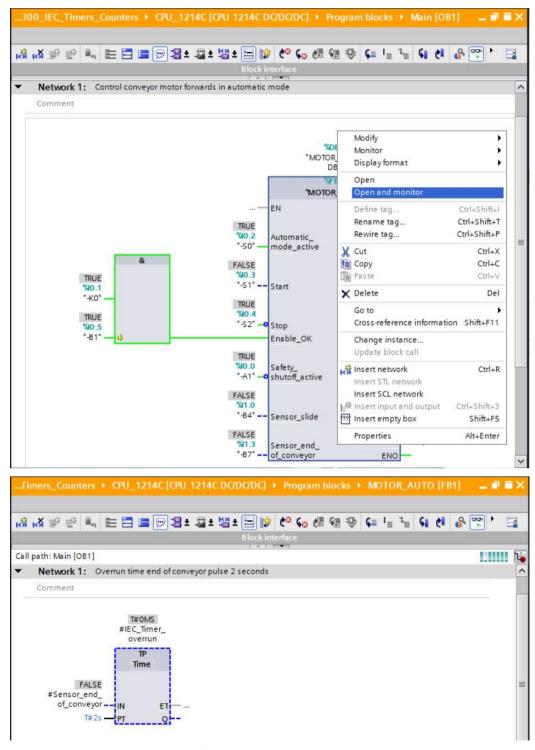
be activated/deactivated by clicking the  $\square$  icon ( $\rightarrow$  Main [OB1]  $\rightarrow$   $\square$ ).



**Note:** The monitoring here is signal-related and controller-dependent. The signal states at the terminals are indicated with TRUE or FALSE.

→ The "MOTOR\_AUTO" [FB1] function block called in the "Main [OB1]" organization block can be selected directly for "Open and monitor" after right-clicking, thereby allowing the program code in the function block with the TP Timer to be monitored

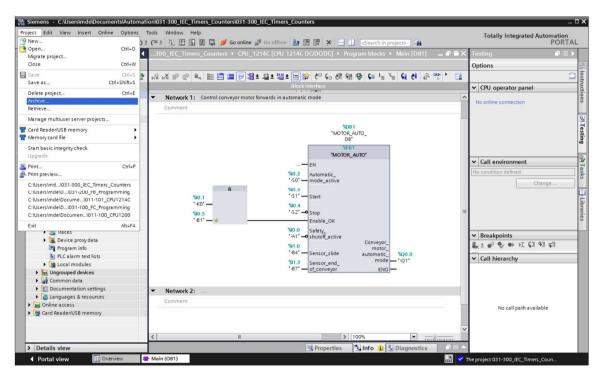
 $(\rightarrow$  "MOTOR\_AUTO" [FB1]  $\rightarrow$  Open and monitor).



**Note:** The monitoring here is function-related and controller-independent. The actuation of sensors and the station status are shown here with TRUE or FALSE.

## 7.7 Archive the project

→ As the final step, we want to archive the complete project. Select the → "Archive ..." command in the → "Project" menu. Select a folder where you want to archive your project and save it with the file type "TIA Portal project archive". (→ Project → Archive → TIA Portal project archive → SCE\_EN\_031-300\_IEC\_Timers\_Counters\_S7-1200.... → Save)



# 7.8 Checklist

No.	Description	Completed
1	Compiling successful and without error message	
2	Download successful and without error message	
3	Switch on station (-K0 = 1) Cylinder retracted / Feedback activated (-B1 = 1) EMERGENCY OFF (-A1 = 1) not activated AUTOMATIC mode (-S0 = 1) Pushbutton automatic stop not actuated (-S2 = 1) Briefly press the automatic start pushbutton (-S1 = 1) Sensor at chute activated (-B4 = 1) Conveyor motor forwards fixed speed then switches on (-Q1 = 1) and stays on.	
4	Sensor at end of conveyor activated (-B7 = 1) $\rightarrow$ -Q1 = 0 (after 2 seconds)	
5	Briefly press the automatic stop pushbutton (-S2 = 0) $\rightarrow$ -Q1 = 0	
6	Activate EMERGENCY OFF (-A1 = 0) $\rightarrow$ -Q1 = 0	
7	Manual mode (-S0 = 0) $\rightarrow$ -Q1 = 0	
8	Switch off station (-K0 = 0) $\rightarrow$ -Q1 = 0	
9	Cylinder not retracted (-B1 = 0) $\rightarrow$ -Q1 = 0	
10	Project successfully archived	

# 8 Exercise

## 8.1 Task – Exercise

In this exercise, an IEC counter is to be added to the MOTOR\_AUTO [FB1] function block. The expanded function block will be planned, programmed and tested:

The magazine for plastic holds only 5 parts. The parts are therefore be counted at the end of the conveyor.

When 5 parts are stored in the magazine, automatic mode is to be stopped.

Once the magazine has been emptied, automatic mode will be restarted with Start\_command is started again and the counter is reset.

## 8.2 **Technology diagram**

Here, you see the technology diagram for the task.

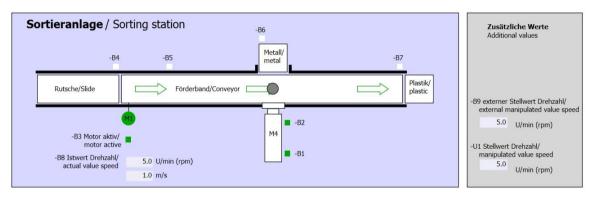
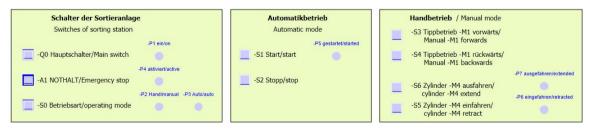


Figure 3: Technology diagram





## 8.3 Reference list

DI	Туре	Identifier	Function	NC/NO
I 0.0	BOOL	-A1	Return signal emergency stop ok	NC
I 0.1	BOOL	-K0	Main switch "ON"	NO
I 0.2	BOOL	-S0	Mode selector manual (0)/ automatic (1)	Manual = 0 Auto = 1
10.3	BOOL	-S1	Pushbutton automatic start	NO
I 0.4	BOOL	-S2	Pushbutton automatic stop	NC
10.5	BOOL	-B1	Sensor cylinder M4 retracted	NO
I 1.0	BOOL	-B4	Sensor at chute occupied	NO
l 1.3	BOOL	-B7	Sensor part at end of conveyor	NO

The following signals are needed as global operands for this task.

DO	Туре	Identifier	Function	
Q 0.0	BOOL	-Q1	Conveyor motor M1 forwards fixed speed	

#### Legend for reference list

DI	Digital Input	DO	Digital Output
AI	Analog Input	AO	Analog Output
I	Input	Q	Output
NC	Normally Closed		

NO Normally Open

### 8.4 Planning

Plan the implementation of the task on your own.

Note: Learn about the use of IEC counters in SIMATIC S7-1200 in the online help.

# 8.5 Checklist – Exercise

No.	Description	Completed
1	Compiling successful and without error message	
2	Download successful and without error message	
3	Switch on station (-K0 = 1) Cylinder retracted / Feedback activated (-B1 = 1) EMERGENCY OFF (-A1 = 1) not activated AUTOMATIC mode (-S0 = 1) Pushbutton automatic stop not actuated (-S2 = 1) Briefly press the automatic start pushbutton (-S1 = 1) Sensor at chute activated (-B4 = 1) Conveyor motor forwards fixed speed then switches on (-Q1 = 1) and stays on.	
4	Sensor at end of conveyor activated (-B7 = 1) $\rightarrow$ -Q1 = 0 (after 2 seconds)	
5	Briefly press the automatic stop pushbutton (-S2 = 0) $\rightarrow$ -Q1 = 0	
6	Activate EMERGENCY OFF (-A1 = 0) $\rightarrow$ -Q1 = 0	
7	Manual mode (-S0 = 0) $\rightarrow$ -Q1 = 0	
8	Switch off station (-K0 = 0) $\rightarrow$ -Q1 = 0	
9	Cylinder not retracted (-B1 = 0) $\rightarrow$ -Q1 = 0	
10	5th part in magazine $\rightarrow$ -Q1 = 0	
11	Project successfully archived	

# 9 Additional information

More information for further practice and consolidation is available as orientation, for example: Getting Started, videos, tutorials, apps, manuals, programming guidelines and trial software / firmware, under the following link:

#### www.siemens.com/sce/s7-1200

#### Preview "Additional information"

- Getting Started, Videos, Tutorials, Apps, Manuals, Trial-SW/Firmware
  - ↗ TIA Portal Videos
  - TIA Portal Tutorial Center
  - > Getting Started
  - ↗ Programming Guideline
  - ↗ Easy Entry in SIMATIC S7-1200
  - > Download Trial Software/Firmware
  - Technical Documentation SIMATIC Controller
  - ↗ Industry Online Support App
  - TIA Portal, SIMATIC S7-1200/1500 Overview
  - ↗ TIA Portal Website
  - ↗ SIMATIC S7-1200 Website
  - ↗ SIMATIC S7-1500 Website

# Notes

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# Notes

# SCE Learn-/Training Textbook

# Automation System SIMATIC S7-1200



#### TIA Portal Modules from Version V14 SP1

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<b>TIA Portal Module 011-001</b> Firmware Update	1
<b>TIA Portal Module 011-100</b> Unspecified Hardware Configuration	
TIA Portal Module 011-101 Specified Hardware Configuration	
<b>TIA Portal Module 020-100</b> Process description of sorting station	4
TIA Portal Module 031-100 Basics of FC Programming	
TIA Portal Module 031-200 Basics of FB Programming	
TIA Portal Module 031-300 IEC Timers and IEC Counters	
TIA Portal Module 031-410 Basics of Diagnostics	8
	8
Basics of Diagnostics TIA Portal Module 031-420	
 Basics of Diagnostics TIA Portal Module 031-420 Diagnostics via Web TIA Portal Module 031-500	
Basics of Diagnostics         TIA Portal Module 031-420         Diagnostics via Web         TIA Portal Module 031-500         Analog Values         TIA Portal Module 031-600	9
Basics of Diagnostics         TIA Portal Module 031-420         Diagnostics via Web         TIA Portal Module 031-500         Analog Values         TIA Portal Module 031-600         Global Data Blocks         TIA Portal Module 041-101	9

# Matching SCE Trainer Packages for these Learn-/Training Document

- SIMATIC S7-1200 AC/DC/RELAY (set of 6) "TIA Portal" Order no.: 6ES7214-1BE30-4AB3
- SIMATIC S7-1200 DC/DC/DC (set of 6) "TIA Portal" Order no.: 6ES7214-1AE30-4AB3
- Upgrade SIMATIC STEP 7 BASIC V14 SP1 (for S7-1200) (set of 6) "TIA Portal" Order no.: 6ES7822-0AA04-4YE5

Note that these trainer packages are replaced with successor packages when necessary. An overview of the currently available SCE packages is available at: <u>siemens.com/sce/tp</u>

#### **Continued training**

For regional Siemens SCE continued training, contact your regional SCE contact siemens.com/sce/contact

#### Additional information regarding SCE

siemens.com/sce

#### Information regarding use

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We wish to thank the TU Dresden, particularly Prof. Dr.-Ing. Leon Urbas and the Michael Dziallas Engineering Corporation and all other involved persons for their support during the preparation of this Learn-/Training Document.

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# **Basics of Diagnostic Functions**

# 1 Goal

In this module, the reader will become acquainted with the tools that support troubleshooting.

This module will present diagnostic functions that, for example, you can test with the TIA project from the SCE\_EN\_031-100\_FC-Programming with SIMATIC S7-1200 module.

The SIMATIC S7 controllers listed in Chapter 3 can be used.

# 2 Prerequisite

This chapter builds on the hardware configuration of SIMATIC S7 CPU1214C. However, other hardware configurations that have digital input and output boards can be used. For this chapter, you can use the following project, for example:

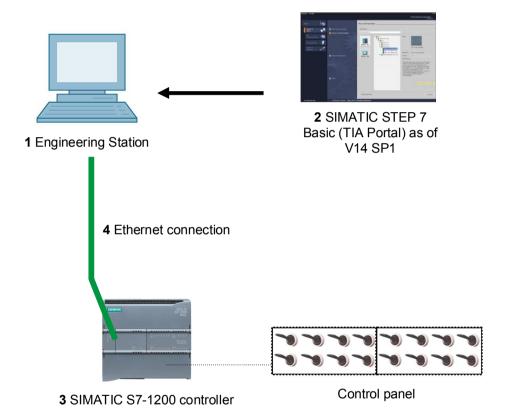
SCE\_EN\_031\_100\_FC-Programming\_S7-1200\_R1504.zap14

# 3 Required hardware and software

- 1 Engineering station: requirements include hardware and operating system (for additional information, see Readme on the TIA Portal Installation DVDs)
- 2 SIMATIC STEP 7 Basic software in TIA Portal as of V14 SP1
- 3 SIMATIC S7-1200 controller, e.g. CPU 1214C DC/DC/DC with ANALOG OUTPUT SB1232 signal board, 1 AO Firmware as of V4.2.1

Note: The digital inputs should be fed out to a control panel.

4 Ethernet connection between engineering station and controller



# 4 Theory

## 4.1 Fault diagnostics and hardware faults

Faults can be caused by a variety of things.

For faults that occur after a changeover to RUN, there are two error patterns.

1. The CPU goes to or stays in the STOP operating state. The yellow STOP LED lights up and other indicator LEDs light up on the CPU, power supply unit, IO modules or bus modules.

A CPU fault is present in this case. For example, a module in the automation system might be defective or have an incorrect parameter assignment or a bus system fault might be present.

An interruption analysis will be performed in this case by evaluating the hardware diagnostics and by reading the module information from the diagnostic buffer of the CPU.

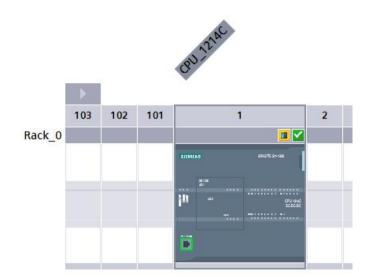
2. The CPU is in a faulty RUN operating state. The green RUN LED lights up and other indicator LEDs light up or flash on the CPU, power supply unit, IO modules or bus modules.

In this case, a fault may be present in the IO devices or power supply.

A visual check will be performed initially to narrow down the fault area. The indicator LEDs on the CPU and IO devices will be evaluated. The diagnostic data of the faulty IO and bus modules will be read from the hardware diagnostics. In addition, a fault analysis can be performed using a watch table on the programming device.

## 4.2 Hardware diagnostics

The device view in online mode of the TIA Portal gives you a quick overview of the configuration and system status of the automation system.



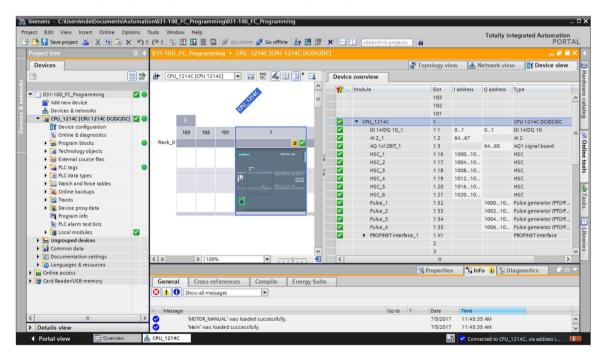


Figure 1: Online view of device configuration

## 4.3 Diagnostics for program blocks

The project tree window of the TIA Portal in online mode gives you an overview of the programmed blocks of the user program. A comparison of the program blocks used offline and online is displayed with the help of diagnostic symbols.

Totally Integrated Automation PORT Project tree	
Project tree         III         031-100_FC_Programming + CPU_1214C [CPU 1214C DC/DC/DC] + Program blocks + Main [081]         = # #           Devices	AI
	×
O 331-100_FC_Programming     Add new device     Block little: "Mein Program Sweep (Cycle)"     Comment     Device & Retworks     Comment     Onine & diagnostics     Pogram blocks     Pogram blocks     Pogram block     Retwork 1: Control conveyor motor forwards in manual mode     Comment     Notione Multiple:     Retwork 1: Control conveyor motor forwards in manual mode     Comment     Notione Multiple:     Pogram blocks     Pogram blocks     Pogram blocks     Pogram blocks     Pogram blocks     Pogram block     Pogram bloc	
Image: Second search     FALSE     %81.4     manual	2

Figure 2: Online view of the Main [OB1] block

# 5 Task

The following diagnostic functions will be shown and tested in this chapter:

- Diagnostic symbols in the online view of the TIA Portal
- Device diagnostics with module information
- Offline/online comparison
- Monitoring and modifying tags
- Forcing tags

# 6 Planning

The diagnostic functions will be performed using a finished project as an example.

A project in the TIA Portal that was previously downloaded to the controller should be open for this.

In our case, once you have opened the TIA Portal, you will retrieve a previously created project that was archived and download it to the associated controller.

You can then start implementing the diagnostic functions in the TIA Portal.

### 6.1 Online interface

Online diagnostics can only be performed when the correct communication connection to the CPU has been established. We connect via Ethernet/PROFINET in this case.

When going online, you must therefore set the appropriate interfaces for your automation system.

xtended download to	device						
	Configured access	nodes of "CPU_1214C"					
	Device	Device type	Slot	Туре	Address	Subnet	
	CPU_1214C	CPU 1214C DC/D	1 X1	PN/IE	192.168.0.1	PN/IE_1	
	c	Type of the PG/PC inter PG/PC inter connection to interface/su 1st gate	rface: bnet:	PN/IE Intel(R) PN/IE_1	Ethernet Connection (4) I	▼ 219-LM ▼	•
	Select target devic	e: Device type	Inter	ace type	Show all compatib	le devices Target devic	•
····	CPU_1214C	CPU 1214C DC/D			192.168.0.1	CPU 12140	
2	-	-	PN/IE		Access address	-	
Flash LED						Start	search
Online status information	:				Display only erro		
Connection establish	ed to the device wit	h address 192.168.0.1.					~
Scan completed. 1 co ?? Retrieving device info		f 1 accessible devices fou	nd.				
Scan and information		i.					~
					Fo	ad <u>C</u> a	ncel

Figure 3: Connecting online

# 7 Structured step-by-step instructions

You will find instructions on how to carry out planning below. If you already have a good understanding of everything, it will be sufficient to focus on the numbered steps. Otherwise, simply follow the detailed steps in the instructions.

### 7.1 Retrieve an existing project

→ Before we can start the diagnostic functions, we need a project with programming and a hardware configuration (e.g., SCE\_EN\_031-100\_FC-Programming\_S7-1200....zap14). To retrieve an existing project that has been archived, you must select the relevant archive with → Project → Retrieve in the project view. Confirm your selection with "Open".

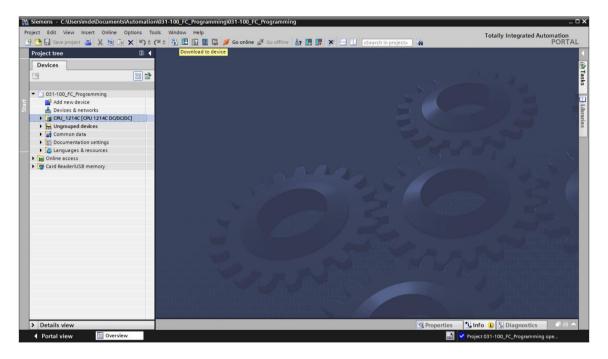
Project	Edit	View	Insert	Online	Options	Тс
New.	1	12112			Ctrl+O	) ±
Close	te proj	ect			Ctrl+W	
Save					Ctrl+S	1
Save	85			Ctrl	+Shift+S	_
Delet	te proje	ct			Ctrl+E	1
Archi	ve					1
Retrie	eve					
Mana	ige mu	ltius er s	erver pro	jects		
T Card	Reader	USB m	emory		•	
🎬 Mem	orycar	d file			•	
Start	basic i	ntegrity	check			
Upgr	ade					

 $(\rightarrow \text{Project} \rightarrow \text{Retrieve} \rightarrow \text{Select a .zap archive} \rightarrow \text{Open})$ 

→ The next step is to select the target directory where the retrieved project will be stored. Confirm your selection with "OK". (→ Target directory  $\rightarrow$  OK)

# 7.2 Download the program

 $\rightarrow$  After the project has been successfully retrieved, the controller can be selected and downloaded together with the created program. ( $\rightarrow$   $\blacksquare$ )



→ Select the correct interfaces and click "Start search". (→ "PN/IE" → Selection of the network adapter of the PG/PC → Direct at slot '1 X1'→ "Start search")

Once '	"Scan and	information	retrieval	completed"	appears.	click "	Load".	$(\rightarrow$	"Load")
						•		<u>۲</u>	

	Device	s nodes of "CPU_1214C" Device type	Slot	Туре	Address	Subnet		
	CPU_1214C				PN/IE	192.168.0.1	PN/IE_	
7								
		Type of the PG/PC inter	face:	PN/IE			•	
		PG/PC inter	face:	Intel(R)	Ethernet Connection (4) I	219-LM		
		Connection to interface/su	bnet:	PN/IE_1			•	
		1st gate	ewav:				-	
	Select target devi				Show all compatib	1		
	Select target devi Device	ce: Device type	Interf	ace type	Show all compatib	le devices Target devi	ice	
				ace type		1		
Flash LED	Device CPU_1214C	Device type	PN/IE	ace type	Address 192.168.0.1	Target dev		
Flash LED	Device CPU_1214C	Device type	PN/IE	ace type	Address 192.168.0.1	Target devi CPU_1214 —	C	
ne status informa	Device CPU_1214C	Device type CPU 1214C DC/D –	PN/IE	ace type	Address 192.168.0.1	Target dev CPU_1214 —	c	
ne status informa Connection estal	Device CPU_1214C	Device type CPU 1214C DC/D - th address 192.168.0.1.	PN/IE PN/IE	ace type	Address 192.168.0.1 Access address	Target dev CPU_1214 —		
ne status informa Connection estal	tion: 1 compatible devices of	Device type CPU 1214C DC/D –	PN/IE PN/IE	ace type	Address 192.168.0.1 Access address	Target dev CPU_1214 —	C	

 $\rightarrow$  Before downloading can be started, other actions may have to be set (pink marking). Then click "Load" again. ( $\rightarrow$  "Load").

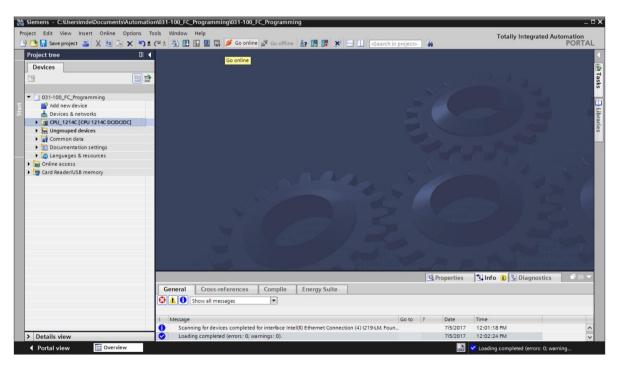
tatus	1	Target	Message A	ction
<b>†</b> ]	0	▼ CPU_1214C	Ready for loading.	
	0	Stop modules	The modules are stopped for downloading to device.	Stop all
	0	<ul> <li>Software</li> </ul>	Download software to device	Consistent download
	0	Additional inform	There are differences between the settings for the project and the	Overwrite all
	0	Text libraries	Download all alarm texts and text list texts	Consistent download
¢				
				Refresh

→ After loading, first select the "Start all" check box under Action. Then click "Finish". (→ select check box → "Finish")

status	1	Target	Message	Action
1	2	▼ CPU_1214C	Downloading to device completed without error.	
	4	Start modules	Start modules after downloading to device.	Start all
(			m	

## 7.3 Connect online

→ To get started with the diagnostic functions, we will select our controller ("CPU\_1214C") and click "Go online". ( $\rightarrow$  CPU\_1214C  $\rightarrow$  Go online)



 $\rightarrow$  Once the online connection to the "PLC\_1" controller is established, the CPU can be started

or stopped with the following buttons **Diagnostic information in the form of symbols** will already be available in the project tree and in the diagnostics window.

Ma Siemens - C:\Users\mde\Documents\Auton	nation\031-100_FC_	Programming\031-100_F	C_Programmin	g						_ 🗆 >
Project Edit View Insert Online Options			Go offline	10 III III X	-	noiecta de		Totally Int	egrated Automa	ORTAL
				Stop CPU		i projecto				K
Devices	-									-
	13									T I ASKS
										19K2
<ul> <li>031-100_FC_Programming</li> </ul>	2 💿									
E Add new device										
Devices & networks										
CPU_1214C [CPU 1214C DC/DC/DC]	2 💿									
Ungrouped devices										9
Common data										- 11 (B)
Documentation settings										
Languages & resources										
Online access										
										K
						10	Properties	🗓 Info 🔒 🗓 Dia	gnostics	
	General	Cross-references	Compile	Energy Suite	7					
		how all messages								
		non un nessages								
	1 Message					Go to ?	Date	Time		_
		g completed (errors: 0; wa	minas: 0).				7/5/2017	12:02:24 PM		^
> Details view		cted to CPU_1214C, via add		.0.1.			7/5/2017	12:03:12 PM		~
Portal view     Overview	A CONTRACTOR OF A CONTRACTOR O	-						Connected to CPU_1.	14C via address I	
								Connected to CPU_1	214C, via address I	

Symbols for the comparison status in the project tree

→ The diagnostic symbols in the project tree show a comparison status representing the online/offline comparison of the project structure.

Symbol	Meaning
0	Folder contains objects with online and offline versions that different (only in the project tree)
•	Online and offline versions of the object are different
0	Object only exists online
0	Object only exists offline
	Online and offline versions of the object are the same

- $\rightarrow$  Double-click the "Device configuration".
- $(\rightarrow \text{Device configuration})$

Image: Second	_FC_Programming > CPU_1214C [CPU 1214C DC/DC/DC] _ 🖬	1	14C DODOD
031-100_FC_Programming       2         0 Add new device       103         0 Devices a networks       102         0 Online & diagnostics       101         0 Online & diagnostics       103         0 Devices configuration       0         0 Devices configuration       0         0 Online & diagnostics       103         0 Devices configuration       0         0 Devices providata       0         0 Devices providata       0         0	🖉 Topology view 🛛 🚠 Network view. 🛛 👔 Device view		
031-100_FC_Programming       Image: Solid readerss       Q address       Type         031-100_FC_Programming       Image: Solid readerss       Q address       Q address       Q address       Type         001-100_FC_Programming       Image: Solid readerss       Q address       Q address       Q address       Q address       Q address       Image: Solid readerss       Q address       Image: Solid readerss       Image: Solid reader		Device overview	
Watch and werke       103       101       002         Devices 8 networks       101       002       101         Working 8 diagnostics       101       001       001       001         Working 8 diagnostics       101       001       001       001       001         Working 8 diagnostics       103       102       101       1       0.1       0.1       011400       102       101       011400       102       101       101400       101       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1	Module Slot Laddress Q address Type	1 Module	^
• Device 2 networks           • Output            • Output	= 103		=
Image: Construction of the sectors	102		
I) Device configuration       V) Online & diagnostics       V)       Online & diagnostics       V)       Online & diagnostics       V)       Online & diagnostics       V)       Online & diagnostics       V)       Online & diagnostics       V)       Online & diagnostics       V)       Online & diagnostics       V)       Online & diagnostics       V)       Online & diagnostics       V)       Online & diagnostics       V)       Online & diagnostics       V)       V)       Online & diagnostics       V)	101		
U Online & diagnestics       U       101 HBUD 10_1       11       0.1       01 HBUD 10_1       11       0.1       0.1       01 HBUD 10_1       11       0.1       0.1       01 HBUD 10_1       11       0.1       11       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0	✓ CPU_1214C 1 CPU 1214C DC/DC/DC/DC	CPU_1214C	
103       102       101       1       Al 2_1       12       6457       A2         103       102       101       1       Al 3128011       13       6455       A2         103       102       101       1       Al 3128011       13       6455       A2         104       105       102       101       1       Al 3128011       13       6455       A2         105       105       105       101       1       Al 3128011       13       6455       A2         105       105       105       101       1       Al 3128011       13       6455       A3       138       10010       HSC       115       10010       HSC       115       10010       HSC       115       10010       HSC       115       10010       HSC       10010       HSC       10010       HSC       110       10010       HSC       HSC       10010       HSC       HSC       10010 <t< td=""><td>DI 14/DQ 10_1 11 01 DI 14/DQ 10</td><td>DI 14/DQ 10_1</td><td></td></t<>	DI 14/DQ 10_1 11 01 DI 14/DQ 10	DI 14/DQ 10_1	
• (a) infolding voligets           • (a) infolding	102 101 101 AI 2_1 1 2 6467 AI 2	AI 2_1	
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Image: Construction of the set of t	волжаз высталия   HSC_2 117 100410 HSC	HSC_2	- 1
→ Watch and force tables       → Watch and fo	т 🗹 HSC_З 118 100810 HSC	HSC_3	
Continue backups     Cont	HSC_4 119 101210 HSC	HSC_4	
* Traces       * Traces       * 121       1000-10       Police of 121       Police of 121       1000-10       Police of 121       Police of	HSC_5 1 20 101610 HSC	HSC_5	duad
Card Reader/USB memory      Card Reader/USB memory	HSC_6 1 21 102010 HSC	HSC_6	
By Program info       Image: Constraint of the second of the	Pulse_1 1 32 100010 Pulse generator (PTO/P	Pulse_1	
Cardam text lists     Card metext lists     Card metext lists     Card metext lists     Card metext lists     Common data     Common datata     Common datatatatatatatatatatatatatatatatatatat	Pulse_2 1 33 100210 Pulse generator (PTO/P	Pulse_2	
Card Reader/USB memory      Card Reader/USB memory	✓ Pulse_3 1 34 100410 Pulse generator (PTO/P	Pulse_3	
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> info ocumentation settings        > info ocumentation setting <td< td=""><td>PROFINET interface_1 1 X1 PROFINET interface</td><td>PROFINET interface</td><td></td></td<>	PROFINET interface_1 1 X1 PROFINET interface	PROFINET interface	
Image: Constraint Settings       Image: Constraint Settings         Image: Constreset Settings       Image: Constrese	2		
Constructes     Constructes     Constructes     Constructes     Constructes     Constructes     Constructed     Construct	× 3		~
Online access         Info         Diagnostics           Card Reader/USB memory         General         Cross-references         Compile         Energy Suite	> 100% T	<	
Card Reader/USB memory  General  Cross-references  Compile  Energy Suite	9 Properties 1 Info 9 Diagnostics		
Show all messages	Cross-references Compile Energy Suite		Energy Suite
	Show all messages		
I Message Go to 7 Date Time		Casa	
l mesage loading completed (errors: 0; warnings: 0). 7/5/2017 12:02:24 PM		0010	

Operating state symbols for CPUs and CPs

→ The graphical representation and device information window show the various operating states of the CPU or communication processors (CPs).

Symbol	Operating state
	RUN
	STOP
	STARTUP
<b>1</b> 10	HOLD
×	DEFECT
12	Unknown operating state
10	The configured module does not support display of the operating state.

Diagnostic symbols for modules and devices in the device overview

→ The graphical representation and Device overview window show the operating states of the various modules, CPU or communication processors (CPs) using the following symbols.

Symbol	Meaning
<b>≝</b> .27	The connection to a CPU is currently being established.
a T	The CPU is not accessible at the configured address.
۹ <mark>.</mark>	The type of CPU configured and type of CPU actually present are incompatible.
a <b>.</b>	On establishment of the online connection to a protected CPU, the password dialog was terminated without entry of the correct password.
<b>~</b>	No fault
9	Maintenance required
2	Maintenance demanded
<b>9</b>	Fault
0	The module or device is deactivated.
L <sub>a</sub>	The module or device cannot be accessed from the CPU (valid for modules and devices below a CPU).
D:	Diagnostic data is not available because the current online configuration data differs from the offline configuration data.
1	The configured module or device and the module or device actually present are incompatible (valid for modules or devices below a CPU).
<b>!</b> ?	The configured module does not support display of the diagnostic status (valid for modules below a CPU).
?	The connection has been established, but the state of the module is currently still being determined.
0	The configured module does not support display of the diagnostic status.
0	Error in lower-level component: A fault is present in at least one lower-level hardware component.

Color coding of ports and Ethernet cables

- → The status of ports and Ethernet cables can be diagnosed in the network view and topology view.
- $\rightarrow$  The following table shows the possible colors and their respective meaning.

Color	Meaning
	No fault or maintenance required
	Maintenance demanded
	Communication error

## 7.4 Online & diagnostics for SIMATIC S7 controller

- $\rightarrow$  Double-click "Online & diagnostics" in project tree. ( $\rightarrow$  Online&Diagnostics)
- → A CPU operating panel, the cycle time and the memory utilization are displayed in the online tools at the right. Switch the CPU to RUN here. (→ RUN)

TIA V14	Siemens - C:\Users\mde\Documents\Autom	ation	\031-100_FC_F	Programming\031-1	00_FC_Programming					_ 🗆 X
Pro	ject Edit View Insert Online Options	Too	ls Window	Help				Totally Inter	grated Automat	tion
2ª	🎦 🔚 Save project 📇 💥 💷 🛅 🗙 🛎	) ± (	*± 🗄 🛄 !	🖬 🖳 🖾 🖾 Go o	nline 🖉 Go offline  🎄 🖪 🔮	🛿 📃 🔜 🔜 😽	i	rotany mee		ORTAL
	Project tree	4	031-100_FC	_Programming 🕨 (	CPU_1214C [CPU 1214C DC/DC/D	c]	_ @ =×	Online tools		
	Devices							Options		8
Online & Diagnostics	Add new device Add new device Devices & networks CPU 214C (CPU 214C COPC/DC) Device configuration U Online & diagnostics Device configuration U Online & diagnostics Device configuration U Online & diagnostics Device configuration Device configuration D		Online acces Diagnostics General Diagnosti Cycle time Memory PROFINET Functions	ic status ics buffer	Article number: Hardware: Firmware: Version of the TIA Portal project: Rack:	2 V 4.2.1		CPU operato     CPU_1214C (CPU     RUN / STOP     ERROR     MAINT     <     Cycle time	r panel 11214C DC/DC/DC] RUN STOP MRES III	Online tools (A) Tasks Libraries          Image: Construction of the
	Conline backups     Conline backups     Conline backups     Constant of the second of the secon				Module information Module name: Plant designation: Location ID: Installation date:			Shortest: Current/last: Longest:	1.000 ms 3.000 ms 3.000 ms	
	Languages & resources	- 1			Additional information:			✓ Memory		
	Gonline access     Gard Reader/USB memory				Manufacturer information			Load memory	Free:99.71 %	_
			_		Manufacturer description: Serial number:		itics	Work memory Retain memory	Free:99.89 %	
			General	Cross-reference	s Compile Energy Suite				Free:100 %	
-	> Details view	-		Show all messages	•					~
	Portal view     Overview	ഫ്റ	PU_1214C	Sonline & dia			🔜 🗸 c	Connected to CPU_121	4C, via address I	

Online access	General		
Diagnostics	Module		
General	Wodule		
Diagnostic status	Short designation:	CPU 1214C DC/DC/DC	
Diagnostics buffer		6ES7 214-1AG40-0XB0	5
Cycle time			4
Memory	Hardware:	2	
PROFINET interface [X1]	Firmware:	V 4.2.1	
Functions	Version of the TIA Portal project:	V14 SP1	٦
	Slot: Module information	1	
	Module name:	CPU_1214C	٦
	Plant designation:		Ĩ
	Location ID:		5
		Marden 144 02 2017 12 11	
	Installation date:	Monday , July 03 , 2017 12 : 41	1
	Additional information:		
	Manufacturer information		
	Manufacturer description:	SIEMENS AG	
	Serial number:	S C-F3SH7589	7
	Profile:	16#0000	7
	Profile details:	16#0001	4

 $\rightarrow$  The working area window contains general information about the CPU. ( $\rightarrow$  General)

→ If diagnostic information is available, it is displayed in Diagnostic status. (→ Diagnostic status)

031_100_FC-Programming	▶ CPU_1214C [CPU 1214C DC/DC/DC]	_ <b>- - -</b> ×
Online access		
<ul> <li>Diagnostics</li> </ul>	Diagnostic status	
General		
Diagnostic status	Module exists.	
Diagnostics buffer	ок	
Cycle time		
Memory		
<ul> <li>PROFINET interface [X1]</li> </ul>		
Functions		

 $\rightarrow$  Detailed Information on the individual events is displayed in Diagnostics buffer. ( $\rightarrow$  Diagnostics buffer)

	CPU_1214C [CPU 1214C DO/DO/D		- •
nline access			
iagnostics	Diagnostics buffer		
-			
General	Events		
Diagnostic status			
Diagnostics buffer	🛃 Display CPU Time Stamps in	PG/PC local time	
Cycle time	No. Date and time	Event	
Memory	1 1/3/2012 8:27:35.6		
PROFINET interface [X1]		en e	
nctions	2 1/3/2012 8:27:35.5		
	3 1/3/2012 8:25:16.9		
	4 1/3/2012 8:25:16.8		
	5 1/3/2012 8:25:16.8		
	6 1/3/2012 8:25:06.1		-
	7 1/3/2012 8:25:04.6		
	8 1/3/2012 8:25:01.9		
•	9 1/3/2012 8:25:00.9	945 PM 👘 Follow-on operating mode change - CPU changes from STOP to STOP m 🗹 🚺	
	Details on event:		
		CPU_1214C	
	Rack/slot:	Rack 0 / Slot 1	
		CPU info: New startup information	^
		Pending startup inhibit(s): - Manual restart required	
		Current CPU operating mode: STOP	=
		CPU_1214C / CPU_1214C	
			~
	Help on event:	The startup inhibit conditions for an operating mode transition to RUN have changed, for example, because blocks or a hardware configuration have been loaded. The current startup information is available in the detailed information for the event.	~
	Help on event:	The startup inhibit conditions for an operating mode transition to RUN have changed, for example, because blocks or a hardware configuration have been loaded. The current startup information is available in the detailed information for the event.	
	Help on event:	The startup inhibit conditions for an operating mode transition to RUN have changed, for example, because blocks or a hardware configuration have been loaded.	^
	Help on event: Plant designation:	The startup inhibit conditions for an operating mode transition to RUN have changed, for example, because blocks or a hardware configuration have been loaded. The current startup information is available in the detailed information for the event.	^

 $\rightarrow$  Next you receive information about the cycle time of the executed program. ( $\rightarrow$  Cycle time)

031-100_FC_Programming	▶ CPU_1214C [CPU 1214C DC/DC/I	DC] — 🖉	= ×
Online access • Diagnostics	Cycle time		
General Diagnostic status Diagnostics buffer <mark>Cycle time</mark> Memory	Cycle time diagram		
PROFINET interface [X1]     Functions	1		
	13	l <b>∍</b> ms 150	
	•		
	, Cycle time set		
	Minimum cycle time:	0 ms	]
	Cycle monitoring time:	150 ms	]
	Cycle times measured		
	Shortest cycle time:	1.000 ms	]
	Current/last cycle time:	3.000 ms	]
	Longest cycle time:	3.000 ms	

 $\rightarrow$  The memory utilization can be seen here in detail ( $\rightarrow$  Memory)

Online access	7				
<ul> <li>Diagnostics</li> </ul>	Memory				
General					
Diagnostic status					
Diagnostics buffer					
Cycle time					
Memory		0.22.0	0.47.0		
PROFINET interface [X1]		0.23 %	0.17 %	0 %	
Functions	Sizes in bytes	Load memory	Work memory	Retain memory	
	Free:	4184632	102229	10240	
	In use:	9672	171	0	
	Total:	4194304	102400	10240	

 $\rightarrow$  The network settings and the status of the PROFINET interface [X1] can also be displayed. ( $\rightarrow$  PROFINET interface [X1])

line access	100000000000000000000000000000000000000						
agnostics	PROFINE	Tinterface [X1]					-
General	> Ether	net address					
Diagnostic status Diagnostics buffer							
Cycle time	>> Ne	twork connection	8				
Memory							
PROFINET interface [X1] nctions		MAC add	ress: 28-63-3	6-88-FF-DA			
nctions	>> IP	parameters					
		IP add	ress: 192.168	8.0.1			
		Subnet n	nask: 255.255	5.255.0			
		Default ro	uter: 0.0.0.0				
	Ê	IP sett	ings:				
	•	IP setting I	time:				
line access gnostics	CPU_121     Ports     Ports		C/DC/DC]			- 4	7
line access ignostics General Diagnostic status Diagnostics buffer	> Ports					- 1	9
line access gnostics General Diagnostic status Diagnostics buffer Cycle time	> Ports	Name	Status	Settings	Mode	- 4	7
line access gnostics General Diagnostic status Diagnostics buffer Cycle time Memory	> Ports			Settings Automatically	Mode TP 100 Mbps full duplex	-	P
ine access gnostics General Diagnostics tatus Diagnostics buffer Cycle time Memory RROFINET interface [X1]	> Ports	Name	Status				<b>P</b>
ine access gnostics General Diagnostics tatus Diagnostics buffer Cycle time Memory RROFINET interface [X1]	> Ports	Name	Status			-	
ine access gnostics General Diagnostics tatus Diagnostics buffer Cycle time Memory RROFINET interface [X1]	> Ports	Name	Status			-	P
line access gnostics General Diagnostic status Diagnostics buffer Cycle time Memory PROFINET interface [X1]	> Ports	Name	Status				<b>م</b>
ine access gnostics General Diagnostics tatus Diagnostics buffer Cycle time Memory RROFINET interface [X1]	> Ports Ports	Name	Status				P
100_FC_Programming line access ignostics General Diagnostics tatus Diagnostics buffer Cycle time Memory PROFINET interface [X1] nctions	Ports Ports Det	Name Port 1 (X1P1) tails: XC address of the inte	Status OK	Automatically			<b>P</b>
line access gnostics General Diagnostic status Diagnostics buffer Cycle time Memory PROFINET interface [X1]	Ports Ports Det	Name Port 1 (X1P1) tails: AC address of the inte rdium: Copper	Status OK	Automatically			<b>P</b>
line access gnostics General Diagnostic status Diagnostics buffer Cycle time Memory PROFINET interface [X1]	Ports Ports Det	Name Port 1 (X1P1) tails: XC address of the inte	Status OK erface: 28-63-30	Automatically 6-88-FF-DA			
line access gnostics General Diagnostic status Diagnostics buffer Cycle time Memory PROFINET interface [X1]	Ports Ports Det	Name Port 1 (X1P1) Caddress of the inte dium: Copper inhor: desknord55	Status OK erface: 28-63-30	Automatically 6-88-FF-DA			
line access Ignostics General Diagnostic status Diagnostics buffer Cycle time Memory RFOCHNET interface [X1]	Ports Ports Det	Name Port 1 (X1P1) Caddress of the inte dium: Copper inhor: desknord55	Status OK erface: 28-63-30	Automatically 6-88-FF-DA			

20

 → Under Functions, "Assign IP address", you can assign the IP address to a controller. However, this is only possible when no hardware has yet been downloaded to the CPU. (→ Functions → Assign IP address)

031-100_rc_Programming	CPU_1214C [CPU 1214C DC/DC/DC]	_ # = ×
Online access	Assign IP address	
<ul> <li>Diagnostics</li> </ul>		
General		
Diagnostic status	Assign IP address to the device	
Diagnostics buffer	Devices connected to an enterprise network or directly to the internet must be appropriately	
Cycle time	Devices connected to an enterprise network or directly to the internet must be appropriately protected against unauthorized access, e.g. by use of firewalls and network segmentation.	
Memory	For more information about industrial security, please visit	
<ul> <li>PROFINET interface [X1]</li> </ul>	http://www.siemens.com/industrialsecurity	
<ul> <li>Functions</li> </ul>		
Assign IP address		
Set time		
Firmware update		
Assign PROFINET devic	MAC address: 28 - 63 - 36 - 88 - FF - DA Accessible devices	
Reset to factory settings		
Format memory card	IP address: 192 . 168 . 0 . 1	
	Subnet mask: 255 . 255 . 0	
	Use router	
	Router address: 192.168.0.1	
	Assign IP address	

 $\rightarrow$  Under "Set time", you can set the time of the CPU. ( $\rightarrow$  Functions  $\rightarrow$  Set time)

Online access	Set time	
<ul> <li>Diagnostics</li> </ul>	Set time	
General		
Diagnostic status		
Diagnostics buffer		
Cycle time	PG/PC time:	
Memory	(UTC+01:00) Amsterdam, Berlin, Bern, Rome, Stockholm, Vienna	<b>v</b>
PROFINET interface [X1]		
• Functions	July 05 , 2017 💌 12 : 24 : 52 PM 🖨	
Assign IP address		
Set time	Module time	
Firmware update		
Assign PROFINET devic	January 03 , 2012 💌 08 : 47 : 46 PM 🖨	
Reset to factory settings	Take from PG/PC Apply	
Format memory card	vppy	

 $\rightarrow$  Under "Firmware update", you can update the firmware of the PLC. ( $\rightarrow$  Functions  $\rightarrow$  Firmware update)

	CPU_1214C [CPU 1214C DC/I	DC/DC]	_ # #
Online access	Firmware update		
<ul> <li>Diagnostics</li> </ul>	Online data		
General	Online data		
Diagnostic status	Article number:	6ES7 214-1AG40-0XB0	
Diagnostics buffer			
Cycle time	Firmware:		
Memory	Name:	CPU_1214C	
PROFINET interface [X1]			
<ul> <li>Functions</li> </ul>	Rack:	0	
Assign IP address	Slot:		
Set time			
Firmware update			
Assign PROFINET devic			
Reset to factory settings	Firmware loader		
Format memory card			
	Firmware file:	▼ Brow	se
	Firmware version:		
	•		
	Suitable for modules with:	Article number Firmware version and higher	
	Status:		
		Run firmware after update	
		Run update	

→ Under "Assign name", you can assign a PROFINET device name to the configured field devices on PROFINET. The device name of the CPU cannot be changed here. It can only be changed by downloading a modified hardware configuration.

Online access   Diagnostics   General   Diagnostics status   Device type:   PRDFINET device name:   Proprinter device   Proprinter device <th>031-100_FC_Programming</th> <th>• CPU_1214C [CPU 12</th> <th>14C DC/DC/DC]</th> <th></th> <th></th> <th></th> <th></th> <th>_ 🕫 🖬 ×</th>	031-100_FC_Programming	• CPU_1214C [CPU 12	14C DC/DC/DC]					_ 🕫 🖬 ×
Assign PROFINET device name      Assign PROFINET device name      Assign PROFINET device name      PROFINET interface [X1]      FROFINET interface [X1]      Functions      Assign PROFINET device      Prover type:     CPU 1214C DC/DC/DC      Prover type:     CPU 1214C DC/DC/DC      Online access      Type of the PG/PC interface:     PG/PC interface:     PG/PC interface:     Online access      Device filter      Configured PROFINET devices of the same type     Only show devices of the same type     Only show devices with bad parameter settings     Only show devices without names      Accessible devices in the network:	Outine and the	Π						
General         Diagnostic status         Diagnostic status         Diagnostic status         Diagnostic status         Diagnostic status         Diagnostic status         Onligend PROFINET device         Reset to factory settings         Format memory card         Portice filter         Portice settings         Only show devices of the same type         Only show devices with bad parameter settings         Only show devices without names         Accessible devices in the network:		Assign PROFINET der	vice name					
Diagnostic status   Diagnostic status   Diagnostic stuffer   Cycle time   Memory   • PROFINET interface [X1]   • PROFINET interfaces   Assign PROFINET device.   Reset to factory settings   Format memory card   • Only show devices of the same type   Only show devices of the same type   Only show devices with bad parameter settings								
Diagnostics buffer       Configured PROFINET device         Gycle time       PROFINET interface [X1]            • FROFINET interface [X1]           PROFINET device name: cpu_1214c          vpu_1214c DC/DC/DC             • FROFINET interface [X1]           Device type: CPU 1214C DC/DC/DC             • FROFINET interface [X1]           Dovice type: CPU 1214C DC/DC/DC             • FROFINET interface [X1]           Online access             Assign FROFINET devic           Place select             Place interface:           Place select             Pormat memory card           Only show devices of the same type             Only show devices with bad parameter settings           Only show devices without names             Accessible devices in the network:								
Cycle time   Memory   PROFINET device name:   Cycle time   Memory   PROFINET interface [X1]   Functions   Assign IP address   Set time   Firmware update   PGIPC interface:			Configured D	OFINET do	vico			
Memory       PROFINET device name:       cpu_1214c       Image: CPU 1214C DC/DC/DC            • PROFINET interface [X1]           Device type:       CPU 1214C DC/DC/DC             • Punctions           Online access           Online access             Assign PROFINET devic           PGPC interface:           Place select               Assign PROFINET devic           Reset to factory settings                 Format memory card           Only show devices of the same type           Only show devices with bad parameter settings           Only show devices without names             Accessible devices in the network:           Accessible devices in the network:           Accessible devices in the network:			configured Pr	UFINET UE	VICE			
			PROFINET de	vice name:	cpu_1214c		-	
Functions Assign IP address Set time Firmware update Assign FROFINET devic Reset to factory settings Format memory card Only show devices of the same type Only show devices of the same type Only show devices with bad parameter settings Only show devices without names Accessible devices in the network:			C	Device type:	CPU 1214C DC/DC/DC			
Assign IP address Set time Firmware update Assign PROFINET devic Reset to factory settings Format memory card Only show devices of the same type Only show devices with bad parameter settings Only show devices without names Accessible devices in the network:								
Set time       Npe of the Park interface:       Please select       Image: Control of the Park interface:         Firmware update       PGIPC interface:       Image: Control of the Park interface:       Image: Control of the Park interface:         Assign PROFINET devic       Reset to factory settings       Device filter         Format memory card       Image: Control of the Park interface:       Image: Control of the Park interface:         Only show devices of the same type       Image: Control of the Park interface:       Image: Control of the Park interface:         Only show devices with bad parameter settings       Image: Control of the Park interface:       Image: Control of the Park interface:         Accessible devices in the network:       Accessible devices in the network:       Image: Control of the Park interface:								
Firmware update Assign FROFINET devic Reset to factory settings Format memory card Only show devices of the same type Only show devices with bad parameter settings Only show devices without names Accessible devices in the network:			Type of the PG/F	C interface:	face: Please select			
Assign PROFINET devic         Assign PROFINET devic         Reset to factory settings         Format memory card         Image: Comparison of the set of the			PG/F	C interface:				
Reset to factory settings     Device filter       Format memory card     Image: Only show devices of the same type       Image: Only show devices with bad parameter settings     Image: Only show devices with bad parameter settings       Image: Only show devices with out names     Image: Only show devices with out names       Accessible devices in the network:     Image: Only show devices with out names								
Format memory card  Only show devices of the same type  Only show devices with bad parameter settings  Only show devices without names  Accessible devices in the network:			Davides filters					
Only show devices of the same type     Only show devices with bad parameter settings     Only show devices without names  Accessible devices in the network:			Device filter					
Only show devices with bad parameter settings Only show devices without names Accessible devices in the network:	Pormat memory card		🔽 Only she	ow devices of	the same type			
Only show devices without names Accessible devices in the network:								
Accessible devices in the network:		•	Only she	ow devices wi	th bad parameter settings			
			Onlysh	ow devices wi	thout names			
IP address MAC address Device PROFINET device name Status		Accessible de	vices in the network:					
		IP address	MAC address	Device	PROFINET device name	Status		
LED flashes Update list Assign name				LEC	flashes U	odate list	Assign name	

 $(\rightarrow$  Functions  $\rightarrow$  Assign name)

→ Under "Reset to factory settings", you can restore the factory settings of the CPU. ( $\rightarrow$ Functions  $\rightarrow$  Reset to factory settings  $\rightarrow$  Retain or delete IP address  $\rightarrow$  Reset)

	_##X	
Online access	Breakty for the section	
<ul> <li>Diagnostics</li> </ul>	Reset to factory settings	
General		
Diagnostic status		
Diagnostics buffer		
Cycle time	IP address : PROFINET device name :	192.168.0.1
Memory		cou 1214c
PROFINET interface [X1]		cpu_1214c
▼ Functions		
Assign IP address		Retain IP address
Set time		O Delete IP address
Firmware update		Reset
Assign PROFINET devic		
Reset to factory settings		
Format memory card		
	1	

→ Under "Format memory card", you can format the optional memory card if it is inserted in the CPU. (→Functions → Format memory card → Format)

031-100_FC_Programming	CPU_1214C [CPU 1214C DC/DC/DC]	∎ = ×
Online access • Diagnostics	Format memory card	_
General Diagnostic status Diagnostics buffer		
Cycle time Memory PROFINET interface [X1] Functions	IP address: 192 . 168 . 0 . 1 PROFINET device name: CPU_1214c	
Assign IP address Set time Firmware update	Format	
Assign PROFINET devic Reset to factory settings Format memory card		

→ The online connection should be disconnected again before the next chapter. (→ Online access → Go offline)

Online access	0-1		
<ul> <li>Diagnostics</li> </ul>	Online access		
General	Status		
Diagnostic status			
Diagnostics buffer			
Cycle time	Online	····	
Memory		It and the second	
PROFINET interface [X1]		5	
<ul> <li>Functions</li> </ul>			
Assign IP address		Flash LED	
Set time			
Firmware update			_
Assign PROFINET devic			
Reset to factory settings			
Format memory card	Online access		
	Type of the PG/PC interface:	L PN/IE	-
	PG/PC interface:	Intel(R) Ethernet Connection (4) I219-LM	- 💽 💽
	Connection to interface/subnet:	PN/IE_1	-
	1st gateway:		- 0
	Device address:	192.168.0.1	
	Device address:	[132.100.0.1	
		Go offline	

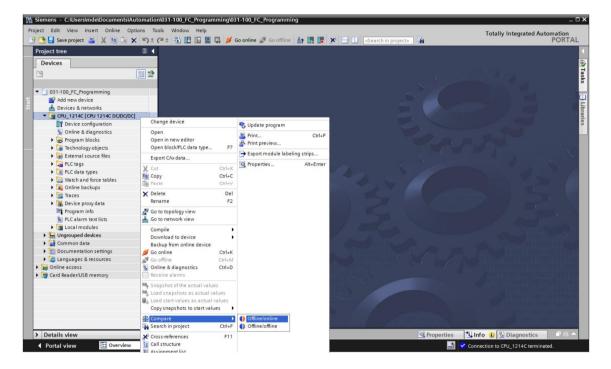
→ The TIA Portal is now back in offline mode. The orange-colored bars and the diagnostic symbols are no longer displayed.

### 7.5 Online/offline comparison

→ It is often important to know whether the saved data matches the data loaded in the controller. First, remove the negation from the "Safety\_shutoff\_active" tag at the AND function in the "MOTOR MANUAL [FC1] block.

Then save the "MOTOR\_MANUAL [FC1]" block, but do **NOT** download it to the controller. Close the "MOTOR\_MANUAL [FC1] block again.

→ To compare, right-click the "PLC\_1" controller and select "Compare", "Offline/online". ( $\rightarrow$  Select controller  $\rightarrow$  Compare  $\rightarrow$  Offline/online)



 $\rightarrow~$  The Compare editor online opens.

Compare editor onlin	ie										-	∎≡×
<b>● ● ♂</b> ± 🖪 8	A C 3	H										
	0. 0.2				_	<u> </u>						
*031-100_FC_Programmi	ng: CPU 1214	IC*	_	-	_		_	"Online PLC"	_	_	_	-
Name	Address	Туре	Time stamp	Time s	Status	Action		Name	Address	Type	Time stamp	Time s.
▼ CPU_1214C		1.21			0			CPU_1214C		1.21		
<ul> <li>Program blocks</li> </ul>					0							
Main (OB1)	OB1	OB	7/21/2008	7/4/20	•			- Main [OB1]	OB1	OB	7/21/2008	7/4/20.
MOTOR_MA.	FC1	FC	7/3/2017	7/5/20	0	11		MOTOR_MANUAL [FC1]	FC1	FC	7/3/2017	7/4/20.
Technology obj.					•							
PLC tags					•							
PLC data types					•							
<	HI	1		>				<	1	0		)
Comparison result: No de	tailed proper	ty compariso	n available.									
			c	PU_1214				0		CPU_1214C		

 $\rightarrow$  If, for example, block differences are indicated  $\P$ , first select the block involved. You can then click the is button to "Start detailed comparison".

 $(\rightarrow MOTOR\_MANUAL \rightarrow Start detailed comparison).$ 

90	8 ± 🛙 🛛	e 13	E of ±		_	_						
		Start d	etailed comp	arison		-	44					
031-10	0_FC_Programmin	g: CPU_1214	IC*					*Online PLC*				
Name		Address	Туре	Time stamp	Time s	Status	Action	Name	Address	Туре	Time stamp	Time s
- 60	PU_1214C					0		CPU_1214C				
	Program blocks					0						
		OB1	OB	7/21/2008	7/4/20			Main [OB1]	OB1	OB	7/21/2008	7/4/20
	MOTOR_MA	FC1	FC	7/3/2017	7/5/20	0		MOTOR_MANUAL [FC1]	FC1	FC	7/3/2017	7/4/20
C	Technology obj					•						
0	PLC tags					•						
E	PLC data types					•						
<		18			>			<		U.		
Compa	rison result: Object	s are differe	nt.			100	Col No.					
					-					-		
								•		R_MANUAL (F		

 $\rightarrow$  The selected offline/online block will be compared in the code block comparison. A detailed description of the difference is shown in the comparison result.

Code block comparison (FC1)												×
CPU_1214C > MOTOR_MANUAL -	Offline			-	мо	FOR MANUAL -	Online					
💊 🥗 📑 🚍 🔄 👻 🕼		_		Т								
MOTOR_MANUAL					N	OTOR_MANUA	AL					
Name	Data type	Default value	C			Name		Data type		Default value	C	
🕣 🔻 Input				^	1 4	🖬 🔻 Input						1
- Manual_mode_active	Bool		M	~	2 -	🖬 🔹 Manual_	mode_active	Bool				5
<			>		Ĩ	<		10			>	1
Network 1: Control of the con Comment     #Manual_mode #Manual_mode #Pushbutton#Safety_shutoff#Safety_shutoff#     Safety_shutoff#	#Conveyor_ motor_manual_ mote	-		1		Network 1: C Comment #Manual_mode_ active #Pushbutton, manual_mode #Enable_OK #Safety_shutoff, active Network 2:	&  *	#C moto	in manual mo ionveyor_ r_manual_ mode =	ode		
Comment				~		Comment						ŀ
< III >	100%	• <u> </u>			<	111	>	100%		• <u> </u>		1
							Properties	1 Info	🖁 Diag		18	Ē
General Cross-references	Compile En	ergy Suite	Synt	ax		Comparison resu	ult					

 $\rightarrow$  Close the window of the code block comparison.

An action can be selected for the block involved in the Compare editor.

Either the "MOTOR\_MANUAL" block will be downloaded from the programming device to the controller and overwritten there or the "MOTOR\_MANUAL" block will be read in from the controller and overwritten in the TIA Portal.

Select the "Upload from device" action ( $\leftarrow$  Upload from device).

🍤 🛛 🚰 ± 📳 🗉	8 C	e Ko 🗄									
						<u>a</u>					
*031-100_FC_Programmin	g: CPU_1214	tC.					*Online PLC*		_		
Name	Address	Туре	Time stamp	Time s	Status	Action	Name	Address	Туре	Time stamp	Time s
▼ 🚰 CPU_1214C					0	Ш	CPU_1214C				
🕶 🛃 Program blocks					0						
🖀 Main [OB1]	OB1	OB	7/21/2008	7/4/20	•		🌗 Main [OB1]	OB1	OB	7/21/2008	7/4/20
MOTOR_MA	FC1	FC	7/3/2017	7/5/20	0	11	MOTOR_MANUAL [FC1]	FC1	FC.	7/3/2017	7/4/20
🚂 Technology obj					•	II No act	tion				
PLC tags					•		d from device				
PLC data types					•	-> Down	load to device				

 $\rightarrow$  Click the "Execute actions" button 2 ( $\rightarrow$  Execute actions)

Compare editor online										• = ×
9 0 8°± 18 1	<b>₽</b> 0	e of ±								
		Execute ad	tions		40					
*031-100_FC_Programmin	g: CPU_1214	4C*			_	*Online PLC*				
Name	Address	Туре	Time stamp Tim	s Status	Action	Name	Address	Туре	Time stamp	Time s
▼ CPU_1214C				0	+	CPU_1214C				
<ul> <li>Program blocks</li> </ul>				0	+					
Main [OB1]	OB1	OB	7/21/2008 7/4	20 🔵		- Main [OB1]	OB1	OB	7/21/2008	7/4/20
MOTOR_MA	FC1	FC	7/3/2017 7/5	20 🌒	¢	MOTOR_MANUAL [FC1]	FC1	FC	7/3/2017	7/4/20
🙀 Technology obj				•						
PLC tags										
PLC data types										

 $\rightarrow$  Confirm "Upload from device" ( $\rightarrow$  Upload from device).

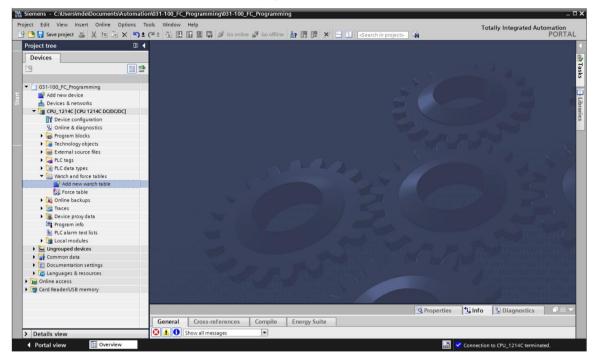
tatus	1	Target	Message	Action
†]	2	▼ CPU_1214C	Ready for loading.	
	4	Conflicts	Conflicts occurred during loading.	Overwrite
:			10	

→ After the upload, there are no more differences. You should now save your project again and close the online connection.

### 7.6 Monitor and modify tags

 $\rightarrow$  To monitor and modify tags, you need a watch table.

Double-click "Add new watch table" in the project tree. ( $\rightarrow$  Add new watch table).



 $\rightarrow$  Open the newly created "Watch table\_1" by double-clicking it ( $\rightarrow$  "Watch table\_1").

You can enter individual tags in the table or you can select the "Tag\_table\_sorting\_station" and then select the tags to be monitored and drag them from the Details view to the watch table ( $\rightarrow$  Tag\_table\_sorting\_station).

Project tree	◀ 031-10	0_FC_Progra	mming > CPU_1214	4C [CPU 1214C DC/	DC/DC] → Wate	h and force ta	ables 🕨 Watch tal	ole_1 🖬 🖬
Devices								
19 III III III III III III III III III I	* * *	11 1 10 10	9. 9. 1 00 00 1					
	i	Name	Address	Display format	Monitor value	Modify value	2 Comment	Tag comment
031-100_FC_Programming	<b>^</b> 1	"-A1"	%0.0	Bool				return signal emergency stop ok (nc)
Add new device	2	*-K0*	%10.1	Bool				main switch "ON" (no)
Devices & networks	3	*-S0*	%10.2	Bool				mode selector manual(0) / automatic(1)
CPU_1214C [CPU 1214C DC/DC/DC]	≡ 4	*-53*	9611.4	Bool				pushbutton manual mode conveyor -M1 forwards
Pevice configuration	5	"-81"	%10.5	Bool				sensor cylinder -M4 retracted (no)
🛂 Online & diagnostics	6	*-54*	%11.5	Bool				pushbutton manual mode conveyor -M1 backwar
<ul> <li>Program blocks</li> </ul>	7	"-Q1"	%Q0.0	Bool				conveyor motor -M1 forwards fixed speed
Add new block	8		<add new=""></add>					
Main [OB1]								
MOTOR_MANUAL [FC1]								
Technology objects								
External source files								
PLC tags								
a Show all tags								
Add new tag table								
💥 Default tag table [29]								
👆 Tag table_sorting_station [28]	~							
Details view								
Name Data type								
🛛 -A1 Bool 🕕	^							
	=							
-B2 Bool								
-B3 Bool								
	<					111		
🖬 -85 Bool							September 201	ties 🗓 Info 🗓 Diagnostics 💷 🖃 🖃
Bool								

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→ To have all monitoring and modifying functions available for selection, the following columns can be displayed:

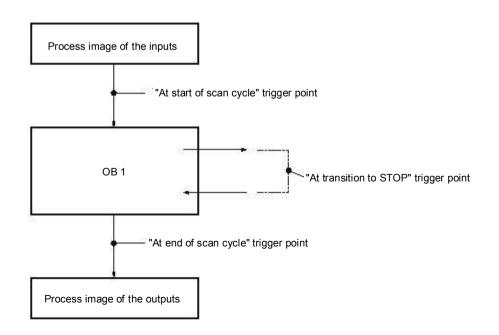
'All modify columns' 💹 and 'All expanded mode columns' 🖽

Continue by selecting the trigger timing for the monitoring ( $\rightarrow$  Permanent).

Ť	2	1	2, %								
	i	Name	Address	Display format	Monitor value	Monitor with trig	Modify with trigge	Modify value	9	Comment	Tag comment
		"-A1"	%10.0	Bool		Permanent	Permanent				return signal emergency sto.
2		"-K0"	%I0.1	Bool		Permanent	Permanent				main switch "ON" (no)
3		"-SO"	%10.2	Bool		Permanent	Permanent				mode selector manual(0) / a
		*-53*	%11.4	Bool		Permanent	Permanent				pushbutton manual mode c.
		"-B1"	%10.5	Bool		Permanent	Permanent				sensor cylinder -M4 retracte
		"-S4"	%11.5	Bool		Permanent	Permanent				pushbutton manual mode c.
		"-Q1"	%Q0.0	Bool	•	Permanent	Permanent 💌	1			conveyor motor -M1 forwar
							Permanent Permanently, at stat Once only, at start Permanently, at end Once only, at trans Once only, at trans	of scan cycle d of scan cycle of scan cycle nsition to STOP			

### The following monitoring and modifying modes are available:

- Permanent (in this mode, the inputs are monitored/modified at the start of the cycle and the outputs at the end.)
- Once only, at start of scan cycle
- Once only, at end of scan cycle
- Permanently, at start of scan cycle
- Permanently, at end of scan cycle
- Once only, at transition to STOP
- Permanently, at transition to STOP



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ightarrow Next, click "Monitor all values once and now" ightarrow or "Monitor all values according to trigger

	setting	s" 🎦	) <sub>(→</sub> 😰	Monitor	all).					
31-1	00_FC_Prog	ramming	CPU_1214C [C	PU 1214C DC/D	C/DC] + Watch	and force tables	Watch tal	ole_1		_ # # X
9 Z	· 🔐 🕼 🛛	9.9								
i	Name	Address	Display format	Monitor value	Monitor with trig	Modify with trigge	Modify value	9	C	Tag comment
	"-A1"	%10.0	Bool	TRUE	Permanent	Permanent				return signal emergency stop ok (nc)
	"-K0"	%IO.1	Bool	TRUE	Permanent	Permanent				main switch "ON" (no)
	"-SO"	%10.2	Bool	FALSE	Permanent	Permanent				mode selector manual(0) / automatic.
	"-S3"	%11.4	Bool	FALSE	Permanent	Permanent				pushbutton manual mode conveyor
	"-B1"	%10.5	Bool	TRUE	Permanent	Permanent				sensor cylinder -M4 retracted (no)
5	"-S4"	%11.5	Bool	FALSE	Permanent	Permanent				pushbutton manual mode conveyor
	"-Q1"	%Q0.0	Bool	FALSE	Permanent	Permanent				conveyor motor -M1 forwards fixed s
							1			

→ To modify tags, enter the desired "Modify values". Then, click 21 to "Modify all activated values once and now" or 22 to "All active values will be modified by modify with trigger".

 $(\rightarrow \text{TRUE} \rightarrow \overset{\text{M}}{=} \text{"All active values will be modified by modify with trigger"})$ 

031	1-100	_FC_Progra	mming )	CPU_1214C [CP	U 1214C DC/E	OC/DC] 🕨 Watch a	and force tables	<ul> <li>Watch tab</li> </ul>	ile_1		_ # = ×
ý	2	11.2 14 Io	9, %	2 00 00 1							
	i	Name	Address	Dicolay format	Monitor value	Monitor with tria	Modify with trigge	Modify value	9	C	Tag comment
1		*-A1*	%IO. All	active values will be	modified by *m	odify with trigger*.	Permanent				return signal emergency stop ok (nc)
2		*-K0*	%10.1	Bool	TRUE	Permanent	Permanent				main switch "ON" (no)
		*-S0*	%10.2	Bool	FALSE	Permanent	Permanent				mode selector manual(0) / automatic.
		*-53*	%11.4	Bool	FALSE	Permanent	Permanent				pushbutton manual mode conveyor
		"-B1"	%10.5	Bool	TRUE	Permanent	Permanent				sensor cylinder -M4 retracted (no)
5		*-54*	%11.5	Bool	FALSE	Permanent	Permanent				pushbutton manual mode conveyor
		*-Q1*	%Q0.0	Bool	FALSE	Permanent 💌	Permanent 💌	TRUE		1	conveyor motor -M1 forwards fixed s

 $\rightarrow$  Confirm the warning with **'Yes'** ( $\rightarrow$  Yes).

Modify w	ith trigger (0610:001) ? 🗙
A	Modify with trigger
	With the 'Modify with trigger' function, you intervene in the process permanently.
	Do you want to continue with 'Modify with trigger' ?
	Do not show this message again
	Yes No

→ The output becomes active even though the programmed conditions are not met.

			(70) [005] 005							
0 ⊉0 i	Name	Address	Display format	Monitor value	Monitor with trig	Modify with trigge	Modify value	9	C	Tag comment
	"-A1"	%10.0	Bool	TRUE	Permanent	Permanent				return signal emergency stop ok (nc)
	"-K0"	%IO.1	Bool	TRUE	Permanent	Permanent				main switch "ON" (no)
	"-SO"	%10.2	Bool	FALSE	Permanent	Permanent				mode selector manual(0) / automatic.
	*-S3*	%11.4	Bool	FALSE	Permanent	Permanent				pushbutton manual mode conveyor
	"-B1"	%10.5	Bool	TRUE	Permanent	Permanent				sensor cylinder -M4 retracted (no)
	*-S4*	%11.5	Bool	FALSE	Permanent	Permanent				pushbutton manual mode conveyor
=_	*-Q1*	∎ %Q0.0	Bool		Permanent 💌	Permanent 💌	TRUE			conveyor motor -M1 forwards fixed s

**Note:** If the watch table is closed or the connection to the PLC is lost, all modify commands are nullified.

30

### 7.7 Force tags

→ The "Force" function can be used to assign a fixed value to tags. Force values are specified in a similar way as for the "Modify tags" function but, in contrast, are retained after the CPU is switched off or stopped. The "Modify tags" and "Force" functions essentially differ as follows:

In contrast to "Modify tags", it is not possible to assign values to data blocks, timers, counters and bit memory with the "Force" function.

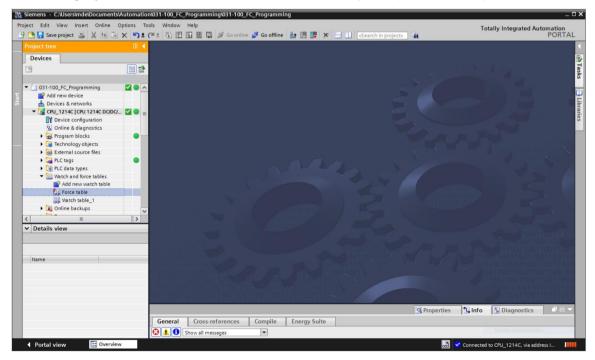
IO device inputs (e.g., IWxx:P) cannot be modified but can be pre-assigned by the "Force" function.

Unlike with the "Modify" function, values permanently assigned by the "Force" function cannot be overwritten by the user program.

If you close the force table, the force values are retained. This is not the case with the "Modify" function.

If the online connection to the CPU is interrupted, the tags assigned with the "Force" function retain their value.

To force tags, you must first double-click the force table to open it. ( $\rightarrow$  Force table)



 $\rightarrow$  Select the "Q1" operand with address %Q0.0 from the list. ( $\rightarrow$  Q1)

P	÷.	🧟 🌆 🗛 F. F.	00 00								
	i	Name	Address	Display for	mat	Monitor value	Force value		F	Comment	Tag commen
			<add new=""></add>								
		*-P5*	1	Bool	%Q	1.1 dis	play_autom	^			
		-P6"		Bool	%Q	1.2 dis	play cylinder				
		• *• P7*		Bool	%Q	1.3 dis	play cylinder				
		🕣 "-Q1"		Bool	%Q1	0.0 co	nveyor moto				
		-Q2*		Bool	%Q	0.1 co	nveyor moto				
		-Q3*		Bool	%Q1	0.2 co	nveyor moto	-			
		*-S0*		Bool	%10	2 m	de selector				
		*-S1*		Bool	%10	3 ри	shbutton aut	~			

 $\rightarrow$  With forcing, the operands are entered with direct IO access (%Q0.0:P).

	Programming	CPU_1214C [CPU	1214C DC/DC/DC]	Watch and for	rce tables 🔸 Fo		_ # # ×
<b>1</b>	🤌 🦽 🗛 F.	F. 00 00					
i	Name	Address	Display format	Monitor value	Force value	F	Comment
1	"-Q1":P	@Q0.0:P	Bool	- 00			
2							

 $\rightarrow$  Enter the desired force value and activate it  $\blacksquare$ .

Click "Start or replace forcing" I. The new force request will be transferred to the CPU.

 $(\rightarrow \%Q0.0:P \rightarrow TRUE \rightarrow \square \rightarrow \blacksquare$  Start or replace forcing)

)	C_Pro	gramming 🕨	CPU_1214C [CPU	1214C DC/DC	/DC] 🕨 Watch an	d force tables 🔸 For	ce table 🛛 💶 🖬 🗮 🗙
-	🦉 u	😤 🗓 F,I F,	F. 😤 😋				
	i	Name	Start or replace fo	rcing of the visib	le addresses in the F	orce table. ce value	F Comment
1		"-Q1":P	(III) %Q0.0:P	Bool	- 8	TRUE	
2							

 $\rightarrow$  Confirm the warning with **'Yes'** ( $\rightarrow$  Yes).

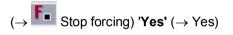
Force all	(0710:001)		? X
	Force all		
	CAUTION: Forcing with " !		
	Do you want to start "forcing" now?		
		Yes	No

→ Forcing is activated and the yellow MAINT LED on the CPU lights up. In addition, an F on a red background is shown at the top right of the display of the S7-1200.

	FC_Pr		CPU	_1214C [CPL	1214C DC/DC/DC]	Watch and for	rce tables 🔸 For		_ # # ×
<b>1</b>	1	🥂 🗓 FJ	F., <b>F</b> .	■ <sup>00</sup> 00					
	i	Name		Address	Display format	Monitor value	Force value	F	Comment
1	F	"-Q1":P		%Q0.0:P	Bool	- 8	TRUE		

**Note:** If the watch table is closed or the connection to the PLC is lost, **forcing remains active** and the yellow **FORCE LED** on the CPU continues to be lit.

→ If you want to '**Stop forcing**', simply click " Stop forcing" and confirm the next dialog with "Yes".



	FC_Pro	gramming 🕨	CPU_1214C [CPU	1214C DC/DC	/DC] 🕨	Watch and fo	rce tables 🔸 For	rce table	_ 🖬 🖬 🗙
-	1	🏄 🌆 🗛 F	F. 📬 📬						
	i	Name	Stops forcing of	f the selected ad	dresses.	Monitor value	Force value	F	Comment
1	F	*-Q1*:P	🔳 %Q0.0:P	Bool		8	TRUE		
2									

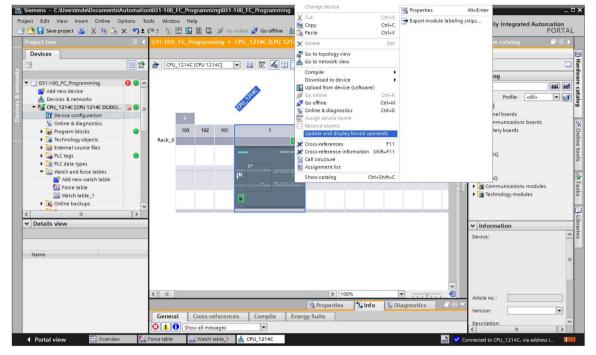
Forcing is stopped and the yellow MAINT LED on the CPU switches off.

→ If a force request already exists in the controller, this is indicated by the E symbol in the watch table. If you then click E, additional information will be displayed (→ E).

i	Name	Address	Display format	Monitor value	Monitor with trig	Modify with trigge	Modify value	9			
	*-A1*	%10.0	Bool		Permanent 💌	Permanent 💽					
	*-K0*	%10.1	Bool		Permanent	Permanent					
	*-S0*	%10.2	Bool		Permanent	Permanent					
	"-S3"	%11.4	Bool		Permanent	Permanent					
	"-B1"	%10.5	Bool		Permanent	Permanent					
8	"-S4"	%11.5	Bool		Permanent	Permanent					
E	"-Q1"	%Q0.0	Bool		Permanent	Permanent	TRUE				

8

→ If a force request already exists in the controller, it can also be displayed and stopped via the online device view. To do this, you must right-click the CPU in online mode of the device view and select "Update and display forced operands".



 $(\rightarrow$  right-click the CPU  $\rightarrow$  Update and display forced operands")

 $\rightarrow$  The force table with the current force requests will now be displayed and you can stop these.

 $(\rightarrow \blacksquare$  Stop forcing)

🔁 🖬 Save project 📑 🐰 🏥 🚡	× -12								-	PORT
			Programming >						- • • ×	Testing 🗊 🗊
Devices										Options
19		9 9	12 Lo F.I	F. F. 00 00						
		i	Name		ig of the selected ad	dresses. litor value	Force value	F	Comment	✓ CPU operator panel
<ul> <li>031-100_FC_Programming</li> </ul>	0 • ^	1 E	*-Q1*:P	%Q0.0:P	Bool	- 8	TRUE			
Add new device		2								CPU_1214C [CPU 1214C DC/DC/DC]
Devices & networks										RUN / STOP RUN
CPU_1214C [CPU 1214C DC/DC/										ERROR STOP
Device configuration										MAINT MRES

### 7.8 Checklist

No.	Description	Completed
1	Project 031-100_FC-programming successfully retrieved.	
2	CPU 1214C from project 031-100_FC-Programming successfully downloaded.	
3	CPU 1214C connected online.	
4	Status of the CPU 1214C checked with Online & Diagnostics.	
5	Offline/online comparison of blocks in the CPU 1214C performed.	
6	Watch table_1 created.	
7	Tags (-S0 / -S3 / -K0 / -B1 / -S4 / -A1 / -Q1) entered in watch table.	
8	Switch on conveyor motor forward by modifying the output $(-Q1 = 1)$ in watch table.	
9	Switch off conveyor motor forward by modifying the output $(-Q1 = 0)$ in watch table.	
10	Open force table	
11	Tag (-Q1:P) entered in force table.	
12	Switch on conveyor motor forward by forcing the output $(-Q1 = 1)$ in force table.	
13	Force output -Q1 to switch off again.	

### 8 Exercise

### 8.1 Task – Exercise

In this exercise, the MOTOR\_AUTO [FB1] function block from chapter SCE\_EN\_031-200\_FB-Programming is to be tested.

The challenge here is that the cylinder is in the front end position and thus the enable conditions for switching on the conveyor are not met.

Using a watch table, the cylinder is to be moved to its rear end position so that the enable conditions for the MOTOR\_AUTO [FB1] block are met.

### 8.2 Planning

Plan the implementation of the task independently using the step-by-instructions as an aid.

### 8.3 Checklist – Exercise

No.	Description	Completed
1	Project 031-200_FB-Programming successfully retrieved.	
2	CPU 1214C from project 031-200_FB-Programming successfully downloaded.	
3	Watch table created and renamed as "Watch_table_cylinder".	
4	Tags (-B1 / -B2 / -M2) entered in watch table.	
5	Retract cylinder by modifying the output (-M2 = 1) in watch table.	
6	Cylinder retracted (-B1 = 1)	
7	Reset output for Retract cylinder in watch table again $(-M2 = 0)$ .	

### 9 Additional information

More information for further practice and consolidation is available as orientation, for example: Getting Started, videos, tutorials, apps, manuals, programming guidelines and trial software / firmware, under the following link:

#### www.siemens.com/sce/s7-1200

#### Preview "Additional information"

- Getting Started, Videos, Tutorials, Apps, Manuals, Trial-SW/Firmware
  - ↗ TIA Portal Videos
  - TIA Portal Tutorial Center
  - > Getting Started
  - ↗ Programming Guideline
  - Easy Entry in SIMATIC S7-1200
  - > Download Trial Software/Firmware
  - 7 Technical Documentation SIMATIC Controller
  - ↗ Industry Online Support App
  - TIA Portal, SIMATIC S7-1200/1500 Overview
  - ↗ TIA Portal Website
  - ↗ SIMATIC S7-1200 Website
  - ↗ SIMATIC S7-1500 Website

### Notes

# SCE Learn-/Training Textbook

# Automation System SIMATIC S7-1200



### TIA Portal Modules from Version V14 SP1

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<b>TIA Portal Module 011-001</b> Firmware Update	1
TIA Portal Module 011-100 Unspecified Hardware Configuration	2
<b>TIA Portal Module 011-101</b> Specified Hardware Configuration	3
<b>TIA Portal Module 020-100</b> Process description of sorting station	4
TIA Portal Module 031-100 Basics of FC Programming	5
TIA Portal Module 031-200 Basics of FB Programming	6
TIA Portal Module 031-300 IEC Timers and IEC Counters	
TIA Portal Module 031-410 Basics of Diagnostics	8
<b>TIA Portal Module 031-420</b> Diagnostics via Web	9
<b>TIA Portal Module 031-500</b> Analog Values	10
<b>TIA Portal Module 031-600</b> Global Data Blocks	11
<b>TIA Portal Module 041-101</b> WinCC Basic with KTP700	12
<b>TIA Portal Module 051-201</b> High-Level Language Programming with SCL	13
<b>TIA Portal Module 051-300</b> PID Controller	14

### Matching SCE Trainer Packages for these Learn-/Training Document

- SIMATIC S7-1200 AC/DC/RELAY (set of 6) "TIA Portal" Order no.: 6ES7214-1BE30-4AB3
- SIMATIC S7-1200 DC/DC/DC (set of 6) "TIA Portal" Order no.: 6ES7214-1AE30-4AB3
- Upgrade SIMATIC STEP 7 BASIC V14 SP1 (for S7-1200) (set of 6) "TIA Portal" Order no.: 6ES7822-0AA04-4YE5

Please note that these trainer packages are replaced with successor packages when necessary. An overview of the currently available SCE packages is provided at: <u>siemens.com/sce/tp</u>

### **Continued training**

For regional Siemens SCE continued training, please contact your regional SCE contact siemens.com/sce/contact

#### Additional information regarding SCE

siemens.com/sce

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#### Information regarding use

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We wish to thank the TU Dresden, particularly Prof. Dr.-Ing. Leon Urbas and the Michael Dziallas Engineering Corporation and all other involved persons for their support during the preparation of this Learn-/Training Document.

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	7.5	5 Checklist	21
8		Additional information	22

## **Diagnostics via web server**

### 1 Goal

In this module, the reader will become acquainted with the contents that can be displayed via the web server of the CPU 1214C.

This module will present the diagnostic functions in the web server that, for example, you can test with the TIA project from the SCE\_EN\_031-410\_Basics Diagnostics with SIMATIC S7-1200 module.

The SIMATIC S7 controllers listed in Chapter 3 can be used.

### 2 Prerequisite

This chapter builds on the hardware configuration of the SIMATIC S7 CPU1214C DC/DC/DC. However, other hardware configurations can be used. You can use the following project for this chapter, for example:

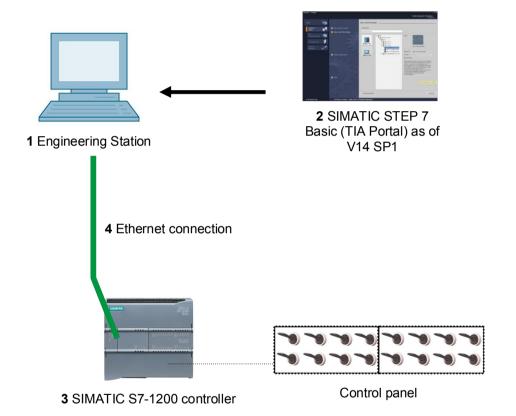
SCE\_EN\_031-410\_Basics\_Diagnostics\_S7-1200.zap14

### 3 Required hardware and software

- 1 Engineering station: requirements include hardware and operating system (for additional information, see Readme on the TIA Portal Installation DVDs)
- 2 SIMATIC STEP 7 Basic software in TIA Portal as of V14 SP1
- 3 SIMATIC S7-1200 controller, e.g. CPU 1214C DC/DC/DC with ANALOG OUTPUT SB1232 signal board, 1 AO Firmware as of V4.2.1

Note: The digital inputs should be fed out to a control panel.

4 Ethernet connection between engineering station and controller



### 4 Theory

### 4.1 Diagnostics via web server

The web server enables monitoring and administering of the CPU by authorized users over a network.

This permits evaluation and diagnostics over long distances. Monitoring and evaluation is possible without the TIA Portal; all you need is a web browser.

The web server is deactivated in the delivery state of the CPU. This means that you must load a project in which the web server is activated to enable access using the web browser.

#### The web server offers the following security functions:

- Access via secure "https" transmission protocol
- User authorization by means of a user list
- Restriction of access from certain interfaces

You need a web browser to access the HTML pages of the CPU.

The following web browsers have been tested for communication with the CPU:

- Internet Explorer (Version 8)
- Mozilla Firefox (Version 21)
- Mobile Safari (iOS5)

				_	10:8	55:39 pm 1/3/20	12 UTC	✓ English
semame	Mo	dule Inform	nation					
Login								🔁 Off 🎩
	Modul	e Information	S7-1200 station_1 - CPU_1214C					
Start Page	Slot	Status	Name		Order number	I address	Q address	Comment
Discretion	1	<b>V</b>	DI 14/DQ 10_1	Details		0	0	
Diagnostics	2		AI 2_1	Details		64		
Diagnostic Buffer	3	<b>□</b> <sub>×</sub>	AQ 1x12BIT_1	Details	6ES7 232-4HA30-0XB0		64	
5	16	<b>V</b>	HSC_1	Details		1000		
Module Information	17	<b>~</b>	HSC_2	Details		1004		
Communication	18	<b>~</b>	HSC_3	Details		1008		
	19	<b>~</b>	HSC_4	Details		1012		
Tag status	20	<b>~</b>	HSC_5	Details		1016		
Tay Status	21	<b>~</b>	HSC_6	Details		1020		
Watch tables	32	<b>V</b>	Pulse_1	Details			1000	
	33	<b>V</b>	Pulse_2	Details			1002	
Online backup	34	<b>V</b>	Pulse_3	Details			1004	
	35	<b>_</b>	Pulse_4	Details			1006	
User-defined pages	X1	Image: A start of the start	PROFINET interface_1	Details				
File Browser	State	Identificatio	n					
The browser								

Figure 1: Web server of the CPU 1214C DC/DC/DC with Module Information

**Note:** Make sure that you protect the CPU from manipulation and unauthorized access through the use of different methods (e.g., limiting network access, using firewalls).

9

### 5 Task

The following advanced diagnostic functions will be shown and tested in this chapter:

- Configuration of the web server of the CPU 1214C DC/DC/DC
- Display messages via the web server of the CPU 1214C DC/DC/DC

### 6 Planning

The diagnostic functions will be performed using a finished project as an example.

A project in the TIA Portal that was previously downloaded to the controller should be open for this.

In our case, after starting the TIA Portal, a previously created project will be retrieved from the archive and downloaded to the associated controller.

You can then configure the web server in the TIA Portal.

To demonstrate the display of an error in the module information, the configured signal board AQ 1x12Bit, for example, can be removed. **Caution!** The PLC should be disconnected from the supply voltage beforehand.

### 7 Structured step-by-step instructions

You can find instructions on how to carry out planning below. If you already have a good understanding of everything, it will be sufficient to focus on the numbered steps. Otherwise, simply follow the detailed steps in the instructions.

### 7.1 Retrieve an existing project

Before we begin with diagnostics via the web server, we need a project from the SCE\_EN\_031-410 Basics Diagnostics S7-1200 module. (e.g., SCE\_EN\_031-410\_Basics Diagnostics\_S7-1200\_2.zap14)

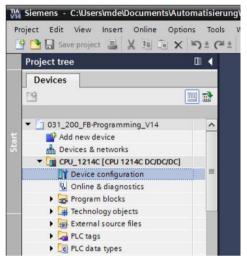
To retrieve an existing project that has been archived, you must select the relevant archive with  $\rightarrow$ Project  $\rightarrow$ Retrieve in the project view. Confirm your selection with "Open". ( $\rightarrow$  Project  $\rightarrow$  Retrieve  $\rightarrow$  Select a .zap archive  $\rightarrow$  Open)

Project	Edit	View	Insert	Online	Options	To
📑 New	2					) ±
Open.					Ctrl+O	4
Migrat	te proj	ect				
Close					Ctrl+W	
Save					Ctrl+S	1
Save	BS			Ctrl	+Shift+S	_
Delete	e proje	ct			Ctrl+E	-
Archiv	e					1
Retrie	ve					
Manag	ge mu	ltiuser s	erver pro	jects		
T Card F	eader	USB me	emory		•	
🎬 Memo	rycar	d file			•	
Start b	oasic i	ntegrity	check			
Upgra	de					

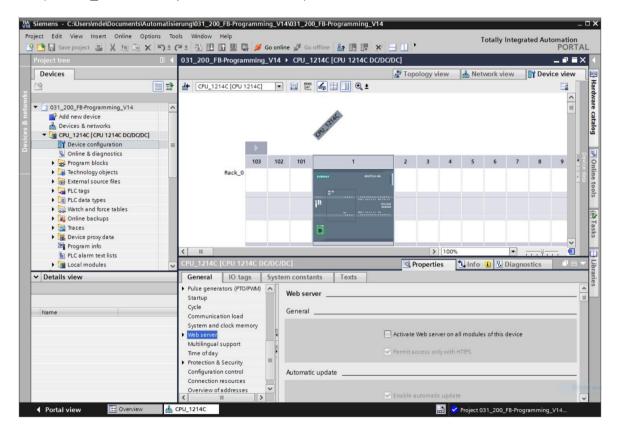
→ The next step is to select the target directory where the retrieved project will be stored. Confirm your selection with "OK". (→ Target directory  $\rightarrow$  OK)

### 7.2 Configure the web server

- ightarrow To configure the web server, open the device configuration of the CPU 1214C DC/DC/DC.
  - $(\rightarrow$  CPU\_1214C [CPU 1214C DC/DC/DC]  $\rightarrow$  Device configuration)



 $\rightarrow$  Select the CPU and choose the 'Web server' menu item in the properties.



 $(\rightarrow CPU_{1214C} \rightarrow Properties \rightarrow Web server)$ 

 $\rightarrow$  Activate the web server on this module and confirm the security note.

 $(\rightarrow \blacksquare$  Activate web server on this module  $\rightarrow$  OK)

CPU_1214C	[CPU 1214C	DC/DC/DC]		Sector Properties	🔄 🛄 Info 🔇	Diagnostics	
General	IO tags	System constants	Texts				
<ul> <li>General</li> <li>PROFINET in:</li> </ul>	terface [X1]	Web server					<u>^</u>
General Ethernet	addresses	General					
Time syn	chronization						
Operatin				🖌 Activate Web serve	r on all modules	of this device	
Advance	d options						
Web serv	eraccess			Permit access only	with HTTPS		
Hardware	e identifier						
DI 14/DQ 10		Aute Web serv				×	
▶ AI 2		vveb serv	/er			^	
AQ1 signal	board						
High speed	counters (HSC)		Security no	ote			
Pulse gener	ators (PTO/PWM		م معتر به مانی م	- Web	ei en ferrer ande	and and the second second	
Startup			external acc	e Web server reduces protected ess to functions and data on	tion from unauth	iorized Internal or	
Cycle		Use					
Communica	tion load						
System and	clock memory					ОК	
Web server						Lannananananana	
Multilingual	support				,		
Time of day				<	Add new user>		
Protection 8	Security						
Configuratio	n control						
Connection	resources						
Overview of	addresses						

→ Leave the check mark I for 'Enable automatic update', and select the security settings of the 'Everybody' user. Enable this user to carry out all possible actions and accept your settings.

### 

SCE\_EN\_031-420 Diagnostics via Webs S7-1200\_R1709

•	The user is authorized to	>% ▼
C/DC]	read tags	🚺 Info 🚺 🖞 Diagnostics 📃 🗆 🗉
tem cons	write tags	
Web s Gener Autom User n	read tag status     write tag status     open user-defined web pages     write in user-defined web pages     write in user-defined web pages     write/delete files     write/delete     delete/delete     write/delete     write/delete/delete/delete/delete/delete/delete/delete/delete/delete/delete/delete/delete/delete/delete/delete/delete/delete/delete/delete/delete/delete/delete/delete/delete/delete/delete/delete/delete/delete/delete/delete/delete/delete/delete/delete/delet	n all modules of this device h HTIPS late s Everyone chdd new user>
	C/DC] stem cons Web s Gener, Autom	Image: status         Image: status <td< td=""></td<>

Notes: You can also create multiple users here with different authorizations. These users then require a password.

11

→ As a result of these authorizations, the 'Everybody' user is now automatically assigned the access level 'Administrative'.

Access level		Password		Name	
Administrative	-			Everyone	
				<add new="" user=""></add>	

→ In the 'Watch tables' menu item, the 'Watch table\_Cylinder' can now be entered in the web server.

 $(\rightarrow Watch table_Cylinder \rightarrow \blacktriangleright)$ 

CPU_1214C [CP	PU 1214C D	C/DC	/DC]				<b>Properties</b>	1 Info	i Diagnostics	
General	IO tags	Syst	tem cor	nstants	Texts	]				
<ul> <li>General</li> <li>PROFINET interface</li> </ul>	ace [X1]	^	Watch	tables						
General										
Ethernet add	resses			Access		Name				
Time synchro	onization			Read		Watch ta	ble_cylinder			
Operating m	ode			-		, Watch table				
Advanced op	otions					Force table				
Web server a	ccess									
Hardware ide	entifier									
DI 14/DQ 10										
▶ AI 2										
AQ1 signal boar	rd									
High speed cou	nters (HSC)	=								
Pulse generator	rs (PTO/PWM)	100								
Startup		•								
Cycle										
Communication	load	-								
System and close	ck memory									
✓ Web server										
General										
Automatic up	pdate					Add new	<ul> <li>X</li> </ul>			
User manage	ement									
Watch tables										
User-defined	pages									
Entry page										
Overview of i	interfaces									

 $\rightarrow$  The access here is read/write access. ( $\rightarrow$  Read/Write)

Read I <add new="" table="" watch=""></add>	Access		Name	
	Read/Write	-	Watch table_cylinder	
Read/Write	Read		<add new="" table="" watch=""></add>	
	Read/Write			

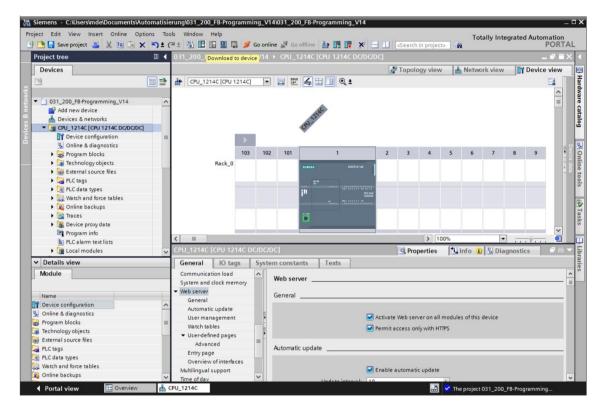
- → User-defined web pages will not be created here. We must enable PROFINET interface\_1 for access to the web server
  - $(\rightarrow \text{Enabled web server access} \rightarrow \square \text{ PROFINET interface}_1)$

CPU_1214C [CPI	U 1214C I	DC/DC	/DC]		<b>Q</b> Properties	s 🚺 Info 🚺	<b>Diagnostics</b>	
General	0 tags	Syst	tem constants	Texts				
General		~	User-defined pa	ages				~
▼ PROFINET interface	ce [X1]							
General				HTML directory				
Ethernet addr	esses							
Time synchron	nization		D	efault HTML page	index.htm			
Operating mo	de		ŀ	Application name	:			
Advanced opt	tions			Status				
Web server ac	cess				Generate blo	eles I	Delete blocks	
Hardware ide	ntifier				Generate bio		Delete blocks	
DI 14/DQ 10								
AI 2			<ul> <li>Advanced _</li> </ul>					
AQ1 signal board	ł							
High speed cour	ters (HSC)	=	Files with	dynamic content	.htm;.html			
Pulse generators	(PTO/PWM)			Web DB number				
Startup		-				•		
Cycle			Fragment	DB start number	334	٢		
Communication	load	10						
System and cloc	k memory		Entry page					
✓ Web server								
General			,	1 + +				-
Automatic up	date		-	Select entry page	intro page			
User manage	ment							
Watch tables			Overview of inte	erfaces				
	pages							
Advanced			Device		Interface	Enabled web se	erver access	
Entry page			CPU_1214	LC	PROFINET interface_1			
Overview of in	terfaces		0.0_1214			-		

### 7.3 Save project and download CPU

 $\rightarrow$  To save your project, click the save project button in the menu. The complete controller with the modified configuration settings in the hardware configuration, as described in the previous modules, can be downloaded.



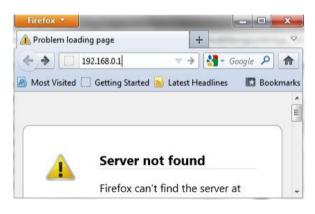


### 7.4 Diagnostics for the S7-1200 via the web

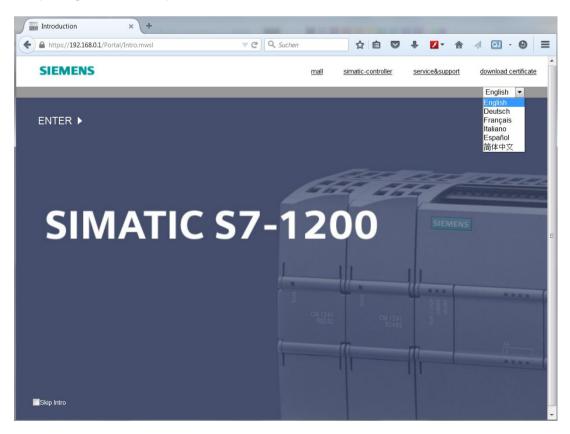
→ In order to access the web server of the CPU 1214C DC/DC/DC, we open any web browser on a PC that is connected to the CPU via TCP/IP.



 $\rightarrow$  There we enter the IP address of the CPU 1214C DC/DC/DC. ( $\rightarrow$  192.168.0.1)



 $\rightarrow$  On the displayed web page, we first select the language and then click 'ENTER'. ( $\rightarrow$  English  $\rightarrow$  ENTER)



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 $\rightarrow$  On the 'Home Page' we see general information about the PLC and its status. ( $\rightarrow$  Home Page)

SIEMENS	S7-1200 station_1 / CPU_1214C	
		10:44:48 pm 1/3/2012 UTC V English V
Username Login	S7-1200 station_1	8 <u>of</u> i 5
Start Page     Diagnostics	SIEMENS SIMATIC S7-1200	General: Project Name: 031 200 FB-Programming V14
Diagnostic Buffer		TIA Portal: V14 Station name: S7-1200 station 1
Module Information	AUSUM DC/DC/DC DC/DC/DC	Module name: CPU_1214C
Communication	5	Module type: CPU 1214C DCDCDC
▶ Tag status		Status: Operating Mode: RUN
<ul> <li>Watch tables</li> </ul>		Status: 🗸 OK
<ul> <li>Online backup</li> </ul>		CPU operator panel:
<ul> <li>User-defined pages</li> </ul>		RUN STOP
▶ File Browser		LED flashes
<ul> <li>Introduction</li> </ul>		

 $\rightarrow$  Hardware, Firmware Version and Serial number are displayed under 'Diagnostics'. ( $\rightarrow$  Diagnostics)

SIEMENS	S7-1200 station_1 / CPU_1214C		
		10:47:34 pm 1/3/2012 UTC	$\checkmark$ English $\checkmark$
Username	Diagnostics		
Login			C Off 🚐
▶ Start Page	Identification Program protection Memory		
Diagnostics	Order Identification:		
► Diagnostic Buffer	Plant designation:		
<ul> <li>Module Information</li> </ul>	Serial number: S C-F3SH7589		
▶ Communication	Order number:		
► Tag status	Hardware: 6ES7 214-1AG40-0XB0		
<ul> <li>Watch tables</li> </ul>	Version:		
Online backup	Hardware: 2 Firmware: V04.02.01		
<ul> <li>User-defined pages</li> </ul>			
▶ File Browser			
► Introduction			

 $\rightarrow$  Under 'Diagnostics Buffer' we see descriptive information for all events in the CPU. Event information is recorded in a circular buffer. The most recent alarm is displayed in the top line.  $(\rightarrow \text{Diagnostics Buffer})$ 

					10:48:48 pm 1/3/2012 UTC 💛 English 🗸
Isemame Login	Disease	ostic Buffer stic buffer entries			8 Off 🛓
	Number	Time	Date	Status	Event
Start Page	1	10:40:39 pm	1/3/2012	Incoming event	Follow-on operating mode change - CPU changes from STARTUP to RUN mode
	2	10:40:39 pm	1/3/2012	Incoming event	Communication initiated request: WARM RESTART - CPU changes from STOP to START
Diagnostics	3	10:40:39 pm	1/3/2012	Incoming event	New startup information - Current CPU operating mode: STOP
	4	10:40:37 pm	1/3/2012	Incoming event	New startup information - Current CPU operating mode: STOP
Diagnostic Buffer	5	10:40:35 pm	1/3/2012	Incoming event	New startup information - Current CPU operating mode: STOP
Module Information	6	10:40:33 pm	1/3/2012	Incoming event	New startup information - Current CPU operating mode: STOP
Wodule mornatori	7	10:40:31 pm	1/3/2012	Incoming event	Follow-on operating mode change - CPU changes from STOP to STOP mode
Communication	8	10:40:30 pm	1/3/2012	Incoming event	New startup information - Current CPU operating mode: STOP
	9	10:40:29 pm	1/3/2012	Incoming event	New startup information - Current CPU operating mode: STOP
Tag status	10	10:40:29 pm	1/3/2012	Incoming event	Communication initiated request: STOP - CPU changes from RUN to STOP mode
Addate to be a	11	08:47:58 pm	1/3/2012	Outgoing event	Force job active: - Current CPU operating mode: RUN
Watch tables	12	08:43:50 pm	1/3/2012	Incoming event	Force job active: - Current CPU operating mode: RUN
Online backup	13	08:47:58 pm	1/3/2012	Outgoing event	Force job active: - Current CPU operating mode: RUN
	14	08:43:50 pm	1/3/2012	Incoming event	Force job active: - Current CPU operating mode: RUN
User-defined pages	15	08-23-00 pm	1/3/2012	Incoming event	Follow-on operating mode change - CPU changes from STARTUP to RUN mode
	Details:	1			Event ID: 16# 02:400
File Browser	Power-on Pending s - No start	tartup inhibit(s): up inhibit set nges from START	I ŘESTART I	o RUN (if CPU was	in RUN before power off)

 $\rightarrow$  The status of the individual modules of our SIMATIC S7-1200 is displayed with additional details in the 'Module Information' view.

				-	10:5	55:39 pm 1/3/20	12 UTC	✓ English
sername		dule Inforn	nation					C Off
	Modul	e Information	- <u>S7-1200 station_1</u> - CPU_1214C					
Start Page	Slot	Status	Name		Order number	I address	Q address	Comment
Diagnostics	1	<b>_</b>	DI 14/DQ 10_1	Details		0	0	
Diagnostics	2	<b>V</b>	AI 2_1	Details		64		
Diagnostic Buffer	3	L <sub>X</sub>	AQ 1x12BIT_1	Details	6ES7 232-4HA30-0XB0		64	
5	16	<b>V</b>	HSC_1	Details		1000		
Module Information	17	<b>V</b>	HSC_2	<b>Details</b>		1004		
	18	<b>~</b>	HSC_3	Details		1008		
Communication	19	<b>V</b>	HSC_4	Details		1012		
▶ Tag status 20	20	<b>_</b>	HSC_5	Details		1016		
Tay status	21	<b>×</b>	HSC_6	Details		1020		
Watch tables	32	<b>V</b>	Pulse_1	Details			1000	
	33	<b>_</b>	Pulse_2	Details			1002	
Online backup	34	<b>~</b>	Pulse_3	Details			1004	
lless defined as a	35	<b>_</b>	Pulse_4	Details			1006	
User-defined pages	X1	<b>V</b>	PROFINET interface_1	Details				
File Browser	State	Identificatio	n					

 $(\rightarrow Module Information)$ 

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S7-1200 station\_1 / CPU\_1214C

S7-1200 station\_1 / CPU\_1214C

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→ Details about communications settings are displayed under 'Communication'.
 (→ Communication)

						10:58:50 pm 1/3/2012	UTC	$\sim$ English $\sim$
Usemame	Communica	ation						
Login								C Off 🎩
							_	
It start Page	Parameter Sta	tistics Co	nnection reso	urces Connection st	atus			
3								
<ul> <li>Diagnostics</li> </ul>	PROFINET In	nterface [X1	]					
<ul> <li>Diagnostic Buffer</li> </ul>	Network	connectio	n:					
Module Information	11	MAC addres	s: 28-63-36-88	B-FF-DA				
		Nam	e: cpuxb1214d	c77d5				
Communication								
	1	P paramete	r:					
▶ Tag status		IP Addres	s: 192.168.0.1					
Watch tables		Subnet mas	k: 255.255.25	5.0				
		Default route	er: 0.0.0.0					
Online backup		IP setting	s: IP address	set in project				
User-defined pages								
P Oser-denned pages	Physica	al propertie	s:					
▶ File Browser	Port number	Link status	Settings	Mode	Connection medium	1		
		ок		100 MBit/s full-duplex	Copper cable			
				the man and a start and a start and a start				

 $\rightarrow$  Values of the individual tags can be displayed and changed under 'Tag Status'. (  $\rightarrow$  Tag Status)

					11:06:27 pm 1/3/2012 UTC	$\sim$ English $\sim$
Usemame	Tag status					
Login						C Off 昌
	Enter the address of a tag	here which you want to monitor/m	odify			
Start Page	Address	Display Format		Monitor Value	Modify Value	9
▶ Diagnostics	q0.3	BOOL	$\sim$	true		Go
r Diagnostics	New variable		$\sim$		true	
Diagnostic Buffer	Refresh				uue	Apply
	Reliesi					Apply
<ul> <li>Module Information</li> </ul>						
▶ Communication						
Tag status						
Watch tables						
Online backup						
User-defined pages						
▶ File Browser						

 $\rightarrow$  'Watch tables' that are linked with the web server, such as the 'Watch table cylinder', can also be displayed. ( $\rightarrow$  Watch tables  $\rightarrow$  Watch table cylinder)

SIEMENS	S7-1200 stat	ion_1 / CPU_1214	C				
					11:08:48 p	om 1/3/2012 UTC	$\sim$ English $\sim$
Usemame	Watch tables	;					
Login	Watch table_cylin	ider ∨					😂 Off 昌
	Name	Address	Display Format		Monitor Value	Modify Value	🐓 Comment
<ul> <li>Start Page</li> </ul>	"-B1"	%10.5	BOOL		true		Go
▶ Diagnostics	"-B2"	%10.6	BOOL		false		Go
	"-M2"	%Q0.3	BOOL	~	false		Go
<ul> <li>Diagnostic Buffer</li> </ul>	Refresh						Apply
Module Information							
▶ Communication							
► Tag status							
▶ Watch tables							
<ul> <li>Online backup</li> </ul>							
User-defined pages							
<ul> <li>File Browser</li> </ul>							

→ Under "Online backup" you can create a backup of the project in the PLC and restore this

	11:10:19 pm 1/3/2012 UTC 💙 English 🗸
Usemame	Online backup
Login	
▶ Start Page	Backup PLC:
▶ Diagnostics	Create online backup
▶ Diagnostic Buffer	
▶ Module Information	Restore PLC:
▸ Communication	Durchsuchen
▶ Tag status	Restore selected online backup
<ul> <li>Watch tables</li> </ul>	Status:
▶ Online backup	
User-defined pages	
File Browser	

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backup later. ( $\rightarrow$  Online backup  $\rightarrow$  Create online backup  $\rightarrow$  Restore selected online backup)

S7-1200 station\_1 / CPU\_1214C

→ Individually created pages for the visualization and also for operator control of processes would be seen under 'User-defined pages'. (→ User-defined pages)

SIEMENS	S7-1200 station_1 / CPU_1214C	
	11:10.56 pm 1/3/2012 UTC 🗸 English 🗸	
Usemame	User-defined pages	
Login	C Off 3	
<ul> <li>Start Page</li> </ul>	The page is not available	
Diagnostics		
Diagnostic Buffer		
Module Information		
▶ Communication		
▶ Tag status		
<ul> <li>Watch tables</li> </ul>		
<ul> <li>Online backup</li> </ul>		
▸ User-defined pages		
▶ File Browser		

 $\rightarrow$  Data can be stored directly on the memory card in the CPU or loaded from there using the 'File Browser'. ( $\rightarrow$  File Browser)

					11:12:02 pm 1/3/2012 UTC	$\sim$ English $\sim$
Usemame	File Browser					
Login						😂 Off 🚢
▶ Start Page	S7-1200 station_1					
	Name	Size	Changed	Delete	Rename	
<ul> <li>Diagnostics</li> </ul>	DataLogs		12:00:00 am 1/1/2012			
► Diagnostic Buffer	Recipes		12:00:00 am 1/1/2012			
Module Information	Directory operations:					
▸ Communication						
▶ Tag status						
▶ Watch tables						
▸ Online backup						
▸ User-defined pages						
File Browser						

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S7-1200 station\_1 / CPU\_1214C

### 7.5 Checklist

No.	Description	Completed
1	Project 031-410_Basics Diagnostics_S7-1200 successfully retrieved.	
2	Web server for the CPU 1214C from project 031-410_Basics Diagnostics_S7-1200 successfully configured.	
3	CPU 1214C from project 031-410_Basics Diagnostics_S7-1200 successfully downloaded.	
4	Voltage supply switched off.	
5	Signal board AQ 1x12Bit removed.	
6	Voltage supply switched on again.	
7	Web server of the CPU 1214C opened in one of the approved web browsers.	
8	Display checked for missing signal board AQ 1x12Bit in the Module Information menu item of the web server.	

### 8 Additional information

More information for further practice and consolidation is available as orientation, for example: Getting Started, videos, tutorials, apps, manuals, programming guidelines and trial software/ firmware, under the following link:

#### www.siemens.com/sce/s7-1200

#### Preview "Additional information"

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  - ↗ TIA Portal Website
  - ↗ SIMATIC S7-1200 Website
  - ↗ SIMATIC S7-1500 Website

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### Notes

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### Notes

# SCE Learn-/Training Textbook

# Automation System SIMATIC S7-1200



TIA Portal Modules from Version V14 SP1

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# TIA Portal Module 011-001 Firmware Update TIA Portal Module 011-100 Unspecified Hardware Configuration TIA Portal Module 011-101 Specified Hardware Configuration TIA Portal Module 020-100 Process description of sorting station TIA Portal Module 031-100 Basics of FC Programming TIA Portal Module 031-200 TIA Portal Module 031-300 IEC Timers and IEC Counters **TIA Portal Module 031-410 Basics of Diagnostics TIA Portal Module 031-420** Diagnostics via Web **TIA Portal Module 031-500** 10 **Analog Values TIA Portal Module 031-600** Global Data Blocks TIA Portal Module 041-101 WinCC Basic with KTP700 TIA Portal Module 051-201 High-Level Language Programming with SCL **TIA Portal Module 051-300**

#### Matching SCE Trainer Packages for these Learn-/Training Document

- SIMATIC S7-1200 AC/DC/RELAY (set of 6) "TIA Portal" Order no.: 6ES7214-1BE30-4AB3
- SIMATIC S7-1200 DC/DC/DC (set of 6) "TIA Portal" Order no.: 6ES7214-1AE30-4AB3
- Upgrade SIMATIC STEP 7 BASIC V14 SP1 (for S7-1200) (set of 6) "TIA Portal" Order no.: 6ES7822-0AA04-4YE5

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We wish to thank the TU Dresden, particularly Prof. Dr.-Ing. Leon Urbas and the Michael Dziallas Engineering Corporation and all other involved persons for their support during the preparation of

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# Analog Values for SIMATIC S7-1200

### 1 Goal

In this chapter, you will become acquainted with the analog value processing of the SIMATIC S7-1200 with the TIA Portal programming tool.

The module explains the acquisition and processing of analog signals and gives a step-by-step description of read and write access to analog values in the SIMATIC S7-1200.

The SIMATIC S7 controllers listed in Chapter 3 can be used.

### 2 Prerequisite

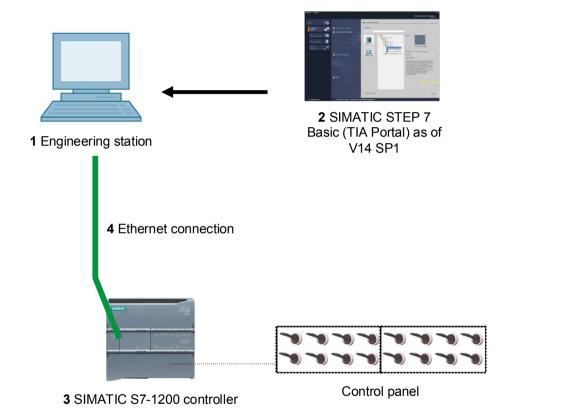
This chapter builds on the chapter IEC Timers and Counters with the SIMATIC S7 CPU1214C. You can use the following project for this chapter, for example: SCE\_EN\_031-300\_IEC\_Timers\_Counters\_S7-1200.zap14

### 3 Required hardware and software

- 1 Engineering station: requirements include hardware and operating system (for additional information, see Readme on the TIA Portal Installation DVDs)
- 2 SIMATIC STEP 7 Basic software in TIA Portal as of V14 SP1
- 3 SIMATIC S7-1200 controller, e.g. CPU 1214C DC/DC/DC with ANALOG OUTPUT SB1232 signal board, 1 AO – Firmware as of V4.2.1

Note: The digital inputs and analog inputs and outputs should be fed out to a control panel.

4 Ethernet connection between engineering station and controller



### 4 Theory

#### 4.1 Analog signals

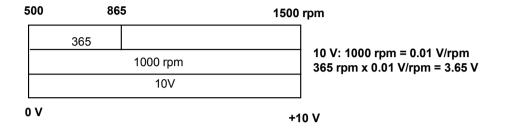
In contrast to a binary signal, which can assume only two signal states ("Voltage present +24 V" and "Voltage not present 0 V"), analog signals can assume any value within a defined range. A typical example of an analog sensor is a potentiometer. Depending on the position of the knob, any resistance can be set, up to the maximum value.

Examples of analog quantities in control engineering:

- Temperature -50 to +150 °C
- Flow rate 0 to 200 l/min
- Speed -500 to +50 rpm
- etc.

#### 4.2 Measuring transducers

These quantities are converted to electrical voltages, currents or resistances with the help of a measuring transducer. If, for example, a speed is to be measured, the speed range of 500 to 1500 rpm can be converted to a voltage range of 0 to +10 V using a measuring transducer. At a measured speed of 865 rpm, the measuring transducer would output a voltage value of +3.65 V.

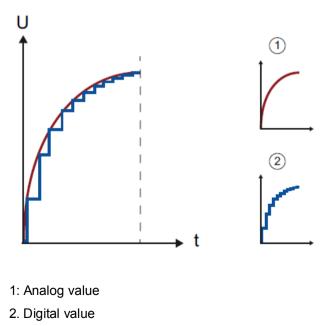


#### 4.3 Analog modules – A/D converter

These electrical voltages, currents or resistances are then connected to an analog module that digitizes this signal for further processing in the PLC.

If analog quantities will be processed with a PLC, the read-in voltage, current or resistance value must be converted to digital information. The analog value is converted to a bit pattern. This conversion is referred to as analog-to-digital conversion (A/D conversion). This means, for example, that the voltage value of 3.65 V is stored as information in a series of binary digits.

The result of this conversion is always a 16-bit word for SIMATIC products. The integrated ADC (analog-to-digital converter) of the analog input module digitizes the analog signal being acquired and approximates its value in the form of a stepped curve. The most important parameters of an ADC are its resolution and conversion rate.



The more binary digits the digital representation uses, the finer the resolution is. For example, if only 1 bit was available for the voltage range of 0 to +10 V, you would only know whether the measured voltage is between 0 and +5 V or between +5 V and +10 V. With 2 bits, the range can be divided into 4 individual ranges, i.e., 0 to 2.5 / 2.5 to 5 / 5 to 7.5 / 7.5 to 10 V. Conventional A/D converters in control engineering use 8 bits, 11 bits or more for converting.

With 8 bits you have 256 individual ranges, while 11 bits provide a resolution of 2048 individual ranges.

0A/0V		<b>20mA</b> /1	10V						
	11-bit		10 V: 2048 = 0.0048828 → Voltage differences of <5 mV can be detected						
0		2048							

#### 4.4 Data types of the SIMATIC S7-1200

The SIMATIC S7-1200 has many different data types for representing different numerical formats. A list of some of the elementary data types is given below.

Data type	Size (bits)	Range	Example of constant entry
Bool	1	0 to 1	TRUE, FALSE, O, 1
Byte	8	16#00 to 16#FF	16#12, 16#AB
Word	16	16#0000 to 16#FFFF	16#ABCD, 16#0001
DWord	32	16#00000000 to 16#FFFFFFF	16#02468ACE
Char	8	16#00 to 16#FF	'A', 'r', '@'
Sint	8	-128 to 127	123,-123
Int	16	-32,768 to 32,767	123, -123
Dint	32	-2,147,483,648 to 2,147,483,647	123, -123
USInt	8	0 to 255	123
UInt	16	0 to 65,535	123
UDInt	32	0 to 4,294,967,295	123
Real	32	+/-1.18 x 10 <sup>-38</sup> to +/-3.40 x 10 <sup>38</sup>	123.456, -3.4, -1.2E+12, 3.4E- 3
LReal	64	+/-2.23 x 10 <sup>-308</sup> to +/-1.79 x 10 <sup>308</sup>	12345.123456789 -1.2E+40
Time	32	T#-24d_20h_31 m_23s_648ms to T#24d_20h_31 m_23s_647ms Saved as: -2,147,483,648 ms to +2,147,483,647 ms	5#-2d
String	Variable	0 to 254 characters in byte size	'ABC'

**Note:** The **'INT'** and **'REAL'** data types play a large role in analog value processing. This is because read-in analog values exist as 16-bit integers in the **'INT'** format, and in order to ensure exact further processing only **'REAL'** floating-point numbers should be used due to rounding errors in the case of **'INT'**.

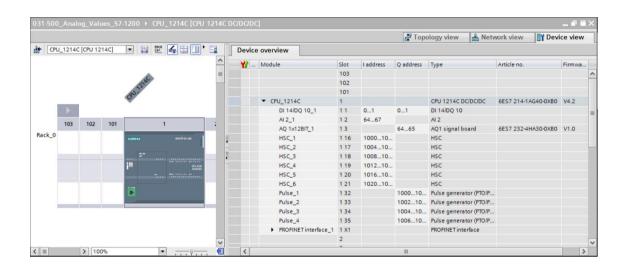
#### 4.5 Reading/writing analog values

Analog values are read into the PLC or output from the PLC as word information. These words are accessed, for example, with the following operands:

%IW 64	Analog input word 64
%QW 64	Analog output word 64

Each analog value ("channel") occupies one input or output word. The format is 'Int', an integer.

The addressing of input and output words conforms to the addressing in the device overview. For example:

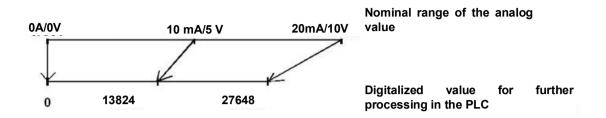


Here, the address of the first analog input would be %IW 64, and the address of the second analog input would be %IW 66.

The address of the analog output would be %QW 64.

The analog value transformation for further processing in the PLC is the same for analog inputs and analog outputs.

The digitized value ranges are as follows:



Often, these digitized values still have to be normalized by further processing them in the PLC in an appropriate manner.

#### 4.6 Normalizing analog values

If an analog input value exists as a digitized value in the range +/- 27648, it must usually still be normalized so that the numerical values correspond to the physical quantities in the process.

Likewise, the analog output usually results from setting of a normalized value that then still has to be scaled to the output value +/- 27648.

In the TIA Portal, ready-made blocks or arithmetic operations are used for normalizing and scaling.

For this to be carried out as exactly as possible, the values for the normalizing must be converted to the REAL data type to minimize rounding errors.

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### 5 Task

In this chapter, a function for analog control of the conveyor speed will be added to the program from chapter "SCE\_EN\_031-300 IEC Timers and Counters S7-1200".

### 6 Planning

The analog control of the conveyor speed will be programmed in the "MOTOR SPEEDCONTROL" [FC10] function as an expansion of the "SCE EN 031-300 IEC Timers and Counters S7-1200" project. This project must be retrieved from the archive in order to add this function. The "MOTOR\_ SPEEDCONTROL" [FC10] function will be called in the "Main" [OB1]" organization block and wired. The control of the conveyor motor must be changed to -Q3 (conveyor motor -M1 variable speed).

#### 6.1 Analog control of the conveyor speed

The speed will be set at an input of the "MOTOR\_SPEEDCONTROL" [FC10] function in revolutions per minute (range: +/- 50 rpm). The data type is 32-bit floating-point number (Real).

First, the function will be checked for correct entry of the speed setpoint in the range +/- 50 rpm.

If the speed setpoint is outside the range +/- 50 rpm, the value 0 with data type 16-bit integer (Int) will be output at the output. The return value of the function (Ret\_Val) will then be assigned the value TRUE (1).

If the speed setting is within the range +/- 50 rpm, this value will first be normalized to the range 0...1 and then scaled to +/- 27648 with data type 16-bit integer (Int) for output as the speed manipulated value at the analog output.

The output will then be connected with signal U1 (manipulated value speed of the motor in 2 directions +/- 10V corresponds to +/- 50 rpm).

### 6.2 Technology diagram

Here you see the technology diagram for the task.

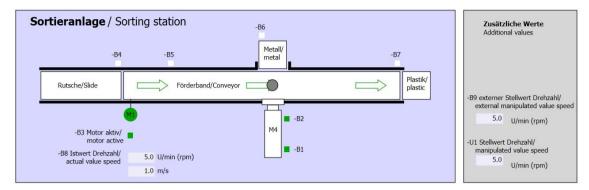


Figure 1: Technology diagram

Schalter der Sortieranlage Switches of sorting station	Automatikbetrieb Automatic mode -P5 gestartel/started	Handbetrieb / Manual mode -S3 Tippbetrieb -M1 vorwärts/ Manual -M1 forwards
-Q0 Hauptschalter/Main switch -P4 attivier/active -P4 attivier/active -P4 attivier/active -P2 Hand/manual -P3 Auto/auto -P2 Hand/manual -P3 Auto/auto -P2 Hand/manual -P3 Auto/auto	-S1 Start/start	-54 Tippbetrieb -M1 rückwärts/ Manual -M1 backwards -P7 ausgefahren/extended -S6 Zylinder -M4 ausfahren/ cylinder -M4 extend -S5 Zylinder -M4 retract

Figure 2: Control panel

#### 6.3 Reference list

DI	Туре	Identifier	Function	NC/NO
I 0.0	BOOL	-A1	Return signal emergency stop OK	NC
I 0.1	BOOL	-K0	Main switch "ON"	NO
I 0.2	BOOL	-S0	Mode selector manual (0)/ automatic (1)	Manual = 0
				Auto = 1
I 0.3	BOOL	-S1	Pushbutton automatic start	NO
I 0.4	BOOL	-S2	Pushbutton automatic stop	NC
I 0.5	BOOL	-B1	Sensor cylinder -M4 retracted	NO
I 1.0	BOOL	-B4	Sensor part at slide	NO
l 1.3	BOOL	-B7	Sensor part at end of conveyor	NO

The following signals are required as global operands for this task.

DO	Туре	Identifier	Function	
Q 0.2	BOOL	-Q3	Conveyor motor -M1 variable speed	
QW 64	BOOL	-U1	Manipulated value speed of the motor in 2 directions +/- 10V corresponds to +/- 50 rpm	

#### Legend for reference list

AI

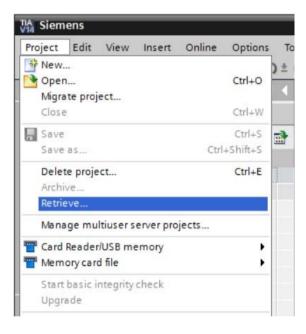
- DI Digital Input DO Digital Output
  - Analog Input AO Analog Output
- I Input Q Output
- NC Normally Closed
- NO Normally Open

### 7 Structured step-by-step instructions

You can find instructions on how to carry out planning below. If you already have a good understanding of everything, it will be sufficient to focus on the numbered steps. Otherwise, simply follow the detailed steps in the instructions.

#### 7.1 Retrieve an existing project

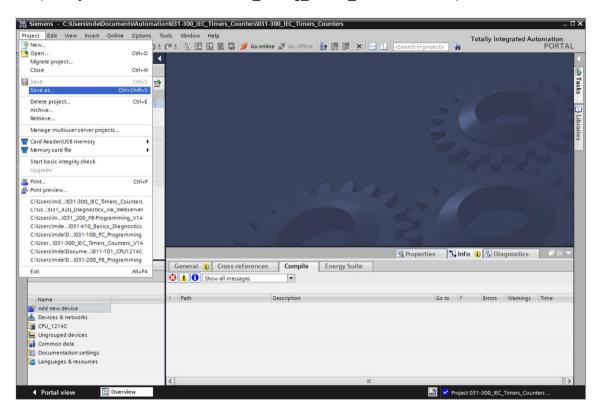
→ Before we can expand the "SCE\_EN\_031-300\_IEC\_Timers\_Counters\_S7-1200.zap14" project from chapter "SCE\_EN\_031-300\_IEC\_Timers\_Counters\_S7-1200", we must retrieve this project from the archive. To retrieve an existing project that has been archived, you must select the relevant archive with → Project → Retrieve in the project view. Confirm your selection with Open.



→ The next step is to select the target directory where the retrieved project will be stored. Confirm your selection with "OK".

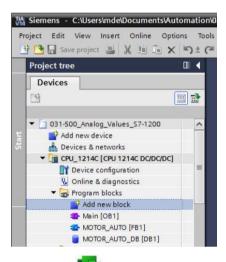
 $(\rightarrow \text{Target directory} \rightarrow \text{OK})$ 

→ Save the opened project under the name 031-500\_Analog\_Values\_S7-1200. ( $\rightarrow$  Project  $\rightarrow$  Save as ...  $\rightarrow$  031-500\_Analog\_Values\_S7-1200  $\rightarrow$  Save)



#### 7.2 Create the "MOTOR\_SPEEDCONTROL" function

- → Select the 'Program blocks' folder of your CPU\_1214C and then click "Add new block" to create a new function there.
  - $(\rightarrow CPU_{1214C} [CPU 1214C DC/DC] \rightarrow Add new block)$



→ Select <sup>\*\*\*</sup> in the next dialog and rename your new block to: "MOTOR\_SPEEDCONTROL". Set the language to FBD and manually assign the number "10". Select the "Add new and open" check box. Click "OK".

Add new block	_		_		
MOTOR_SPEEDCONT	ROL				
Organization block	Language: Number:	FBD 10 Manual Automatic	•		
Function block	Description: Functions are c	ode blocks or subrouti	ines without dec	licated memory.	
Function					
Data block	more				
Additional infor	mation				
Add new and open				ОК	Cancel

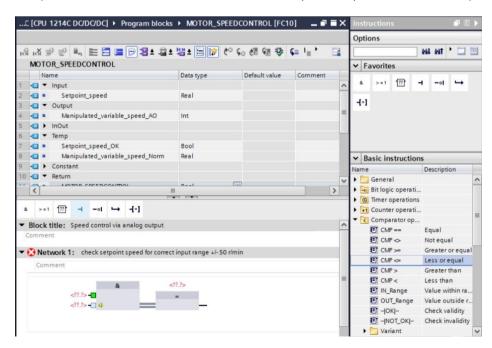
10

→ Create the local tags with their comments as shown here and change the data type of the 'Return' tag from 'Void' to 'Bool'. (→ Bool)

A	Analog_Values_S7-1200 → CPU_1214C [CPU 1214C DC/DC/DC] → Program blocks → MOTOR_SPEEDCONTROL [FC10] 📃 🖬 🖬 🗙																																		
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		Na				-									Data	type			Defa	ult v	alue		Co	mme	ent										
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2	•				s	etp	oi	nt.	spee	d					Real																				
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4					N	la n	iρι	lat	ed_	variab	le_	speed	_AO		Int																				
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7					S	etp	oi	nt s	spee	d_OK					Bool																				
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9			3	C	ns	tar	nt																												
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	C	on	nn	ne	nt																														

Note: Be sure to use the correct data types.

- → Insert an Assignment ' <sup>-</sup>/<sub>1</sub> in the first network and an 'And' <sup>\*</sup> ' in front of it. Then use drag & drop to move the 'Comparator operation' 'Less or equal' from the 'Basic instructions' onto the first input of the <sup>\*</sup> AND logic operation.
  - $(\rightarrow$  <sup>-[-]</sup>  $\rightarrow$  <sup>a</sup>  $\rightarrow$  Basic instructions  $\rightarrow$  Comparator operations $\rightarrow$  CMP<=)

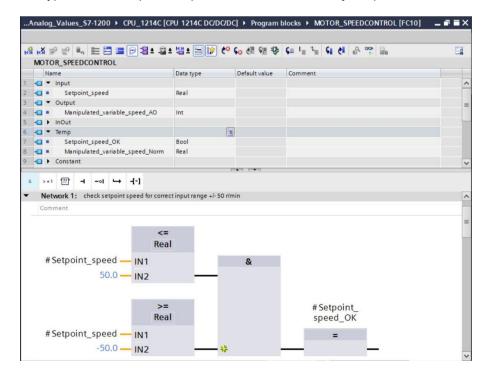


→ Next use drag & drop to move the 'Comparator operation' 'Greater or equal' onto the second input of the AND logic operation.

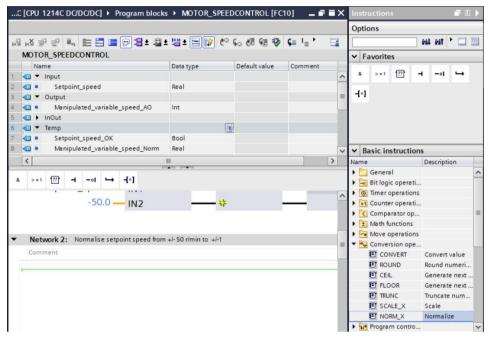
C [CPU 1214C DC/DC/DC] > Program blocks	MOTOR_SPE	EDCONTROL [FC1	0] _ 🗖	∎×	Instructions	<b>■</b> 🛛 🕨
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MOTOR SPEEDCONTROL					✓ Favorites	
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1 🕣 🔻 Input	1			^	& >=1 ???	• →
2 - Setpoint speed	Real			-		
3 🕣 🕶 Output					-(-)	
4 - Manipulated variable speed AO	Int			=		
5 d InOut						
6 🕣 🕶 Temp						
7 - Setpoint speed OK	Bool					
8 - Manipulated_variable_speed_Norm	Real				✓ Basic instructi	one
9 😋 🕨 Constant					Name	Description
10 - Return					General	> Description
	nl		-	>	Bit logic opera	jame .
				/	G Timer operatio	
a >=1 [??]0[-]					+1 Counter opera	
					<ul> <li>Comparator opena</li> </ul>	
<ul> <li>Block title: Speed control via analog output</li> </ul>				^	E CMP ==	Equal
Comment					CMP >>	Not equal
Network 1: check setpoint speed for correct		ten in		- 1	E CMP >=	
•	t input range +i- 50 r	imin			E CMP <=	
Comment					E CMP >	Greater than
				12	CMP <	Less than
<= 777					IN Range	Value within ra
					U OUT Range	
?? — IN1	8				E - OK -	Check validity
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 $(\rightarrow \text{Basic instructions} \rightarrow \text{Comparator operations} \rightarrow \text{CMP}>=)$ 

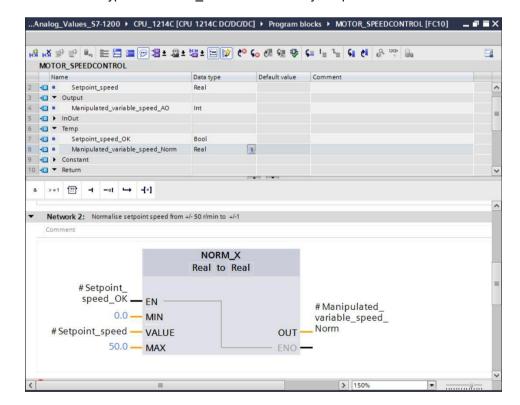
→ Connect the contacts in Network 1 with the constants and local tags as shown here. The data types in the comparator operations are automatically adapted to 'Real'.



→ Use drag & drop to move the 'Conversion operation' 'NORM\_X' into Network 2 in order to normalize the speed setpoint of +/- 50 rpm to +/- 1. (→ Basic instructions → Conversion operations → NORM\_X)



→ Connect the contacts in Network 2 with the constants and local tags as shown here. The data types in 'NORM\_X' are automatically adapted to 'Real'.



10

→ Use drag & drop to move the 'Conversion operation' 'SCALE\_X' into Network 3 in order to scale the speed setpoint from the normalized +/- 1 onto the range for the analog output +/-27468.

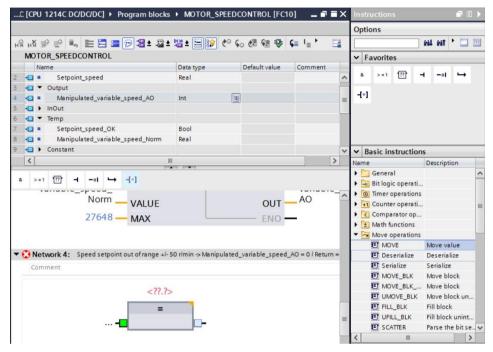
з	[CPU 1214C DC/DC/DC] • Program blocks	MOTOR_SPE	EDCONTROL [FC1	0] _ 7	×	Instruction	15			D
						Options				
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	MOTOR SPEEDCONTROL					✓ Favorit	0.6			-
	Name	Data type	Default value	Comment		+ ravono	es	- Y - 1	_	-
2	Setpoint_speed	Real			^	& >=1	7?		-→	
3	G ▼ Output									
4	Manipulated_variable_speed_AO	Int				-[-]				
5	InOut									
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	Setpoint_speed_OK	Bool								
	Manipulated_variable_speed_Norm	Real								
	Constant				~	✓ Basic in	struction	5		
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å	>=1 [??] ⊣ −0! ↦ -[=]					🕨 🔄 Bit log	ic operati			
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						Move				
						<ul> <li>Conve</li> </ul>				
•	Network 3: Scale normalised setpoint speed	d for analog output	t to +/- 27648			(and)	NVERT	Convert v		
	Comment				- 11	E RO		Round nu		
					-88	E CE		Generate		
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					~	> Techno	logy			
<		> 150%		Q		> Commu	nication			

 $(\rightarrow \text{Basic instructions} \rightarrow \text{Conversion operations} \rightarrow \text{SCALE}_X)$ 

→ Connect the contacts with the constants and local tags in Network 3 as well, as shown here. The data types in 'SCALE\_X' are automatically changed to 'Real' or 'Int'.

in in	100	ý 🔄 🐛 🖿 🗖 🚍 💬 🚝 :	🖀 ± 🔚 ± 🔚 🎲 🥙	😡 🖑 🗺 🤒		
MO	TO	DR_SPEEDCONTROL				
	Nar	ime	Data type	Default value	Comment	
-		Setpoint_speed	Real			1
	•	Output				
-		Manipulated_variable_speed_A	Int			
-		InOut				
-	•	Temp				L
		Setpoint_speed_OK	Bool			
		Manipulated_variable_speed_N	rm Real			
-	•	Constant				
-	-	Return				
N	let	twork 3: Scale normalised setpoint		+/- 27648		
N	let	twork 3: Scale normalised setpoi	speed for analog output to SCALE_X			
N	let	twork 3: Scale normalised setpoi	speed for analog output to			

→ Insert an Assignment ' -[-] in the fourth network. Use drag & drop to move the 'Move' command from the 'Move operations' folder under 'Basic instructions' in front of the Assignment.



 $(\rightarrow$  -[=]  $\rightarrow$  Basic instructions  $\rightarrow$  Move operations  $\rightarrow$  MOVE)

→ The contacts in Network 4 will now be connected with constants and local tags as shown here. If the speed setpoint is not within the range +/- 50 rpm, the value '0' is output at the analog output and the value TRUE is assigned to the return value (Return) of the "MOTOR\_SPEEDCONTROL" function.

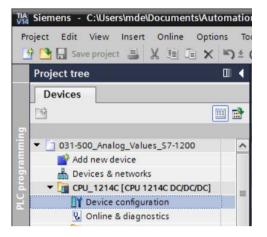
Analog_Values_S7-1200    CPU_1214C [CP	U 1214C DC/DC/DC]	<ul> <li>Program b</li> </ul>	locks  MOTOR_SPEEDCONTROL [FC10]	_₽₽>
KĂ # # # ■ E E E E @ @ 8 ± 8 ± MOTOR_SPEEDCONTROL	별 ± ː= 🎲 ৫º 두	e 🕫 😵	ς≡ <sup>1</sup> ≡ <sup>3</sup> ≡ <b>ςι (1</b> ⊕, ∞, ⊒₀	3
Name	Data type	Default value	Comment	
4 📲 = Manipulated_variable_speed_AO 5 📲 🕨 InOut	Int			
🗧 🕶 Temp				
7 💶 = Setpoint_speed_OK	Bool			
Manipulated_variable_speed_Norm	Real			
9 📲 🕨 Constant 10 📲 🗶 Return				
11 MOTOR_SPEEDCONTROL	Bool			
		a horand		
a     >=1     1177     -1     -01     →     -[+2]       Network 4:     Speed setpoint out of range +/-5       Comment	0 r/min -> Manipulated_	variable_speed	_AO = 0 / Return = TRUE	
# Setpoint_ speed_OK - EN - * O	# Manip variable	ulated_ speed_	# MOTOR_ SPEEDCONTROL	

 $\rightarrow$  Do not forget to click **Save project**. The finished function "MOTOR\_SPEEDCONTROL" [FC10] in FBD is shown below.

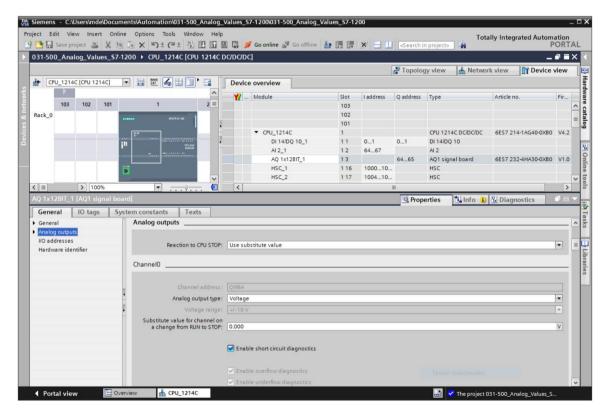


#### 7.3 Configuration of the analog output channel

 $\rightarrow$  Double-click the 'Device configuration' to open it.



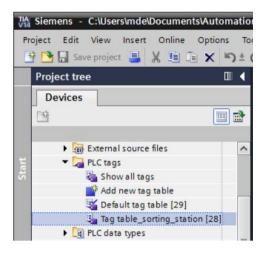
→ Check the address setting and the configuration of the analog output channel 0. (→ Q address: 64...65 →Properties → General → Analog outputs → Reaction to CPU STOP: Use substitute value → Channel 0 → Analog output type: Voltage → Substitute value for channel on a change from RUN to STOP: 0.000 V → Seable short circuit diagnostics)



10

#### 7.4 Expand the tag table to include analog signals

 $\rightarrow$  Double-click the 'Tag table\_sorting station' to open it.



 $\rightarrow$  Add the global tags for the analog value processing to the "Tag table\_sorting station". An analog input B8 and an analog output U1 must be added.

									🕣 Tags 🛛 🗉 User constant	s
ý,	ž [	• • • •	îî .							
1	ag ta	ble_sorting_	station							
	1	lame	Data type	Address	Retain	Acces	Writa	Visibl	Comment	
11	-	-B6	Bool	%11.2					sensor part in front of cylinder -M4 (no)	1
12	-	-B7	Bool	%11.3					sensor part at end of conveyor (no)	
13	-	-53	Bool	%11.4					pushbutton manual mode conveyor –M1 forwards (no)	
14	-	-54	Bool	%11.5					pushbutton manual mode conveyor -M1 backwards (no)	
15	-	-55	Bool	%11.6					pushbutton manual mode cylinder -M4 retract (no)	
16	-	-56	Bool	%11.7					pushbutton manual mode cylinder -M4 extend (no)	
17	-	-Q1	Bool	%Q0.0					conveyor motor -M1 forwards fixed speed	
18	-	-Q2	Bool	%Q0.1					conveyor motor -M1 backwards fixed speed	
19	-	-Q3	Bool	%Q0.2					conveyor motor -M1 variable speed	
20	-	-M2	Bool	%Q0.3					cylinder -M4 retract	
21	-	-M3	Bool	%Q0.4					cylinder -M4 extend	
22	-	-P1	Bool	%Q0.5					display "main switch on"	
23	-	-P2	Bool	%Q0.6					display "manual mode"	
24		-P3	Bool	%Q0.7					display "automatic mode"	
25	-	-P4	Bool	%Q1.0					display "emergency stop activated"	
26	-	-P5	Bool	%Q1.1					display "automatic mode started"	
27	-	-P6	Bool	%Q1.2					display cylinder -M4 "retracted"	
28	-	-P7	Bool	%Q1.3					display cylinder -M4 "extended"	
29	-	-U1	Int	%QW64					manipulated value speed in 2 directions +/- 10V	
30	-	-88	Int	%IW64					sensor actual value speed 010V	
31		<add new=""></add>		1						

#### 7.5 Call the block in the organization block

 $\rightarrow$  Open the "Main [OB1]" organization block with a double-click.



- → Add the temporary tag 'Motor\_speed\_monitoring\_Ret\_Val' to the local tags of OB1. These will be needed in order to interconnect the return value of the "MOTOR\_SPEEDCONTROL" function.
  - $(\rightarrow \text{Temp} \rightarrow \text{Motor\_speed\_monitoring\_Ret\_Val} \rightarrow \text{Bool})$

03	1-5	00	_Analog_Values_S7-1200  > CPU_	1214C [CPU 1214C	DC/DC/DC] > F	Program blocks 🕨 Main [OB1]	_ @ =×
ю			🖗 🖗 💺 🚍 🚍 💬 🕾 ± 🕿	± 🕲 ± 🖃 🈥 🥙	60 🖑 🐨 🍄		
	M	ain					
		Na	me	Data type	Default value	Comment	
1		-	Input				
2	-0		Initial_Call	Bool		Initial call of this OB	
3			Remanence	Bool		=True, if remanent data are available	
4	-	-	Temp				
5	-		Motor_speed_monitoring_Ret_Val	Bool	1	Return value of FC10 MOTOR_SPEEDCONTROL	
6			<add new=""></add>				
7	-	-	Constant				
8			<add new=""></add>				
					-		

→ Select the block title of OB1 and then click '<sup>1</sup><sup>1</sup>/<sub>10</sub>' to insert a new Network 1 in front of the other networks (→ <sup>1</sup>/<sub>10</sub>)

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	Insert r	network								
	Nar	me		Data type		Default value	Comment			
	- 🕞									
2	- 🗈	Initial_Call		Bool			Initial call of this C	-		
3	• 🕞	Remanence		Bool			=True, if remanent	data are availab	ole	
ŧ					_		-			
5	•		_monitoring_Ret_Val	Bool			Return value of FC	10 MOTOR_SPEED	DCONTROL	
5		<add new=""></add>								
		Constant								
3	•	<add new=""></add>								
						* *				
		_								
2	>=1	· · · · · · · · · · · · · · · · · · ·	I → -[=]							
	Block t	title: *Main Prog	ram Sweep (Cycle)*							[
•		title: *Main Prog						]		
-	Block t	title: *Main Prog nt	gram Sweep (Cycle)*	vards in automat	ic mode					-
•	Block t Commer	title: "Main Prog nt work 1: Contro		vards in automat	ic mode					-
•	Block t Commer	title: *Main Prog nt	gram Sweep (Cycle)*	vards in automat	ic mode					
•	Block t Commer	title: "Main Prog nt work 1: Contro	gram Sweep (Cycle)*	vards in automat	ic mode					
•	Block t Commer	title: "Main Prog nt work 1: Contro	gram Sweep (Cycle)*	vards in automat	ic mode	%DB1 *MOTOR_AUTO				
•	Block t Commer	title: "Main Prog nt work 1: Contro	gram Sweep (Cycle)*	vards in automat	ic mode		_			-
•	Block t Commer	title: "Main Prog nt work 1: Contro	gram Sweep (Cycle)*	vards in automat	ic mode	"MOTOR_AUTO	-			

→ Use drag & drop to move your "MOTOR\_SPEEDCONTROL [FC10]" function onto the green line in Network 1.

🎦 🖬 Save project 📑 🐰 🏥 🕞 🗙 roject tree		-	Analog_Values_S7-1200 > CPU				PORTA
		031300				regram brocks - manifeori	
Devices							
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		Main					
031-500_Analog_Values_S7-1200	^	Na	me	Data type	Default value	Comment	
Add new device		1 🕣 🕶	Input				
n Devices & networks		2 📶 🖷	Initial_Call	Bool		Initial call of this OB	
▼ [] CPU_1214C [CPU 1214C DC/DC/DC]	-	3 📲 🗉	Remanence	Bool		=True, if remanent data are available	
Device configuration		4 📶 🕶	Temp				
😵 Online & diagnostics		5 🕣 🔹	Motor_speed_monitoring_Ret_Val	Bool		Return value of FC10 MOTOR_SPEEDCONTROL	
<ul> <li>Program blocks</li> </ul>		6 .	<add new=""></add>				
Add new block		7 🕣 🕶	Constant				
🚁 Main [OB1]		8 .	<add new=""></add>				
MOTOR_SPEEDCONTROL [FC							
MOTOR_AUTO [FB1] MOTOR_AUTO_DB [DB1]		& >=1	[??]				
Technology objects		- Block	title: *Main Program Sweep (Cycle)*				
External source files		Comme					-
PLC tags		135000003					
PLC data types		<ul> <li>Net</li> </ul>	work 1: Speed monitoring conveyor n	notor			
Watch and force tables	~	Com	ment				
	>						
Details view			MOTOR_SPEEDCO	NTROL [FC10]			
Details view	_		in the second				

 $\rightarrow$  Connect the contacts with the constants and global and local tags here as shown.

031-500_Analog_Values_S7-1200 + CPU_	1214C [CPU 1214C	DC/DC/DC] > P	rogram blocks 🕨 Main [OB1]	_ <b>= =</b> ×
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Main				
Name	Data type	Default value	Comment	
1 🕣 🔻 Input				^
2 💶 = Initial_Call	Bool		Initial call of this OB	
3 🕣 = Remanence	Bool		=True, if remanent data are available	=
4 📲 🔻 Temp				
5 - Motor_speed_monitoring_Ret_Val	Bool		Return value of FC10 MOTOR_SPEEDCONTROL	
6 <li><add new=""></add></li>				
7 🕣 🔻 Constant				~
<		III		>
		hurkent hurkent		
& >=1 [??] ⊣ −ol ↦ -[=]				
<ul> <li>Network 1: Speed monitoring conveyor m</li> </ul>	otor			^
Comment				
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"MO	TOR_SPEEDCO	NTROL"		
			#Motor speed	
			monitoring_Ret_	
		Ret_Val	Val	
	Ma	nipulated		
		variable	% QW 64	
— EN		speed AO		
15.0 — Setpoint	_speed	ENO	_	
				~
<			> 150%	

→ Change the connection of output tag "Conveyor\_motor\_automatic\_mode" in Network 2 to '-Q3' (Conveyor motor -M1 variable speed) so that the conveyor motor is controlled taking the analog speed setting into consideration. (→ -Q3)

031-500_A	nalog_Values_S7	-1200 ▶ CPU	_1214C [CPU 12140	CDC/DC/DC] → Pro	gram bloc	ks ► Main [OB1	] -	·₽■>
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& >=1 *	?? <b>`</b> -1 <b>-</b> -	+ -[=]						
				DR_AUTO_ DB"				
				6FB1 DR_AUTO"				
		—	EN					- 1
			Automatic_ mode_active					
è		%10.3 "-S1" —	Start					
		%10.4 "-S2" <b>⊸o</b>	Stop					1
			Enable_OK					
		%10.0 "-A1" <b></b> 0	Safety_ shutoff_active					
		<mark>%11.0</mark> "-B4" —	Sensor_slide	automa	otor_ atic_			
		<mark>%11.3</mark> "-B7" —	Sensor_end_ of_conveyor		Bool	"-Q3" %Q0.2	conveyor mot	^ ` `

### 7.6 Save and compile the program

 $\rightarrow$  To save your project, select the  $\Box$  Save project button in the menu. To compile all blocks, click

the	"Program	blocks"	folder	and	select	the	icon	for	compiling	in	the	menu.
(→	Save project	$\rightarrow$ Progr	am bloo	$:$ ks $\rightarrow$	<b>b</b> )							

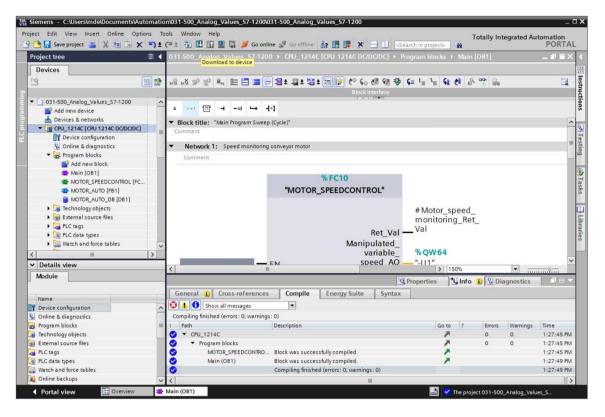
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Portices Project Table Values_S7-1200 F CPU_214C (CPU 1214C DODODOD Program blocks > Main (OB1)  Project tree Project Table Proj	oject Edit View Inser	rt Online Opt	tions To	ls Window Help Totally Integrated Aut	tomation
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Comment     C		orks			
Water     Wein [OB1]       Words_SPEEDCONTROL [FC     % FC10       MotoR_AUTO_B8 [DB1]     * Methodagy objects       * External source files     * Motor speed_monitoring_Ret_       * TrC data types     * Motor tables       * Details view     * Motor speed_MON_       * Details view     * Setpoint_speed       * Name     Val       * Add new block     * Network 2: Control conveyor motor forwards in automatic mode       * Motor_AUTO_D8     B81					^
Water     Wein [OB1]       Words_SPEEDCONTROL [FC     % FC10       MotoR_AUTO_B8 [DB1]     * Methodagy objects       * External source files     * Motor speed_monitoring_Ret_       * TrC data types     * Motor tables       * Details view     * Motor speed_MON_       * Details view     * Setpoint_speed       * Name     Val       * Add new block     * Network 2: Control conveyor motor forwards in automatic mode       * Motor_AUTO_D8     B81	Device config	uration	=	comment	
Water     Wein [OB1]       Words_SPEEDCONTROL [FC     % FC10       MotoR_AUTO_B8 [DB1]     * Methodagy objects       * External source files     * Motor speed_monitoring_Ret_       * TrC data types     * Motor tables       * Details view     * Motor speed_MON_       * Details view     * Setpoint_speed       * Name     Val       * Add new block     * Network 2: Control conveyor motor forwards in automatic mode       * Motor_AUTO_D8     B81	😵 Online & diag	nostics		<ul> <li>Network 1: Speed monitoring conveyor motor</li> </ul>	
Image: Add new block	💌 🔂 Program bloci	ks		Comment	
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Motor_Juro_De [De1]  Wotok and force tables  Musch and					
Motor_Juro_De [De1]  Wotok and force tables  Musch and				"MOTOR_SPEEDCONTROL"	
Watch and force tables     Watch and force				# Motor_speed_	
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Korrel Comment     Korrel Conveyor motor forwards in automatic mode     Korrel Conveyor motor forwards in automatic mode     Korrel Comment     Korrel Commen					
Details view     Details view     Details     Add new block     Main     OB1     MotroR_AUTO_DB     DB1     MotroR_AUTO_DB     DB1     Comment     SetPoint_speed     MotroR_AUTO_DB     DB1     SetPoint_speed     SetPo		rce tables	~		
Name     Details       Name     Details       Main     OB1       Motion_RAUTO_DB     DB1       MotorR_AUTO_DB     DB1			>		
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Mein OB1     Mortor_SPEEDCoNTROL FC10     Mortor_AUTO_DB DB1     Comment	Add new block			Network 2: Control conveyor motor forwards in automatic mode	
MOTOR_SPEEDCONTROL FC10 MOTOR_AUTO F81 MOTOR_AUTO_D8 DB1 C C Properties Linfo	💁 Main	OB1	_	· · · · · · · · · · · · · · · · · · ·	
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Image: State	MOTOR_AUTO	FB1			
🖳 Properties 🕅 🗓 Info 🚯 🗓 Diagnostics 📰 🖃 🥆	MOTOR_AUTO_DB	DB1		% DB1	
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General Cross-references Compile Energy Suite Syntax				🖳 Properties 🔤 🗓 Diagnostics	
Portal view B Overview Main (081)				General 🚯 Cross-references Compile Energy Suite Syntax	

 $\rightarrow$  The "Info", "Compile" area shows which blocks were successfully compiled.

			Q Prop	erties 🚺 Info	😧 🔽 Dia	agnostics	
General (1) Cross-ref	erences Compile	Energy Suite	Syntax				
🚱 🛕 🚺 Show all message	es 💌						
Compiling finished (errors: 0;	warnings: 0)						
Path	Description			Go to ?	Errors	Warnings	Time
✓ ▼ CPU_1214C				~	0	0	1:27:45 PM
Program blocks				7	0	0	1:27:45 PM
MOTOR_SPEEDO	~			1:27:45 PM			
Main (OB1)	Main (OB1) Block was successfully compiled.						1:27:49 PM
<u> </u>				1:27:49 PI			
(			E.				

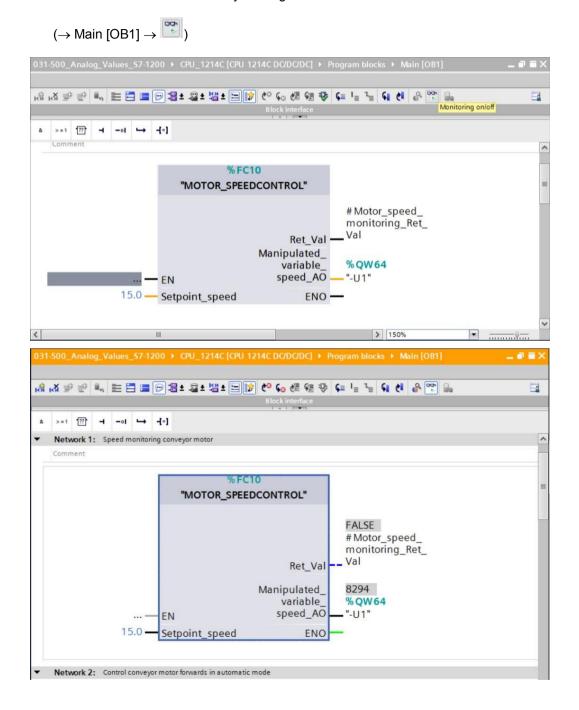
#### 7.7 Download the program

→ After successful compilation, the complete controller with the created program including the hardware configuration can, as described in the previous modules, be downloaded. (→  $\blacksquare$ )



#### 7.8 Monitor program blocks

 $\rightarrow$  The desired block must be open for monitoring the downloaded program. The monitoring can



→ The "MOTOR\_SPEEDCONTROL" [FC10] function called in the "Main [OB1]" organization block can be selected directly for "Open and monitor" after right-clicking and the program code in the function can thus be monitored.

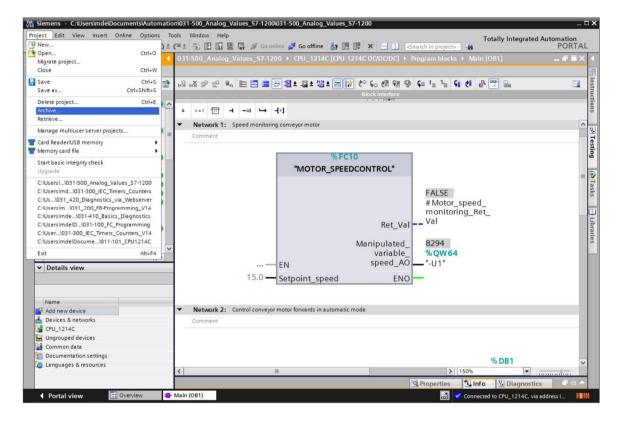
 $(\rightarrow$  "MOTOR\_SPEEDCONTROL" [FC10]  $\rightarrow$  Open and monitor)

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							R	e	Rewire tag		Ctrl+Shift+P			
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#### 7.9 Archive the project

→ As the final step, we want to archive the complete project. Select the → 'Archive ...' command in the → 'Project' menu. Select a folder where you want to archive your project and save it with the file type "TIA Portal project archive".

 $(\rightarrow$  Project  $\rightarrow$  Archive  $\rightarrow$  TIA Portal project archive  $\rightarrow$  031-500\_Analog\_Values\_S7-1200....  $\rightarrow$  Save)



## 8 Checklist

No.	Description	Completed
1	Compiling successful and without error message	
2	Download successful and without error message	
3	Switch on station (-K0 = 1) Cylinder retracted / Feedback activated (-B1 = 1) EMERGENCY OFF (-A1 = 1) not activated AUTOMATIC mode (-S0 = 1) Pushbutton automatic stop not actuated (-S2 = 1) Briefly press the automatic start pushbutton (-S1 = 1) Sensor part at slide activated (-B4 = 1) then Conveyor motor -M1 variable speed (-Q3 = 1) switches on and stays on. The speed corresponds to the speed setpoint in the range +/- 50 rpm	
4	Sensor part at end of conveyor activated (-B7 = 1) $\rightarrow$ -Q3 = 0 (after 2 seconds)	
5	Briefly press the automatic stop pushbutton (-S2 = 0) $\rightarrow$ -Q3 = 0	
6	Activate EMERGENCY OFF (-A1 = 0) $\rightarrow$ -Q3 = 0	
7	Manual mode (-S0 = 0) $\rightarrow$ -Q3 = 0	
8	Switch off station (-K0 = 0) $\rightarrow$ -Q3 = 0	
9	Cylinder not retracted (-B1 = 0) $\rightarrow$ -Q3 = 0	
10	Project successfully archived	

## 9 Exercise

#### 9.1 Task – Exercise

In this exercise a "MOTOR\_SPEEDMONITORING" [FC11] function will be created additionally.

The actual value will be made available to B8 (Sensor actual value speed of the motor +/-10V corresponds to +/- 50 rpm) as an analog value and queried at an input of the "MOTOR\_SPEEDMONITORING" [FC11] function. The data type is 16-bit integer (Int).

This actual speed value will first be normalized to the range +/- 1 as 32-bit floating-point number (Real) in the function.

The normalized actual speed value will then be scaled to revolutions per minute (range: +/- 50 rpm) as 32-bit floating-point number (Real) and made available at an output.

The following 4 limit values can be specified as 32-bit floating-point numbers (Real) at the block inputs in order to monitor them in the function:

Speed > Motor\_speed\_monitoring\_error\_max

Speed > Motor\_speed\_monitoring\_warning\_max

Speed < Motor\_speed\_monitoring\_warning\_min

Speed < Motor\_speed\_monitoring\_error\_min

If a limit value is exceeded or fallen below, the value TRUE (1) is assigned to the corresponding output bit.

If a fault is present, the protective tripping of the "MOTOR\_AUTO" [FB1] function block will be tripped.

### 9.2 Technology diagram

Here you see the technology diagram for the task.

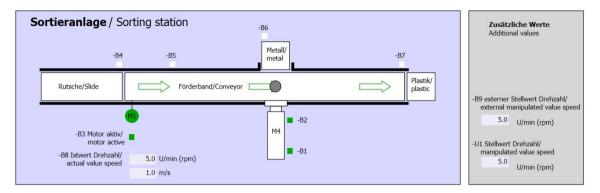


Figure 3: Technology diagram

Schalter der Sortieranlage Switches of sorting station -P1 ein/on -Q0 Hauptschalter/Main switch	Automatikbetrieb Automatic mode -PS gestartel/started -S1 Start/start	Handbetrieb / Manual mode -S3 Tippbetrieb -M1 vorwärts/ Manual -M1 forwards -S4 Tippbetrieb -M1 rückwärts/ Manual -M1 backwards -P7 ausofahren/extended
-A1 NOTHALT/Emergency stop -P2 Handimanual -P3 Auto/auto -S0 Betriebsart/operating mode	-S2 Stopp/stop	-S5 Zylinder -M4 ausfahren/ cylinder -M4 extend -S5 Zylinder -M4 einfahren/ cylinder -M4 retract

Figure 4: Control panel

#### 9.3 Reference list

DI	Туре	ldentifier	Function	NC/NO
10.0	BOOL	-A1	Return signal emergency stop OK	NC
I 0.1	BOOL	-K0	Main switch "ON"	NO
10.2	BOOL	-S0	Mode selector manual (0)/ automatic (1)	Manual = 0 Auto = 1
10.3	BOOL	-S1	Pushbutton automatic start	NO
10.4	BOOL	-S2	Pushbutton automatic stop	NC
10.5	BOOL	-B1	Sensor cylinder -M4 retracted	NO
I 1.0	BOOL	-B4	Sensor part at slide	NO
I 1.3	BOOL	-B7	Sensor part at end of conveyor	NO
IW64	BOOL	-B8	Sensor actual value speed of the motor +/-10V corresponds to +/- 50 rpm	

The following signals are required as global operands for this task.

DO	Туре	Identifier	Function	
Q 0.2	BOOL	-Q3	Conveyor motor -M1 variable speed	
QW 64	BOOL	-U1	Manipulated value speed of the motor in 2 directions +/- 10V corresponds to +/- 50 rpm	

#### Legend for reference list

- DI Digital Input DO Digital Output
- AI Analog Input AO Analog Output
- I Input Q Output
- NC Normally Closed
- NO Normally Open

#### 9.4 Planning

Plan the implementation of the task on your own.

## 9.5 Checklist – Exercise

No.	Description	Completed
1	Compiling successful and without error message	
2	Download successful and without error message	
3	Switch on station (-K0 = 1) Cylinder retracted / Feedback activated (-B1 = 1) EMERGENCY OFF (-A1 = 1) not activated AUTOMATIC mode (-S0 = 1) Pushbutton automatic stop not actuated (-S2 = 1) Briefly press the automatic start pushbutton (-S1 = 1) Sensor part at slide activated (-B4 = 1) then Conveyor motor M1 variable speed (-Q3 = 1) switches on and stays on. The speed corresponds to the speed setpoint in the range +/- 50 rpm	
4	Sensor part at end of conveyor activated (-B7 = 1) $\rightarrow$ -Q3 = 0 (after 2 seconds)	
5	Briefly press the automatic stop pushbutton (-S2 = 0) $\rightarrow$ -Q3 = 0	
6	Activate EMERGENCY OFF (-A1 = 0) $\rightarrow$ -Q3 = 0	
7	Manual mode (-S0 = 0) $\rightarrow$ -Q3 = 0	
8	Switch off station (-K0 = 0) $\rightarrow$ -Q3 = 0	
9	Cylinder not retracted (-B1 = 0) $\rightarrow$ -Q3 = 0	
10	Speed > Motor_speed_monitoring_error_max $\rightarrow$ -Q3 = 0	
11	Speed < Motor_speed_monitoring_error_min $\rightarrow$ -Q3 = 0	
12	Project successfully archived	

## **10** Additional information

More information for further practice and consolidation is available as orientation, for example: Getting Started, videos, tutorials, apps, manuals, programming guidelines and trial software / firmware, under the following link:

#### www.siemens.com/sce/s7-1200

#### Preview "Additional information"

- Getting Started, Videos, Tutorials, Apps, Manuals, Trial-SW/Firmware
  - ↗ TIA Portal Videos
  - TIA Portal Tutorial Center
  - > Getting Started
  - ↗ Programming Guideline
  - Easy Entry in SIMATIC S7-1200
  - > Download Trial Software/Firmware
  - 7 Technical Documentation SIMATIC Controller
  - ↗ Industry Online Support App
  - TIA Portal, SIMATIC S7-1200/1500 Overview
  - ↗ TIA Portal Website
  - ↗ SIMATIC S7-1200 Website
  - ↗ SIMATIC S7-1500 Website

## Notes


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# SCE Learn-/Training Textbook

## Automation System SIMATIC S7-1200



TIA Portal Modules from Version V14 SP1

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<b>TIA Portal Module 011-001</b> Firmware Update	1
TIA Portal Module 011-100 Unspecified Hardware Configuration	2
<b>TIA Portal Module 011-101</b> Specified Hardware Configuration	3
<b>TIA Portal Module 020-100</b> Process description of sorting station	4
TIA Portal Module 031-100 Basics of FC Programming	5
TIA Portal Module 031-200 Basics of FB Programming	6
TIA Portal Module 031-300 IEC Timers and IEC Counters	7
TIA Portal Module 031-410 Basics of Diagnostics	8
<b>TIA Portal Module 031-420</b> Diagnostics via Web	9
<b>TIA Portal Module 031-500</b> Analog Values	10
<b>TIA Portal Module 031-600</b> Global Data Blocks	11
<b>TIA Portal Module 041-101</b> WinCC Basic with KTP700	12
<b>TIA Portal Module 051-201</b> High-Level Language Programming with SCL	13
TIA Portal Module 051-300	14

#### Matching SCE Trainer Packages for these Learn-/Training Document

- SIMATIC S7-1200 AC/DC/RELAY (set of 6) "TIA Portal" Order no.: 6ES7214-1BE30-4AB3
- SIMATIC S7-1200 DC/DC/DC (set of 6) "TIA Portal" Order no.: 6ES7214-1AE30-4AB3
- Upgrade SIMATIC STEP 7 BASIC V14 SP1 (for S7-1200) (set of 6) "TIA Portal" Order no.: 6ES7822-0AA04-4YE5

Please note that these trainer packages are replaced with successor packages when necessary. An overview of the currently available SCE packages is provided at: <u>siemens.com/sce/tp</u>

#### **Continued training**

For regional Siemens SCE continued training, please contact your regional SCE contact siemens.com/sce/contact

#### Additional information regarding SCE

siemens.com/sce

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We wish to thank the TU Dresden, particularly Prof. Dr.-Ing. Leon Urbas and the Michael Dziallas Engineering Corporation and all other involved persons for their support during the preparation of this Learn-/Training Document.

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# Global Data Blocks for the SIMATIC S7-1200

## 1 Goal

In this chapter, you will become acquainted with the use of global data blocks for the SIMATIC S7-1200 with the TIA Portal programming tool.

The module explains the structure and creation of and access to global data blocks for the SIMATIC S7-1200. It also shows the steps for creating a global data block in the TIA Portal and for accessing this data in the program with read and write access.

The SIMATIC S7 controllers listed in Chapter 3 can be used.

## 2 Prerequisite

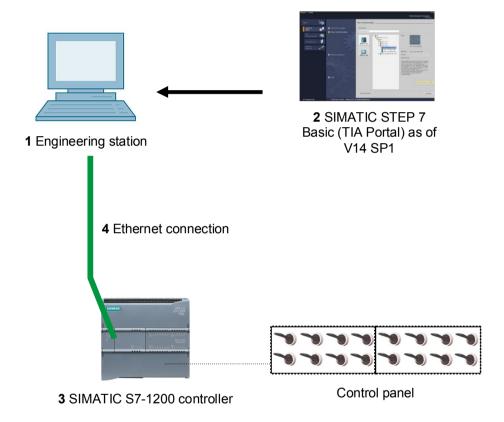
This chapter builds on the chapter Analog Values with the SIMATIC S7 CPU1214C DC/DC/DC. You can use the following project for this chapter, for example: "SCE\_EN\_031-500\_Analog\_Values\_S7-1200.zap14".

## 3 Required hardware and software

- 1 Engineering station: requirements include hardware and operating system (for additional information, see Readme on the TIA Portal Installation DVDs)
- 2 SIMATIC STEP 7 Basic software in TIA Portal as of V14 SP1
- 3 SIMATIC S7-1200 controller, e.g. CPU 1214C DC/DC/DC with ANALOG OUTPUT SB1232 signal board, 1 AO Firmware as of V4.2.1

Note: The digital inputs and analog inputs and outputs should be fed out to a control panel.

4 Ethernet connection between engineering station and controller



5

## 4 Theory

#### 4.1 Data blocks

In contrast to logic blocks, data blocks contain no instructions. Rather, they serve as memory for user data.

Data blocks thus contain variable data that is used by the user program. You can define the structure of global data blocks as required.

Global data blocks store data that can be used **by all other blocks** (see Figure 1). Only the associated function block should access instance data blocks. The maximum size of data blocks varies depending on the utilized CPU.

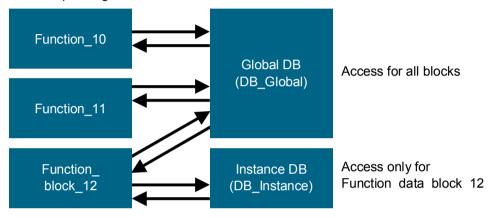


Figure 1: Difference between global DB and instance DB.

Application examples for global data blocks are:

- Saving of information about a storage system. "Which product is located where?"
- Saving of recipes for particular products.

The data in data blocks is stored retentively in most cases. This data is then retained in the event of a power failure or after a STOP/START of the CPU.

#### 4.2 Data types of the SIMATIC S7-1200

The SIMATIC S7-1200 has many different data types for representing different numerical formats. A list of some of the elementary data types is given below.

Data type	Size (bits)	Range	Example of constant entry
Bool	1	0 to 1	TRUE, FALSE, O, 1
Byte	8	16#00 to 16#FF	16#12, 16#AB
Word	16	16#0000 to 16#FFFF	16#ABCD, 16#0001
DWord	32	16#00000000 to 16#FFFFFFFF	16#02468ACE
Char	8	16#00 to 16#FF	'A', 'r', '@'
Sint	8	-128 to 127	123,-123
Int	16	-32,768 to 32,767	123, -123
Dint	32	-2,147,483,648 to 2,147,483,647	123, -123
USInt	8	0 to 255	123
UInt	16	0 to 65,535	123
UDInt	32	0 to 4,294,967,295	123
Real	32	+/-1.18 x 10 <sup>-38</sup> to +/-3.40 x 10 <sup>38</sup>	123.456, -3.4, 1.2E+12 3.4E-3
LReal	64	+/-2.23 x 10 <sup>-308</sup> to +/-1.79 x 10 <sup>308</sup>	12345.123456789 -1.2E+40
Time	32	T#-24d_20h_31 m_23s_648ms to T#24d_20h_31 m_23s_647ms Saved as: -2,147,483,648 ms to +2,147,483,647 ms	T#5m_30s 5#-2d T#1d_2h_15m_30x_45ms
String	Variable	0 to 254 characters in byte size	'ABC'
Array		With arrays, data of a uniform data type is arranged one after the other and addressed consecutively in the address area. The properties of each array element are identical and are configured in the array tag.	
Struct		The STRUCT data type represents a data structure that consists of a fixed number of components of different data types. Components of STRUCT or ARRAY data type can also be nested in a structure. For other data types, refer to the	
		online help.	

#### 4.3 Optimized blocks

S7-1200 controllers have optimized data storage. In optimized blocks all tags are automatically sorted based on their data type. The sorting ensures that data gaps between the tags are minimized and the tags are stored in a manner that optimizes their access by the controller.

- The tags are always accessed as fast as possible because the file storage by the system is
  optimized and is independent of the declaration.
- There is no danger of inconsistencies due to incorrect, absolute accesses because symbolic access is generally used.
- Declaration changes do not result in access errors because accesses by process visualization systems, for example, occur symbolically.
- Individual tags can be selectively defined as retentive.
- No settings are needed or possible in the instance data block. Everything will be set in the assigned FB (e.g., retentivity).
- Memory reserves in the data block enable changes to be made without loss of actual values (download without reinitialization).

#### 4.4 Downloading without reinitialization

To enable the subsequent editing of user programs that are already running in a CPU, the S7-1200 controllers support the option of expanding the interfaces of optimized function or data blocks during operation. You can download the modified blocks without switching the controller to STOP mode and without affecting the actual values of previously downloaded tags.

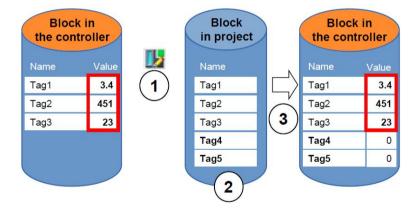


Figure 2: Download without reinitialization

The following steps can be performed while the controller is in RUN mode:

- 1. Activate "Download without reinitialization"
- 2. Insert newly defined tags in an existing block
- 3. Download expanded block to the controller

The newly defined tags are initialized. The existing tags retain their current value.

Prerequisite: a memory reserve must have been defined for the block beforehand and the block with this memory reserve must have downloaded to the CPU.

## 5 Task

In this chapter, the program from chapter "SCE\_EN\_031-500 Analog Values\_S7-1200" will be expanded to include a data block that centrally provides the parameters for the two functions "MOTOR\_SPEEDCONTROL" [FC10] and "MOTOR\_ SPEEDMONITORING" [FC11].

## 6 Planning

The data management and setpoint setting for the "MOTOR\_SPEEDCONTROL" [FC10] and "MOTOR\_SPEEDMONITORING" [FC11] functions will be carried out using the global data block "SPEED\_MOTOR" [DB2].

This will be added to the "031-500\_Analog\_Values\_S7-1200" project. This project must be retrieved from the archive beforehand.

In the "Main" [OB1] organization block, the two functions "MOTOR\_SPEEDCONTROL" [FC10] and "MOTOR\_SPEEDMONITORING" [FC11] must then be connected with the tags from global data block "SPEED\_MOTOR" [DB2].

## 6.1 Global data block for speed control and speed monitoring of the motor

Speed setpoint and actual speed value will be created in Real data format (32-bit floating-point number) as the first tags in the "SPEED\_MOTOR" [DB2] data block. The speed setpoint is thereby given the start value + 10 rpm.

A structure (Struct) 'Positive\_Speed' will then be created for monitoring the positive speed limits.

This structure contains the 2 tags 'Threshold\_Error' (start value + 15 rpm) and 'Threshold\_ Warning' (start value + 10 rpm) in Real data format (32-bit floating-point number) and the 2 tags 'Error' and 'Warning' in Bool data format (binary number).

The structure (Struct) 'Positive\_Speed' will then be inserted again as a copy and renamed to 'Negative\_Speed' for monitoring the negative speed limits.

The 'Threshold\_Error' tag is given the start value - 16 rpm and the 'Threshold\_Warning' tag the start value - 14 rpm.

#### 6.2 Technology diagram

Here you see the technology diagram for the task.

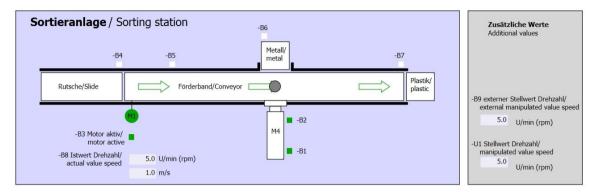


Figure 3: Technology diagram

-Po engetantementation	Schalter der Sortieranlage Switches of sorting station -P1 ein/on -Q0 Hauptschalter/Main switch -P4 aktriet/sctive -A1 NOTHALT/Emergency stop -P2 Hand/manual -P3 Autolauto -S0 Betriebsart/operating mode	Automatikbetrieb Automatic mode -PS gestartet/started -S1 Start/start	
------------------------	---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------	--

Figure 4: Control panel

#### 6.3 Reference list

DI	Туре	Identifier	Function	NC/NO
10.0	BOOL	-A1	Return signal emergency stop OK	NC
I 0.1	BOOL	-K0	Main switch "ON"	NO
10.2	BOOL	-S0	Mode selector manual (0)/ automatic (1)	Manual = 0 Auto = 1
10.3	BOOL	-S1	Pushbutton automatic start	NO
10.4	BOOL	-S2	Pushbutton automatic stop	NC
10.5	BOOL	-B1	Sensor cylinder -M4 retracted	NO
I 1.0	BOOL	-B4	Sensor part at slide	NO
I 1.3	BOOL	-B7	Sensor part at end of conveyor	NO
IW64	BOOL	-B8	Sensor actual value speed of the motor +/-10V corresponds to +/- 50 rpm	

The following signals are required as global operands for this task.

DO	Туре	Identifier	Function	
Q 0.2	BOOL	-Q3	Conveyor motor -M1 variable speed	
QW 64	BOOL	-U1	Manipulated value speed of the motor in 2 directions +/- 10V corresponds to +/- 50 rpm	

#### Legend for reference list

AI

- DI Digital Input DO Digital Output
  - Analog Input AO Analog Output

Q

Output

- I Input
- NC Normally Closed
- NO Normally Open

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## 7 Structured step-by-step instructions

You can find instructions on how to carry out planning below. If you already have a good understanding of everything, it will be sufficient to focus on the numbered steps. Otherwise, simply follow the detailed steps in the instructions.

#### 7.1 Retrieve an existing project

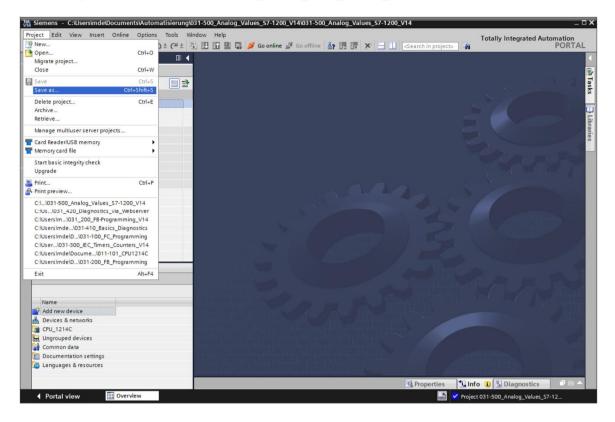
→ Before we can expand the "SCE\_EN\_031-500\_Analog\_Values\_S7-1200.zap14" project from chapter "SCE\_EN\_031-500\_Analog\_Values\_S7-1200", we must retrieve this project from the archive. To retrieve an existing project that has been archived, you must select the relevant archive with → Project → Retrieve in the project view. Confirm your selection with Open. (→ Project → Retrieve → Select a .zap archive → Open)

Project	Edit	View	Insert	Online	Options	Тс
😚 New.						) ±
👌 Oper	1				Ctrl+O	4
	te proj	ect				
Close					Ctrl+W	
Save					Ctrl+S	-
Save	85			Ctrl	+Shift+S	
Delet	te proje	ct			Ctrl+E	
Archi	ve					
Retrie	eve					
Mana	ige mu	ltiuser s	erver pro	jects		
T Card	Reader	/USB me	emory		•	
🍟 Mem	orycar	d file			•	
Start	basic i	ntegrity	check			
Upgr	ade					

→ The next step is to select the target directory where the retrieved project will be stored. Confirm your selection with "OK".

 $(\rightarrow \text{Target directory} \rightarrow \text{OK})$ 

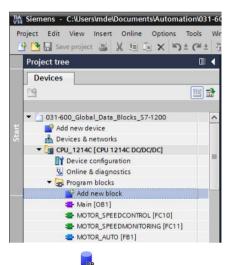
→ Save the opened project under the name 031-600\_Global\_Data\_Blocks\_S7-1200. ( $\rightarrow$  Project  $\rightarrow$  Save as ...  $\rightarrow$  031-600\_Global\_Data\_Blocks\_S7-1200  $\rightarrow$  Save)



#### 7.2 Create the global data block "SPEED\_MOTOR"

→ Select the 'Program blocks' folder of your CPU 1214C DC/DC/DC and then click "Add new block" to create a new global data block there.

 $(\rightarrow CPU_{1214C} [CPU 1214C DC/DC] \rightarrow Add new block)$ 



→ Select set in the next dialog and rename your new block to: "SPEED\_MOTOR". Select 'Global DB' as the type. The number '2' will be automatically assigned. Select the "Add new and open" check box. Click "OK".

 $(\rightarrow \text{true black} \rightarrow \text{Name: SPEED}_\text{MOTOR} \rightarrow \text{Type: Global DB} \rightarrow \blacksquare \text{Add new and open} \rightarrow \text{OK})$ 

	Type:	🧧 Global DB	•	
OB	Language:	DB	*	
Organization	Number:	2	\$	
DIOCK		Manual		
		<ul> <li>Automatic</li> </ul>		
FB	Description:			
Function block		s) save program data.		
	more			
-				
FC				
Function				
DB				
Data block				
Data block				

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→ The "SPEED\_MOTOR" data block is automatically displayed. Start by creating the 'Speed\_Setpoint' and 'Speed\_Actual\_Value' tags shown here with their associated comments. Select 'Real' as the data type. Also set a start value of 10.0 rpm for the 'Speed\_Setpoint'.

 $(\rightarrow \text{Speed}\_\text{Setpoint} \rightarrow \text{Real} \rightarrow 10.0 \rightarrow \text{Speed}\_\text{Actual}\_\text{Value} \rightarrow \text{Real})$ 

)31	1-6	00_	Global_Data_Blocks_	_ <b>57-1200 →</b> C	PU_12	214C [CPU 121	4C DC/DC/D	OC] 🕨 Program	m block	s ▶ SPEED	_MOTOR[	DB2] _ ┛ ■
	_		MOTOR	ctual values 🏻 🔒	a Sna	apshot 🔤 🛤	Copy snap:	shots to start va	lues 🧝	. 🖳 Load	start values	as actual values 🛛 🗐 🖉
		Nam	- ie	Data type		Start value	Retain	Accessible f	Writa	Visible in	Setpoint	Comment
	-	-	Static									
	-		Speed_Setpoint	Real		10.0						Speed setpoint in revolution per minute (range:+/-50rpm)
	-		Speed_Actual_Value	Real	-	0.0						Speed actual value in revolution per minute (range:+/-50rpm)
		101.000	<add new=""></add>				0	0	0	0		

Note: Be sure to use the correct data types.

 $\rightarrow$  Next we create a tag structure 'Struct' so it can be duplicated later. ( $\rightarrow$  Struct)

		MOTOR	ctual values 🔒	Snapshot the the	, Copy snap	shots to start va	ilues 🖁	. 🖳 Load	start values	s as actual values 🛛 🖉 μ 🖓 μ	5
	Nan		Data type	Start value	Retain	Accessible f	Writa	Visible in	Setpoint	Comment	
0	-	Static									
-0		Speed_Setpoint	Real	10.0						Speed setpoint in revolution per minute (range:+/-50rpm)	
-0		Speed_Actual_Value	Real	0.0						Speed actual value in revolution per minute (range:+/-50rpm)	)
		<add new=""></add>									
			String	^							
			Struct								
			Time								
			Time_Of_Day								
			UDInt								
			UInt								
			USInt	=							
			WChar	~							

 $\rightarrow$  Name the structure 'Positive\_Speed' and enter a comment.

 $(\rightarrow \text{Positive}_\text{Speed})$ 

 10	•	👆 🛃 🗮 😤 Keepa	ctual values	inapshot 🖷 🖳	Copysnap	shots to start val	lues 🔣	. R. Load	start values	as actual values 🛛 🖳 🕮
SPI	EED	MOTOR								
	Nan	ne	Data type	Start value	Retain	Accessible f	Writa	Visible in	Setpoint	Comment
-	•	Static								
-		Speed_Setpoint	Real	10.0						Speed setpoint in revolution per minute (range:+/-50rpm)
-		Speed_Actual_Value	Real	0.0						Speed actual value in revolution per minute (range:+/-50rpm)
-0		<ul> <li>Positive_Speed</li> </ul>	Struct							Parameters for error / warning positive speed
		Add new>								
		<add new=""></add>								

 $\rightarrow$  Create the tags for the speed monitoring with the corresponding start values below the structure as shown here.

03	1-	500	)_G	ilobal_Data_Blocks_	57-1200 ▶ CPU_	1214C [CPU 12	14C DC/DC/[	)C] → Program	n block	s ▶ SPEED	_MOTOR	[DB2] <u> </u>	
134		100	8.,	🛃 🔃 👓 Keep ad	tual values 🔒	Snapshot 🔤 🛤	, Copy snap	shots to start val	lues 🧝	🖳 Load	start values	as actual values 🛛 🗐 🔉	E
	SI	EE	D_1	MOTOR									
		N	ame	R.	Data type	Start value	Retain	Accessible f	Writa	Visible in	Setpoint	Comment	
	-	•	St	atic									
	-	•		Speed_Setpoint	Real	10.0						Speed setpoint in revolution per minute (range:+/-50rpm)	
	-			Speed_Actual_Value	Real	0.0						Speed actual value in revolution per minute (range:+/-50rpm)	
ŝ	-	1 -	-	Positive_Speed	Struct							Parameters for error / warning positive speed	
	-	1		Threshold_Error	Real	15.0	<ul> <li>Image: A start of the start of</li></ul>					Speed limit / if exceeded an error is displayed	
ŧ.	•	1		Threshold_Warning	Real	10.0	Image: A start and a start					Speed limit / if exceeded an warning is displayed	
į.	-	1		Error	Bool	false	<b>V</b>					Error limit exceeded	
3	-			Warning	Bool	false	<ul> <li>Image: A start of the start of</li></ul>					Warning limit exceeded	
9				<add new=""></add>	1								

Note: Be sure to use the correct data types.

 $\rightarrow$  Then select the structure and copy it.

 $(\rightarrow Copy)$ 

👻 🔩 🛃 🧮 🤭 Keepa SPEED_MOTOR	ctual values 🔒	Snapshot 🔤 🛤	Copy snap	oshots to start va	lues 📓 1	Load	start values	sasactualvalues Wa⊱ ∰a	5
Name	Data type	Start value	Retain	Accessible f	Writa \	isible in	Setpoint	Comment	
💶 🔻 Static									
Speed_Setpoint	Real	10.0						Speed setpoint in revolution per minute (range:+/-50rpm)	
Speed_Actual_Value	Real	0.0						Speed actual value in revolution per minute (range:+/-50rpm)	
- Desister Canad	Course							Parameters for error / warning positive speed	
Insert row		15.0						Speed limit / if exceeded an error is displayed	
Add row		10.0	1					Speed limit / if exceeded an warning is displayed	
X Cut	Ctrl+X	false	1					Error limit exceeded	
💷 Сору	Ctrl+C	false						Warning limit exceeded	
👔 Paste	Ctrl+V								
X Delete	Del								
Rename	F2								
Update interface									
	Ctrl+Shift+G								
	Ctrl+Shift+D								
Cross-references	F11								
K Cross-reference informatio	n Shift+F11								

 $\rightarrow$  Paste the copied structure below the 'Positive\_Speed' structure again.

 $(\rightarrow \text{Paste})$ 

· 🛃 💺	🛃 🗮 🧐 Keep ac	tual values 🔒	Snapshot 🔤 🛤	Copysnap	shots to start va	lues 🗑	Load	start values	sasactual values 🖉 🖟 🕮	Ę
SPEED_N	OTOR									
Name		Data type	Start value	Retain	Accessible f	Writa	Visible in	Setpoint	Comment	
💶 🕶 Sta	tic									
- D-	Speed_Setpoint	Real	10.0						Speed setpoint in revolution per minute (range:+/-50rpm)	
- D-	Speed_Actual_Value	Real	0.0						Speed actual value in revolution per minute (range:+/-50rpm)	
	Positive_Speed	Struct							Parameters for error / warning positive speed	
• 10	Threshold_Error	Real	15.0	1					Speed limit / if exceeded an error is displayed	
• 0	Threshold_Warning	Real	10.0	<b>V</b>					Speed limit / if exceeded an warning is displayed	
• D	Error	Bool	false	1					Error limit exceeded	
• 🗈	Warning	Bool	false	<ul> <li>Image: A start of the start of</li></ul>					Warning limit exceeded	
✤ Insert rou ✤ Add row	widd news				-					
Cut Copy	Ctrl+X Ctrl+C									
Paste	Ctrl+V Del									
Rename	F2									

- $\rightarrow$  Rename the new structure to 'Negative\_Speed' and enter a comment.
  - $(\rightarrow Negative\_Speed)$

 $(\rightarrow \square \square \square \square)$ 

031	-60	0_0	Global_Data_Blocks_S	57-1200 → CPU_	_1214C [CPU 1214	IC DC/DC/I	)C] → Program	n block	s 🕨 SPEED	_MOTOR	[DB2]	
				tual values 🔒	Snapshot 🔤 👬	Copysnap	shots to start va	lues 🖁	. 🖳 Load	start value:	s as actual values 🛛 🖳 🕄	E
			MOTOR									
		Nam		Data type	Start value	Retain	Accessible f	Writa	Visible in	Setpoint	Comment	
			tatic									
			Speed_Setpoint	Real	10.0						Speed setpoint in revolution per minute (range:+/-50rp	m)
			Speed_Actual_Value	Real	0.0						Speed actual value in revolution per minute (range:+/-	50rpm)
		•	Positive_Speed	Struct							Parameters for error / warning positive speed	
	•		Threshold_Error	Real	15.0	Image: A start and a start					Speed limit / if exceeded an error is displayed	
			Threshold_Warning	Real	10.0						Speed limit / if exceeded an warning is displayed	
			Error	Bool	false						Error limit exceeded	
			Warning	Bool	false						Warning limit exceeded	
		•	Negative_Speed	Struct							Parameters for error / warning negative speed	
2	•		Threshold_Error	Real	-16.0						Speed limit / if exceeded an error is displayed	
1 -	•		Threshold_Warning	Real	-14.0	Image: A start and a start					Speed limit / if exceeded an warning is displayed	
2 -	•		Error	Bool	false	Image: A start and a start					Error limit exceeded	
3 .			Warning	Bool	false						Warning limit exceeded	
4	1		<add new=""></add>									

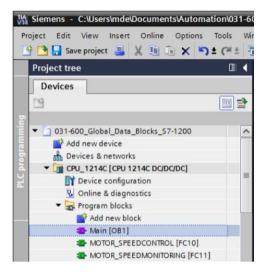
→ Do not forget to click Save project. The finished global data block "SPEED\_MOTOR" [DB2] is shown below. Check to verify that Retain is selected and the corresponding start value is entered for all tags. The data will thus be retained in the data block even after a power failure or a STOP/START of the CPU. The check boxes for 'Accessible from HMI' and 'Visible in HMI' should also all have a check mark so that all tags in future expansions of this project will be accessible by the visualization systems (HMI). We will select the 'Setpoint' check box box only for the default values in our data block.

	-			tual values 📓 Sni	apshot 🖷 🖷	Copysnap	shots to start va	lues 🖉	- B- Load	start values	as actual values 🛛 🖳 🕄	E
		D_I ame	MOTOR	Data type	Start value	Retain	Accessible f	15/100	Visible in	Catalant	Comment	
			atic	Data type	Start value	Retain	Accessible I	vvrita	visible in	Setpoint	Comment	
		50	Speed_Setpoint	Real	10.0						Speed setpoint in revolution per minute (range:+/-50rpm)	
	•		Speed_Actual_Value	Real	0.0					Ā	Speed actual value in revolution per minute (range:+/-50rpm)	
	•	-	Positive_Speed	Struct							Parameters for error / warning positive speed	
			Threshold_Error	Real	15.0						Speed limit / if exceeded an error is displayed	
			Threshold_Warning	Real	10.0						Speed limit / if exceeded an warning is displayed	
	-		Error	Bool	false	<b>V</b>					Error limit exceeded	
			Warning	Bool	false						Warning limit exceeded	
	•	•	Negative_Speed	Struct							Parameters for error / warning negative speed	
0			Threshold_Error	Real	-16.0						Speed limit / if exceeded an error is displayed	
1			Threshold_Warning	Real	-14.0	<b>V</b>					Speed limit / if exceeded an warning is displayed	
2			Error	Bool	false						Error limit exceeded	
3			Warning	Bool	false						Warning limit exceeded	

Note: The use of setpoints is described further below in the step-by-step instructions.

#### 7.3 Access to data of the data block in the organization block

 $\rightarrow$  Open the "Main" [OB1] organization block with a double-click.



- → Delete the temporary tags in "Main" [OB1] that are no longer needed. Only the Boolean tag 'Motor\_Speed\_Control\_Ret\_Val' is still needed.
  - $(\rightarrow \text{Delete})$

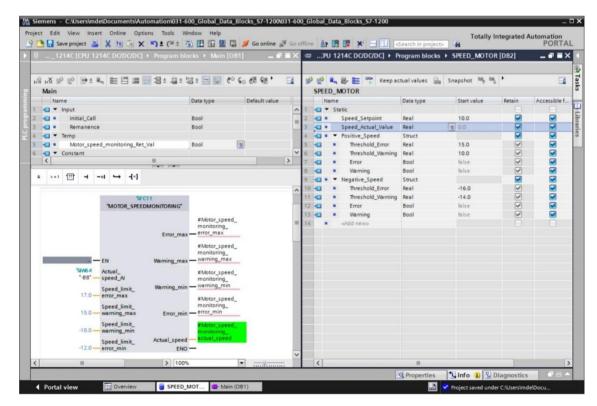
03	1-6	00	_Global_Data_Blocks_S7-1200 → CPU_12	14C [CPU 1214C	DC/DC/DC] • Prog	jram blocks 🔸 Main [OB1] 🛛 🗕 🖬 🗮 🗙
ŝ	В	1 3	🖗 🔮 🐛 🖿 🚍 🖃 🗐 📲 📲 📲 📲 📲	🗏 😥 🥙 💊 🤅	🛤 🖷 🕹 年	표표報 투 🖩 비 위 이 🐂 📑
	Ma					
		Na	me	Data type	Default value	Comment
	-00	•	Input			
2	-00		Initial_Call	Bool		Initial call of this OB
3	-		Remanence	Bool		=True, if remanent data are available
L :	-00	•	Temp			
	-		Motor_speed_monitoring_error_max	insert row		
0.	-00		Motor speed monitoring warning max	Add row		
	-01		Motor_speed_monitoring_warning_min			
3	-		Motor_speed_monitoring_error_min	Cut	Ctrl+X	
1			Motor_speed_monitoring_actual_speed	Copy Paste	Ctrl+C Ctrl+V	
0	-		wotor_speed_monitoring_rec_var	-	Ctrl+v	
1	-	•	Constant	X Delete	Del	
2			<add new=""></add>	Rename	F2	
				Update interface		
				Go to next point o	of use Ctrl+Shift+G	i
	<	-		Go to definition	Ctrl+Shift+D	
_	4	_		Cross-references		
8		>=1	1??? -1 -01 -→ -[=]	Cross-reference i	nformation Shift+F11	

→ Have the "SPEED\_MOTOR" [DB2] data block and the "Main" [OB1] organization block displayed side by side by clicking the ' $\square$ ' icon to vertically split the editor area. (→  $\square$ )

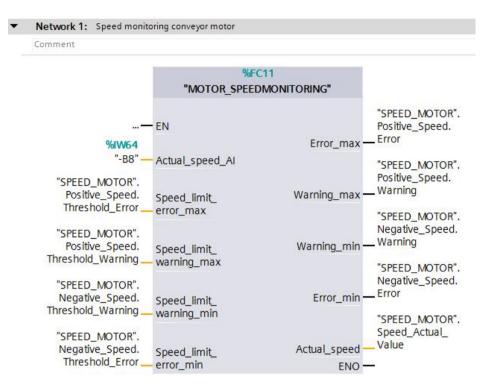
ject Edit View Insert Online Options			Go offline	×==	Search in project>	Totally Inte	grated Autom	nation PORT
Project tree		31-600_Global_Data_Blocks_S					n [OB1] 🗕	
Devices								
19		ଶ 🗚 🥩 😻 🐛 🖿 🗖 🔳		- 10 0 60 0	1 SH TH SD G	에 해 해 나 나는	11 61 61 '	
		Main						
<ul> <li>031-600_Global_Data_Blocks_S7-1200</li> </ul>	^	Name		Data type	Default value	Comment		
Add new device	1	- Input						
h Devices & networks	2	- Initial_Call		Bool		Initial call of this OB		
CPU_1214C [CPU 1214C DC/DC/DC]	3	- Remanence		Bool		=True, if remanent da	ta are available	
Device configuration	- 4	- Temp						
V Online & diagnostics	5	Motor_speed_monitorin	ng_Ret_Val	Bool				
<ul> <li>Program blocks</li> </ul>	6	Constant						
Add new block		<						>
🖀 Main [OB1]				former however				
MOTOR_SPEEDCONTROL [FC10]		& >=1 [??]0  →	-[=]					
MOTOR_SPEEDMONITORING [FC11		Block title: "Main Program Swee	en (Cyrle)*					
MOTOR_AUTO [FB1]		Comment	ip (cjeic)					_
MOTOR_AUTO_DB [DB1]		comment						
SPEED_MOTOR [DB2]		🖸 Network 1: Speed monitorin	g conveyor motor					
Technology objects		Comment						
External source files								

→ Use drag & drop to move the tags needed for the interconnection from the "SPEED\_MOTOR" [DB2] data block onto the connections of the called functions and function blocks in the "Main" [OB1] organization block. First we move the 'Speed\_Actual\_Value' tag onto the 'Actual\_speed' output of the "MOTOR\_SPEEDMONITORING" [FC11] block.

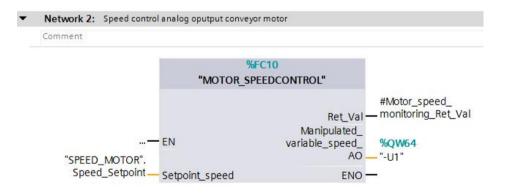
 $(\rightarrow \text{Speed}_\text{Actual}_\text{Value})$ 



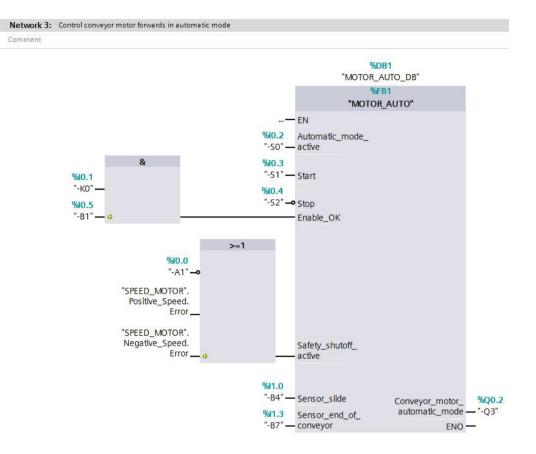
→ Also connect the other contacts in Network 1 with tags from the "SPEED\_MOTOR" [DB2] data block as shown here.



→ Connect the contacts in Network 2 with tags from the "SPEED\_MOTOR" [DB2] data block as shown here.



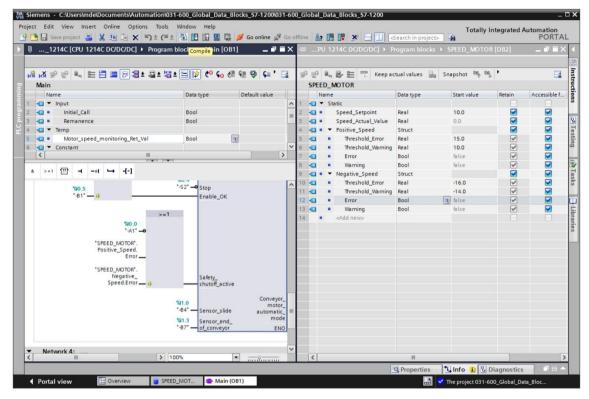
→ Connect the contacts in Network 3 with tags from the "SPEED\_MOTOR" [DB2] data block as shown here.



•

#### 7.4 Save and compile the program

→ To save your project, click the save project button in the menu. To compile all blocks, click the "Program blocks" folder and select the sicon for compiling in the menu.  $(\rightarrow \begin{tabular}{l} \begi$ 

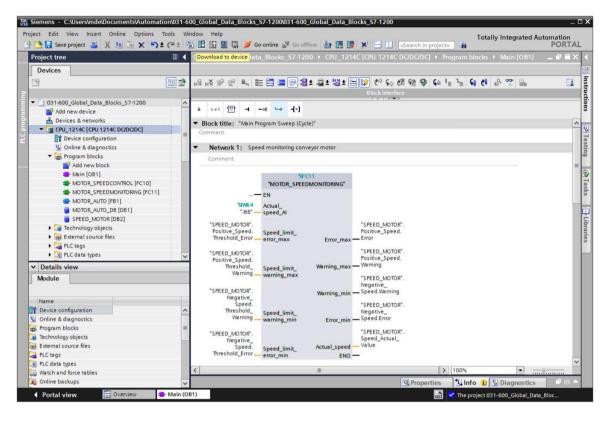


 $\rightarrow$  The "Info", "Compile" area shows which blocks were successfully compiled.

			Q Properties	🚺 Info 🔒	🞖 Diagn	ostics		•
General (1) Cross-references	Compile	Energy Suite	Syntax					
🕽 🛕 🚺 Show all messages								
Compiling finished (errors: 0; warning	s: 0)							
Path	Description				Go to	?	Errors	
CPU_1214C					~		0	0
Program blocks					7		0	0
SPEED_MOTOR (DB2)	Block was success	sfully compiled.			~			
Main (OB1)	Block was succes	sfully compiled.			~			
3	Compiling finished	d (errors: 0; warnings	:: 0)					
		Ш						3

#### 7.5 Download the program

 $\rightarrow$  After successful compilation, the complete controller with the created program including the hardware configuration can, as described in the previous modules, be downloaded. ( $\rightarrow$   $\blacksquare$ )



#### 7.6 Monitor/modify values in data blocks

 $\rightarrow$  The desired block must be open for monitoring the tags of a downloaded data block. The

monitoring can then be activated/deactivated by clicking the  $\begin{tabular}{ll} \end{tabular}$  icon.

 $(\rightarrow \text{SPEED}_\text{MOTOR} [\text{DB2}] \rightarrow \textcircled{\begin{subarray}{c} \begin{subarray}{c} \begin{subarray}{c} \end{subarray} \end{subarray}$ 

Monitor all Da peed_Setpoint Re peed_Actual_Value Re sitive_Speed Set Threshold_Error Re Threshold_Error Re Warning Re egative_Speed St Threshold_Error Re Threshold_Error Re Threshold_Error Re Threshold_Warning Re Error Re	ata type	pshot the test of test			Visible in S		Comm Speed s Speed l Speed l Warnin Warnin
Monitor all Da peed_Setpoint Re peed_Actual_Value Re sostive_Speed Set Threshold_Error Re Threshold_Error Re Warning Re egative_Speed St Threshold_Error Re Threshold_Error Re Threshold_Error Re Threshold_Warning Re Error Re	ata type	Start value         Reti           10.0         0.0           15.0         1           10.0         1           16.0         1           -16.0         -1           false         1		sible f Write	Visible in S		Comm Speed s. Speed I Speed I Speed I Error Ii Warnin Parame Speed I Speed I Speed I
C C C C C C C C C C C C C C C C C C C	keal III keal keal keal keal kool kool truct keal keal keal keal	10.0 0.0 0.0 15.0 10.0 16.0 16.0 16.0 16.0 16.0 16.0 16					Speed s. Speed Speed I Speed I Error Ii Warnin Parame Speed I Speed I Speed I
c Reped_Setpoint Re peed_Setual_Value Re ositive_Speed St Threshold_Error Re Error Be Warning Be Gative_Speed St Threshold_Error Re Threshold_Warning Re Error BE	keal III keal keal keal keal kool kool truct keal keal keal keal	10.0 0.0 0.0 15.0 10.0 16.0 16.0 16.0 16.0 16.0 16.0 16					Speed s Speed Parame. Speed I. Speed I. Error Ii Warnin Parame. Speed I. Speed I. Error Ii
peed_Setpoint Re peed_Actual_Value Re ositive_Speed St Threshold_Error Re Threshold_Error Re Warning Re egative_Speed St Threshold_Error Re Threshold_Warning Re Error Bc	keal kruct keal kool kool keal keal keal	0.0 15.0 15.0 10.0 false false -16.0 -14.0 false					Speed Parame. Speed I. Speed I. Error Ii Warnin Parame. Speed I. Speed I. Error Ii
peed_Actual_Value Re ositive_Speed St Threshold_Error Re Threshold_Warning Re Error Bc Warning Bc egative_Speed St Threshold_Error Re Threshold_Warning Re Error Bc	keal kruct keal kool kool keal keal keal	0.0 15.0 15.0 10.0 false false -16.0 -14.0 false					Speed Parame. Speed I. Speed I. Error Ii Warnin Parame. Speed I. Speed I. Error Ii
sitive_Speed St Threshold_Error Re Threshold_Warning Re Error Bc Warning Bc egative_Speed St Threshold_Error Re Threshold_Warning Re Error Bc	truct keal keal kool truct keal keal	15.0 10.0 false false -16.0 -14.0 false					Parame Speed I. Speed I. Error Ii Warnin Parame Speed I. Speed I. Error Ii
Threshold_Error Re Threshold_Warning Re Error Br Warning Bo egative_Speed St Threshold_Error Re Threshold_Warning Re Error Bo	keal Real Bool Struct Real Real Bool	10.0 false false -16.0 -14.0 false					Speed I. Speed I. Error li Warnin Parame. Speed I. Speed I. Error li
Threshold_Warning Re Error Bo Warning Bo egative_Speed St Threshold_Error Re Threshold_Warning Re Error Bo	keal Bool Struct Real Real Bool	10.0 false false -16.0 -14.0 false					Speed I. Error Ii Warnin Parame. Speed I. Speed I. Error Ii
Error Bo Warning Bo egative_Speed St Threshold_Error Re Threshold_Warning Re Error Bo	Bool Bool Struct Real Real Bool	false					Error li Warnin Parame Speed I. Speed I. Error li
Warning Bo egative_Speed St Threshold_Error Re Threshold_Warning Re Error Bo	Bool Struct Real Real Bool	-16.0 -14.0 false					Warnin Parame. Speed I. Speed I. Error Ii
egative_Speed St Threshold_Error Re Threshold_Warning Re Error Bo	itruct Real Real Bool	-16.0 -14.0 false					Parame. Speed I. Speed I. Error Ii
Threshold_Error Re Threshold_Warning Re Error Bo	teal teal Bool	-14.0 false					Speed I. Speed I. Error li
Threshold_Warning Re Error Bo	leal Iool	-14.0 false	>>>				Speed I. Error li
Error Bo	Bool	false					Error li
Error Bo							Error li
Warning Bo	Bool	false					
		88					>
						Properties 1 Info V Diagnos	

 $\rightarrow$  In the 'Monitor value' column, the values currently available in the CPU can be monitored.

,	-		ctual values 🔒 Sn	apshot ඁ 🐴	Copy snapshots to	start values	B- B- '		
	SP	D_MOTOR	Data type	Start value	Monitor value	Retain	Accessible f	Write	Visible in
1	-00	Static	Data type	Start value	Monitor value	Retain	Accessible I	willd	visible in
2	0	Speed_Setpoint	Real	10.0	10.0				
3	-	Speed_Actual_Value	Real	0.0	10.42933				
1	-	<ul> <li>Positive_Speed</li> </ul>	Struct						
5	-	Threshold_Error	Real	15.0	15.0				
5	-	Threshold_Warning	Real	10.0	10.0	Image: A start and a start			
į.	-	Error	Bool	false	FALSE				
3	-	Warning	Bool	false	TRUE	Image: A start and a start			
2	-	<ul> <li>Negative_Speed</li> </ul>	Struct						
0	-	Threshold_Error	Real	-16.0	-16.0	Image: A start and a start			
1	-	Threshold_Warning	Real	-14.0	-14.0	Image: A start and a start			
12	-	Error	Bool	false	FALSE	Image: A start and a start			
13	-	Warning	Bool	false	FALSE				

→ If you right-click on one of the values, the 'Modify' dialog for modifying this value opens (→ Modify → Modify value:  $15.0 \rightarrow OK$ )

ý	_				ctual values  🔒	Snap	pshot 🛰 🔩	Copy snapshots to	start values	B- B-		
	SPI		)_N me	NOTOR	Data type		Start value	Monitor value	Retain	Accessible f	Write	Visible in
1	-	1000		atic	botto type			inomicor torac				
2				Speed_Setpoint	Real		10.0	10.0				
3	<b>9</b>		•	Speed_Actual Modify Positive_Spe			0.0	40 42022		ā	×	
	- -		•	Threshold Operand Threshold Modify vi		NOTOR".	Speed_Setpoint		Real Floating-point	number		
	- -		•	Warning	15.0			Tomor.	rioating-point	number		
0	<b>9</b>	-	•	Negative_Sp Threshold					0	Cance	el	
1	-			Threshold_vvarning	кеат		-14.0	-14.0	V.	<b>M</b>	<b>M</b>	
	-			Error	Bool	1	false	FALSE				
12	-											

#### 7.7 Initialize setpoints / reset start values

→ The setpoints can be initialized by clicking the '<sup>1</sup>/<sub>1</sub> icon. For the tags whose 'Setpoint' check box is selected <sup>1</sup>/<sub>2</sub>, the start value will then be applied as the current value.
(→<sup>1</sup>/<sub>2</sub>)

Ť	-	-	<b>.</b>	🛃 🗮 📴 Keep ad	tual values 🧧	Snapshot 🏽 🍟 💐	Copy snapshots to	o start values	🛃 🐼 Load	start valu	les as actual	values 🛃	B. 📑
	SP	EEI	D_1	MOTOR (snapshot cre	eated: 7/6/201	7 5:04:14 PM)							
		Na	me		Data type	Start value	Monitor value	Retain	Accessible f	Writa	Visible in	Setpoint	Comment
1	-	•	St	atic									
2	-			Speed_Setpoint	Real	10.0	15.0		$\checkmark$	Image: A start and a start	Image: A start and a start		Speed set
3				Speed_Actual_Value	Real	0.0	15.12044		<b>V</b>	<b>V</b>	Image: A start and a start		Speed act
1			-	Positive_Speed	Struct			<ul> <li>Image: A start of the start of</li></ul>	<b>V</b>	1	Image: A start and a start		Paramete
5				Threshold_Error	Real	15.0	15.0	Image: A start and a start	<b>V</b>	<b>V</b>			Speed lim
5	-			Threshold_Warning	Real	10.0	10.0	Image: A start and a start	$\checkmark$	<b>V</b>			Speed lim
7				Error	Bool	false	TRUE		$\checkmark$	<b>V</b>			Error limit
3	-			Warning	Bool	false	TRUE	Image: A start and a start		<b>v</b>			Warning li
9	-		•	Negative_Speed	Struct				$\checkmark$	Image: A start and a start	Image: A start and a start		Paramete
0				Threshold_Error	Real	-16.0	-16.0	Image: A start of the start	<b>~</b>	<b>V</b>			Speed lim
11	-			Threshold_Warning	Real	-14.0	-14.0	Image: A start and a start	$\checkmark$	1	<b>V</b>		Speed lim
12	1			Error	Bool	false	FALSE	<b>V</b>	¥	1	1		Error limit
13				Warning	Bool	false	FALSE	Image: A start and a start	<b>¥</b>	1	1		Warning li
	<	r	_										

 $\rightarrow$  All start values can be reset by clicking the  $\blacksquare$  icon.

(→	<b>.</b>	
( /		

					Carologica and		100000	and the second second	100	
	Reset start values	Data type	Start value	Monitor value	Retain	Accessible f	Writa	Visible in	Setpoint	Comment
•										Speed se
•			0.0	15.12044						Speed ac
• •										Paramete
	Threshold_Error	Real	15.0	15.0						Speed lin
	Threshold_Warning	Real	10.0	10.0						Speed lin
	Error	Bool	false	TRUE	Image: A start and a start	<b>V</b>	<b>V</b>			Error limi
	Warning	Bool	false	TRUE	Image: A start and a start	Image: A start and a start	<ul> <li>Image: A start of the start of</li></ul>	Image: A start and a start		Warning
	<ul> <li>Negative_Speed</li> </ul>	Struct				<b>V</b>	1	Image: A start and a start		Paramete
	Threshold_Error	Real	-16.0	-16.0		<b>V</b>	1	Image: A start and a start		Speed lin
	Threshold_Warning	Real	-14.0	-14.0		<b>V</b>	1		<b></b>	Speed lin
	Error	Bool	false	FALSE		¥	1			Error limi
	Warning	Bool	false	FALSE	Image: A start and a start	<b>V</b>	<ul> <li>Image: A start of the start of</li></ul>	Image: A start and a start		Warning I
				1111						
		Speed_Actual_Value     Positive_Speed     Threshold_Error     Threshold_Warning     Error     Warning     Negative_Speed     Threshold_Error     Threshold_Error     Threshold_Warning     Error	Speed_Setpoint Real     Speed_Actual_Value Real     Positive_Speed Struct     Threshold_Error Real     Error Bool     Warning Bool     Wagative_Speed Struct     Threshold_Error Real     Threshold_Error Real     Threshold_Error Real     Error Bool	Speed_Setpoint     Real     10.0       Speed_Actual_Value     Real     0.0       Positive_Speed     Struct       Threshold_Error     Real     15.0       Threshold_Warning     Bool     false       Warning     Bool     false       Vegative_Speed     Struct       Threshold_Error     Real     16.0       Threshold_Error     Real     -16.0       Threshold_Warning     Bool     false       Error     Bool     false	Speed_Setpoint     Real     10.0     15.0       Speed_Actual_Value     Real     0.0     15.12044       Positive_Speed     Struct     Image: Struct       Threshold_Error     Real     15.0     15.0       Threshold_Warning     Bool     false     TRUE       Warning     Bool     false     TRUE       Threshold_Warning     Real     -16.0     -16.0       Threshold_Warning     Real     -14.0     -14.0       Warning     Bool     false     FALSE       Warning     Bool     false     FALSE	Speed_Setpoint     Real     10.0     15.0     V       Speed_Actual_Value     Real     0.0     15.12044     V       Threshold_Error     Real     15.0     15.0     V       Threshold_Warning     Real     10.0     10.0     V       Warning     Bool     false     TRUE     V       Threshold_Warning     Real     16.0     -16.0     V       Threshold_Warning     Real     -14.0     V       Warning     Bool     false     TRUE     V       Warning     Bool     false     TRUE     V       Warning     Bool     false     TRUE     V       Warning     Bool     false     FALSE     V	Speed_Setpoint     Real     10.0     15.0     V     V       Speed_Actual_Value     Real     0.0     15.12044     V     V       Positive_Speed     Struct     V     V     V       Threshold_Error     Real     15.0     15.0     V     V       Threshold_Warning     Real     10.0     10.0     V     V       Error     Bool     false     TRUE     V     V       Warning     Bool     false     TRUE     V     V       Threshold_Warning Real     -16.0     -16.0     V     V       Threshold_Warning Real     -14.0     -14.0     V     V       Error     Bool     false     FALSE     V     V	Speed_Setpoint         Real         10.0         15.0         V         V           Speed_Actual_Value         Real         0.0         15.12044         V         V         V           Positive_Speed         Struct         V         V         V         V         V         V           Threshold_Warning         Real         15.0         15.0         V         V         V         V           Error         Bool         false         TRUE         V         V         V           Warning         Bool         false         TRUE         V         V         V           Threshold_Warning         Real         -16.0         -16.0         V         V         V           Threshold_Warning         Real         -14.0         -14.0         V         V         V           Error         Bool         false         FALSE         V         V         V	Speed_Setpoint         Real         10.0         15.0         V         V         V           Speed_Actual_Value         Real         0.0         15.12044         V         V         V         V           Positive_Speed         Struct         V         V         V         V         V         V           Threshold_Error         Real         15.0         15.0         V         V         V         V           Threshold_Warning         Real         10.0         10.0         V         V         V         V           Warning         Bool         false         TRUE         V         V         V         V           Threshold_Error         Real         -16.0         -16.0         V         V         V         V           Threshold_Warning         Real         -14.0         -14.0         V         V         V         V           Error         Bool         false         FALSE         V         V         V         V	Speed_Setpoint         Real         10.0         15.0         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V         V

		Na	ame		Data type	Start value	Monitor value	Retain	Accessible f	Writa	Visible in	Setpoint	Comment
1		•	St	atic									
2	-			Speed_Setpoint	Real	0.0	15.0	Image:	¥	<ul> <li>Image: A start of the start of</li></ul>			Speed set.
3	-			Speed_Actual_Value	Real	0.0	15.12044		<b>V</b>		Image: A start and a start		Speed act.
4	-		-	Positive_Speed	Struct				<b>V</b>	<ul> <li>Image: A start of the start of</li></ul>			Parameter
5	-	1		Threshold_Error	Real	0.0	15.0	Image: A start and a start	$\checkmark$	<ul> <li>Image: A start of the start of</li></ul>	Image: A start and a start		Speed lim.
6	-01	1		Threshold_Warning	Real	0.0	10.0						Speed lim.
7	-0	1		Error	Bool	false	TRUE		¥				Error limit.
8	-	1		Warning	Bool	false	TRUE		1	<ul> <li>Image: A start of the start of</li></ul>			Warning li
9			•	Negative_Speed	Struct			<b>V</b>	4	<ul> <li>Image: A start of the start of</li></ul>	Image: A start and a start		Parameter
10	-	1		Threshold_Error	Real	0.0	-16.0			<ul> <li>Image: A start of the start of</li></ul>	Image: A start and a start		Speed lim.
11	-	1		Threshold_Warning	Real	0.0	-14.0		¥	<ul> <li>Image: A start of the start of</li></ul>	<b>V</b>		Speed lim.
12	-	1	-	Error	Bool	false	FALSE		<b>V</b>		<b>V</b>		Error limit.
13		1		Warning	Bool	false	FALSE	Image: A start and a start	<b>V</b>	<b>V</b>	Image: A start and a start		Warning li
	<	T					111						

#### 7.8 Snapshots in data blocks

→ If you click the 'M' icon, a snapshot of the actual values can be taken in order to apply these values as start values or to transfer them back to the CPU later by clicking the icon 'M, (→ M → M).

di	*				Snapshot 📑 👒	Copy snapshots t		🛃 🏭 Load	start val	ues as actu	al value:	s 👢 🖥	4 📑
į	SPEE	D_N	MOTOR (snapshot cre	eated: 7/6/2017	5:04:14 PM	shot of the actual	valuer						
	N	lame		Data type	Start value	Monitor value	Retain	Accessible f	Writa	Visible in .	Setpo	oint	Comment
	•	- St	atic										
2	•		Speed_Setpoint	Real	10.0	15.0					1		Speed se
3		•	Speed_Actual_Value	Real	0.0	15.12044					[		Speed ac
	• •	•	Positive_Speed	Struct									Paramete
5			Threshold_Error	Real	15.0	15.0	4				1	<b>~</b>	Speed lin
5			Threshold_Warning	Real	10.0	10.0	Image: A start and a start				1		Speed lin
7			Error	Bool	false	TRUE	Image: A start and a start				1		Error limit
3			Warning	Bool	false	TRUE					(		Warning I
9	• •	•	Negative_Speed	Struct							1		Paramete
0			Threshold_Error	Real	-16.0	-16.0	Image: A start and a start				1		Speed lin
1			Threshold_Warning	Real	-14.0	-14.0	Image: A start and a start				1		Speed lin
12			Error	Bool	false	FALSE					1		Error limi
3	< -60		Warning									-	
3	< -60	0_G	lobal_Data_Blocks_	57-1200 → CPU_ itual values 🔒	1214C [CPU 1214 Snapshot 🍇 💐	₩ 4C DC/DC/DC] ▶	Program blo	cks + SPEED	_мото			-	
)3'	< 60 e	0_G	Iobal_Data_Blocks_ Iobal_Data_Blocks_ Keep ac WOTOR (snapshot cro	57-1200 → CPU_ tual values 🔒	1214C [CPU 1214 Snapshot 💐 💐 5:15:16 PM)	III AC DC/DC/DC] → Copy snapshots	Program blo	cks > SPEED	_MOTO	R [DB2]	al value:	s 💽 🕻	
031 9	<	0_G ED_N lame	Iobal_Data_Blocks_4	57-1200 → CPU_ itual values 🔒	1214C [CPU 1214 Snapshot 🍇 💐	₩ 4C DC/DC/DC] ▶	Program blo	cks > SPEED	_MOTO	R [DB2]	al value:	s 💽 🕻	
)3 <sup>1</sup>	<	0_G ED_N lame	lobal_Data_Blocks_s	tual values and tables tual values and tables atted: 7/6/2017	1214C [CPU 1214 Snapshot 👫 🖏 5:15:16 PM0 Start value	III AC DC/DC/DC[ + Copy snapshots I Snapshot	Program blo to start values Monitor value	cks > SPEED	_MOTO	R [DB2] ues as actur essible f 1	al value: Writa	s 💽 E	
031 2	<	0_G ED_N lame	Iobal_Data_Blocks_ Keep ec WOTOR (snapshot creatic Speed_Setpoint	tual values and tual values ated: 7/6/2017 Solution of the set of	1214C [CPU 1214 Snapshot 🧠 👒 5:15:16 PM) Start value	III AC DC/DC/DC] Copy snapshots I Snapshot 15.0	Program blo to start values Monitor value 15.0	cks + SPEED	_MOTO	R [DB2] ues as actu essible f 1	al value: Writa	s 💽 E	
031 2 3	<	0_G ED_N lame St	Iobal_Data_Blocks_1	tual values 🔒 s aated: 7/6/2017 9 Data type Real Real	1214C [CPU 1214 Snapshot 👫 🖏 5:15:16 PM0 Start value	III AC DC/DC/DC[ + Copy snapshots I Snapshot	Program blo to start values Monitor value	cks > SPEED	_MOTO	R [DB2] ues as actu essible f 1	al value: Writa	s 💽 E	
031 2 3 4	<	0_G ED_N lame	Iobal_Data_Blocks_ Keep ac WOTOR (snapshot cre atic Speed_Setpoint Speed_Actual_Value Positive_Speed	tual values 🔒 : eated: 7/6/2017 : Data type Real Real Struct	1214C [CPU 1214 Snapshot 🦄 🍇 5:15:16 PM) Start value 10.0 0.0	III AC DODODOC + Copy snepshots Snepshot 15.0 15.12044	Program blo to start values Monitor value 15.0 15.12044	cks + SPEED	_MOTO	R [DB2] ues as actu essible f 1	al value: Writa	s 💽 Visible i	Warning I
031 2 3 4 5	<	0_G ED_N lame St	Iobal_Data_Blocks_ Keep ac MOTOR (snapshot creation atic Speed_Setpoint Speed_Actual_Value Positive_Speed Threshold_Error	57-1200 ► CPU_ tual values and tual values eated: 7/6/2017 Data type Real Struct Real Struct Real	1214C [CPU 1214 Snapshot 🦄 🥞 5:15:16 PM) Start value 10.0 0.0 15.0	III AC DC/DC/DC] • Copy snepshots I Snepshot 15.0 15.12044 15.0	Program blo to start values Monitor value 15.0 15.12044 15.0	cks + SPEED	_MOTO	R [DB2]	al value: Writa	s 💽 E	n Setp
031 2 3 4 5		0_G ED_N lame	Iobal_Data_Blocks_ Keep ac WOTOR (snapshot creation atic Speed_Setpoint Speed_Actual_Value Positive_Speed Threshold_Error Threshold_Warning	57-1200 → CPU tual values ated: 7/6/2017 Data type Real Real Struct Real Real Real Real	1214C (CPU 1214 Snapshot 🧠 🛸 5:15:16 PM) Start value 10.0 0.0 15.0 10.0	III Copy snapshots I Snapshot 15.0 15.12044 15.0 10.0	Program blo to start values Monitor value 15.0 15.12044 15.0 10.0	cks + SPEED	_MOTO	R [DB2] ues as actu essible f 1	al value: Writa	s 💽 E	n Setp
		0_G ED_N lame	Iobal_Data_Blocks_ Keep ac WOTOR (snapshot creation atic Speed_Setpoint Speed_Actual_Value Positive_Speed Threshold_Warning Error	57-1200 ► CPU_ tual values and tual values eated: 7/6/2017 Data type Real Struct Real Struct Real	1214C (CPU 1214 Snapshot R Start value Start value 10.0 0.0 15.0 10.0 false	III AC DC/DC/DC] • Copy snepshots I Snepshot 15.0 15.12044 15.0	Program blo to start values Monitor value 15.0 15.12044 15.0 10.0 TRUE	cks > SPEED	_MOTO	R [DB2] ues as actu essible f 1 V V	al value: Writa	s 💽 E	n Setp
		0_G ED_N lame	Iobal_Data_Blocks_ Keep ac WOTOR (snapshot cro atic Speed_Setpoint Speed_Actual_Value Positive_Speed Threshold_Warning Error Warning	57-1200 → CPU tual values 🔒 S aated: 7/6/2017 Data type Real Real Struct Real Beal Bool	1214C (CPU 1214 Snapshot 🧠 🛸 5:15:16 PM) Start value 10.0 0.0 15.0 10.0	III Copy snapshots Snapshot 15.0 15.12044 15.0 10.0 TRUE	Program blo to start values Monitor value 15.0 15.12044 15.0 10.0	cks + SPEED	_MOTO	R [DB2]	al value: Writa V	visible i	n Setp
031 2 3 4 5 7 3 9		0_G ED_N lame	Iobal_Data_Blocks_ WOTOR (snapshot creation atic Speed_Setpoint Speed_Actual_Value Positive_Speed Threshold_Error Threshold_Error Warning Negative_Speed	7-1200 ► CPU_ tual values 🔐 1 eated: 7/6/2017 1 Data type Real Real Struct Real Bool Struct	1214C [CPU 1214 Snepshot 🔌 🖏 Start value 10.0 0.0 15.0 10.0 false false	III Copy snapshots Snapshot 15.0 15.12044 15.0 10.0 TRUE TRUE	Program blo to start values Monitor value 15.0 15.12044 15.0 10.0 TRUE TRUE	Cks + SPEED	_MOTO	R [DB2]	al value: Writa V	visible i	- 🖓 🖬 1
031 2 3 4 5 5 7 3 9 10		0_G	Iobal_Data_Blocks_ Keep ac WOTOR (snapshot creation atic Speed_Setpoint Speed_Actual_Value Positive_Speed Threshold_Error Threshold_Warning Error Warning Negative_Speed Threshold_Error	x7-1200 → CPU tual values ated: 7/6/2017 : Data type Real Struct Real Bool Bool Bool Bool Struct Real	1214C (CPU 1214 Snepshot 🧠 🛸 5:15:16 PM) Start value 10.0 0.0 15:0 10.0 false false false -16.0	III Copy snapshots I Snapshot 15.0 15.12044 15.0 10.0 TRUE TRUE -16.0	Program blo to start values Monitor value 15.0 15.12044 15.0 10.0 TRUE TRUE -16.0	cks + SPEED Cks + SPEED Retain Retain V V V V V V	_MOTO	R [DB2]	al value: Writa V V V	s Visible i	
1 2 3 4 5 5 5 7 8 9 10		0_G	Iobal_Data_Blocks_ WOTOR (snapshot creation atic Speed_Setpoint Speed_Actual_Value Positive_Speed Threshold_Error Threshold_Error Warning Negative_Speed	7-1200 ► CPU_ tual values 🔐 1 eated: 7/6/2017 1 Data type Real Real Struct Real Bool Struct	1214C [CPU 1214 Snepshot 🔌 🖏 Start value 10.0 0.0 15.0 10.0 false false	III Copy snapshots Snapshot 15.0 15.12044 15.0 10.0 TRUE TRUE	Program blo to start values Monitor value 15.0 15.12044 15.0 10.0 TRUE TRUE	Cks + SPEED	_MOTO	R [DB2]	al value: Writa V	visible i	n Setp

→ Alternatively, values from the snapshot can be copied to the start values by clicking the '<sup>k</sup>, icon for all values or by clicking the '<sup>k</sup>, icon for the setpoints only. Only the setpoints are needed here in most cases.

(→ 🔽)

			lobal_Da	ata_Blocks_	57-1200 →	CPU_1214	IC [CPU 1214	IC DC/DC/DC]			PEED_N	IOTOR [DB2		- •	
Ø .	*	<b>.</b>	₽ =	Keep ad	tual values	Snaps	hot 🐴 🐴	Copysnapshot	s to start valu	ies 💽 🅵	Load sta	irt values as a	actual values	<b>8</b> , 8,	
S	PEEL	D_N	MOTOR (	snapshot cr	eated: 7/6/	2017 5:15:	16 PM)			All va	lues				
	Na	me			Data type	Start value	Snapshot	Monitor value	Retain	Accessible f		Visible in	Setpoint	Comment	
	•	St	atic												
-	•		Speed_S	etpoint	Real 🔳	10.0	15.0	15.0						Speed set	poin
-			Speed_A	ctual_Value	Real	0.0	15.12044	15.12044						Speed act	ual
-		•	Positive_	Speed	Struct									Parameter	rs for
-	0		Thres	hold_Error	Real	15.0	15.0	15.0	Image: A start and a start					Speed lim	it / if
-	0		Thres	hold_Warning	Real	10.0	10.0	10.0	Image: A start and a start					Speed lim	it / if
-			Error		Bool	false	TRUE	TRUE	Image: A start and a start					Error limit	exce
-			Warni	ing	Bool	false	TRUE	TRUE	Image: A start and a start				-	Warning lin	mit e
-	•	•	Negative	_Speed	Struct									Parameter	rs for
0 🗸			Thres	hold_Error	Real	-16.0	-16.0	-16.0						Speed lim	it / if
1	0		Thres	hold_Warning	Real	-14.0	-14.0	-14.0						Speed lim	it / if
2 🖪	0		Error		Bool	false	FALSE	FALSE	<ul> <li>Image: A start of the start of</li></ul>					Error limit	exce
3 📢	0		Warni	ing	Bool	false	FALSE	FALSE						Warning lin	mite
31-	A	_G	lobal_Da	ata_Blocks_9	§7-1200 →	CPU_1214	ic [CPU 1214	III IC DC/DC/DC]	Program	blocks 🕨 S	PEED_M	OTOR [DB2	2]	- •	
31-	600		lobal_Da		57-1200 •								2] actual values		
31-	600	•	₽ E		tual values	Snaps	hot 🛤 🖏	IC DC/DC/DC]		ies 🛃 🚱	Load sta	rt values as a			
31-	600 PEEI	•	Notor (	Keep ad	tual values	Snaps	hot 🛤 🖏	IC DC/DC/DC]	s to start valu	ies 🛃 🚱	Load sta Only setp	rt values as a	ectual values		
31- \$	600 PEEI	D_N	iler ∎ Motor (	Keep ad	tual values	Ga Snaps 2017 5:15:	hot 🙀 🐴 16 PM)	Copy snapshot	s to start valu	ies 🛃 🚱	Load sta Only setp	rt values as a	ectual values	<b>8</b> 4 84	
31- SI	600	D_N	iler ∎ Motor (	Keep ad	tual values	Snaps 2017 5:15: Start value	hot 🙀 🐴 16 PM)	Copy snapshot	s to start valu	ies 🛃 🚱	Load sta Only setp	rt values as a	ectual values	<b>8</b> 4 84	
31- SI	600 PEEI Na	D_N	₩ ► MOTOR ( atic Speed_S	Keep ad	tual values eated: 7/6/ Data type	Snaps 2017 5:15: Start value	hot 🧤 🖏 16 PM) Snapshot	C DC/DC/DC]	s to start valu Retain	es 🕵 🕵	Load sta Only setp Writa	rt values as a oints Visible in	octual values Setpoint	Comment	point
31- SI	600 PEEI Na 2 -	D_N	₩ ► MOTOR ( atic Speed_S	Keep ad snapshot cro etpoint actual_Value	tual values eated: 7/6/ Data type Real	Snaps 2017 5:15: Start value	hot in	C DC/DC/DC] Copy snapshot Monitor value 15.0	s to start valu Retain	es 🕵 🕵	Load sta Only setp Writa	rt values as a oints Visible in	Setpoint	Comment Speed set	point ual v
31- SI	600 PEEI Na 2 •	D_N sme	MOTOR ( atic Speed_S Speed_A Positive_	Keep ad snapshot cro etpoint actual_Value	tual values eated: 7/6/ Data type Real	Snaps 2017 5:15: Start value	hot in	C DC/DC/DC] Copy snapshot Monitor value 15.0	s to start valu Retain	es 💽 💽	Load sta Only setp Writa	rt values as a oints Visible in	Setpoint	Comment Speed set Speed actu	point ual v s for
31- SI	600	D_N sme St	MOTOR ( atic Speed_S Speed_A Positive_ Thres	(snapshot cro etpoint cctual_Value Speed	tual values eated: 7/6/ Data type Real Real Struct Real	Snaps           2017 5:15:           Start value           10.0           0.0	hot 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	C DC/DC/DC Copy snapshot Monitor value 15.0 15.12044	s to start valu Retain	es 🛃 🚱	Load sta Only setp Writa	rt values as a oints Visible in V	Setpoint	Comment Speed sets Speed acts Parameter	point ual v s for it / if
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→ If you want to load the start values back into the actual values there are two possibilities.
 Alternatively all start values can be copied to the actual values by clicking the '<sup>1</sup>, icon or only the setpoints by clicking the '<sup>1</sup>, icon.

(	$\rightarrow$	💾 )	

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	_MOTOR (snapshot cre			-							Only setpoints
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• •	Speed_Setpoint	Real	15.0	15.0	10.0						Speed setpoint in revol.
• 🗈	Speed_Actual_Value	Real	0.0	15.12044	15.12044						Speed actual value in re
-	<ul> <li>Positive_Speed</li> </ul>	Struct									Parameters for error / w
	intestiona_citor	Real	15.0	15.0	15.0	Image: A start and a start					Speed limit / if exceede.
	<ul> <li>Threshold_Warning</li> </ul>	Real	10.0	10.0	10.0	<b>V</b>					Speed limit / if exceede.
-CI - I	Error	Bool	false	TRUE	TRUE	Image: A start and a start					Error limit exceeded
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-0 - 1	<ul> <li>Negative_Speed</li> </ul>	Struct									Parameters for error / w
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-	Threshold_Warning	Real	-14.0	-14.0	-14.0	1					Speed limit / if exceede.
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#### 7.9 Expand data block and download it without reinitialization

→ To enable 'Download without reinitialization' for the "SPEED\_MOTOR" [DB2] data block, you

must go offline ' Go offline' and then open the properties of the data block. 🦪 Go offline (→

> 🎤	Go offline	$\rightarrow$ SPEED_	_MOTOR	$[DB2] \rightarrow$	Properties)
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Via Siemens - C:\Use Open	Call structure	600_Global_	Data_Blocks	_ <mark>\$7-120</mark> 0		_			_ 🗆 ×
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Project tree Ctrl+V	Know-how protection	CPU 1214C	[CPU 1214C		Program	blocks	► SPEED I	MOTOR [D	821 <b>– 7 5 X 4</b>
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🛥 MC 🙀 Search in project Ctrl+F									Parameters for err
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MC Cross-references F11		-14.0	-14.0	Image: A start and a start					Speed limit / if ex
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PLC tags				v		5 14	anno alla	Diagnos	ucs Liter
< III > Gener		npile En	ergy Suite	Syntax	<b>i</b>				
✓ Details view	Show all messages	•							
I Mess	age				Got	to ?	Date	Time	
Name Offset	'MOTOR_SPEEDMONITORING' was I	oaded success	fully.				7/6/201	7 4:30:	9 PM ^
	'Main' was loaded successfully.						7/6/201	7 4:30:	9 PM
Speed_Setpoint	canning for devices completed for inter	face Intel(R) Et	hernet Connec	tion (4) 1219	-LM. Foun		7/6/201	7 4:28:4	I3 PM
Speed_Actual_Value	oading completed (errors: 0; warnings:	0).					7/6/201	7 4:30:2	24 PM
Versitive_speed	onnected to CPU_1214C, via address IP	=192.168.0.1.					7/6/201	7 4:32:0	04 PM
	onnection to CPU_1214C terminated.						7/6/201	7 4:50:3	6 PM 🗉
	connected to CPU_1214C, via address IP	=192.168.0.1.					7/6/201	7 4:50:4	2 PM
	setpoint values successfully written to						7/6/201	7 4:51:	IS PM
	setpoint values successfully written to	the PLC.					7/6/201	7 5:28:	IS PM
	onnection to CPU 1214C terminated.						7/6/201	7 5:35:4	
< III > <			1	1					>
Portal view SPEED_M	от					🔄 🗸 c	onnection to	CPU_1214C	terminated.

 $\rightarrow$  Select the 'Optimized block access' check box  $\blacksquare$  in the properties under 'General', 'Attributes'.

Attributes Only store in load memory Data block write-protected in the device Optimized block access	
Data block write-protected in the device	
Data block write-protected in the device	
Data block write-protected in the device	
Optimized block access	

 $(\rightarrow \text{General} \rightarrow \text{Attributes} \rightarrow \blacksquare \text{Optimized block access})$ 

→ Assign a 'Retentive memory reserve' to the data block for 'Download without reinitialization'. (→Download without reinitialization → Retentive memory reserve → 10 bytes → OK)

General			
ieneral nformation	Download without reinitializat	ion	
íme stamps			
ompilation	Memory reserve:	100 Byt	es (100 bytes available)
rotection			ad without reinitialization for
ttributes		retentive tags.	
ownload without reinitialization	Retentive memory reserve	10 Byt	es (10 bytes available)
	•		
	•		

 $\rightarrow$  Download your "SPEED\_MOTOR" [DB] data block to the controller again and select

t Edit View Insert Online Options B 🔜 Saveproject 🚇 💥 🟥 📺 🗙 🔩		/ Help 🛛 🌆 🖳 🐺 💋 Goo	online 🖉 G	o offline	r 🖪 🖪 🗶		≪earch in pro	ject>	Total M	ly Integrat	ted Automation PORT
oject tree 🛛 🔲		obal Data Blocks_S7 Download to device	-1200 ▶	CPU_12140	[CPU 12140	DC/DC/DC]	Program	blocks	▶ SPEED_	MOTOR [[	082] 💶 🖬 🖬 🗍
Devices											
i 🔲 🖬	) = = i,	🛃 🔃 😳 Keep ad	tual values	Snaps	hot the tag	Copy snaps	hots to start va	lues 🖁	- B-		-
	SPEED	MOTOR									
031-600_Global_Data_Blocks_S7-1200	^ Nam		Data type	Start value	Snapshot	Retain	Accessible f	Writa	Visible in	Setpoint	Comment
Add new device	1 🕣 🕶 S	tatic		1						i n	
Devices & networks	2 📲 🔳	Speed Setpoint	Real	15.0							Speed setpoint i
CPU_1214C [CPU 1214C DC/DC/DC]	= 3 🕣 =	Speed Actual Value	Real	0.0							Speed actual va
Device configuration	4	Positive_Speed	Struct								Parameters for e
😧 Online & diagnostics	5 🕣 🔹	Threshold_Error	Real	15.0							Speed limit / if e
Program blocks	6 🕣 🔳	Threshold_Warning	Real	10.0							Speed limit / if e:
Add new block	7 🕣 🔳	Error	Bool	false							Error limit excee
- Main [OB1]	8 🕣 🔹	Warning	Bool	false							Warning limit ex
MOTOR_SPEEDCONTROL [F	9 🕣 🖬 🔻	Negative_Speed	Struct								Parameters for e
MOTOR_SPEEDMONITORING	10 🕣 🔹	Threshold_Error	Real	-16.0		Image: A start and a start					Speed limit / if e:
MOTOR_AUTO [FB1]	11 🕣 🔹	Threshold_Warning	Real	-14.0		Image: A start and a start					Speed limit / if e
MOTOR_AUTO_DB [DB1]	12 📶 🖷	Error	Bool	false		Image: A start and a start					Error limit excee
SPEED_MOTOR [DB2]	13 📶 📲	Warning	Bool	false		Image: A start and a start					Warning limit ex
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External source files								+-	Info 🔒	0) pt	stics
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	General	Cross-references	Com	pile Er	ergy Suite	Syntax	1				
Details view	<b>₿ 1 0</b>	Show all messages	-								
	! Message						Go	to ?	Date	Time	
Name Offset	- O	'MOTOR_SPEEDMONITO	RING' was lo	aded succes	sfully.				7/6/20	17 4:30:	19 PM
Speed_Setpoint	<ul> <li>Image: A start of the start of</li></ul>	'Main' was loaded such	cessfully.						7/6/20	17 4:30:	19 PM
Speed_Actual_Value		nning for devices comple	ted for interfa	ace Intel(R) E	thernet Conne	ction (4) 1219-	LM. Foun		7/6/20	17 4:28:	43 PM
Positive Speed		ling completed (errors: 0	; warnings : (	0).					7/6/20	17 4:30:	24 PM
Negative_Speed		nected to CPU_1214C, via	address IP=	192.168.0.1.					7/6/20	17 4:32:	04 PM
<ul> <li>Negauve_speed</li> </ul>		nection to CPU_1214C ter	minated.						7/6/20	17 4:50:	36 PM
		nected to CPU_1214C, via							7/6/20		42 PM
		tpoint values successfull							7/6/20		15 PM
	✓ 5 se	tpoint values successfull	y written to t	he PLC.					7/6/20	17 5:28:	15 PM

 $(\rightarrow \text{SPEED}_\text{MOTOR} [DB] \rightarrow \blacksquare \rightarrow \blacksquare \text{Go online})$ 

→ Then click the 'e, icon to activate memory reserve and thus activate downloading without reinitialization for keeping actual values. Confirm the safety prompt with 'OK'. ( $\rightarrow$  e,  $\rightarrow$  OK)

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	-	-		Data ty	pe	Start value	Monitor value	Retain	Accessibl	Writabl	Visible in	Setpoint	Comment
_		St											
													Speed setpoint in revolution per minute (range:+/-50rpm)
	•		and the second se	Real		0.0	0.0						Speed actual value in revolution per minute (range:+/-50rp
		•	Positive_Speed	Struct									Parameters for error / warning positive speed
-			Threshold_Error	Real		15.0	15.0						Speed limit / if exceeded an error is displayed
			Threshold_Warning	Real		10.0	10.0						Speed limit / if exceeded an warning is displayed
-			Error	Bool		false	FALSE						Error limit exceeded
-			Warning	Bool		false	FALSE					Ā	Warning limit exceeded
		•	Negative_Speed	Struct									Parameters for error / warning negative speed
-			Threshold_Error	Real		-16.0	-16.0						Speed limit / if exceeded an error is displayed
			Threshold_Warning	Real		-14.0	-14.0						Speed limit / if exceeded an warning is displayed
-			Error	Bool		false	FALSE						Error limit exceeded
•		•	Warning	Bool		false	FALSE					Ō	Warning limit exceeded
	SPE Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q	SPEEL Na SPEEL SPEE	SPEED_N Name * St * * * * * * * * * *	SPEED_MOTOR (snapshot cre Name Static Speed_setpoint Speed_setpoint Speed_setupint Positive_Speed Speed_setupint Speed_Speed_Spee	SPEED_MOTOR (snapshot created: Name Data ty Static Speed_Setpoint Real Speed_Setpoint Real Speed_Setpoint Real Speed_Setpoint Real Struct Speed_Setpoint Real Speed_Setpoint Real Struct Speed_Setpoint Real Speed_Setpoint Real	SPEED_MOTOR (snapshot created: 08. Name Data type Speed_setpoint Real Speed_Actual_Value Real Speed_Actual_Value Real Struct Fror Real Struct Struct Name Data type Speed_Actual_Value Speed_Actual_Value Struct Struct Struct Struct Struct Struct Struct Speed_Actual_Value Struct Struct Speed_Actual_Value Struct Struct Speed_Actual_Value Struct Speed_Actual_Value Struct Speed_Actual_Value Struct Speed_Actual_Value Struct Speed_Actual_Value Struct Speed_Actual_Value Speed_Actual_Value Struct Speed_Actual_Value Struct Speed_Actual_Value Speed_Actual_Value Struct Speed_Actual_Value Speed_Actual_Value Struct Speed_Actual_Value Speed_Actual_Value Speed_Actual_Value Struct Speed_Actual_Value Sp	SPEED_MOTOR (snapshot created: 08.08) Active       Name     Data type     Start value       ■ Speed_Setpoint     Real     III       ■ Speed_Actual_Value     Real     0.0       ■ Positive_Speed     Struct     Inveshold_Error       ■ Threshold_Warning     Real     10.0       ■ Threshold_Warning     Bool     false       ■ Warning     Bool     false       ■ Threshold_Error     Real     14.0       ■ Threshold_Warning     Real     -14.0       ■ Threshold_Warning     Real     -14.0	SPEED_MOTOR (snapshot created: 08.08) Activate memoryrese         Name       Data type       Start value       Monitor value         ■ Speed_stopint       Real       115.0       10.0         ■ Speed_stopint       Real       0.0       0.0         ■ * Positive_Speed       Struct	SPEED_MOTOR (snapshot created: 08.08) Activate memory reserve         Name       Data type       Start value       Monitor value       Retain         II       Speed_Setpoint       Real       115.0       10.0       Image: Colspan="2">Image: Colspan="2">Image: Colspan="2">Image: Colspan="2">Image: Colspan="2">Image: Colspan="2">Image: Colspan="2">Image: Colspan="2">Image: Colspan="2">Image: Colspan="2">Colspan="2">Image: Colspan="2">Image: Colspan="2" Image: Col	SPEED_MOTOR (snapshot created: 08.08) Activate memoryreserve         Name       Data type       Stat value       Monitor value       Retain       Accessibl         I       Speed_Setpoint       Real       10.0       Image: Colspan="2">Image: Colspan="2">Image: Colspan="2">Image: Colspan="2">Colspan="2">Image: Colspan="2">Image: Colspan="2">Image: Colspan="2">Image: Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2"         I       Speed_Setpoint       Real       15.0       Image: Colspan="2"       Image: Colspan="2"	SPEED_MOTOR (snapshot created: 08.08) Activate memoryreserve         Name       Data type       Stativalue       Monitor value       Retain       Accessibl       Writabl         Image: Speed_Setpoint       Real       11       15.0       10.0       Image: Speed_Setpoint       Real       11       15.0       Image: Speed_Setpoint       Image: Speed_Setpoint       Image: Speed_Setpoint       Real       11       15.0       Image: Speed_Setpoint       Image	SPEED_MOTOR (snapshot created: 08.08) Activate memory reserve         Name       Data type       Start value       Monitor value       Retain       Accessibl       Writabl       Visible in         I > Speed_Setpoint       Real       15.0       10.0       Image: Colspan="2">Image: Colspan="2">Image: Colspan="2">Image: Colspan="2">Image: Colspan="2">Image: Colspan="2">Colspan="2">Image: Colspan="2">Image: Colspan="2">Image: Colspan="2">Image: Colspan="2">Real         I > Speed_Actual_Value       Real       0.0       0.0       Image: Colspan="2">Image: Colspan="2"         II = Threshold_Warning       Real       10.0       10.0       Image: Colspan="2">Image: Colspan="2"         III = Threshold_Warning       Real       10.0       10.0       Image: Colspan="2"       Image	SPEED_MOTOR (snapshot created: 08.08) Activate memory reserve         Name       Data type       Start value       Monitor value       Retain       Accessibl.       Wittabl.       Visible in       Sepoint         I > Speed_Setpoint       Real       15.0       10.0       IV       IV

Activatio	n (0601:000020) X
	Do you want to enable the block function "Load without reinitialization"?
	You can download the following changes to the block interface in "RUN" mode without having to reinitialize the program. The number of possible changes is limited. You can specify the size of the memory reserved for changes under "Options > Settings". Please note that changes which were made before activating the memory reserve may cause a reinitialization.
	OK Cancel

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 $\rightarrow$  Next add any tag in your data block 99.0

 $(\rightarrow \text{Name: Value\_test} \rightarrow \text{Data type: Real} \rightarrow \text{Start value: 99.0})$ 

- Se				tual values	Snaps	hot 🧤	Copy	snapshots	to start value	es 🖳 🖳	Load start values as actual values 🔹 🗐
			MOTOR		1			Part of the second	1		
		Vame		Data type	Start value	Retain	Accessibl	Writabl	Visible in	Setpoint	Comment
1		<ul> <li>St</li> </ul>									
2	-	•	Speed_Setpoint	Real	15.0	<b>v</b>	Image: A start and a start	<ul> <li>Image: A start of the start of</li></ul>	<ul> <li>Image: A start of the start of</li></ul>		Speed setpoint in revolution per minute (range:+/-50rpm)
3			Speed_Actual_Value	Real	0.0	<ul> <li>Image: A start of the start of</li></ul>		<ul> <li>Image: A start of the start of</li></ul>	<b>V</b>		Speed actual value in revolution per minute (range:+/-50r
1	-	• •	Positive_Speed	Struct		<ul> <li>Image: A start of the start of</li></ul>	<b>V</b>		<b>V</b>		Parameters for error / warning positive speed
5	-		Threshold_Error	Real	15.0	<b>v</b>	Image: A start and a start	<ul> <li>Image: A start of the start of</li></ul>	<b>V</b>		Speed limit / if exceeded an error is displayed
5			Threshold_Warning	Real	10.0				<b>V</b>		Speed limit / if exceeded an warning is displayed
7	-		Error	Bool	false			<ul> <li>Image: A start of the start of</li></ul>	$\checkmark$		Error limit exceeded
3	-		Warning	Bool	false				Image: A start and a start		Warning limit exceeded
)	-	• •	Negative_Speed	Struct							Parameters for error / warning negative speed
0	-		Threshold_Error	Real	-16.0				Image: A start and a start		Speed limit / if exceeded an error is displayed
11			Threshold_Warning	Real	-14.0				Image: A start and a start		Speed limit / if exceeded an warning is displayed
12			Error	Bool	false						Error limit exceeded
3	-		Warning	Bool	false					Ā	Warning limit exceeded
4	-		Value_test	Real	99.0					Ā	
15			<add new=""></add>							Ā	

 $\rightarrow$  Download your "SPEED\_MOTOR" [DB] data block to the controller again.

 $\rightarrow$ SPEED\_MOTOR [DB]  $\rightarrow \blacksquare \rightarrow$  Download)

Project t			I 📢 03	-000_	d to device Global_Data_Blocks _	_37-1200_	VIN P CP	U_1214C1	[CPU 121	40000		grannorot	cks → SPEED_MOTOR [DB2] _ 🖬 🖬
Device	es								tra .				
		<u></u>	Contraction of the second		MOTOR	tual values	Snap	shot ""	Copy	snapshots	to start value	s 🔊 - Bi-	Load start values as actual values 📕 🖓 🕫
Name			- 2 C - 2	Nam		Data type	Start value	Retain	Accessibl	Writabl	Visible in	Setpoint	Comment
	1-600_ Global_Data_Blocks _S7	7-1200 V 🔽	0 ^ 1	• • •		obto type	Store roroe						comment
	Add new device				Speed Setpoint	Real	15.0						Speed setpoint in revolution per minute (range:+/-5
山山	Devices & networks		3	•	Speed_Actual_Value	Real	0.0						Speed actual value in revolution per minute (range:
- 🖬	CPU_1214C [CPU 1214C DC/DC	/DC]	0 <sup>=</sup> 4		Positive_Speed	Struct							Parameters for error / warning positive speed
	T Device configuration		5	•	Threshold_Error	Real	15.0	Image: A start and a start		<ul> <li>Image: A start of the start of</li></ul>			Speed limit / if exceeded an error is displayed
	😵 Online & diagnostics		6	•	Threshold_Warning	Real	10.0			<ul> <li>Image: A start of the start of</li></ul>			Speed limit / if exceeded an warning is displayed
(	Rrogram blocks		0 7	• ID	Error	Bool	false		1	1			Error limit exceeded
	💕 Add new block			- D		Bool	false	<b>V</b>	1	<ul> <li>Image: A start of the start of</li></ul>			Warning limit exceeded
	🖶 Main [OB1]		9		<ul> <li>Negative_Speed</li> </ul>	Struct							Parameters for error / warning negative speed
			0 10		Threshold_Error	Real	-16.0						Speed limit / if exceeded an error is displayed
	MOTOR_SPEEDMONITOR		9 11	_		Real	-14.0						Speed limit / if exceeded an warning is displayed
	MOTOR_AUTO [FB1]		12		Error	Bool	false						Error limit exceeded
	MAGAZINE_PLASTIC (DB:		13			Bool	false						Warning limit exceeded
	MOTOR_AUTO_DB [DB1]		14	• ID	Value_test	Real	99.0						
	SPEED_MOTOR [DB2]		15		<add new=""></add>		20						
oad prev	Fil Tachnalasu abiaste III		Y	<									×
ad prev	View heck before loading		>							II			×
ad prev	View		Y	<	≪Add new>								×
CH Status	View heck before loading Target CPU_1214C		Message Ready for	< l	<dd new=""></dd>					II			×
CH Status	View heck before loading Target CPU_1214C		Message Ready for	< l	≪Add new>					II			×
oad prev	I Target CPU_Textendencesion heck before loading I Target CPU_1214C Simulated Simulated Software	d module	Message Ready for The down	< loadir nload v	<dd new=""></dd>					tion			×
CH Status	ER Tocheologicalization iiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiii	d module	Message Ready for The down	< loadir nload v d softv	<pre> cAdd news ng. will be performed to</pre>	e a simula	ted PLC.			tion			×
oad prev	Pill Tocheology of Larget  Country  Country  Pill Target  Country   d module rrite onli	Message Ready for The down	< loadir nload v d softv	<pre> cAdd news ng. will be performed to ware to device</pre>	e a simula	ted PLC.		Ac	tion	tent down		×	
oad prev	PB Tocheology objects wiew heck before loading ↓ Target ♥ CPU_1214C ♥ Software ♥ Software ♥ Software ♥ New	d module rite onli in [OB1]	Message Ready for The down	< loadir nload v d softv	<pre> cAdd news ng. will be performed to ware to device</pre>	e a simula	ted PLC.		Ac	tion Consis Overw	tent down		×
CH Status	PB Tocheology objects wiew heck before loading ↓ Target ♥ CPU_1214C ♥ Software ♥ Software ♥ Software ♥ New	d module rrite onli	Message Ready for The down	< loadir nload v d softv	<pre> cAdd news ng. will be performed to ware to device</pre>	e a simula	ted PLC.		Ac	tion Consis Overw	tent down		×
oad prev	PB Tocheology objects wiew heck before loading ↓ Target ♥ CPU_1214C ♥ Software ♥ Software ♥ Software ♥ New	d module rite onli in [OB1]	Message Ready for The down	< loadir nload v d softv	<pre> cAdd news ng. will be performed to ware to device</pre>	e a simula	ted PLC.		Ac	tion Consis Overw	tent down		×
oad prev	PB Tocheology objects wiew heck before loading ↓ Target ♥ CPU_1214C ♥ Software ♥ Software ♥ Software ♥ New	d module rite onli in [OB1]	Message Ready for The down	< loadir nload v d softv	<pre> cAdd news ng. will be performed to ware to device</pre>	e a simula	ted PLC.		Ac	tion Consis Overw	tent down		×
CH Status	PB Tocheology objects wiew heck before loading ↓ Target ♥ CPU_1214C ♥ Software ♥ Software ♥ Software ♥ New	d module rite onli in [OB1]	Message Ready for The down	< loadir nload v d softv	<pre> cAdd news ng. will be performed to ware to device</pre>	e a simula	ted PLC.		Ac	tion Consis Overw	tent down		×
CH Status	PB Tocheology objects wiew heck before loading ↓ Target ♥ CPU_1214C ♥ Software ♥ Software ♥ Software ♥ New	d module rite onli in [OB1]	Message Ready for The down	< loadir nload v d softv	<pre> cAdd news ng. will be performed to ware to device ist online and are o</pre>	e a simula	ted PLC.		Ac	tion Consis Overw	tent down	oad	
oad prev	PB Tocheology objects wiew heck before loading ↓ Target ♥ CPU_1214C ♥ Software ♥ Software ♥ Software ♥ New	d module rite onli in [OB1]	Message Ready for The down	< loadir nload v d softv	<pre> cAdd news ng. will be performed to ware to device</pre>	e a simula	ted PLC.		Ac	tion Consis Overw	tent down		

→ If you click ' $\square$ ' to monitor the block again, you will see that the monitored values for the previously existing tags have not been overwritten with the start values. (→ )

-	SPE		MOTOR	tual values	Snaps	ihot 🏘 🖏	Copysna	pshots to sta	rt values	<b>₽</b> - <b>₽</b> - Lo	ad start val	ues as actual values 🔋 🐉 📑
		Nam	e	Data type	Start value	Monitor value	Retain	Accessibl	Writabl	Visible in	Setpoint	Comment
1	-	• 9	itatic									
2	-	•	Speed_Setpoint	Real	15.0	10.0	<ul> <li>Image: A start of the start of</li></ul>	¥	<ul> <li>Image: A start of the start of</li></ul>	Image: A start and a start		Speed setpoint in revolution per minut
3			Speed_Actual_Value	Real	0.0	0.0		<ul><li>✓</li></ul>		Image: A start and a start		Speed actual value in revolution per m
4	-		Positive_Speed	Struct				¥	<ul> <li>Image: A start of the start of</li></ul>	Image: A start and a start		Parameters for error / warning positive
5			Threshold_Error	Real	15.0	15.0			<ul> <li>Image: A start of the start of</li></ul>	Image: A start and a start		Speed limit / if exceeded an error is dis
6	-		Threshold_Warning	Real	10.0	10.0	<ul> <li>Image: A start of the start of</li></ul>	<ul> <li>Image: A start of the start of</li></ul>	<b>V</b>	Image: A start and a start		Speed limit / if exceeded an warning is
7	-		Error	Bool	false	FALSE			<ul> <li>Image: A start of the start of</li></ul>			Error limit exceeded
8	-		Warning	Bool	false	FALSE			<ul> <li>Image: A start of the start of</li></ul>			Warning limit exceeded
9	-	• •	Negative_Speed	Struct			$\checkmark$					Parameters for error / warning negative
10	-	1	Threshold_Error	Real	-16.0	-16.0		<ul> <li>Image: A start of the start of</li></ul>	<ul> <li>Image: A start of the start of</li></ul>			Speed limit / if exceeded an error is dis
11	-		Threshold_Warning	Real	-14.0	-14.0	<ul> <li>Image: A start of the start of</li></ul>			<b>V</b>		Speed limit / if exceeded an warning is
12	-	1	Error	Bool	false	FALSE						Error limit exceeded
13	-		Warning	Bool	false	FALSE		<ul> <li>Image: A start of the start of</li></ul>	<ul> <li>Image: A start of the start of</li></ul>	Image: A start and a start		Warning limit exceeded
14		•	Value_test	Real	99.0	99.0		<ul> <li>Image: A start of the start of</li></ul>				
15			<add new=""></add>									

## 7.10 Archive the project

→ As the final step, we want to archive the complete project. Select the → 'Archive ...' command in the → 'Project' menu. Select a folder where you want to archive your project and save it with the file type "TIA Portal project archive".

 $(\rightarrow$  Project  $\rightarrow$  Archive  $\rightarrow$  TIA Portal project archive  $\rightarrow$  031-600\_Global\_Data\_Blocks\_S7-1200....  $\rightarrow$  Save)

oject Edit View Insert Online	Options	Tools Wi	ndow Help								Totally Integrated Autor	nation
New	)	± (* ± 4	1 🔃 II 🖳 🛄 🥖 (	o online 🦼	Go offline	å? 🖪 📭	× = II	Sear	ch in projects			PORTAL
	Ctrl+O		Global_Data_Blocks_			and the second second second						. ₽ E X
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Close	Ctrl+W											
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Save as Ctrl+:	Shift+S	SPEED	MOTOR									1
Delete project	Ctrl+E	Nar	-	Data type	Start value	Retain	Accessible f	Writa	Visible in	Setpoint	Comment	
Archive		1 🐨 🔻	Static	1								L
Retrieve		2 🕣 =	Speed_Setpoint	Real	15.0			1	Image: A start and a start		Speed setpoint in revolut	ion per mi
Manage multiuser server projects		3 🕣 🗉	Speed_Actual_Value	Real	0.0				Image: A start and a start		Speed actual value in rev	olution per.
Card Reader/USB memory	-	4 🕣 =	<ul> <li>Positive_Speed</li> </ul>	Struct			Image: A start and a start		Image: A start and a start		Parameters for error / wa	ning positi.
Memory card file	- 1	5 🕣	Threshold_Error	Real	15.0		<ul> <li>Image: A start of the start of</li></ul>				Speed limit / if exceeded	an error is
-	- <u></u>	6 🕢	Threshold_Warning	Real	10.0	<u> </u>	Image: A start and a start		Image: A start and a start		Speed limit / if exceeded	an warnin
Start basic integrity check		7 🕣	Error	Bool	false		<ul> <li>Image: A start of the start of</li></ul>				Error limit exceeded	
Upgrade		8 🕣	Warning	Bool	false		<ul> <li>Image: A start of the start of</li></ul>		Image: A start and a start		Warning limit exceeded	
Print	Ctrl+P	9	<ul> <li>Negative_Speed</li> </ul>	Struct					Image: A start and a start		Parameters for error / wa	ning negat.
Print preview		10 🕣	Threshold Error	Real	-16.0		Image: A start and a start		<b>V</b>		Speed limit / if exceeded	
C:\\031-600_Global_Data_Blocks_S7-12	200	11 🕣	Threshold_Warning	Real	-14.0		Image: A start and a start		Image: A start and a start		Speed limit / if exceeded	an warnin
C:\\031-500_Analog_Values_S7-1200_V		12 🕣	Error	Bool	false		Image: A start and a start			Ā	Error limit exceeded	
C:lUsl031 420 Diagnostics via Webse		13 -	Warning	Bool	false				Image: A start and a start	Ă	Warning limit exceeded	
C:lUserslml031_200_FB-Programming	V14	14 -	Value_test	Real	99.0				Image: A start and a start	Ä		
C:\Users\mde\031-410_Basics_Diagno:	stics	15	Add news			Ä	- A	Ä	Ä	- O		_
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		340	Show all messages		1							
			Show all messages		]							
Name O	ffset								Go to ?	2.0	**	
Speed_Setpoint		I Messa							Go to ?	Date		
Speed_Actual_Value		-	nnected to CPU_1214C, vi	address IP=	192.168.0.1						2017 5:52:08 PM	^
Positive_Speed			art downloading to device.								2017 5:56:00 PM	_
Negative_Speed			CPU_1214C								2017 5:56:00 PM	
		0	'SPEED_MOTOR' was le		sstully.						2017 5:58:01 PM	
		0	'Main' was loaded suc		- )						2017 5:58:01 PM	
			ading completed (errors : I		D).						2017 5:58:02 PM	=
		📀 Co	nnection to CPU_1214C te	minated.						7/6/	2017 6:02:28 PM	×
<	>	<										>
Portal view     Overview	1.5	SPEED_I		_				_		_		

# 8 Checklist

No.	Description	Completed
1	Data block SPEED_MOTOR [DB2] successfully created.	
2	Program changes made in Main [OB1].	
3	Compiling successful and without error message	
4	Download successful and without error message	
5	Switch on station (-K0 = 1) Cylinder retracted / Feedback activated (-B1 = 1) EMERGENCY OFF (-A1 = 1) not activated AUTOMATIC mode (-S0 = 1) Pushbutton automatic stop not actuated (-S2 = 1) Briefly press the automatic start pushbutton (-S1 = 1) Sensor part at slide activated (-B4 = 1) then Conveyor motor M1 variable speed (-Q3 = 1) switches on and stays on. The speed corresponds to the speed setpoint in the range +/- 50 rpm	
6	Sensor part at end of conveyor activated (-B7 = 1) $\rightarrow$ -Q3 = 0 (after 2 seconds)	
7	Briefly press the automatic stop pushbutton (-S2 = 0) $\rightarrow$ -Q3 = 0	
8	Activate EMERGENCY OFF (-A1 = 0) $\rightarrow$ -Q3 = 0	
9	Manual mode (-S0 = 0) $\rightarrow$ -Q3 = 0	
10	Switch off station (-K0 = 0) $\rightarrow$ -Q3 = 0	
11	Cylinder not retracted (-B1 = 0) $\rightarrow$ -Q3 = 0	
12	Speed > Motor_speed_monitoring_error_max $\rightarrow$ -Q3 = 0	
13	Speed < Motor_speed_monitoring_error_min $\rightarrow$ -Q3 = 0	
14	Project successfully archived	

# 9 Exercise

## 9.1 Task – Exercise

In this exercise a global data block "MAGAZINE\_PLASTIC" [DB3] will be created additionally.

The setpoint and actual value of the counter for the plastic parts will be specified and displayed in this data block.

A connectable input for the setpoint setting and an output for displaying the actual value will also be added to the "MOTOR\_AUTO" [FB1] function block.

## 9.2 Technology diagram

Here you see the technology diagram for the task.

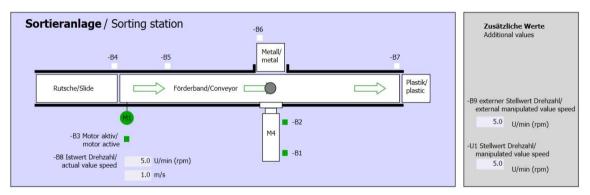


Figure 5: Technology diagram

Schalter der Sortieranlage Switches of sorting station	Automatikbetrieb Automatic mode	Handbetrieb / Manual mode -S3 Tippbetrieb -M1 vorwärts/ Manual -M1 forwards
-P1 einon -P4 einon -P4 einon -P4 aktiviet/active -P4 aktiviet/active -P4 aktiviet/active -P2 Handmanual -P3 Auto/auto -P3 Handmanual -P3 Auto/auto -P3 Handmanual -P3 Auto/auto	s gestateUstanea	-54 Tippbetrieb -M1 rückwärts/ Manual -M1 backwards -P7 ausgefahren/extended -56 Zylinder -M4 ausfahren/ cylinder -M4 extend -55 Zylinder -M4 einfahren/ cylinder -M4 retract

Figure 6: Control panel

# 9.3 Reference list

DI	Туре	Identifier	Function	NC/NO
1 0.0	BOOL	-A1	Return signal emergency stop OK	NC
I 0.1	BOOL	-K0	Main switch "ON"	NO
I 0.2	BOOL	-S0	Mode selector manual (0)/ automatic (1)	Manual = 0 Auto = 1
I 0.3	BOOL	-S1	Pushbutton automatic start	NO
I 0.4	BOOL	-S2	Pushbutton automatic stop	NC
I 0.5	BOOL	-B1	Sensor cylinder -M4 retracted	NO
l 1.0	BOOL	-B4	Sensor part at slide	NO
l 1.3	BOOL	-B7	Sensor part at end of conveyor	NO
IW64	BOOL	-B8	Sensor actual value speed of the motor +/-10V corresponds to +/- 50 rpm	

The following signals are required as global operands for this task.

DO	Туре	ldentifier	Function	
Q 0.2	BOOL	-Q3	Conveyor motor -M1 variable speed	
QW 64	BOOL	-U1	Manipulated value speed of the motor in 2 directions +/- 10V corresponds to +/- 50 rpm	

#### Legend for reference list

- DI Digital Input DO Digital Output
- AI Analog Input AO Analog Output
- I Input Q Output
- NC Normally Closed
- NO Normally Open

## 9.4 Planning

Plan the implementation of the task on your own.

# 9.5 Checklist – Exercise

No.	Description	Completed
1	Data block MAGAZINE_PLASTIC [DB3] successfully created.	
2	Program changes made in MOTOR_AUTO [FB1].	
3	Program changes made in Main [OB1].	
4	Compiling successful and without error message	
5	Download successful and without error message	
6	Switch on station (-K0 = 1) Cylinder retracted / Feedback activated (-B1 = 1) EMERGENCY OFF (-A1 = 1) not activated AUTOMATIC mode (-S0 = 1) Pushbutton automatic stop not actuated (-S2 = 1) Briefly press the automatic start pushbutton (-S1 = 1) Sensor part at slide activated (-B4 = 1) then Conveyor motor M1 variable speed (-Q3 = 1) switches on and stays on. The speed corresponds to the speed setpoint in the range +/- 50 rpm	
7	Sensor part at end of conveyor activated (-B7 = 1) $\rightarrow$ -Q3 = 0 (after 2 seconds)	
8	Briefly press the automatic stop pushbutton (-S2 = 0) $\rightarrow$ -Q3 = 0	
9	Activate EMERGENCY OFF (-A1 = 0) $\rightarrow$ -Q3 = 0	
10	Manual mode (-S0 = 0) $\rightarrow$ -Q3 = 0	
11	Switch off station (-K0 = 0) $\rightarrow$ -Q3 = 0	
12	Cylinder not retracted (-B1 = 0) $\rightarrow$ -Q3 = 0	
13	Speed > Motor_speed_monitoring_error_max $\rightarrow$ -Q3 = 0	
14	Speed < Motor_speed_monitoring_error_min $\rightarrow$ -Q3 = 0	
15	Project successfully archived	

# **10** Additional information

More information for further practice and consolidation is available as orientation, for example: Getting Started, videos, tutorials, apps, manuals, programming guidelines and trial software / firmware, under the following link:

#### www.siemens.com/sce/s7-1200

#### Preview "Additional information"

Getting Started, Videos, Tutorials, Apps, Manuals, Trial-SW/Firmware

- ↗ TIA Portal Videos
- TIA Portal Tutorial Center
- > Getting Started
- ↗ Programming Guideline
- Easy Entry in SIMATIC S7-1200
- > Download Trial Software/Firmware
- ↗ Technical Documentation SIMATIC Controller
- Industry Online Support App
- TIA Portal, SIMATIC S7-1200/1500 Overview
- ↗ TIA Portal Website
- ↗ SIMATIC S7-1200 Website
- SIMATIC S7-1500 Website

# Notes


# Notes

# SCE Learn-/Training Textbook

# Automation System SIMATIC S7-1200



#### TIA Portal Modules from Version V14 SP1

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<b>TIA Portal Module 011-001</b> Firmware Update	1
TIA Portal Module 011-100 Unspecified Hardware Configuration	2
<b>TIA Portal Module 011-101</b> Specified Hardware Configuration	3
<b>TIA Portal Module 020-100</b> Process description of sorting station	4
TIA Portal Module 031-100 Basics of FC Programming	5
TIA Portal Module 031-200 Basics of FB Programming	6
TIA Portal Module 031-300 IEC Timers and IEC Counters	7
<b>TIA Portal Module 031-410</b> Basics of Diagnostics	8
<b>TIA Portal Module 031-420</b> Diagnostics via Web	9
<b>TIA Portal Module 031-500</b> Analog Values	10
<b>TIA Portal Module 031-600</b> Global Data Blocks	11
TIA Portal Module 041-101 WinCC Basic with KTP700	12
<b>TIA Portal Module 051-201</b> High-Level Language Programming with SCL	13
<b>TIA Portal Module 051-300</b> PID Controller	14

#### Matching SCE Trainer Packages for these Learn-/Training Document

#### **SIMATIC HMI Panels**

- 1 SIMATIC HMI KTP700 BASIC COLOR PANEL for S7-1200
  Order no.: 6AV2123-2GB03-0AA1
- 6x SIMATIC HMI KTP700 BASIC COLOR PANEL for S7-1200
   Order no.: 6AV2123-2GB03-0AA0

#### SIMATIC controllers

- SIMATIC S7-1200 AC/DC/RELAY (set of 6) "TIA Portal" Order no.: 6ES7214-1BE30-4AB3
- SIMATIC S7-1200 DC/DC/DC (set of 6) "TIA Portal" Order no.: 6ES7214-1AE30-4AB3

#### SIMATIC STEP 7 Software for Training

 Upgrade SIMATIC STEP 7 BASIC V14 SP1 (for S7-1200) (set of 6) "TIA Portal" Order no.: 6ES7822-0AA04-4YE5

Note that these trainer packages are replaced with successor packages when necessary. An overview of the currently available SCE packages is available at: <u>siemens.com/sce/tp</u>

#### **Continued training**

For regional Siemens SCE Continued Training, get in touch with your regional SCE contact: <u>siemens.com/sce/contact</u>

#### Additional information regarding SCE

siemens.com/sce

#### Information regarding use

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We wish to thank the TU Dresden, particularly Prof. Dr.-Ing. Leon Urbas and the Michael Dziallas Engineering Corporation and all other involved persons for their support during the preparation of this Learn-/Training Document.

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# Process Visualization with the SIMATIC HMI Panel KTP700 Basic and WinCC Basic

# 1 Objective

In this section, you will become familiar with the basics of process visualization and the use of a SIMATIC HMI Panel KTP700 Basic together with SIMATIC S7-1200 and the TIA Portal programming tool.

The module explains the configuring of a SIMATIC HMI Panel KTP700 Basic, the creation of a connection to the SIMATIC S7-1200 and the read and write access to CPU data of the SIMATIC HMI Panel KTP700 Basic.

The SIMATIC S7 controllers listed in section 3 SIMATIC S7 controllers can be used.

# 2 Requirements

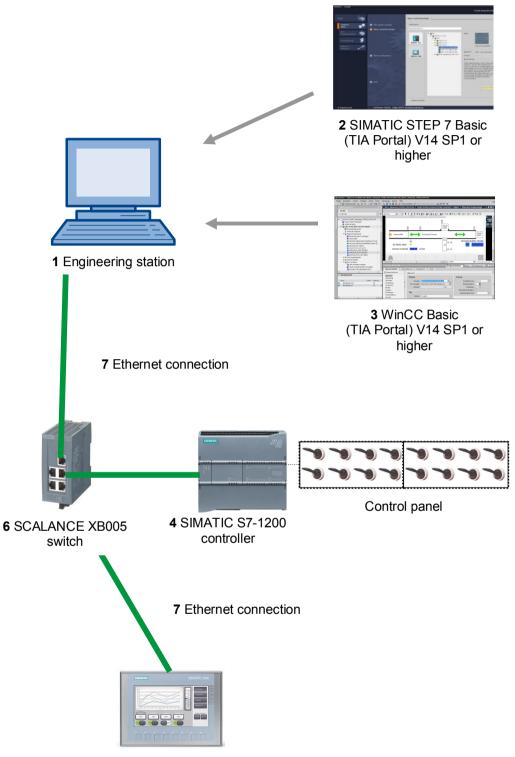
This module builds on the Global Data Blocks for SIMATIC S7-1200 module. To implement this module, you can use the following project, for example: "SCE\_EN\_031-600 Globale\_Data\_Blocks\_S7-1200....zap14".

# 3 Hardware and software required

- Engineering Station: Requirements for hardware and operating system (for additional information, see Readme on the TIA Portal Installation DVD)
- 2 SIMATIC STEP 7 Basic software in the TIA Portal V14 SP1 or higher
- 3 WinCC Basic software in the TIA Portal V14 SP1 or higher
- 4 SIMATIC S7-1200 controller, e.g. CPU 1214C DC/DC/DC with signal board ANALOG OUTPUT SB1232, 1 AO, firmware V4.2.1 or higher

**Note:** The digital inputs and the analog inputs and outputs should be fed out to a control panel.

- 5 SIMATIC HMI Panel KTP700 Basic
- 6 SCALANCE XB005 INDUSTRIAL ETHERNET Switch
- 7 Ethernet connection between the engineering station and switch, controller and switch and HMI Panel KTP700 Basic and switch



5 SIMATIC HMI Panel KTP700 Basic

# 4 Theory

## 4.1 **Process visualization**

Due to production processes are becoming more and more complex and requirements for machine and plant functionality are increasing, operators need a powerful tool for controlling and monitoring production plants. An HMI system (human-machine interface) represents the interface between man (operator) and process (machine/plant). It is the controller that actually controls the process. Hence, there is an interface between the operator and WinCC (at the HMI device) and an interface between WinCC and the controller.

#### The SIMATIC HMI Basic Panels and WinCC perform the following tasks:

#### · Display processes with a straightforward screen structure

The process is mapped on the HMI device. The display on the HMI device is updated when a process state changes, for example. A process can be displayed in a clearly structured manner in multiple screens.

#### Communicate with processes

The operator can communicate with the process via the graphical user interface For example, the operator can define a setpoint for the controller or start a motor.

#### Output alarms

When critical process states occur, such as when a specified limit is exceeded, an alarm is automatically triggered.

#### • Archive process values and alarms

The HMI system can log alarms and process values. In this way, you can document the process history. As a result you can later access older production data.

#### • Document process values and alarms

The HMI system can print out alarms and process values as reports. This allows you to output production data at the end of a shift, for example.

#### Manage process and machine parameters in recipes

The HMI system can store parameters for processes and machines in recipes. For example, you can transfer these parameters from the HMI device to the controller in one step in order to switch the production to a different product version.

#### User management

Certain rights can be assigned to the devices, thereby limiting the possible operator inputs for particular users.

## 4.2 SIMATIC HMI Panel KTP700 Basic

#### 4.2.1 Device description

The SIMATIC HMI Basic Panels product line features key and touch panels (operator input via keyboard and touch screen)

SIMATIC HMI Basic Panels cover all requirements described in the previous section.

These HMI devices are explained in this document using the KTP700 Basic as an example.



Figure 1: KTP700 Basic

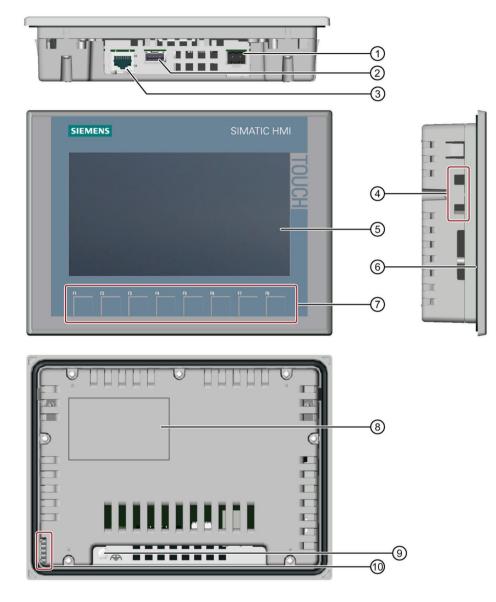
The WinCC Basic (TIA Portal) software is needed for configuration and programming. This software is included in the SCE Trainer Package "SIMATIC HMI KTP700 BASIC COLOR PANEL for S7-1200"!

#### Notes:

Because all the devices in this product series have similar functionality, it would also be possible to implement this section with another product device in this series.

The Touch Panel KTP700 Basic can also be displayed on the PC as Runtime simulation with WinCC Basic.





- (1) Connection for power supply
- (2) USB interface for USB mass storage device or USB mouse
- ③ PROFINET interface
- (4) Recesses for a mounting clip
- (5) Display/touch screen
- 6 Mounting gasket
- 7 Function keys
- (8) Rating plate
- (9) Connection for functional ground
- 10 Guide for labeling strip

#### 4.2.3 Memory concept

The HMI devices can use the following memory:

- Internal memory
- USB mass storage on USB interface

#### Internal memory

The following data is stored here:

- Operating system
- Project file
- License keys
- User management
- Recipes

#### USB mass storage on USB interface

The following data can be stored here:

- Operating system for update
- Project file as backup
- User management as backup
- Recipes as backup
- Recovery software for resetting to factory settings via USB
- License keys for transfer to the panel
- Certificates for web-based communication

#### 4.2.4 Settings on Touch Panel KTP700 Basic/Start Center

Several important settings must be made directly on the Touch Panel KTP700 Basic.

The Touch Panel KTP700 Basic runs with the Windows CE operating system. Similar to all touch panels, operator inputs can be made directly on the screen. For better performance, you should use a special touch pen or connect a mouse to the panel's USB port.

After startup of the panel, the 'Start Center' window appears.

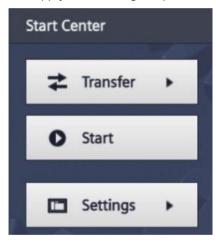
#### Buttons in the Start Center:

**Transfer:** Data transfer is activated and the panel waits for the configuration data to be downloaded from WinCC to the PC. "Transfer" mode can only be activated when at least one data channel is enabled for the transfer.

**Start:** Runtime is started and the process visualization appears on the panel. Often the panel is set in such a way that the start occurs automatically after a few seconds.

**Settings:** The Windows CE settings dialog is opened. Settings for the panel can be made here: You make various settings on this page, such as settings for the transfer.

→ Select → the "Settings" button in the "Start Center" immediately after switching on the power supply and starting the panel.



Note:

You must select "Settings" in the "Start Center" quickly before Runtime automatically starts.

## 4.2.5 Setting the date and time

_	6		3	
	È		~	
	П	1		

 $\rightarrow$  Under "System", select the <sup>Date & Time</sup> icon to make the date and time settings.

Start Center	_
<b>≵</b> Transfer	Settings System
Start	Service & Date & Time Sounds System Control/Info
Settings	Transfer, Network & Internet
	Network   Network   Transfer   Transfer   Settings   Internet Settings

 $\rightarrow$  Under "Date & Time", set the time zone ("Time shift") and the date and time.

Start Center							_
<b>≵</b> Transfer	Date & T	ime					
	30	April	2015	20	24		
Start	1	May	2016	21	25		
Start	2	June	2017	22	26		
	3	July	2018	23	27		
Settings	4	August	2019	00	28		
	Time shift:			-01.00			
Date & Time				±00:00			
				+01:00			
Network Time Protocol				+02:00			
Date & Time	Localtime: 2017-06-02T23:26				26		

## 4.2.6 Setting the transfer properties and assigning the IP address



→ Under "Transfer, Network & Internet", select the <sup>Settings</sup> icon to navigate to the transfer properties.

Start Center	_	
<b>≵</b> Transfer	Settings	
Start	System	
	Service & Date & Time Sounds System Commissioning Control/Info	
Settings	Transfer, Network & Internet	
	Network Transfer Internet	
	Interface Settings Settings	
	Display & Operation	

 $\rightarrow$  Select the following settings for the "Transfer Settings".

Start Center	_
<b>≵</b> Transfer	Transfer Settings
O Start	Enable transfer: ON
Settings	Automatic: ON
1999 (Sec. 20	Digital Signatures
	Validate Signatures: ON



→ Under "Transfer, Network & Internet", select the Interface icon to navigate to the network settings.

Start Center		
<b>↓</b> Transfer	Settings	
Start	System	
Settings	Service & Date & Time Sounds System Commissioning Control/Info	
	Transfer, Network & Internet	
	Network Transfer Internet Interface Settings Settings	
	Display & Operation	

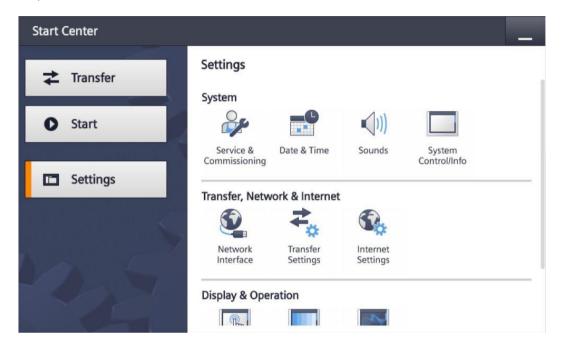
→ In menu item "Interface PN X1", set the IP address under "IP address" and the subnet mask under "Subnet mask".

Start Center		-
<b>≵</b> Transfer	Interface PN X1	
	IP address	
Start	DHCP:	OFF
Settings	IP address:	192.168.0.10
an anna an anna	Subnet mask:	255.255.255.0
	Default gateway:	0.0.0.0
	Note: Applying IP setti	ings will take a few seconds!

## 4.2.7 Switching off the sound on the touch panel



→ Under "System", select the Sounds icon to navigate to the sounds settings of the touch panel.



 $\rightarrow~$  Under "Volume", switch  $\rightarrow$  "Sound" to "OFF".

Start Center	
<b>≵</b> Transfer	Volume
Start	Sound: OFF
Settings	

## 4.2.8 Calibrating the touch panel

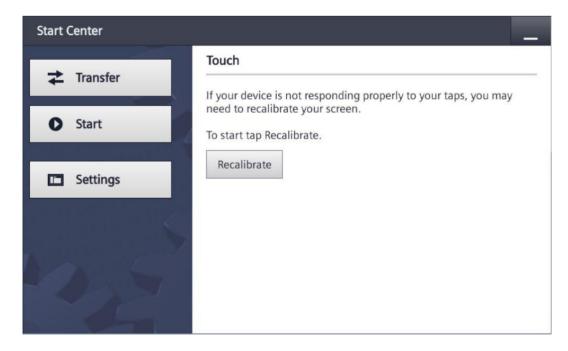


→ Under "Display & Operation", select the touch panel.

icon to navigate to the calibration of the

Start Center					_
<b>≵</b> Transfer	Settings Commissioning			Control/Info	
O Start	Transfer, Netw	ork & Interne	t		
		₹.,			
Settings	Network Interface	Transfer Settings	Internet Settings		
	Display & Ope	ration			_
	LP.		~		
	Touch	Display	Screensaver		
and the second					

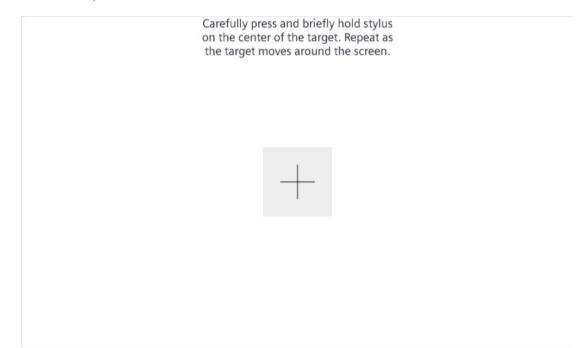
 $\rightarrow$  Select the "Touch" menu item. Start the calibration with  $\rightarrow$  "Recalibrate".



 $\rightarrow$  Touch anywhere on the screen within 15 seconds to start the calibration.

Tap the screen anywhere to start calibration
or wait for 15 seconds to cancel
and keep current settings.
Time limit: 7 sec
Three mile, 7 sec

→ Follow the instructions on the touch panel and press as close to the center of the displayed cross as possible.



## 4.3 WinCC Basic programming software

The WinCC Basic software is included in the TIA Portal as an integral component of STEP 7 Basic or STEP 7 Professional and is the programming tool for the following visualization system:

SIMATIC Basic Panels

With WinCC Basic you have the following functions for creating HMI systems:

- Hardware configuration and parameter assignment
- Specification of communication and creation of a connection to a PLC
- Creation and layout of screens with hierarchical structure
- Creation of internal and external tags
- Creation of alarms and alarm displays
- Creation and display of logs as trends and in tables
- Creation of recipes and recipe displays
- Creation and printing of reports
- Testing, commissioning and service with operational/diagnostic functions
- Documentation

All functions are supported by an extensive online help.

#### 4.3.1 Project

For the solution to an automation and visualization task, you create a project in the TIA Portal. A project in the TIA Portal contains data on the configuration and networking of devices as well as the programs and the configuration of the visualization.

#### 4.3.2 Hardware configuration

The *hardware configuration* contains the configuration devices, consisting of the automation system hardware, the field devices on the PROFINET bus system and the hardware for visualization. The configuration of the networks specifies the communication between the various hardware components. Individual hardware components are inserted from catalogs into the *hardware configuration*.

The hardware of SIMATIC S7-1200 automation systems consists of the controller (CPU), the signal modules for input and output signals (SM), the communication modules (CM) and other special modules.

The signal modules and field devices connect the input and output data of the process to be automated and visualized to the automation system.

The hardware configuration enables automation and visualization solutions to be downloaded to the automation system and the controller to have access to the connected signal modules.

#### 4.3.3 Planning the hardware

Before you can configure the hardware, you must plan it. In general, you start by selecting the required controllers and the number needed. Next you select the communication modules and signal modules. The signal modules are selected based on the number and type of inputs and outputs needed. Finally, a power supply must be selected for each controller or each field device to ensure the required power is supplied.

The functionality needed and the environmental conditions are of critical importance for planning the hardware configuration. For example, the temperature range in the application area is one of the limiting factors for selecting possible devices. Fail-safe capability could be another requirement.

The <u>TIA Selection Tool</u> (select Automation System  $\rightarrow$  TIA Selection Tool and follow the instructions) offers you support.

#### Notes:

- TIA Selection Tool requires Java
- Online research: To obtain the device specifications, look for the manual described as "Product Manual" or "Manual" among the various manuals listed.

There are centralized and distributed applications available for the visualization. For local, distributed operator input, panels are often used. These can communicate with the controller via Ethernet, WLAN or fieldbus. For central operator control and monitoring, PC can also be used. These are usually connected to the controller via Ethernet.

The <u>TIA Selection Tool</u> also supports you when selecting panels (select Automation System  $\rightarrow$  TIA Selection Tool and follow the instructions).

#### 4.3.4 Planning the screen structure

After selecting a device for the visualization, the screen structure must be planned. To do this, you should assemble, group and structure the information to be displayed. From this it should be possible to derive a screen structure like the one shown in Figure 2. The entry point to the screen structure is always ensured by a "root screen".

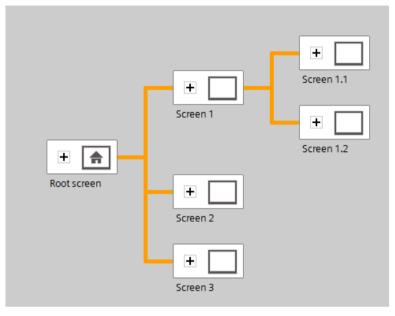


Figure 2: Example of screen structure

The determining factor for the screen structure should be its support of the operator when navigating through the information distributed among the screens for operator control and monitoring of the process.

The following questions may be helpful:

What conceptual model of the process must be followed for the information display?

What data belong together?

What data belong in a specific sequence?

What data belong to specific operations/processes?

Are there data and the like that apply across operations?

What data represent key information and what data are additional information?

#### 4.3.5 Planning of screen design

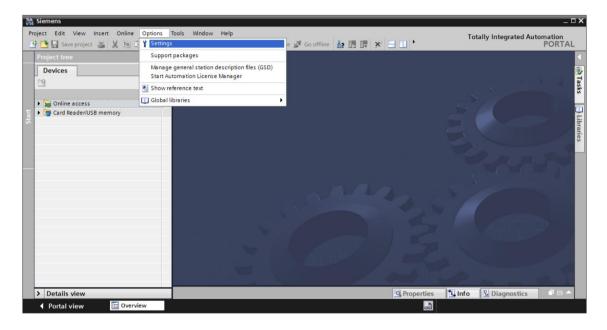
Every individual screen must also be planned. Considerations regarding use by the operator are also necessary for the information display. It is helpful here to follow design principles such as the principles of proximity, similarity and symmetry. The following rules of thumb derived from design principles can also support the design of screens:

- → Form groups of data blocks
- → Uniform subdivision of the entire screen into work information, status or system information and controller information
- $\rightarrow$  Observe average distribution of attention on the screen as a function of reading direction
- → Use compactness as design principle (numbers, column headings same as column content)
- → Make appropriate use of 30-40 % of available space: Accommodate as little information as possible and as much as necessary
- → Economical coding (for example, color, bold text, lightness, shape, border, appearance, flashing)
- → Organize numbers: organize numbers with more than 4 digits in groups of 2, 3 or 4 (for example, 66 234)
- $\rightarrow$  Preferably choose numerals in listing of objects, properties, etc.
- → Use and position designations uniformly
- $\rightarrow$  Use short words if possible

### 4.3.6 Basic settings for WinCC Basic in the TIA Portal

The user can make customized presets for certain settings in the TIA Portal. The method for making the settings for the visualization is shown here.

 $\rightarrow$  In the Project view, select menu command  $\rightarrow$  "Options" and then  $\rightarrow$  "Settings".



→ In the → "Visualization" item of Settings, select the desired presets for the design of the user interface.

Settings	
General	Visualization
<ul> <li>Hardware configuration</li> <li>PLC programming</li> </ul>	**Subil_2.001
STEP 7 Safety	Screens
Simulation	General
Online & diagnostics	
PLC alarms	Show templates in screens
<ul> <li>Visualization</li> <li>Screens</li> </ul>	Use same font for all languages
Resize screen	Colors
HMI tags	
Runtime scripting	Screen background: Light gray
Keyboard shortcuts	
<ul> <li>Password providers Multiuser</li> </ul>	Settings editor
CAx	Snap to lines
	Snap to grid
	O None
	Grid
	Show grid
	Grid size X: 8
	Grid size Y: 8
	Resize screen
	Note
	The settings for the screen layout have an effect when a screen is copied to another device or when the device type and the resolution are changed. The configuration is also valid for slide-in screens and pop-up screens.

Note: Keep the default settings as the settings for the visualization here.

### 4.3.7 Resetting the SIMATIC HMI Panel KTP700 and setting the IP address

The HMI Panel KTP700 Basic can be reset directly in the TIA Portal. A new IP address can also be assigned to the panel there.

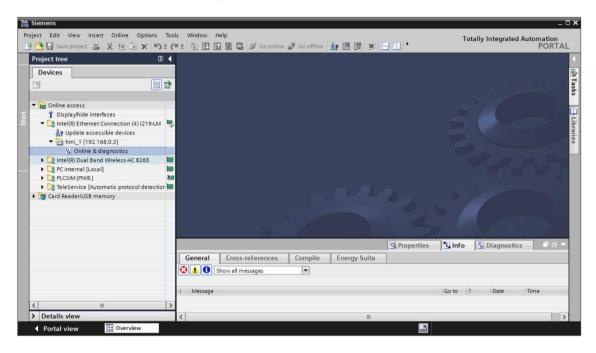
To do this, select the Totally Integrated Automation Portal, which is opened by a double-click. ( $\rightarrow$  TIA Portal V14)



 $\rightarrow~$  Click the  $\rightarrow$  "Online & Diagnostics" item and open the  $\rightarrow$  "Project view".



→ In the project tree, select the network adapter of your computer under → "Online access". When you click → "Update accessible devices", you see the IP address (if already set) or the MAC address (if the IP address has not yet been assigned) of the connected SIMATIC HMI Panel → Click → "Online & diagnostics".



→ To assign the IP address, select the → "Assign IP address" function. For example, enter the following IP address and subnet mask here: → IP address: 192.168.0.10 → Subnet mask: 255.255.255.0. Next, click → "Assign IP address". The new address is assigned to your SIMATIC HMI Panel KTP700 Basic.

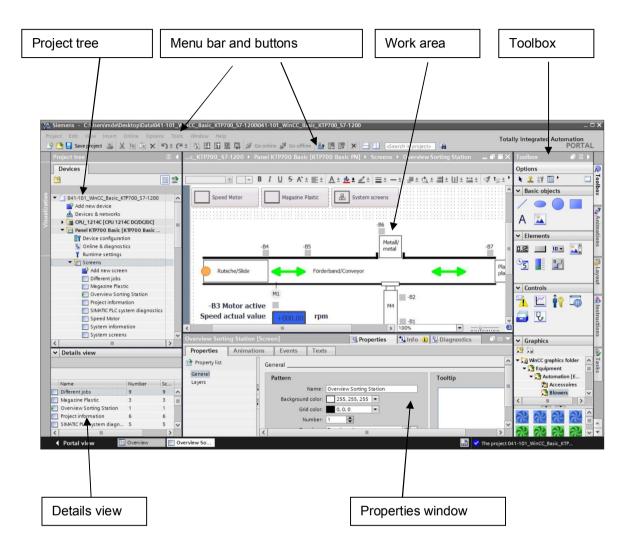
MA Siemens	_ D X
	dow Help Totally Integrated Automation PORTAL
Project tree II	e access 🔸 Intel(R) Ethernet Connection (4) I219-LM 🔸 hmi_1 [192.168.0.3] 🔸 hmi_1 [192.168.0.3] 🧼 🖬 🖬 🗙 🗹
Devices	U.
Conline access     Displayhide interfaces     Displayhide interfaces     Displayhide interfaces     Displayhide accessible devices     Conline & diagnostics     Difference & diagnostics     Difference & diagnostics	eneral tions ssign IP address ssign RDATINET device na eset to factory settings Devices connected to an enterprise network or directly to the internet must be appropriated protected against unauthorized access, e.g. by use of firevalls and network segmentation. For more information about industrial security. Image: State St
C internal [Local]	MAC address: E0 -DC -A0 -00 -50 -1E Accessible devices IP address: 192 168 0 10 Subnet mask: 255 255 0 Use router Router address: 192 168 0 3 Assign IP address W Assign a device address to the module Assign a device address to the module C Properties 11 Info Diagnostics
< III > Gen	
> Details view	
Portal view Dverview U Online & d	lia

→ The successful (or unsuccessful) assignment of the IP address is shown as a message in the → "Info" window, → "General" tab.

				Q Prop	perties	1	i, Info	😮 Diag	gnostics	
General	Cross-references	Compile	Energy Suite							
8 1 0	Show all messages	•								
Message				Go to	?	Da	te	Time		
💙 🛛 The pa	arameters were transferred	d successfully.				6/2	28/2017	12:30:54	PM	
				Q	Properti	es	🔄 In	fo 🖁 Di	agnostics	18
				Q	Properti	es	L In	fo 🗓 Di	agnostics	1 =
General		Compile		9	Properti	es	Li In	fo 🗓 Di	agnostics	18
	Cross-references	Compile		9	Properti	es	1 In	fo ይ Di	agnostics	
Message				9	Propertio Go t		2 In	fo 🗓 Di	agnostics Time	
Message				9						
Message	now all messages	ed.		9				Date 5/28/2016	Time	•

**Note:** If there are problems assigning the IP address, the IP address of the SIMATIC HMI Panel KTP700 Basic can also be set via Windows CE of the panel.

## 4.3.8 WinCC user interface

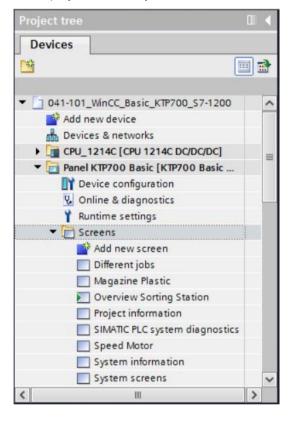


#### 4.3.9 Project tree

The project tree is the central control point for the project handling. All component parts and all the available editors of a project are displayed in a tree structure in the project window and can be opened from there.

Each editor is assigned a symbol which you can use to identify the corresponding objects. Only elements that are supported by the selected HMI device are displayed in the project window.

In the project window, you have access to the device settings of the HMI device.



#### 4.3.10 Details view

The Details view shows the contents or other information on the objects selected in the project tree.

~	Details view			_
	Name	Number	Sc	-
	Different jobs	9	9	^
	Magazine Plastic	3	з	
	Overview Sorting Station	1	1	
	Project information	6	6	
	SIMATIC PLC system diagn	5	5	~
<	III		>	

#### 4.3.11 Menu bar and buttons

The menus and toolbars provide access to all functions you need to configure your HMI device. When a corresponding editor is active, editor-specific menu commands and toolbars are visible.

When the mouse pointer is moved over a command, you receive a corresponding tooltip for each function.

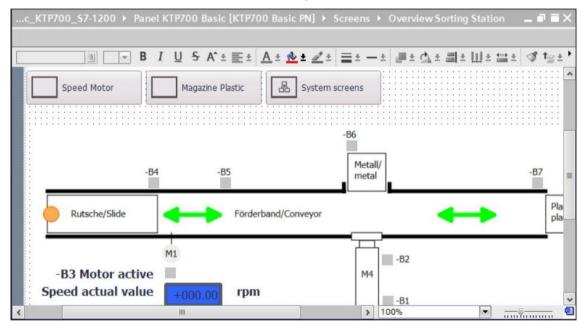


#### 4.3.12 Work area

You edit the objects of the project in the work area. All other elements of WinCC are arranged on the borders of the work area.

Project data can also be edited here either in tabular form (e.g. tags) or graphically (e.g. process screens).

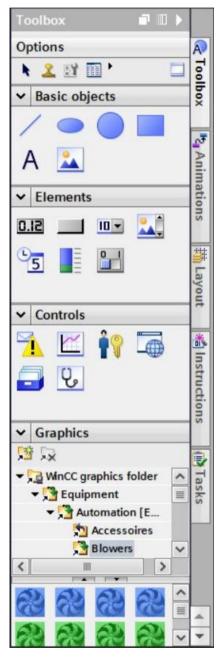
A toolbar is located at the top of the work area. For example, you can select formatting such as font and font color and functions such as rotate, align, etc. here.



#### 4.3.13 Toolbox

In the toolbox window, you will find a selection of objects that you can insert in your screens, e.g. graphic objects and operator controls. In addition, the toolbox window also contains libraries with ready-made graphic objects and collections of faceplates.

The objects are moved to the work area using drag & drop.



#### 4.3.14 Properties window

In the properties window, you edit the properties of the objects selected in the work area, e.g. the color of screen objects. The window is only available in specific editors.

The properties window also shows the properties of the selected object, organized by category. The changed values take effect as soon as the input field is exited. If you enter an invalid value, it is highlighted in color. The tooltip gives you information about the valid value range, for example.

Animations (e.g. color change at a change of signal state in the PLC) and events (e.g. screen change when a button is released) are also configured for a selected object in the properties window. Multilingual texts can also be managed here.

g Station [Scree	en]	<b>Q</b> Properties	🗓 Info 🔒	2 Diagnostics	
Animations	Events Texts				
Ge	neral				^
	Pattern			Tooltip	
•					=
•					
	Number: 1				~
	Animations	General Pattern Background color: Grid color: Number:	Animations Events Texts General Pattern Background color: 255, 255, 255  Grid color: 0, 0, 0 Number: 1	Animations Events Texts General Pattern Name: Overview Sorting Station Background color: 255, 255, 255 Grid color: 0, 0, 0 Number: 1	Animations Events Texts  General Pattern  Name: Overview Sorting Station Background color: 255, 255, 255  Grid color: 0, 0, 0 Number: 1

## 4.3.15 Additional tabs

The settings of the work area, such as the layer selection and the grid functions, can be made in the "Layout" window.

Animations, instructions, tasks and libraries of the selected object can be selected via other tabs.

	Þ	7 10			yout	La
A					otions	Op
Too						
oolbox					Layer	~
	~			Sorting	Oven	•
T		10		_0	🕨 🍠 La	
A	=	۲		_1	🗾 La	
nin				_2	🚽 La	
lati		۲		_3	😸 La	
on		۲		_4	🗾 La	
S		۲		_5	🗾 La	
#		٩			🗾 La	
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# 5 Task

In this section, a process visualization is to be added to the program from section "SCE\_EN\_031-600 Global Data Blocks for S7-1200". This enables you to better monitor and process flow and control it more effectively.

# 6 **Process visualization planning**

A Touch Panel KTP700 Basic is to be used for the process visualization.

The programming device, a SIMATIC S7-1200 controller and the Touch Panel KTP700 Basic are connected to one another via the **Ethernet interface** using a SCALANCE XB005 UNMANAGED INDUSTRIAL ETHERNET SWITCH.

The wizard in the TIA Portal is to be used for the basic configuring. In doing this, all **system** screens are also to be created.

The process will be represented with the conveyor and sensors in an "Overview Sorting Station" overview screen. Conveyor speed and the plastic parts count will also be displayed here.

This operator is to be able to select the operating mode, start and stop in automatic mode and reset the counter in this screen.

In an additional **"Speed Motor"** screen, the actual speed of the motor will be graphically displayed. The speed setpoint can also be specified here.

The "Magazine Plastic" screen will be initially only created.

The screen name, date/time and system states "Emergency stop ok/released", "Main switch ON/OFF" and "Automatic started/stopped" are displayed in the **header**.

The **footer** has a button for returning to the root screen, a button for displaying the alarm window and a button for ending Runtime mode.

The **alarm system** is also to be configured.

System events of the panel are to be displayed as alarms and motor speed limit violations of the main switch are to be monitored.

In doing so, the alarms are automatically displayed in alarm windows when errors/warnings occur.

# 6.1 Program description for the sorting station with motor speed control and monitoring

The "MOTOR\_AUTO" [FB1] function block controls a conveyor in automatic mode.

The Memory\_Automatic\_Start\_Stop is switched on in a latching manner with Start, but only if the reset conditions are not present.

The Memory\_Automatic\_Start\_Stop is to be reset if Stop is pending, the safety shutoff is active or automatic mode is not activated from the visualization.

The Automatic\_Motor output is controlled when Memory\_Automatic\_Start\_Stop is set, the enabling conditions are met and Memory\_Conveyor\_Start\_Stop is set.

For energy saving reasons, the conveyor is to run only when a transport part is present. Therefore, Memory\_Conveyor\_Start\_Stop is set if Sensor\_slide signals a part and is reset if Sensor\_end\_of\_conveyor generates a negative edge or the safety shutoff is active or automatic mode is not activated (manual mode).

Because Sensor\_end\_of\_conveyor is not mounted directly at the end of the conveyor, a signal delay of the Sensor\_end\_of\_conveyor signal is programmed.

The magazine for plastics holds only five parts. Therefore, the parts are counted at the end of the conveyor. If the magazine contains five parts, automatic mode is to be stopped. After the magazine is emptied, automatic mode is restarted with another Start, once the counter has been reset from the visualization.

The **speed is specified** with an input in the "MOTOR\_SPEEDCONTROL" [FC10] function in revolutions per minute (range: +/- 50 rpm).

The speed setpoint is first checked in the function for correct input in the range +/- 50 rpm.

If the speed setpoint is outside the range +/- 50 rpm, the value 0 is output at the speed setpoint output. The value TRUE (1) is assigned to the return value of the function (Ret\_Val).

If the specified speed is in the range +/- 50 rpm, this value is first scaled to the range 0...1 and then scaled for the output as manipulated speed value at the analog output to +/- 27648 with data type 16-bit integer (Int).

In the "MOTOR\_SPEED\_MONITORING" [FC11] function, the actual value is made available at - B8 as an analog value and is queried at an input of the "MOTOR\_SPEEDMONITORING" [FC11] function.

The actual speed value is scaled to revolutions per minute (range: +/- 50 rpm) and made available at an output.

The following four limits can be specified at the block inputs in order to monitor them in the function:

Speed > Speed limit error max

Speed > Speed limit warning max

Speed < Speed limit warning min

Speed < Speed limit warning min

If a limit is exceeded or undershot, the value TRUE (1) is assigned to the corresponding output bit.

If a fault is present, the safety shutoff of the "MOTOR\_AUTO" [FB1] function block is to be triggered.

Speed setpoint and actual speed value as well as the positive and negative error and warning limits are created in the "SPEED\_MOTOR" [DB2] data block, as are the error and warning bits.

The setpoint and actual value of the counter for plastic parts will be specified and displayed in the global "MAGAZINE\_PLASTIC" [DB3] data block. These values are connected with the "MOTOR\_AUTO" [FB1] function block via an input for specification of the setpoint and via an output for display of the actual value.

# 6.2 Technology schematic diagram

Sortieranlage / Sorting station Zusätzliche Werte -B6 Additional value Metall/ -B4 -B5 -B7 metal Plastik/ Rutsche/Slide > Förderband/Conveyor 0 plastic -B9 externer Stellwert Drehzahl/ external manipulated value speed 5.0 U/min (rpm) **-B2** M4 -B3 Motor aktiv/ motor active -U1 Stellwert Drehzahl/ manipulated value speed -B1 -B8 Istwert Drehzahl/ actual value speed 5.0 U/min (rpm) 5.0 U/min (rpm) 1.0 m/s

Here you see the technology schematic diagram of the system for the task.

Figure 3: Technology schematic diagram

Schalter der Sortieranlage Switches of sorting station	Automatikbetrieb Automatic mode -P5 gestartet/started	Handbetrieb / Manual mode -S3 Tippbetrieb - M1 vorwarts/ Manual -M1 forwards
-Q0 Hauptschalter/Main switch -P4 aktiviert/active -A1 NOTHALT/Emergency stop -P2 Hand/manual -P3 Auto/auto -P3 Auto/auto	-S1 Start/start  -S2 Stopp/stop	-S4 Tippbetrieb -M1 rückwärts/ Manual -M1 backwards -P7 ausgefahren/extended -S6 Zylinder -M4 ausfahren/ cylinder -M4 extend -S5 Zylinder -M4 einfahren/ cylinder -M4 retract

Figure 4: Operator panel

# 6.3 Reference table

The following signals are required as global operands for this task.
----------------------------------------------------------------------

DI	Туре	ID	Function	NC/NO
I 0.0	BOOL	-A1	Return signal emergency stop ok	NC
I 0.1	BOOL	-K0	Main switch "ON"	NO
10.2	BOOL	-S0	Mode selector manual (0) / automatic (1)	Manual = 0 Auto=1
1 0.3	BOOL	-S1	"Automatic start" pushbutton	NO
I 0.4	BOOL	-S2	"Automatic stop" pushbutton	NC
I 0.5	BOOL	-B1	Sensor cylinder -M4 retracted	NO
I 1.0	BOOL	-B4	Sensor part at slide	NO
I 1.3	BOOL	-B7	Sensor part at end of conveyor	NO
IW64	BOOL	-B8	Sensor actual motor speed +/-10V corresponds to +/- 50 rpm	

DO	Туре	ID	Function	
Q 0.2	BOOL	-Q3	Conveyor motor -M1 variable speed	
QW 64	BOOL	-U1	Motor speed manipulated variable in both directions +/-10V corresponds to +/- 50 rpm	

### Legend for reference list

- DI Digital input
- AI Analog input
- I Input
- NC Normally Closed
- NO Normally Open

- DO Digital output
- AO Analog output
- O Output

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# 7 Structured step-by-step instructions

Here you will find an example of instructions for the planning task. If you already have a good understanding of everything, it is sufficient to focus on the numbered steps. Otherwise, follow the step-by-step instructions below.

## 7.1 Retrieving an existing project

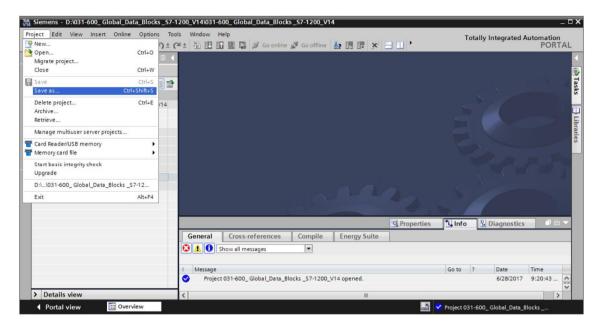
→ Before you can expand the "SCE\_EN\_031-600 Global\_Data\_Blocks\_S7-1200.....zap14" project from section "SCE\_DE\_031-600 Global Data Blocks for S7-1200", you must retrieve it. To retrieve an existing project, you must select the respective archive from the Project view below → Project → Retrieve. Confirm your selection with Open.

Project	Edit	View	Insert	Online	Op
👫 New					>
👌 Ope	n			Ctrl+O	
Migr	ate proj	ect			
Clos	e			Ctrl+W	
Save	1			Ctrl+S	
Save			C	trl+Shift+S	
Dele	te proje	ct		Ctrl+E	
Arch	ive				
Retri	eve				
Man	age mu	ltius er s	erver pro	jects	
T Card	Reader	/USB m	emory	•	
👕 Merr	nory car	d file		•	
Star	t basic i	ntegrity	check		
Upgi	rade				
Exit	1			Alt+F4	

 $(\rightarrow \text{Project} \rightarrow \text{Retrieve} \rightarrow \text{Selection of a .zap archive } \dots \rightarrow \text{Open})$ 

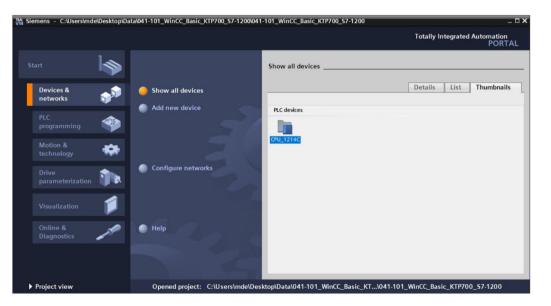
→ Next, the target directory in which the retrieved project is to be stored can be selected. Confirm your selection with "OK". (→ Target directory ... → OK)

→ You save the opened project under the name 041-101\_WinCC\_Basic\_KTP700\_S7-1200. ( $\rightarrow$  Save  $\rightarrow$  project as ...  $\rightarrow$  041-101\_WinCC\_Basic\_KTP700\_S7-1200  $\rightarrow$  Save)



# 7.2 Adding SIMATIC HMI Panel KTP700 Basic

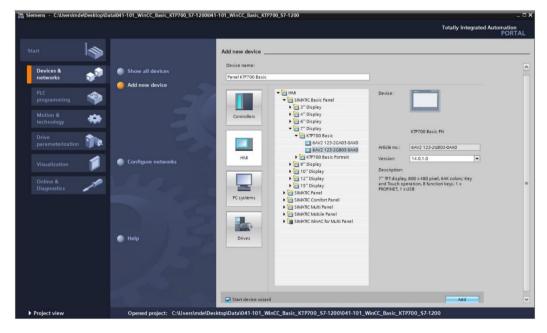
→ To create a new panel in the project, switch to the Portal view. Select menu item → "Devices & Networks" and → "Add new device" in the Portal.



→ Next, select → "HMI" → "SIMATIC Basic Panel" → "7" Display" → "KTP700 Basic" as the device variant and the correct order number of your panel; here, e.g. → 6AV2 123-2GB03-0AX0.

dd new device _				
Controllers	<ul> <li>HMI</li> <li>SIMATIC Basic Panel</li> <li>3" Display</li> <li>4" Display</li> <li>6" Display</li> <li>6" Display</li> <li>7" Display</li> <li>KTP700 Basic</li> <li>6AV2 123-2GA03-0AX0</li> </ul>	Device:	KTP700 Basic PN	
	6AV2 123-2GA03-0AX0	Article no.:	6AV2 123-2GB03-0AX0	
HM	► 🔚 KTP700 Basic Portrait	Version:	14.0.1.0	
	<ul> <li>Image: Barbon State Sta</li></ul>	Description:		
PC systems			, 800 x 480 pixel, 64K colors eration, 8 function keys; 1 x USB	

→ Enter the device name Panel KTP700 Basic and  $\rightarrow$  select the  $\boxed{}$  "Start device wizard" check box. Click the  $\boxed{}^{\text{Add}}$  button.



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## 7.3 HMI device wizard for Panel KTP700 Basic

The TIA Portal creates the desired panel and automatically starts the HMI device wizard for Panel KTP700 Basic. This supports you in specifying some basic settings and functions for the panel.

→ You are first prompted for the PLC connections. Select your previously configured CPU 1214C as the communication partner.

Browse 💌	
Name	CPU type
None	
CPU_1214C	CPU 1214C

 $\rightarrow$  In order to connect your panel to the CPU, select the "PROFINET(X1)" interface.

HMI Device Wizard: KTP700	) Basic PN		×
	PLC connections Configure	the PLC connection(s).	
PLC connections Screen layout Alarms Screens System screens Buttons	Panel KTP700 Basic KTP700 Basic+ PN	Communication driver: SIMATIC S7 1200 Interface: PROFINET (X1)	CPU_1214C CPU 1214C DC/DC/DC Browse
Save settings		«Back Next »	<u>E</u> inish <u>C</u> ancel

 $\rightarrow$  Confirm your selection by clicking on "

→ You can change the default background color of your panel under "Screen layout".
 → Select the I "Header", I "Date/time" and I "Logo" check boxes. → Confirm your selection by clicking on "

	Screen layout Select the screen objects to	o be displayed.
PLC connections		
Screen layout Alarms Screens System screens	Screen Resolution 800 x 480 pixe • Background color •	Preview
Buttons	Date/time     Date/time     Logo	
Save settings		Next >> Finish Cancel

→ In the "Alarms" section, you can specify which of the alarms are to be displayed in a window. Select all three alarm types  $\boxed{} \boxed{} \boxed{} \boxed{} \rightarrow$  Confirm your selection by clicking on

PLC connections Screen layout Alarms Screens System screens Buttons	<ul> <li>Alarms</li> <li>Unacknowledged alarms</li> <li>Pending alarms</li> <li>Active system events</li> </ul>	Preview With and a set of the se

Next >>

→ In the "Screen navigation" section, the screen structure is displayed with the screen name of the last created project, starting with the root screen on the far left.

 $\rightarrow$  A new name can be assigned simply by clicking on a screen name.  $\rightarrow$  If you click on |+| you can insert new screens in the hierarchy  $\rightarrow$  and delete selected screens by clicking on "



	- + 🗌
+ 🔒	Screen0
Overview	
Sorting Station	- ± 🛄
	Screen1

→ Use this approach to create the screen structure shown below with the corresponding screen names. → Confirm your selection by clicking on " $\square$ ext>>=".

HMI Device Wizard: KTP70	O Basic PN	×
	Screen navigation Add new screens by clicking this button: +	
	📑 Add screen 💂 Delete screen 📝 Rename 🗖 Delete all screens	
PLC connections	9	
Screen layout	<u>ې</u>	
Alarms	9	
Screens (	•	
System screens		
Buttons	Speed Motor	
	Overview Sorting Station	
	Magazine Plastic	
	Flasuc	
Save settings	<< <u>B</u> ack <u>Next</u> <u>F</u> inish	<u>C</u> ancel

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→ In the System screens section, you can select previously preset views for system functions and have them automatically added. → Select all system screens by clicking  $\blacksquare$  "Select all".

HMI Device Wizard: KTP70	System screens	Select the system screens.	×
PLC connections Screen layout	9	- <b>v</b>	SIMATIC PLC System diagnostics view
Alarms	0 0	- V <b>b</b> i	Project information
System screens Buttons	Overview Sorting Station	System screens	User administration
		<u>-</u>	System information
			<ul> <li>Operating modes</li> <li>Language switching</li> <li>Stop Runtime</li> </ul>
	Select all		
Save settings		<< <u>B</u> ack Next >>	<u>Einish</u> <u>C</u> ancel

 $\rightarrow$  Confirm your selection by clicking on "

→ In the System buttons section, you will find four user-selectable buttons for Exit (Runtime), Log on (Runtime), Language 
System buttons	
Exit Log on Language Start Closes runtime. screen	
	Button area
	Button area

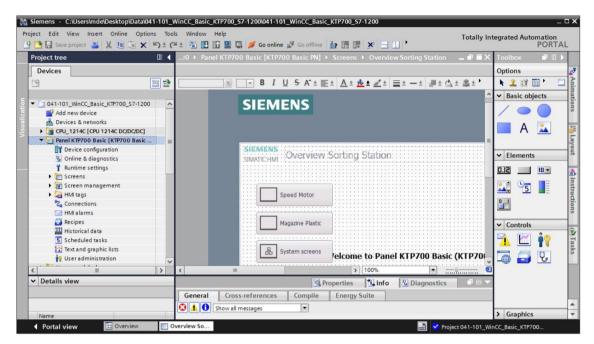
→ Select only the "Button area" I Bottom". → Insert the button for the "Root screen" on the left and the button for "Exit" Runtime on the right. → Confirm your selection by clicking on "<u>Einish</u>".

HMI Device Wizard: KTP700 B	Jasic PN	×
	Buttons Add buttons with drag-and-	drop or by clicking on available system buttons.
PLC connections		
Screen layout 🥥	System buttons	Preview
Alarms 🥥	φD φD	Sectors and Sectors
Screens 🥥	Log on Language	No. Time Date
System screens 🥥		
Buttons 🥚		
		Button area
		🗌 Left 🛛 🖌 Bottom 📄 Right
		Reset all
Save settings	<< <u>B</u> ack	Next >>> Einish Cancel

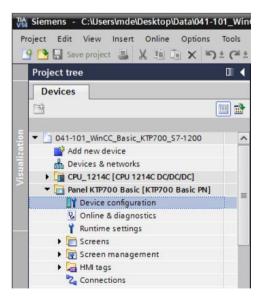
12

# 7.4 Device configuration of Panel KTP700 Basic

→ The TIA Portal now automatically changes to the Project view and displays the root screen of the visualization.



→ To configure the panel, select "Panel KTP700 Basic" in the project tree and open its "Device configuration" with a double-click.



#### 7.4.1 Setting the IP address

- $\rightarrow$  Select the Ethernet interface of the panel in the Device view with a double-click.
- → Under "General" in → "Properties", open menu item → "PROFINET interface [X1]" and select in the → "Ethernet addresses" entry.
- $\rightarrow$  Set the IP address "192.168.0.10" under IP protocol.

041-101_WinCC_Basic_KTP7	00_\$7-1200   Panel KTP700	Basic [KTP700 Basic	PN] _ 🖬 🖬 🗙
	🚽 Topolog	y view 🔒 Netwo	rk view
Panel KTP700 Basic [KTP700	• • • • • • • • • • • • • • • • • • • •	Ł	Device overview
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			HMI_RT_1
			-
12			
			▼ Panel KTP70
			PROFINE
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Panel KTP700 Basic.IE_CP_1	[PROFINET Interface]	erties Linfo	🕑 Diagnostics 🛛 🗖 🗖 🤝 🤝
General IO tags S	ystem constants Texts		
General	Ethemet addresses		^
PROFINET Interface [X1]			
General Ethernet addresses	Interface networked with		
Advanced options	Subnet	PN/IE_1	
		Add new subn	et
4	IP protocol		
		Set IP address in the set of t	ne project
		IP address:	192.168.0.10
		Subnet mask:	255 . 255 . 255 . 0
		Use router	
		Router address:	0.0.0.0
		O IP address is set di	rectly at the device 🗸

**Note:** The subnet mask was already set in the settings of the CPU 1214C and is automatically applied by the panel.

ightarrow To obtain an overview of the assigned addresses within a project, you can click the

 $\rightarrow$  " $\clubsuit$ " button in the  $\rightarrow$  "Network view". If you click on  $\rightarrow$   $\clubsuit$  Connections here, the "HMI connection" between the CPU and panel that was created previously in the wizard is displayed.

041-101_W	inCC_Basic_KTP	700_\$7-1200 → De	vices & networks	. <b>-</b>	
		Topology view	h Network view	Device v	/iew
Network	Connections	HMI connection	💌 🖭 🛄	🔍 ± 🚦	4
CPU_1214C CPU 1214C PN/IE_1: 1		Р Л/ Е_	Panel KTP700 B KTP700 Basic PN PN/IE_1: 192.168.0.	10	
< 111		> 100	%		~

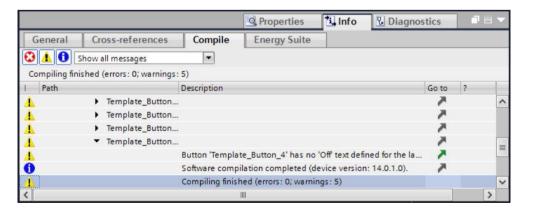
# 7.5 Compiling the CPU and panel and saving the project

→ To compile the CPU, click on the "CPU\_1214C" folder, and select the button for compiling in the menu. To compile the panel, click on the "Panel KTP700 Basic" folder, and select the button for compiling in the menu. You can save your project by clicking on the save project button in the menu.

 $(\rightarrow CPU_1214C \rightarrow \square \rightarrow Panel KTP700 Basic \rightarrow \square \rightarrow \square Save project).$ 

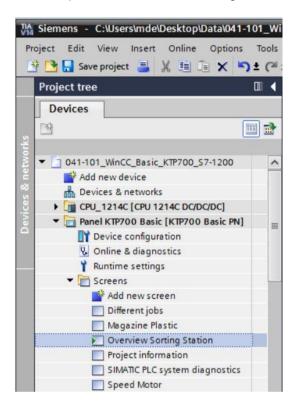
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oject tree Save project		041-101_Wi	nCC_Basic_KTP700_S	7-1200 ▶ De	vices & networks	(		_ # =×	Hardware	• •
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User administration			isned (errors: 0; warnings							
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Common data		<u>+</u>	Template_Button				5	^		
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Name		N			10.0			/	- Informatic	

→ In the "Info" area under "Compile", it is then shown whether the compilation was successful or whether warnings or errors occurred.



## 7.6 Configuring the Graphic view

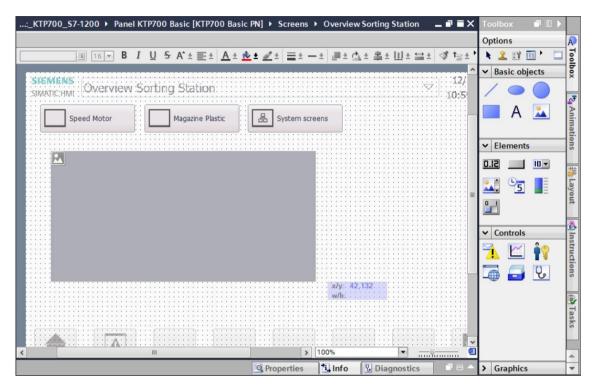
→ After successful compilation, you want to design the first screen for the visualization. To do this, open the → "Overview Sorting Station" screen with a double-click:



→ Several objects, such as the screen change buttons, have already been created by the wizard. The text box in the center of the screen is to be removed by right-clicking on it and selecting → "Delete" in the displayed dialog.

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	Paste     Copy to excel format     Create faceplate     Order     Group     Animations	Ctrl+V Del	96				

→ Select → "Graphic view" in the mouse pointer changes in such a way that it can now be used to draw an area for the display of a graphic in the work window.



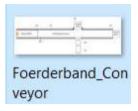
→ You can double-click on the area of the Graphic view to have its properties displayed. In subitem → "General", select → the symbol for  $\rightarrow \boxed{2}$  "Create new graphic from file".

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Note: There are four sub-items for the properties of objects.

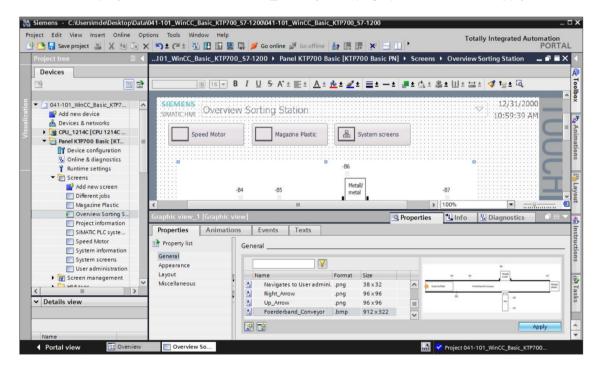
- Properties for static settings of the object
- Animation for dynamic settings of the object
- Events when actions are to be triggered from an object
- Texts for multilingual display within an object

→ In the displayed dialog, select the "Foerderband\_Conveyor.bmp" file from the "SCE\_EN\_041-101\_Screens" folder and click  $\rightarrow$  "Open".



**Note:** You can draw the graphics used in this document yourself and save them in \*.bmp format or download them from the Internet at <u>www.siemens.com/sce/S7-1200</u> in module "SCE\_EN\_041-101 WinCC Basic with KTP700 and S7-1200" under "SCE\_EN\_041-101\_Screens".

 $\rightarrow$  For the display, select the "Foerderband\_Conveyor.bmp" graphic and click  $\rightarrow$  "Apply".



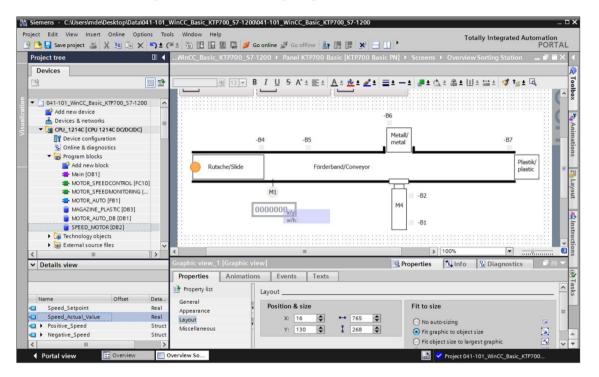
**Note:** The created graphic is stored in the project in the "Languages & resources" path under "Graphic collection".

→ Use the mouse to position the graphic in such a way that the positions and sizes indicated below are entered → under "Layout" in → Properties. The → "Fit graphic to object size" option can be used for adjusting the size.

041-101_WinCC_Basic_I	CTP700_S7-1200 ▶ Panel KTP700 Ba	sic [KTP700 Basic P	N] • Screens • Overview	Sorting Station	_ 7 5	×
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## 7.7 Displaying a process value in an IO field

→ First, insert a display of the actual value of the current speed below the conveyor motor. For this, select → "Program blocks" and the → "SPEED\_MOTOR[DB2]" data block of → "CPU\_1214C". Next, move the → "Speed\_Actual\_Value" tag from the → Details view to the "Overview Sorting Station" screen using drag & drop.



→ The connection to the tag in the PLC is already created in "Properties" of the IO field under "General" and "Process". The "Display format" is correctly set to "Decimal". Only the "Format pattern" and the "Type" of the field are changed here to → "s999.99" and → "Output", respectively.

		+000.00			M4			
<			<u></u> MU		>	100%	•	(
I/O field_1 [I/O f	ield]				<b>Properties</b>	🗓 Info 🛛 🖳 Dia	gnostics	
Properties Property list General	Animations	eral	Texts		_			
Appearance Characteristics Layout	Pr	rocess Tag:		DR_Speed_Actual_Value		rmat Display format:		•
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Miscellaneous Security	- Tj	ype Mode:				Format pattern:		•
			Input Input/output Output					

**Note:** The format pattern s999.99 means that the IO field is displayed with three places before decimal, two places after the decimal and a sign.

 $\rightarrow$  The "Color" of "Background" is changed to  $\rightarrow$  "Blue" under "Appearance" in "Properties".

I/O field_1 [I/O f	ield]		P	roperties 🚺	Info	Diagnostics	
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Property list	Appeara	ince					
General Appearance	Back	ground		Border			
Characteristics		Color:	49, 101, 255 💌		Width:	4	
Layout Text format		Fill pattern:			Style:	Double line	-
Limits		Corner radius :			Color:	66, 73, 82 💌	]
Styles/Designs				Backgro	und color:	99, 101, 115 💌	
Miscellaneous	Text						
Security	<b>!</b>	Color:					
		Unit:	More colors				

 $\rightarrow$  Under "Text format" in "Properties", change "Alignment" "Horizontal" to  $\rightarrow$  "Right".

I/O field_1 [I/O fi	ield]			<b>Properties</b>	1. Info	Diagnostics		
Properties	Animations	Events	Texts					
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Characteristics			Font:	Tahoma, 17px				
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Miscellaneous		Hor	rizontal:	Right				
Security	•		/ertical:					•

 $\rightarrow$  Under "Layout" in "Properties", you change  $\rightarrow$  "Position & size" as illustrated here so that the IO field is displayed below the conveyor motor.

I/O field_1 [I/O f	ield]			<b>Properties</b>	i Info	<b>U</b> Diagnostics		
Properties	Animations	Events	Texts					
Property list	Layout							
General	Desit	ion & size			Margins			
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Security	•							

→ For the description, you insert a → "Text field" A from → "Basic objects" of Toolbox after the IO field using drag & drop. Type in the texts → "Speed actual value" and → "rpm".

			Options	3
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Rutsche/Slide	Förderbar	id/Conveyor		Text field
			Elen	nents
	M1	-B2	51.0	<b>□ □</b>
Speed actual value	ue	M4		5
	+000.00			2

→ Select the three objects → IO field → text field "Speed actual value" → text field "rpm" in this order and click on the → "Align selected objects on top" I function in the toolbar of the work area. Save your project by clicking on Save project.

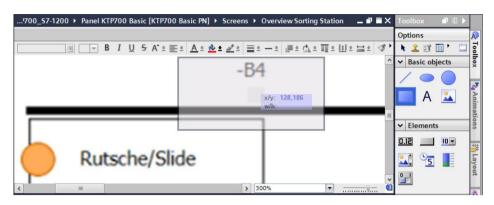
.?700_\$7-1200   Panel KTP7	00 Basic [KTP700 Basic PN] → Screens	5 > Overview Sorting Station 🛛 🗕 🖬 🗮 🗙	Toolbox III
Fahoma 🔳 💌 B	I <u>U</u> ⊱ A <sup>*</sup> ±≣± <u>A</u> ± <u>&amp;</u> ± <u>∠</u> ±	≝±−±∥±⊈±≪' ≇щ÷₩⊑	Basic objects
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	M1		Elements
Speed actual value	+000.00	M4 -81	
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# 7.8 Visualizing binary signals with animated rectangles/lines

→ For visualization of the sensors, start with sensor "-B4" at the slide. To enable you to better draw and position the rectangle, change the zoom factor to  $\rightarrow$  "300%".



 $\rightarrow$  Then, use drag & drop to move a "Rectangle" from  $\rightarrow$  "Basic objects" of Toolbox to the position of sensor "-B4".



→ Next, use the mouse to change the rectangle to the appropriate position and size or set the → "Position & size" under "Layout" in "Properties" as shown here. As a result the sensor is displayed below the "-B4" label.

?700_\$7-1200	▶ Pane	КТР70	0 Basic	[KTP70	0 Basic I	PN] 🕨	Scree	ns 🕨	Over	view	Sort	ing S	Statio	on	- 1	×∎۱
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→ Under "Appearance" in "Properties", change the "Color" of "Background" to  $\rightarrow$  "Gray" and the "Width" of "Border" to  $\rightarrow$  "0".

Rectangle_1 [Re	ctangle]			Richard Properties	🗓 Info 👔 🖫 Diagnostics 📃		
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Property list	Appearance	e					
Appearance	Backgro	und			Border		
Layout	backgro	unu			border		
Styles/Designs			Color:	198, 195, 198 🔻		Width: 0	•
Miscellaneous	<u>+</u>	F	ill pattern:	Solid 💌		Style:	Solid
					-	Color:	24, 28, 49
	•					Color:	24, 28, 4

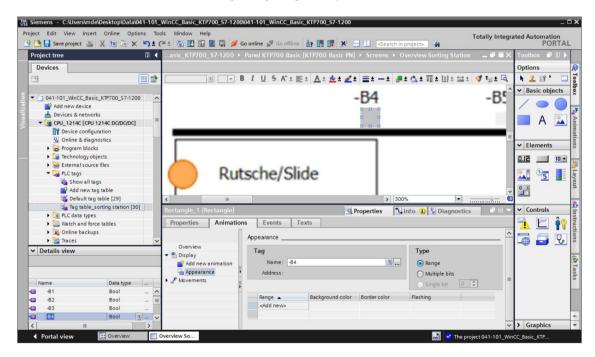
 $\rightarrow$  Now switch to the "Animations" tab, select "Display" and click  $\rightarrow \vec{l}$  "Add new animation".

Properties	Animations	Events	Texts		
	An	imation types			
Overview		Display			
Add new	animation	Appearan Visibility	ce		Dynamize colors and flashing Make visibility dynamic

 $\rightarrow$  In the displayed dialog, select  $\rightarrow$  "Appearance" and click  $\rightarrow$  "OK".



→ To establish the connection to the global tag in the CPU, select → "PLC tags" and → "Tag table\_sorting station" below → "CPU\_1214C". Next, move the → "-B4" tag from the Details view to the "Name" field for the tag using drag & drop.



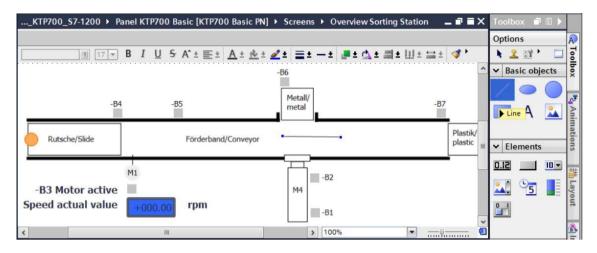
→ Under "Appearance" in "Display", add a range with value → "1" (signal state "High") and change the "Background color" to  $\rightarrow$  "Green".

Rectangle_1 [Rectangle]				🔍 Pro	perties	🛄 Info (	i) 🕄 Diagno	stics	
Properties	Animations	Events	Texts						
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		Range A 1 <add new=""></add>		round color 1 255, 0 •	24, 28, 49		hing		

- → Next, use the steps shown previously to create a display for sensors → "-B1", → "-B2", → "-B5", → "-B6" and → "-B7".
- → Insert an additional binary display below motor M1 and connect it to the global tag  $\rightarrow$  "-B3". For the description, insert a text field  $\rightarrow$  "-B3 Motor active" in front.

KTP700_\$7-1200 > Pa	nel KTP700 Basic [KTP7	00 Basic PN] 🕨 Screens	Overview Sorting Station	_ <b>=</b> = ×
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		-B6		^
-B4	-B5	Metall/ metal		-B7
Rutsche/Slide	Förderba	nd/Conveyor		Plastik/
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			-B2	
-B3 Motor active Speed actual value		M4		
Speeu actual value	+000.00 rpm		-B1	1
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Properties Animati	ons Events Tex			1
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Movements	Address:		O Multiple bits	
	-		Congressie L	
	Range 🔺	Background color Border	color Flashing	
	<add new=""></add>	0,235,0	, 20, 49 VIII	
				~

→ In order to display that the conveyor is being controlled, drag the "Line" object from → "Basic objects" of Toolbox onto the conveyor.



→ Under "Appearance" in "Properties", change "Style" of the line to  $\rightarrow$  "Solid" and "Color" of "Foreground" to  $\rightarrow$  "Green". Change the "Line ends" at "Start" and "End" to "Arrow".

asic_KTP700_S7-	1200 › Panel KTP700 Basic [KTP700 B	lasic PN] + Screens	Overview Sorting St	tation 🔔 🖬 🗮 🗙
	17 ▼ B I U S A*± ± A± 1	<u>&amp; ± <b>∠</b> ±</u> ≡ ± − ±	.■± ☆± 릐± Ш±	🔛 ± 🖪 ᡟ 🚽 🗔
		-B6		· · ·
	-B4 -B5	Metall/		-B7
	-04 -03	metal		-07
				Plastik/
Rutsche/Slide	Förderband/Convey	or		plastic
<	111	>	100%	·····
Line_1 [Line]		Roperties	🗓 Info 追 📱 Diagn	ostics 🔲 🗆 🗖 🗖 🤍
Properties A	nimations Events Texts			
Property list	Appearance			
Appearance	Line	Line e	ends	
Layout Styles/Designs			_	
Miscellaneous	Width: 6		Start:	Arrow
	Style: Solid	-	End:	Arrow
	Color: 0, 255, 0		Line end shape:	Flush 💌
	Background color: 255, 255, 25	5		
· · · · · · · · · · · · · · · · · · ·	Fill style: Transparent			

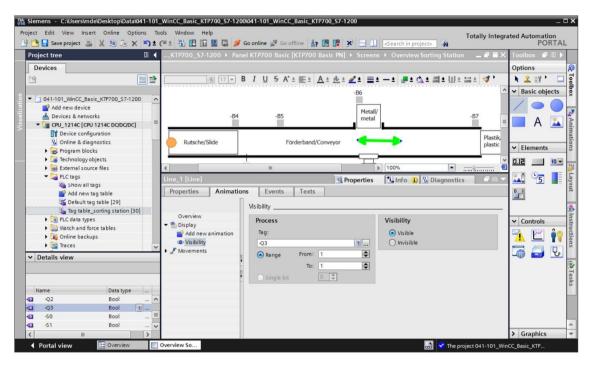
 $\rightarrow$  Now switch to the "Animations" tab, select "Display" and click  $\rightarrow$  **\mathbf{i}** "Add new animation".

Line_1 [Line]			0	<b>Properties</b>	🔄 Info (	i) 🗓 Diagnostics		
Properties	Animations	Events	Texts					
	An	imation type:	5					
Overview		Display						
	Add new animation		nce	-	» Dynamize	colors and flas	hina	
► J Movements	in the second	• Visibility		-		pility dynamic		

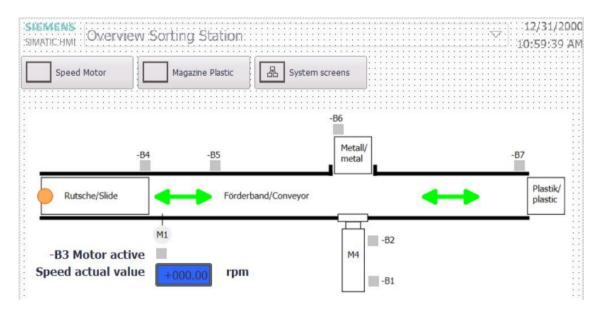
 $\rightarrow$  In the displayed dialog, select  $\rightarrow$  "Visibility" and click  $\rightarrow$  "OK".

Add animation	×
Select the animation you want to add.	
Appearance Visibility	
	OK Cancel

→ To establish the connection to the global tag in the CPU, select → "PLC tags" and → "Tag table\_sorting station" below → "CPU\_1214C". Next, drag the → "-Q3" tag from the Details view to the "Tag" field. In addition for the type of evaluation, select → "Range", enter "From" → 1 "To" → 1 and select → "Visible" for "Visibility".



→ Copy the arrow from the symbol library with all its properties using  $\rightarrow$  <sup>1</sup> "Copy" and <sup>1</sup> "Paste".



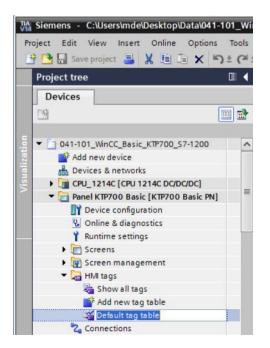
## 7.9 Connections and HMI tags

→ Before you download the configuration to the Panel KTP700 Basic, you should check the connection to the CPU 1214C. To do this, double-click → "Connections" in → "Panel KTP700 Basic". In the displayed view, you can check the IP addresses and connection settings again. It is also important that the I Online check box is selected for the connection.

VA Siemens - C:\Users\mde\Desktop\Data\041-101_V	WinCC_Basic_KTP700_S7-1	200\041-101_WinCC_Ba	sic_KTP700_\$7-1200					-	ΠX
Project Edit View Insert Online Options Tool		🍠 Go online 📓 Go offlin		Search in project> ] 🕌		Totally Int	egrated Au	tomation PORTA	L
Project tree 🔲 🖣	041-101_WinCC_Basic_			lasic PN] → Connecti				_ # # ×	
Devices									i,
E E E E E E E E E E E E E E E E E E E	A Connections to S7 PLCs	in Devices & Networks						8	Tasks
	Connections								ks
• 041-101_WinCC_Basic_KTP700_S7-1200	Name	Communication driver	HMI time synchronization mode	Station	Partner	Node	Online	Comment	100
Add new device	HML_Connection_1	SIMATIC S7 1200	None	<ul> <li>\$7-1200 station_1</li> </ul>	CPU_1214C	CPU 1214C DC/DC/			12
Devices & networks	<add new=""></add>								Librarie
CPU_1214C [CPU 1214C DC/DC/DC]     Panel KTP700 Basic [KTP700 Basic									rie
Device configuration									~
V. Online & diagnostics	<							>	
Y Runtime settings	Parameter Area	pointer		and herein					
Screens	Parameter Area	pointer							4
Screen management	KTP700 Basic PN							ation	
HMI tags							St	ation	
Connections	Interfac								
Recipes	PROFIN	IET (X1)							
Details view	1								
• Details view	HMI device				PLC				
	Address E					Address [		0 1	
							192 . 100 .	0 . 1	
Name	Access point:	TONLINE				Access password:	5		
HMI_Connection_1									
					<b>Properties</b>	🚺 Info 🚺 🗓 Dia	agnostics		1
✓ Portal view 2 Overview 2 G	onnections					The project 041-101.	WinCC Basic	KTP	

**Note:** If access protection has been enabled for the CPU 1214C, the access password can also be entered for the panel here.

→ To go to the HMI tags, you must double-click the → "Default tag table" in the → "HMI tags" folder below → "Panel KTP700 Basic". All tags that were created with drag & drop have been entered here.



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 $\rightarrow$  In the default tag table, you can check which tags are being accessed in the CPU 1214C. You can also make other settings.

The "Acquisition cycle" of the tags is to be accelerated from 1 second to 100 milliseconds. For this, click on the  $\rightarrow$  selection field and double-click a new acquisition cycle  $\rightarrow$  "100 ms" to select it.

Def	ault tag table										
N	lame 🔺	Data type	Connection	PLC name	PLC tag	Ad	dress Access mode	Ac	quisition cycle Sou	rce comment	
•	-81	Bool	HMI_Connecti	CPU_1214C	"-B1"	1222	symbolic acce	. 🔻 1 s	1 sen	sor cylinder -M4 retrac	ted (no)
	-82	Bool	HMI_Connection_1	CPU_1214C	*-B2*			-			
	-83	Bool	HMI_Connection_1	CPU_1214C	*-B3*		el KTP700 Basic [KT				
01	-84	Bool	HMI_Connection_1	CPU_1214C	*-B4*	¢.	lycles	N	ame	Cycle time	Cycle unit
01	-85	Bool	HMI_Connection_1	CPU_1214C	*-B5*				None		
01	-86	Bool	HMI_Connection_1	CPU_1214C	*-B6*			C	100 ms	100	Millisecon
01	-87	Bool	HMI_Connection_1	CPU_1214C	*-B7*			Ċ	500 ms	500	Millisecor
01	-Q3	Bool	HM_Connection_1	CPU_1214C	*-Q3*			e	1 s	1	Second
01	SPEED_MOTOR_Speed_Actual	Real	HMI_Connection_1	CPU_1214C	SPEED_N			.e	25	2	Second
	Tag_ScreenNumber	UInt	<internal tag=""></internal>		<undefin< td=""><td></td><td></td><td>è</td><td>5 s</td><td>5</td><td>Second</td></undefin<>			è	5 s	5	Second
<	Add new>							1 ch	10 s	10	Second
								è	1 min	1	Minute
								è	5 min	5	Minute
								e	10 min	10	Minute
								e b	1 h	1	Hour

→ You can make the settings of other tags using the "Auto complete" function by selecting the bottom right corner of the first entry with the mouse and dragging over the other entries.

100 ms	■	
1 s	1	
1 s		
1 s		
1 s		
1 s		
1 s		
1 s		
1 s		

Autocom	plete	×
?	What do you want to do?	
	<ul> <li>Overwrite Tag attributes</li> </ul>	
	O Insert new Tags	
		OK Cancel

Acquisition cycle							
100 ms							
100 ms							
100 ms							
100 ms							
100 ms							
100 ms							

# 7.10 Downloading the CPU and panel

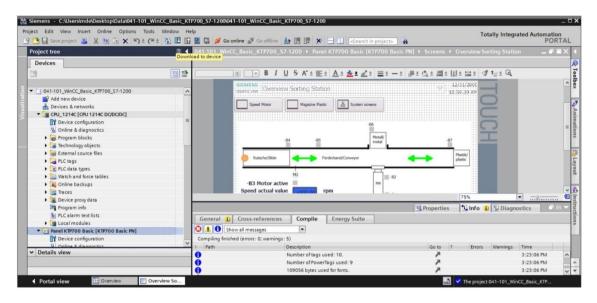
→ Before the project is downloaded to the CPU and the panel, compile the CPU and panel again and save the project.

$(\rightarrow \text{CPU}\_1214\text{C} \rightarrow \square \rightarrow \text{Panel KTP700 Basic} -$	→ 🛅 →		Save project	)
-----------------------------------------------------------------------------------------------------	-------	--	--------------	---

→ After successful compilation, the entire controller with the created program including the hardware configuration, as previously described in earlier modules, can be downloaded.
(→ III)

ect Edit View Insert Online Options Too		💋 Go online 🖉 Go offline 🛔 🖪 🕼 🗶 🖃 🛄 <earch in="" projects="" th="" 🕌<=""><th>Totally Integrated Automation PORTAL</th></earch>	Totally Integrated Automation PORTAL
Project tree	Download to devi	WinCC_Basic_KTP700_S7-1200    Panel KTP700 Basic [KTP700 Basic PN]    Screens	Overview Sorting Station 📃 🖬 🗮 🗙
Devices			
3		a - B I U S A*± ≝± A± ± 2± ≡± −± #± 5± =±	비소 달 호
		SIGMEN	12/31/2000
041-101_WinCC_Basic_KTP700_57-1200	^	SIGNERS Overview Sorting Station	
Add new device			
📥 Devices & networks		Speed Motor Magazive Pastic C System screens	
CPU_1214C [CPU 1214C DC/DC/DC]			
Device configuration	12	-N	0
Online & diagnostics			
Program blocks		Ba as Metall/	
Technology objects		-84 -85 metal -87	
External source files			Plastk/
PLC tags		Rutsche/Slide	plastic
Cel PLC data types			
Watch and force tables		M1 = -62	
Conline backups		-B3 Motor active 14	
Fraces		Speed actual value +000.00 rpm -81	
Device proxy data			· · · · · · · · · · · · · · · · · · ·
Program info			75% 💌 🗐
PLC alarm text lists		Q Properties	🚺 Info 🚯 🖏 Diagnostics 📰 🖃 🗸 🗸
Local modules			Same S S Diagnostics
Panel KTP700 Basic [KTP700 Basic PN]	Gene	ral 1) Cross-references Compile Energy Suite	
Device configuration	L 🖸 🔺	1 Show all messages	
Q Online & diagnostics	Y Compil	ing finished (errors: 0; warnings: 5)	
Details view	I Pati		P Errors Warnings Time
Module	0	Number of tags used: 10.	3:23:06 PM
	ŏ	Number of PowerTags used: 9	3:23:06 PM
	ŏ	109056 bytes used for fonts.	3:23:06 PM

→ To download the visualization to the panel, follow the same procedure. Select the → "Panel KTP700 Basic [KTP700 Basic PN]" folder and click the → "Download to device" button.



- → The manager for configuration of connection properties (Extended download) opens. First, the interface must be correctly selected. This is done in three steps:
- $\rightarrow$  Type of the PG/PC interface  $\rightarrow$  PN/IE
- → PG/PC interface → here, e.g. Intel(R) Ethernet Connection I219-LM
- $\rightarrow$  Connection to interface/subnet  $\rightarrow$  "PN/IE\_1"

The field  $\rightarrow$  "Show all compatible devices" must be selected and the search for devices in the network must be started by clicking the  $\rightarrow$  [Start search] button.

	Device	Device type	Slot	Туре	Address	Subnet		
	Panel KTP700 Basic.IE	PROFINET Interface	5 X1	PN/IE	192.168.0.10	PN/IE_1		
	Ţ	ype of the PG/PC inter	face:	PN/IE				
		PG/PC inter	face:	Intel(R) Ethernet Connection (4) I219-LM				
	Conne	ection to interface/su	bnet:	Direct at s	•			
		1st gate	eway:			*		
	Select target device:				Show all compatib	le devices		
	Device	Device type	Inter	ace type	Address	14		
		Device type —	Inter PN/IE	ace type	Address Access address	Target device —		
					a second s	Target devic		
n LED					a second s	Target devic		

 $(\rightarrow \text{Device type SIMATIC HMI} \rightarrow "$ 

Load

→ If your panel is displayed in the "Compatible devices in target subnet" list, it must be selected and the download must be started.

")

Load

	Device	Device type	Slot	Туре	Address	Subnet
	Panel KTP700 Basic.IE	PROFINET Interface	5 X1	PN/IE	192.168.0.10	PN/IE_1
	Ţ	ype of the PG/PC inter PG/PC inter		PN/IE	Ethernet Connection (4) I2	▼ 219-LM
	Conne	ection to interface/sul		Direct at s		
	Conne	1st gate		Directars		*
				<u>t.</u>		
	Select target device:				Show all compatib	la devices
	Device	Device time	Interi	ace type	Address	Target device
	hmi_1	Device type SIMATIC-HMI	PN/IE		192,168,0,10	
a a a a a a a a a a a a a a a a a a a	-		PN/IE		Access address	
-						
Flash LED						
	•					Start se
						Start se
ne status informatio					Display only erro	r messages
the second se	hed to the device with add					
		ressible devices fou	nd.			
Connection establis Scan completed. 1 Retrieving device in						

 $\rightarrow$  You first receive a preview. Confirm the prompt  $\rightarrow$  "Overwrite all" and continue with  $\rightarrow$ 

Status	1	Target	Message	Action							
+0	0	▼ Panel KTP700 Basic	Ready for loading.								
	0	Overwrite	Overwrite if object exists online?	🗹 Overwrite all							
	0	Fit	Components with a different version are installed on the target de	🗹 Fit							
	0	HMI Runtime	Informations								
<			11								

**Note:** In the "Load preview", you should see the Symbol in each line, in which actions will be performed. You will see additional information in the "Message" column.

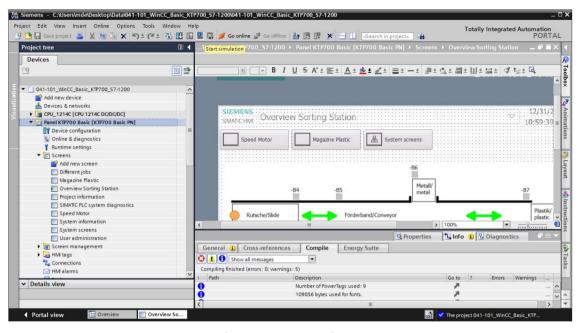
# 7.11 Testing the process visualization in the simulation

So that a connection can be established between the Runtime Simulation on the PG/PC and the S7-1200 CPU, the PG/PC interface must first be set to TCP/IP.

No.	Procedure:
1	<ul> <li>Open the Control Panel</li> <li>Using "Start &gt; Control Panel"</li> <li>Or using "Start &gt; Settings &gt; Control Panel" (in the classical start menu as in earlier Windows versions)</li> </ul>
2	Double-click the "Set PG/PC interface" icon in the Control Panel.
3	<ul> <li>On the "Access Path" tab, set the following parameters:</li> <li>1. For "Access Point of the Application", select S7ONLINE (STEP 7).</li> <li>2. From the "Interface Parameter Assignment Used" list, select the interface "TCP/IP(Auto) -&gt; with your network adapter that is connected directly to the panel and controller, e.g. Intel® Ethernet Connection.</li> <li>3. Click OK and confirm the subsequent prompt with OK.</li> <li>Set PG/PC Interface <ul> <li>Access Path LLDP / DCP PNIO Adapter Info</li> <li>Access Path LLDP / DCP PNIO Adapter Info</li> <li>Access Path LLDP / DCP PNIO Adapter Info</li> <li>(Standard for STEP 7)</li> <li>Intel(R) Ethernet Connection (4) I219-LM.TCPIP.</li> <li>(Standard for STEP 7)</li> <li>Intel(R) Dual Band Wireless-AC 3265.T(</li> <li>(Bintel(R) Dual Band Wireless-AC 2325.T(</li> <li>(Parameter Assignment Used)</li> <li>(Parameter assignent for the IE-PG access to your NDIS CPs with TCP/IP Protocol (RFC-1006)</li> </ul> </li> </ul>
	OK Cancel Help

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 $\rightarrow$  Select "Panel KTP700 Basic" and click the  $\rightarrow$   $\blacksquare$  "Start simulation" button.



ightarrow The process visualization is performed on the PC in its entirety with connection to the

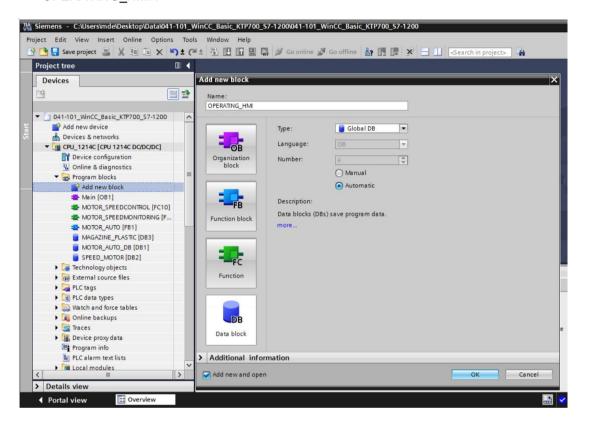
process data in the CPU 1214C. To close the simulation, you can select the  $\rightarrow$  button for "End Runtime" or close the window by clicking on  $\rightarrow$  "

RT Simulator				×
	SIEMENS SIMATIC HI	MI		
	SIEMENS       Overview Sorting Station       6/28/2         SIMATIC HMI       Overview Sorting Station       3:16:15         Speed Motor       Magazine Plastic       Esseet	-	TO	
	-B4 -B5 Metall/ Rutsche/Slide Förderband/Conveyor Plastic/			
	-B3 Motor active Speed actual value			
	F1 F2 F3 F4 F5 F6 F7 F8			
		J		

## 7.12 Switches and buttons for process operation

 $\rightarrow$  To have an interface for process operation available in the PLC, select  $\rightarrow$  "Add new block" in

the "Program blocks" folder below "CPU\_1214C" and create a global data block "OPERATING HMI".



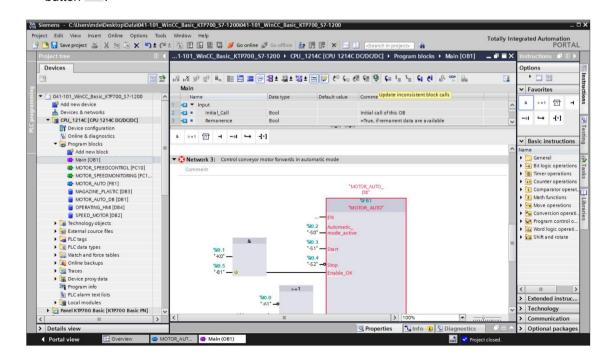
→ In the "OPERATING\_HMI" data block, create four tags of data type Bool: → "mode\_selector",
 → "automatic\_start", → "automatic\_stop" and → "reset\_counter\_plastic". The start value of the "automatic\_stop" is also preassigned with → "true".

04	1-10	01_	WinCC_Basic_KTP700	_\$7-1200	▶ CPU_12	14C [CPU	1214C DC	/DC/DC]	Program	blocks	OPERATING_HMI [DB4] 📃 🖬 🖬 🗙
		1.0			0		-				
			🖌 🛃 🗮 😤 Keep ad ATING HMI	ctual values	Snap:	shot 🔤	Copy s	napshots	to start value	s 🖳 🔛	" Load start values as actual values 📩 📑
		Nan		Data type	Start value	Retain	Accessibl	Writabl	Visible in	Setpoint	Comment
1	-	-	Static								
2	-		mode_selector	Bool	false						HMI mode selector manual(0) / automatic(1)
3	-		automatic_start	Bool	false						HMI pushbutton automatic start
4	-		automatic_stop	Bool	true						HMI pushbutton automatic stop
5	-		reset_counter_plastic	Bool	false						HMI reset counter workpieces plastic

→ The "MOTOR\_AUTO[FB1]" function block is now expanded to include an input tag → "Reset\_Counter\_Workpieces\_Plastic" of type → "Bool". This tag is move onto the → "R" input of the "CTUD" counter in Network 2 using drag & drop.

	041 101	WinCC Basic KTP700 \$7-1200 >			-					(FB1) _ 🗖
	041-101_	MILCE_DasiC_KTP700_37-1200 V	Cr0_12140 [0	-FO 1214C DO	JUGUC] /	riogiai	III DIOCK		N_AUTO	
Devices			ten 🖂 a a						e	0.00
i 🔳	🗄 छि। छि। 🛅	) 🔮 🐛 🖿 🚍 💬 🕾 ± 😂 ±	: 🖀 t 🗐 🎲	€~ 60 €	编 := 会	<b>⊊</b> = =≡	目神	'≡ '≡   III	61 61	0° 0° 00
	MOTO	R_AUTO								
041-101_WinCC_Basic_KTP700_S7-1200	Nar	ne	Data type	Default value	Retain	Accessi	Writa	Visible in	Setpoint	Comment
Add new device	1 📶 🕶	Input								
B Devices & networks	2 🕣 🖷	Automatic_mode_active	Bool	false	Non-ret					Automatic mode activated
CPU_1214C [CPU 1214C DC/DC/DC]	3 🕣 =	Start	Bool	false	Non-ret					Pushbutton automatic start
Device configuration	4 🕣 =	Stop	Bool	false	Non-ret					Pushbutton automatic stop
V. Online & diagnostics	5 🕣 =	Enable_OK	Bool	false	Non-ret					All enable conditions OK
<ul> <li>Program blocks</li> </ul>	_ 6 🕣 =	Safety_shutoff_active	Bool	false	Non-ret					Safety shutoff active e.g. emerger
Add new block	7 🕣 🖷	Sensor_slide	Bool	false	Non-ret					Sensor part at slide
Main [OB1]	8 🕣 =	Sensor_end_of_conveyor	Bool	false	Non-ret					Sensor part at end of conveyor
MOTOR_SPEEDCONTROL [FC10]	9 🕣 🔳	Setpoint_Capacity_Magazine_Plastic	Int	0	Non-ret					Setpoint capacity magazine plast
MOTOR_SPEEDMONITORING [FC1	10 🕣 =	Reset_Counter_Workpieces_Plastic	Bool 3	false	Non 💌					reset counter workpieces plastic
MOTOR_AUTO [FB1]	<				10					
MAGAZINE_PLASTIC [DB3]										
MOTOR_AUTO_DB [DB1]	V Net	work 2: Counter plastic parts								
OPERATING_HMI [DB4]	Comr									
SPEED_MOTOR [DB2]	Com	nent								
Technology objects										
External source files			Counter_ lastic							
PLC tags										
C PLC data types			Int							
Watch and force tables		#IEC_Timer_	m							
Online backups		overrun.Q — 🗱 🛛 CU								
Fraces										
Device proxy data		false — CD								
Program info		#Reset								
PLC alarm text lists		Counter								
Local modules		Workpieces_ Plastic								
Panel KTP700 Basic [KTP700 Basic PN]	×									

→ Next, the call of the "MOTOR\_AUTO[FB1]" function block must be updated in the "Main[OB1]" block. This is done by clicking the → "Update inconsistent block calls" button <sup>1</sup>/<sub>2</sub>.

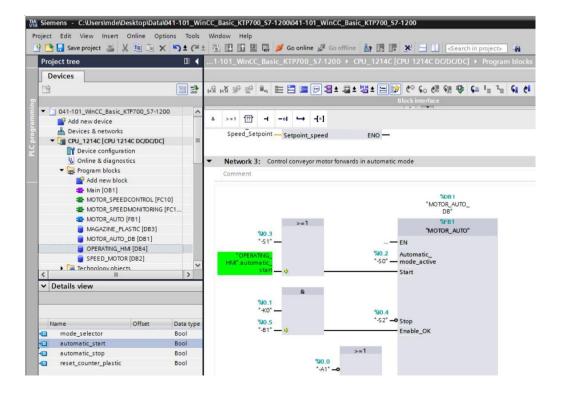


12

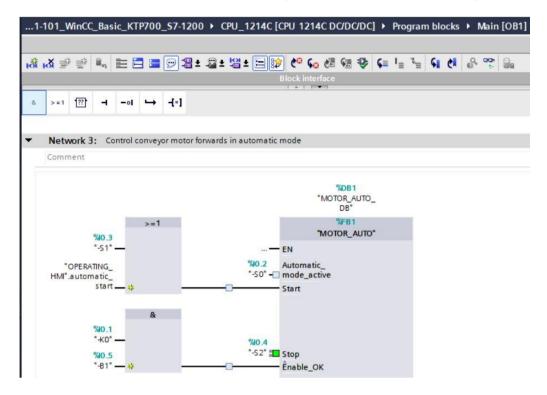
 $\rightarrow$  In Network 3 of the "Main[OB1]" block, drag an  $\rightarrow$  "OR" in front of input tag  $\rightarrow$  "Start".

			<b>1</b>			2	@ - ≪ - ∞	± ⊟ 8₽ (- %0	d≣ 4≣ 4≱ 6≡ 1≡ 1≡ 61 d1 6° 9° 🔒
N	Main	1							
	N	lame					Data type	Default value	Comment
1	•	<ul> <li>Input</li> </ul>							
2 🔫	•	Init	tial_Ca	11			Bool		Initial call of this OB
-	•	Rei	maner	ice			Bool		=True, if remanent data are available
-	-				17	7			
8	> =	1 ???	-	-01	$\rightarrow$	-[=]			
								.,	%DB1 MOTOR_AUTO_
									MOTOR_AUTO_ DB*
									MOTOR_AUTO_
									MOTOR_AUTO_ DB* %FB1
								ייי <del>- ר</del> פא	MOTOR_AUTO_ DB* %FB1 MOTOR_AUTO*
								ייי <del>-</del> בא	MOTOR_AUTO_ DB" %FB1 MOTOR_AUTO"
					&			™	MOTOR_AUTO_ DB" %FB1 MOTOR_AUTO"
			%10.1		&			™ EN %40.2 Automatic_ *-S0* mode_activ %40.3 *-S1* Start	MOTOR_AUTO_ DB" %FB1 MOTOR_AUTO"
			%40.1 *-K0*		å				MOTOR_AUTO_ DB" %FB1 MOTOR_AUTO"
					&			™ EN %40.2 Automatic_ *-S0* mode_activ %40.3 *-S1* Start	MOTOR_AUTO_ DB" %FB1 MOTOR_AUTO"

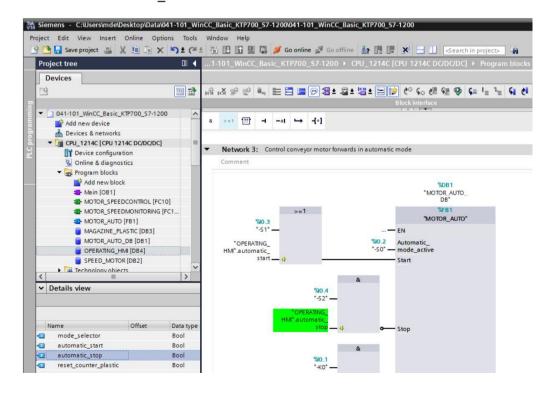
→ The second free input of the → "OR" is connected to the → "automatic\_start" tag from data block "OPERATING\_HMI".



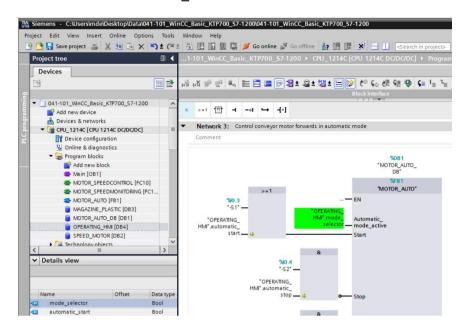
 $\rightarrow$  In Network 3 of the "Main[OB1]" block, drag an  $\rightarrow$  "AND" in front of input tag  $\rightarrow$  "Stop".



→ The second free input of the → "AND" is connected to the → "automatic\_stop" tag from data block "OPERATING HMI".



 $\rightarrow$  The input tag  $\rightarrow$  "Automatic\_mode\_active" is connected to the  $\rightarrow$  "mode\_selector" tag from data block "OPERATING HMI".



→ The input tag → "Reset\_Counter\_Workpieces\_Plastic" is connected to the → "reset\_counter\_plastic" tag from data block "OPERATING\_HMI".

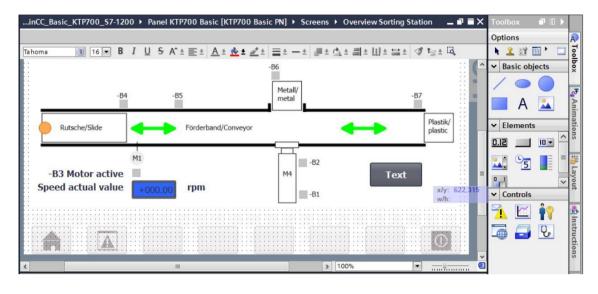
Proi	🔜 Save project 📑 🐰 🛅 🗎 :			1-10	1 WinC		sic KT	P700	\$7-120	)0 ⊁ C	PU 12	214C	CPU 1	214C D0		Progr.	am blocks 🕨
	evices																
1	evices				the the		-		<b>.</b>		ю.	-	<u>a</u> ao	C . 48	Con alle	c- 1- 3	કારાં જ
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- 5	041-101_WinCC_Basic_KTP700_57-12												BIOCK	nterface			
	Add new device	00 ^	8	>	= 1 ??	H.	-01	↔	-(-)								
	Devices & networks				-												
	CPU_1214C [CPU 1214C DC/DC/DC								"-B1" -	- <del>12</del>		_	Enable	e_OK			
	Device configuration									-							
	Q. Online & diagnostics									>	=1						
	Program blocks		1						%0.0								
	Add new block																
	- Main [OB1]						# N	Motor_s	peed_								
	MOTOR_SPEEDCONTROL [F	10]							r_max_	_							
	MOTOR_SPEEDMONITORING	[FC1															
	MOTOR_AUTO [FB1]						- 1		peed_				Safety				
	MAGAZINE_PLASTIC [DB3]								or_min_	- +				f_active			
	MOTOR_AUTO_DB [DB1]																
	OPERATING_HMI [DB4]											41.0					
	SPEED_MOTOR [DB2]										•	-84" -	Senso	r_slide			
<	Technology objects	>									9	41.3	Senso	r_end_			
_	Details view										•	-B7* -	of_cor	iveyor			
													Setpo	int.	0	onveyor_	
_											MAGAZI		Capac	ity_		motor_	
											TC*.Plas		Magaz		au	tomatic_	%Q0.2
N	ame Offset	Data type								Fart	s_setp	ioint _	Plastic			mode -	Q3-
-	mode_selector	Bool											Reset			L_Value_	"MAGAZINE_
-0	automatic_start	Bool									PERATI		Count	er_	M	plastic -	PLASTIC".Plast Parts_Actual
-0	automatic_stop	Bool									HMI".res iter pla		- Plastic	ieces_		ENO -	
-	reset_counter_plastic	Bool														ENU	

 $\rightarrow$  Compile the CPU again and save the project.



 $\rightarrow$  Download the changed program including the hardware configuration to the CPU 1214C.

→ To implement a pushbutton that resets the workpiece counter for the plastic parts, use drag & drop to move the → "Button" object from → "Elements" in Toolbox to the "Overview Sorting Station" screen below the plastic parts storage.



 $\rightarrow$  Under "General" in "Properties", enter  $\rightarrow$  "Reset" for "Label".

Button_1 [Butto	n]	<b>Properties</b>	🗓 Info 🚺 🗓 Diagnostics	
Properties	Animations Events Texts			
Property list	General			^
General	Mode	Label		
Appearance	wode	Laber		
Fill pattern	Text	Tex	t	
Design		Ŭ		=
Layout	Graphic	O Tex	tlist	
Text format	Graphics or text	Text w	hen button is "not pressed"	
Styles/Designs		Reset		
Miscellaneous	Graphics and text			
Security	O Invisible	Tex	t when button is "pressed"	

→ Under "Appearance" in "Properties", change the fill pattern to "Solid" and "Color" of "Background" to → "Blue".

Button_1 [Butto	on]			Rep Prope	erties	🗓 Info 🚺 🖁	Diagnostics	▋▋■▼
Properties	Animations	Events	Texts					
Property list	Appearance							
General Appearance Fill pattern Design Layout Text format	Backgrour	Fill p	attern: Soli	101, 255 💌 d 💌	Bord	Width:	Solid	<b>.</b>
Styles/Designs Miscellaneous Security	Text		Color: 255	, 255, 255 🔻		Background color:	107, 105, 1	07

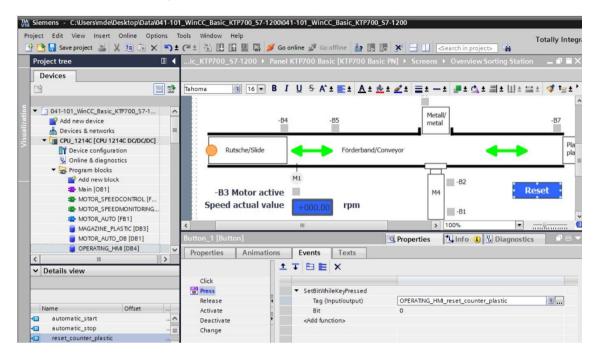
→ The functionality must also be configured as a pushbutton. To do this, go to the "Events" menu, select the  $\rightarrow$  "Press" event and  $\rightarrow$  "<Add function>".

utton_1 [Button	]		<b>Properties</b>	🗓 Info 🔒 🗓 Diagnostics	
Properties	Animations	Events Texts			
Click	1	T BEX			
Press		<add function=""></add>			-
Release	•				
Activate					
Deactivate	-				
Change					
		<			>

 $\rightarrow$  Under "System functions", select "Edit bits" and  $\rightarrow$  "SetBitWhileKeyPressed" as the function.

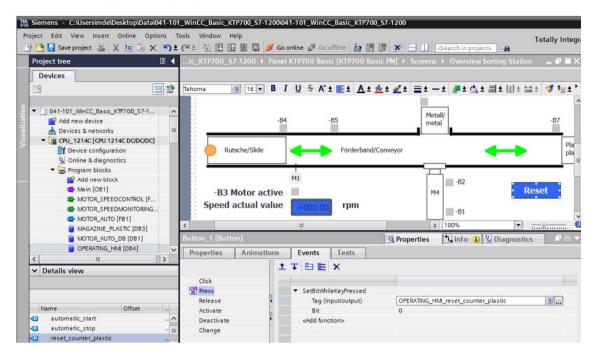
tton_1 [Button]	Properties 1 Info 1 Diagnostic					
Properties Animatio	ns Events Texts					
	1 T BE X					
Click						
Press						
Release		- Contraction of the Contraction				
	▼ System functions	^				
Activate	All system functions					
Deactivate	Alarms					
Change	Calculation script					
	▼ Edit bits					
•	InvertBit					
	InvertBitInTag					
-	ResetBit					
	ResetBitInTag					
	SetBit					
	SetBitInTag					
	SetBitWhileKeyPressed	~				

→ For the process connection, select → "Program blocks" and the → "OPERATING\_HMI[DB4]" data block of → "CPU\_1214C". Next, drag the → "reset\_counter\_plastic" tag from the → Details view to the "Tag (input/output)" field.



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→ As previously shown in the document, insert a text → "Counter workpieces plastic" above the button and a display of the → "actual\_plastic\_parts" tag from the "MAGAZINE\_PLASTIC[DB3]" block to the left of the button.



→ To implement the button, use drag & drop to move the → "Button" object  $\blacksquare$  from → "Elements" in Toolbox to the top next to the buttons for the screen change.

KTP700_\$7-120	0 🕨 Panel KTP700 Basi	: [KTP700 Basic PN] • Screer	ns  ▶ Overview Sorting Station	_∎∎×	Toolbox	
					Options	
Tahoma 🔳	16 ▼ B I U <del>S</del> A	*±≣± <u>A</u> ± <u>&amp;</u> ± <u>⊿</u> ± ≡	キーキ 通さ点を始き出す	≝± ∢'	k 🚨 🖽	bjects
				110 20.00	✓ Basic of	bjects
ed Motor	Magazine Plastic	品 System screens	Text		/ •	
				*/y: 607,63		ts
		-86		: w/h: 116,38	A	
					✓ Element	ts
-B4	-B5	Metall/ metal	-87		51.0	
					S	
Rutsche/Slide	Förderbar	nd/Conveyor		Plastik/		
	roluciour			olastic		
	M1		Counter workpieces	alastic		-
Motor active		-B2				1
actual value	+000 00 rpm	1914	00 Res	et		
<	+000.00 rpm		> 100%	<b>①</b>		

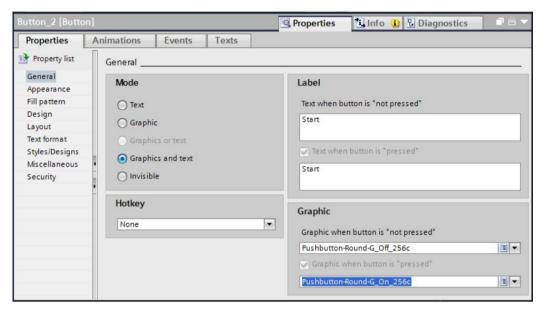
→ Under "General" in "Properties", change "Mode" to  $\rightarrow$  "Graphics and text". Click the symbol to open the selection dialog for the  $\rightarrow$  "Graphic when button is not pressed".

Button_2 [Butto	on]			Reporties	🗓 Info 👔 🎦 Diagnostics			
Properties	Animations	Events	Texts					
📑 Property list	General							
General Appearance Fill pattern Design Layout Text format Styles/Designs Miscellaneous Security		ics or text ics and text		Start	Text when button is "not pressed" Start Text when button is "pressed"			
	Hotkey				en button is "not pressed" when button is "pressed"			

→ Next, click the symbol for "Create graphic from file" and double-click the "Pushbutton-Round-G\_Off\_256c.bmp" file in the "SCE\_EN\_041-101\_Screens" folder in the displayed dialog.

	Name	Format	Size	
A.	NavigateHome_KTP700	.png	71 x 50	^
<b>A</b>	Navigates to Different jo	.png	38 x 32	
	Navigates to Magazine Pl	.png	38 x 32	
<b>A</b>	Navigates to Project info	.png	38 x 32	
<b>A</b>	Navigates to SIMATIC PL	.png	38 x 32	
<b>A</b>	Navigates to Speed Moto	.png	38 x 32	
<b>A</b>	Navigates to System info	.png	38 x 32	=
	Navigates to System scre.	.png	38 x 32	
<b>A</b>	Navigates to User admini.	.png	38 x 32	
	Pushbutton-Round-G_Of	.bmp	504 x 504	
	Right_Arrow	.png	96 x 96	
<b>A</b>	Up_Arrow	.png	96 x 96	
				~

→ Similarly, select the "Pushbutton-Round-G\_On\_256c.bmp" file in the "SCE\_EN\_041-101\_Screens" folder for the "Graphic when button is pressed".



**Note:** The created graphics are stored in the project in the "Languages & resources" path under "Graphic collection".

 $\rightarrow$  Under "Layout" in "Properties", change the size of the button under  $\rightarrow$  "Position & size".

Button_2 [Butto	on]			Q Prope	rties	🗓 Info 追 📱	Diagnostics	
Properties	Animations	Events	Texts	]				
Property list General	Layout	size			Fit to	) size		
Appearance Fill pattern Design	X: 6 Y: 5	and	⊷+ 50 ፤ 50	•	🗌 Fi	t object to contents		20
Layout Text format Styles/Designs Miscellaneous	Fit graphic	Interioral			Text	margins	*** 0 	•
Security	Stretch g					re margins	**** 0	
<	н	orizontal:	entered liddle	•				•

→ The functionality as a pushbutton is implemented again as a → "Press" event with "System function" → "SetBitWhileKeyPressed".

The  $\rightarrow$  "automatic\_start" tag from the  $\rightarrow$  "OPERATING\_HMI[DB4]" data block is used for the process connection.

TIA V14	Siemens - C:\Users\mde\Desktop\Data	041-101_Win	CC_Basic_KTP700_S7-120	00\041-101_WinCC_Basic_KTP7	00_\$7-1200		
	iject Edit View Insert Online Opr C Saveproject 🚉 💥 📺 🔎		and the second	Go online 🖉 Go offline 🛔		Search in projects	Totally Inte
	Project tree	□ ◀	)0_\$7-1200 → Pane				_ = = ×
	Devices						
	13		Tahoma II 16		<u>A ± 🕸 ± 🖉 ±</u>	≡t —t <b>№t ₫t ₩t U</b>	!± \
Visualization	Devices & networks  CPU_1214C[CPU_1214CD0DCDC] CPU_1214C[CPU_1214CD0DCDC] CPU_1214C[CPU_1214CD0DCDC]  POINTE & diagnostics  POINTE & diagnostics  Add new block  Add new block  Add new block  Add Notrol SPECOCNTROL IFC	=	eed Motor	Magazine Plastic	-B6 Metall/	Sar	[U.39:39] =
	<ul> <li>MOTOR_SPEEDUGUNING [PC</li> <li>MOTOR_APPEDUGUNING [PG]</li> <li>MOTOR_AUTO [FB1]</li> <li>MAGAZINE_PLASTIC [DB3]</li> <li>MOTOR_AUTO_DB [DB1]</li> <li>OPERATING_HMI [DB4]</li> </ul>		-B4 Rutsche/Slide	-B5 Förderband/Convey III	yor	-8	Plastik/ plastic v
_	SPEED_MOTOR [DB2]  Technology objects  Details view	~	Button_2 [Button]	nations Events Text	Properties	Info 👔 🖞 Diagnostics	
	Details view		Click	± ∓ ⊟ ≣ ×			_
	Name Offset	Data type	ress	▼ SetBitWhileKeyPre			
	mode_selector	Bool	Release	Tag (Input/out     Bit	put)	OPERATING_HMI_automatic_start	
	automatic_start	Bool	Deactivate	<add function=""></add>		0	-
	automatic_stop	Bool	Change	< Add functions			
1	<pre>mail reset_counter_plastic</pre>	Bool	chunge				

→ Next, a "button" for the Stop pushbutton is inserted, as shown in the last steps. The "Pushbutton-Stop\_Off\_256c.bmp" and "Pushbutton-Stop\_On\_256c" files in the "SCE\_EN\_041-101\_Screens" folder are used as graphics.

Basic_KTP700_	S7-1200   Panel KTP700 Basic [KTP700	Basic PN] → Screens → Overview Sorting Station 🛛 🗕 🖬 🚍	×
Tahoma 🔳 🛛		± ∠± ≡±−± ₽± ₫± ∰± №± ≌± 🛷 №± ⊑ stem screens	- In
<		-B6	•
Button_3 [Button] Properties Property list	nimations Events Texts	🔄 Properties 🚺 Info 👔 💟 Diagnostics 📄 🖃	
General Appearance Fill pattern Design Layout Text format Styles/Designs Miscellaneous Security	General Mode Text Graphic Graphics or text Graphics and text Invisible	Label Text when button is "not pressed" Stop Text when button is "pressed" Stop	
	Hotkey None	Graphic          Graphic when button is *not pressed*         Pushbutton-Stop_Off_256c         ♥ Graphic when button is *pressed*	
		Pushbutton-Stop_On_256c	-

→ The functionality as a "normally closed" pushbutton is implemented here with two events. The first event is the → "Press" event with "System function" → "ResetBit" and the second event is the → "Release" event with "System function" → "SetBit". In both cases, the → "automatic\_stop" tag from the → "OPERATING\_HMI[DB4]" data block is used for the process connection.

	<b>Properties</b>	🗓 Info 🚺 🏆 Diagnostics	<b>-</b>
mations Events To	exts		
±∓⊟≣×			
▼ ResetBit			
Tag (Inputio	output)	OPERATING_HMI_automatic_stop	
<add functions<="" td=""><td>•</td><td></td><td></td></add>	•		
-			
		mations Events Texts	Events     Texts       ⊥     T     E     X       ✓     ResetBit     OPERATING_HMI_automatic_stop

Button_3 [Butt	on]			<b>Properties</b>	🗓 Info 追 🏾 Diagnostics	1
Properties	Animations	Events	Texts			
	1	TBE	×			
Click						
Press		▼ SetBit				
🛗 Release		Tag (I	nputioutput	:)	OPERATING_HMI_automatic_stop	
Activate		<add fun<="" td=""><td>ction&gt;</td><td></td><td></td><td></td></add>	ction>			
Deactivate	-					
Change						
	-					

→ To implement the mode selector, use drag & drop to move the → "Switch" object  $\square$  from → "Elements" in Toolbox to the top between the buttons for the screen change and the Start pushbutton.

700_S7-1200 > Panel KTP700 Basic [KTP700 Basic PN] > Screens > Overview Sorting Station 🛛 🗕 🖬 🗮 🗙	Toolbox 📑 🗉 🕨
	Options A
Tahoma 🔳 16 - B I U S A ± ± A ± ½ ± 2 ± = ± − ± ■ ± ∆ ± ± ± ± 4	▶     ▲     III     III     III     III       ✓     Basic objects     Ø
Speed Motor Magazine Plastic System screens	
-86	A Animatio
	✓ Elements
-B4 -B5 Metall/ metal -B7	S 10 10 10
	S =
Rutsche/Slide	ayout
M1 Counter workpieces	✓ Controls
-B3 Motor active M4 M4	

→ Under "General" in "Properties", enter the texts → "Auto" for the "ON" state and → "Man" for the "OFF" state. The → "mode\_selector" tag from the → "OPERATING\_HMI[DB4]" data block is used for the process connection.

IA Siemens - C:\Users\mde\Desktop\Data\041	-101_WinCC_Basic	_KTP700_S7-1200\041	1-101_WinCC_Basi	ic_KTP700_S7-12	00			
Project Edit View Insert Online Options		and the second second second	<b>nline </b> Go offline	Å? IR IF 3	e 🖃 💷	Search in proje	c> <b>W</b>	Totally Inte
Project tree  Devices		7-1200 ▶ Panel KTP						_ = = = ×
Devices & networks     CPU_1214C [CPU 1214C DC/     Device configuration     Device datagnostics     Online & diagnostics     CPU Program blocks	Speed Mot			몶 System scre		Mar Star	)	=
Add new block  Mein [081]  Motor_SPEEDCONTRO  Motor_SPEEDMONITO  Motor_Auto [FB1]	Switch_1 [Switc	-B4	-85	C Pro		100%	<b>•</b>	-87
MAGAZINE_PLASTIC [D MOTOR_AUTO_DB [DB1] OPERATING_HMI [DB4] SPEED_MOTOR [DB2]	Properties	Animations Ex	vents Texts					
<	General Appearance Fill pattern Design		OPERATING_HMI_m			Mode Format:	Switch	×
Name Offset .	Layout Text format Limits Styles/Designs Miscellaneous	Address: Value for *ON*:		Bool	É		Auto Man	
<pre>automatic_stop automatic_stop automatic_stop</pre>	Security							

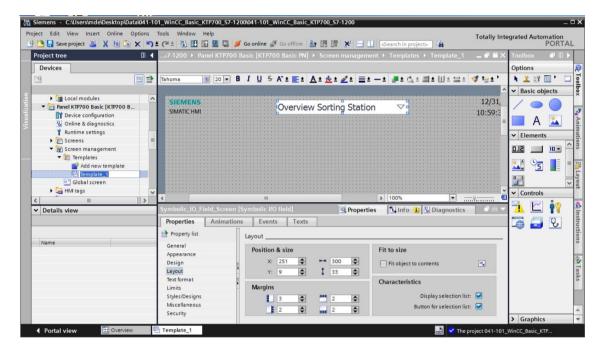
 $\rightarrow\,$  Under "Layout" in "Properties", change the size of the mode selector under  $\rightarrow$  "Position & size".

KTP700_\$7-12	200 🕨 Panel KTP700 Basic [KTP700 Basic PN] 🕨	Screens $\bullet$ Overview Sorting Station $\_$ $\blacksquare$ $\blacksquare$ $\times$
Tahoma	16 ■ B I U S A ± 🔤 ± A ± 👲 ± 🖉	± 글±─± @±☆±해±Ш±≌± ◈'
Speed Mot	or Magazine Plastic B System s	creens Man Start
		-B6
		Metall/
<	III	> 100%
Switch_1 [Switch	h] 🧕 Prop	perties 🚺 Info 🚺 🗓 Diagnostics 💿 🗆 🥆
Properties	Animations Events Texts	
Property list	Layout	
General Appearance	Position & size	Settings
Fill pattern	X: 506 🗢 🏎 100 🗢	Change direction: Left to right
Design	Y: 51 🗘 🚦 50 🗢	Fit object to contents
Layout Text format	Fit graphic to size	
Limits		Margins text
Styles/Designs	O No stretching of graphic	1 0 🗢 🇮 0 🗢
Miscellaneous	Stretch graphic	
Security	Alignment graphic	Marsing graphic
	Alignment graphic	Margins graphic
-	Horizontal: Centered	
	Vertical: Middle	
<		

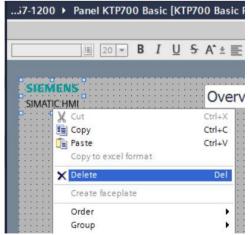
- $\rightarrow$  Compile the panel and save the project. ( $\rightarrow$  Panel KTP700 Basic  $\rightarrow$   $\square$   $\rightarrow$   $\square$  Save project)
  - $\rightarrow$  Download the modified visualization to the panel. ( $\rightarrow$   $\blacksquare$ )

### 7.13 Changing the header and footer in the template

- → The plant states should be displayed universally in the header. "Template\_1" was created for the header and footer by the wizard when the panel was created. The footer contains the system buttons. The logo, date and time and the symbolic IO field for selection and display of screens have already been created in the header.
- → First, the "Symbolic\_IO\_Field\_Screen" is changed to the size specified here under "Layout" in "Properties" in → "Position & size".



→ Delete the logo on the left side of the header by right-clicking the → Graphic view for the LOGO and clicking → "Delete".



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 $\rightarrow~$  Open the  $\rightarrow$  "Text and graphic lists" folder below "Panel KTP700 Basic".

-	ject Edit View Insert Online Opti ♪ Saveproject 📑 💥 🗐 🗊 🗙 Project tree		C	E 🖥 🖸			Go offline 🏭 🖪 🖪 3			
	Devices		_					oo busiciiiij	1: Text lists	Graphic lists
ľ	B I			*						
		-	-	ext lists						
5	Local modules	~		Name .			Selection	Comment		
į.	Panel KTP700 Basic [KTP700 B			TextList	OriginalScree	nNames	Value/Range			
Visuali	Device configuration				ScreenName		Value/Range			
	😧 Online & diagnostics			<add new=""></add>						
	Y Runtime settings									
	Screens									
l	🕨 🕎 Screen management									
ļ	🕨 🔚 HMI tags									
I	2 Connections		Т	Text list entries						
l	MI alarms			Default	Value 🔺	Text				
l	📑 Recipes									
1	Historical data	1								
1	5 Scheduled tasks	=								
	🔛 Text and graphic lists									
1	💡 User administration									

→ Under "Graphic lists", create an additional → "Graphic\_list\_warning" with → Selection "Bit (0,1)".

_w	InCC_Basic_F	KTP/00_57-12	00 🕨 Panel	KTP700 Basic [KTP	/00 E	asic PNJ 🕨	ext and grap	10	hic lists
							44	•	
Gra	phic lists								
	Name 🔺			Selection		Comment			
2	Graphic_list_warning <add new=""></add>		Bit (0, 1)	-	1				
8				Bit (0, 1)		]			
				Bit number (0 - 31 Value/Range	)				
Gra	aphic list entr	ries							
	Value 🔺	Graphic na	Graphic						
	<add new=""></add>								

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→ Click the symbol next to "Value 0" to open the selection dialog for the graphics stored in the "Graphic collection" in the "Languages & resources" path. Next, click the symbol for "Create graphic from file" and double-click the "Warning.bmp" file in the "SCE\_EN\_041-101\_Screens" folder in the displayed dialog. This file is now stored in the "Languages & resources" path under "Graphic collection".

									1: Text li	sts 🔄 Gr	aphic list
									L. I CAL	<u> </u>	
0											
	phic lists				1.						
	Name 🔺					lection		Comment			
	Graphic_list_v	Narr	ning		BI	t (0, 1)	-				
	<add new=""></add>										
Gra	phic list en	trie	c			here h	•				
	Value 🔺	are	Graphic	name	Graphic						
				- Hume	areprire						
	0	-	Warnin	a							
					•		2				
	<add new=""></add>	-									
			N	lame		Format	Size				
					o System info.	1.000000000	38 x 32	~			
				-	o System scre		38 x 32				
				-	o User admini	1 2	38 x 32				
				Pushbutton	-Round-G_Of	.bmp	504 x 504	4			
				Pushbutton	-Round-G_O	.bmp	497 x 497	7 -			
				Pushbutton	-Stop_Off_2	.bmp	108 x 108	3 🔤			
				Pushbutton	-Stop_On_25	bmp	108 x 107			-	
				Right_Arrow	1	.png	96 x 96				
				Up_Arrow		.png	96 x 96				
				Warning		.jpg	640 x 640				

→ The graphic that you want to assign to "Value 1" is already stored in the "Languages & resources" path under "Graphic collection". After you click the  $\rightarrow$   $\blacksquare$  symbol, you can select the  $\rightarrow$  "Logo of Panel KTP700 Basic" file directly here.

						1: Text lists	📘 🚡 Graphic list
Gra	aphic lists						
	Name 🔺		Selection	Co	mment		
*	Graphic_list_wa	irning	Bit (0, 1)	-			
	<add new=""></add>						
				hat a start			
	aphic list entr						
	Value 🔺	Graphic name	Graphi	c			
-				A			
	0	Warning		<u>/!\</u>			
				SIEMEN	IS		
	1	<ul> <li>Logo of Panel KTP700 Basic</li> </ul>		SIMATIC H	MI		
				SIMATIC I	IVII		
			( <b>1</b> 11)				
			Y				
		Name	Format	Size			
		ExitRuntime_KTP700		71 x 50	^	SIEN	<b>IENS</b>
		Foerderband_Conve	yor .bmp	912 x 322		SIEN	IENS.
		Home	.png	96 x 96			
		Left_Arrow	.png	96 x 96		SIMAT	IC HMI
		Logo of Panel KTP700		663 x 371		5	
		NavigateHome_KTP7		71 x 50			
		Navigates to Differen		38 x 32	~		
				20 20			

→ Change to the "Text lists" and create three text lists → "Text\_list\_emergency\_stop" → "Text\_list\_main\_switch" and → "Text\_list\_automatic", each with → Selection "Bit (0,1)".

			E Text lists	🚡 Graphic lists
B	ŀ			E
Te	xt lists			
	Name 🔺	Selection	Comment	
1-2-	TextList_OriginalScreenNames	Value/Range		
1-2-	TextList_ScreenNames	Value/Range		
1-2-	Text_list_emergency_stop	Bit (0, 1)	Display status emergency stop	
1-2-	Text_list_main_switch	Bit (0, 1)	Display status main switch	
1-2-	Text_list_automatic	Bit (0, 1)	Display status start/stop	
	<add new=""></add>			

→ Specify the following assignments in "Text\_list\_emergency\_stop": "Value 0" → "emergency stop released" and → "Value 1" → "emergency stop OK".

					1: Text lists	🖹 Graphic lists
•	ŀ					
Te	ext lists					
	Name 🔺		Selection		Comment	
1-2-	Text_list_eme	ergency_stop	Bit (0, 1)		Display status emergency stop	
1-2-	Text_list_main	n_switch	Bit (0, 1)		Display status main switch	
1-2-	Text_list_auto	omatic	Bit (0, 1)		Display status start/stop	
	<add new=""></add>					5
			last last	m		
Te	ext list entrie	S				
	Value 🔺 Text					
1	0 emergency stop released					
1	1	emergency stop OK				

→ Specify the desired assignments in "Text\_list\_main\_switch". "Value  $0" \rightarrow$  "main switch OFF" and  $\rightarrow$  "Value 1"  $\rightarrow$  "main switch ON".

1_1	WinCC_Basic_	_KTP700_\$7-1200  > Pa	nel KTP700 Basic [K	TP700 B	lasic PN]  ► Text and graphi	clists 🔔 🖬 🖬 🗙
					E Text lists	Craphic lists
₽.	<del>•] -</del>					
T	ext lists					
	Name 🔺		Selection		Comment	
1-2.	Text_list_eme	Text_list_emergency_stop			Display status emergency stop	1
1-2.	Text_list_main_switch		Bit (0, 1)	-	Display status main switch	
1-2	Text_list_automatic		Bit (0, 1)		Display status start/stop	-
	<add new=""></add>					
-			ter	-		
T	ext list entrie	s				
	Value 🔺 Text					
1.	0	main switch OFF				
1.	1	main switch ON				

→ Specify the following assignments in "Text\_list\_automatic". "Value 0" → "automatic stopped" and → "Value 1" → "automatic started"

					E Text lists	Craphic lists
	-					Ē
Tex	xt lists					
	Name 🔺		Selection		Comment	
1-2-	Text_list_eme	ergency_stop	Bit (0, 1)		Display status emergency stop	
1-2-	E Text_list_main_switch Text_list_automatic		Bit (0, 1)		Display status main switch	
1-2-			matic Bit (0, 1) 🔽 Disp		Display status start/stop	
	<add new=""></add>					
			how and have	• 111		
Tex	xt list entrie	5				
Value 🔺 Text						
1		automatic stopped				
1	1	auitomatic started				

→ Back in "Template\_1" for the header, use drag & drop to move the → "Graphic IO field" object from → "Elements" in Toolbox to the upper left corner.

el KTP700 Basic [l	KTP700 Basic PN] →	Screen management + T	emplates 🕨 Templa	ite_1 _ 🖬 🖬 🗙	Toolbox 📑 🗉	
					Options	
2	○ <del>-</del> B I <u>U</u> <del>S</del>	A* ± 🗄 ± <u>A</u> ± <u>A</u> ± <u>A</u> ±	t 🚍 t — t 🥊 t 🤉	7∓≡1∓,	k 🙎 🖬 🔟 🔭 🛛	
				^	✓ Basic objects	
		Overview Sorting S	Station 🗸			
	x/v: 101 57				Α 🔽	
<mark>Na</mark> r	ne: Template_Graphic I	O field_1 Mode: Input/output	Layer: 0		✓ Elements	
					SIZ 💷 🛄 SI.0	Ĵ
					95 -	

 $\rightarrow~$  Under "General" in "Properties", change "Mode" to  $\rightarrow$  "Output".

Click the symbol  $\overline{III}$  to open the selection dialog for the  $\rightarrow$  "Graphic list" and select the "Graphic\_list\_warning" you just created.

Template_Grap	hic I/O field_1 [Gra	aphic I/O f	ield]	<b>Propertie</b>	s 🚺 Info 🚺 🗓 I	Diagnostics	
Properties	Animations	Events	Texts				
Property list	General						
General	Process				Contents		
Appearance Layout		-					
Limits	P	Tag:			Graphics list:	Graphic_list_v	
Miscellaneous		ddress:		-			
Security							
	Bit ni	umber: 0	•				~
	Mode						
	M	Node: Outp	out	•			

→ To establish the connection to the global tag in the CPU, select → "PLC tags" and → "Tag table\_sorting station" below → "CPU\_1214C". Next, move the

	$\rightarrow$ "-A1" tag from the	"Details view" to the	"Tag" field. Also select	Bit number 0".
--	----------------------------------	-----------------------	--------------------------	----------------

TIA Siemens - C:\Users\mde\Desktop\Data\041-101_\	WinCC_Basic_KTP7	00_\$7-1200/041-101_WinCC_Basic_KTP700_\$7-1200	
Project Edit View Insert Online Options Too		Totally	Integra
Project tree		anel KTP700 Basic [KTP700 Basic PN] > Screen management > Templates > Template_1 _ i	
Devices			
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5 • 1 041-101_WinCC_Basic_KTP700_S7-1200		12/2	31/2 =
Add new device	° 🗥 °	Overview Sorting Station $\bigtriangledown$ 10:59	9:39
Device configuration			
🕨 🙀 Program blocks	<	III > 100%	1
Technology objects     External source files	Template_Graph	nic I/O field_1 [Graphic I/O field] 📴 Properties 🔝 Info 🗊 🖫 Diagnostics	
- PLC tags	Properties	Animations Events Texts	
Show all tags	Property list	General	
Default tag table [29]	General Appearance	Process Contents	
Lag table_sorting station [30] ► Lig PLC data types	Layout Limits	Tag: -A1 Graphics list: Graphic_list_v	
✓ Details view	Miscellaneous	PLC tag: "-A1"	
	Security	Address: Bool Bit number: 0	
Name Data type D			
-A1 Bool 🔳 % 🔨		Mode	
-©1 -B1 Bool %		Mode: Output	
401 -B3 Bool %		4	

→ Under "Layout" in "Properties", change the size of the "Graphic IO field" under → "Position & size".

	20 <b>- B</b>	I <u>U</u> SA	* ± ≣ ± <u>A</u>	<u>\ ± 📌 ± 4</u>	<u>(+</u> =+	± d		± 🔛 ± 👒	f t <u>s</u> ± [
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<b>4</b>			Overview	Sorting	Station		<u> </u>		10:59:3
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						::: :::			· · · · · · · · · · ·
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			200. 24.42			>	100%		
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mplate_Graph Properties	ic I/O field_1		field] Texts		Properties	>			
	Animations	Graphic I/O	7		Rroperties	>			
Properties	Animations	Graphic I/O Events	7				🗓 Info 👔 📱 Dia		
Properties	Animations	Graphic I/O Events	7	]	Properties Fit to		🗓 Info 👔 📱 Dia		
Properties	Animations	Graphic I/O Events	7		Fit to	size	🗓 Info 👔 📱 Dia		
Properties Property list General Appearance ayout Limits	Animations Layout Position	Graphic I/O Events & size	Texts	•	Fit to	size	🔽 Info 👔 🗓 Dia		
Properties	Animations Layout Position X:	Graphic I/O Events & size	Texts		Fit to	size auto grap	🗓 Info 🧻 🗓 Dia	ignostics	

→ To display the Emergency Stop status in the header as text, use drag & drop to move the → "Symbolic IO field" object III from → "Elements" in Toolbox to the right of the "Graphic IO field".

) 🕨 Pan	el KTP700 Bas	ic [KTP	700 Bas	ic PN] ▶ 9	Screen mana	agement 🕨 Ten	nplates 🕨	Template_1	_∎≡×	Toolb	ох	
										Option	ns	A
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					· · · · · · · · · · · · · · · · · · ·		· · · · · · · · · · · · · · · · · · ·			6		#100 L

Template_Sym	bolic I/O field_1 [Symbolic I/O field]	🔍 Properties 🚺 Info 追 🗓 Diagnostics 📃 🗆 🗉
Properties	Animations Events Texts	
Property list	General	
General Appearance	Process	Contents
Design Layout Text format	Tag: PLC tag: Address:	Image: Second
Limits Styles/Designs Miscellaneous	Bit number: 0	
Security	Mode Mode: Output	•

→ To establish the connection to the global tag in the CPU, select → "PLC tags" and → "Tag table\_sorting station" below → "CPU\_1214C". Next, move the → "-A1" tag from the "Details view" to the "Tag" field and also select → "Bit number 0".

oject Edit View Insert Online } 🎦 🔒 Save project 进 💥 🏥 🗍			🔄 💋 Go online 💋	🕻 Go offline 🛔 🖪 🖪 🚺 🤜 🖛	Totally Inte
Project tree		<u></u> \$7-1200 ▶ Pa			🗆 🕨 Templates 🕨 Template_1 🛛 💻 🖬
Devices					
1	💷 🖻	Tahoma 🔳	<u>16 <b>•</b></u> <b>B</b> <i>I</i> <u>U</u>	SA'±≣± A±±±±≡±-	± ]# ± 쇼 ± 릐 ± 비 ± 음 ± 🗳 1등 ± 대
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Devices & networks			ergency stop	Overview Sorting Station	√ 12/31/
CPU_1214C [CPU 1214C DC/DC	[/DC]		crucier stop g	overview sorting station	10:59:3
Device configuration					
🖳 Online & diagnostics					
Program blocks					
Technology objects		۲		III	> 100%
External source files					
		Template_Symbo		bolic I/O field]	Linfo 🚺 🖁 Diagnostics 🛛 🗖 =
🔻 🎑 PLC tags					🚺 Info 👔 🖞 Diagnostics 🔹 🗖 🗕
✓ Carps PLC tags Show all tags		Properties		vents Texts	🚯 Info 👔 🖞 Diagnostics 📃 🗖 =
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▼ 📮 PLC tags る Show all tags 督 Add new tag table S Default tag table [29]	on [30]	Properties	Animations Ev		
✓ Carrie PLC tags Show all tags Add new tag table	on [30]	Properties Property list General Appearance	Animations Ev		Contents
✓ PLC tags Show all tags Add new tag table ✓ Add new tag table ✓ Default tag table [29] ↓ Tag table_sorting static	on [30]	Properties Property list General Appearance Design	Animations Ev	vents Texts	Contents
<ul> <li>PLC tags</li> <li>Show all tags</li> <li>Add new tag table</li> <li>Default tag table [29]</li> <li>Tag table_sorting static</li> <li>PLC data types</li> </ul>	on [30]	Properties Property list General Appearance Design Layout	Animations Ev General Process	A1	Contents
<ul> <li>Cap PLC tags</li> <li>Show all tags</li> <li>Add new tag table</li> <li>Default tag table [29]</li> <li>Tag table_sorting static</li> <li>Cap PLC dat types</li> <li>Watch and force tables</li> </ul>	on [30]	Properties Property list General Appearance Design Layout Text format	Animations Ev General Process Tag:	A1 II	Contents Text_list: Text_list_eme ]]
<ul> <li>Cap PLC tags</li> <li>Show all tags</li> <li>Add new tag table</li> <li>Default tag table [29]</li> <li>Tag table_sorting static</li> <li>Cap PLC data types</li> <li>Watch and force tables</li> </ul>	on [30]	Properties Property list General Appearance Design Layout Text format Limits	Animations Ev General Process Tag: PLC tag: Address:	-A1 3 -A1 Bool	Contents Text list: Text_list_eme ]]
Carl PLC tags     Show all tags     Add new tag table     Cefault tag table [29]     Tag table_sorting static     Carl PLC data types     Watch and force tables     Details view	~	Properties Property list General Appearance Design Layout Text format Limits Styles/Designs	Animations Ev General Process Tag: PLC tag:	-A1 3 -A1 Bool	Contents Text list: Text_list_eme ]]
PLC tags     Show all tags     Ad new tag table     Sow all tags     Pefult tag table[29]     Tag table_sorting static     Office tables     Sow Watch and force tables     Details view  Name Data ty	pe De	Properties Property list General Appearance Design Layout Text format Limits Styles/Designs Miscellaneous	Animations Ev General Process Tag: PLC tag: Address:	-A1 3 -A1 Bool	Contents Text list: Text_list_eme ]]
Class     Show all tags     Name     Data ty     All     Bool	~	Properties Property list General Appearance Design Layout Text format Limits Styles/Designs Miscellaneous Security	Animations Ev General Process Teg: PLC tag: Address: Bit number: Mode	A1 IIIII A1 Bool	Contents Text list: Text_list_eme ]]
PLC tags     Show all tags     Show all tags     Add new tag table     Set table_sorting static     Part tag table_sorting static     Out at types     Watch and force tables     Vector tables     Name     Data ty     A1 Bool	pe De	Properties Property list General Appearance Design Layout Text format Limits Styles/Designs Miscellaneous Security	Animations Ev General Process Teg: PLC tag: Address: Bit number: Mode	-A1 3 -A1 Bool	Contents Text list: Text_list_eme ]]]

→ Under "Layout" in "Properties", change the size of the "Graphic IO field" under → "Position & size".

1200 > Pane	KTP700 Basic [I	KTP700 Basic	PN] > Scre	een manageme	nt 🕨 Templates	Template_	1 _∎≡×
Tahoma	■ 16 <b>▼ B</b> <i>I</i>	<u>U</u> ⊱ A^±	Et At	<u>≜ ± ∠ ±</u> ≡	± — ± 📕 ± 👌	<mark>∖±≣l±</mark> ⊞±:	📑 ∓ 🔌 1≅ ∓ ,
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Template Syml	bolic I/O field_1 [	Symbolic I/O	field	<b>Propertie</b>	s Tillafo (i	Diagnostic	
Properties	Animations	Events	Texts	3	- 13 <b>-</b>		
Property list	Π						
	Layout						
General	Position	& size		F	it to size		
Appearance							
Design		50	*** 201		Fit object to cor	ntents	
Layout	Y:	9	I 32	•			
Text format	1				Characteristics		
Limits	Margins						
Styles/Designs	- 1	3	*** 2	•	Di	splay selection list	
Miscellaneous					Butto	on for selection list	: 🖃
Security	L.R.	2		•			

- → Repeat the previous steps for the text lists → "Text\_list\_main\_switch" and → "Text list\_automatic" to insert them directly one below the other to the left of the date and time. Change the size and font so that the text has enough space.
- → The connection of the "Text\_list\_main\_switch" is made using the  $\rightarrow$  "-K0" tag from the "Tag table\_sorting station".

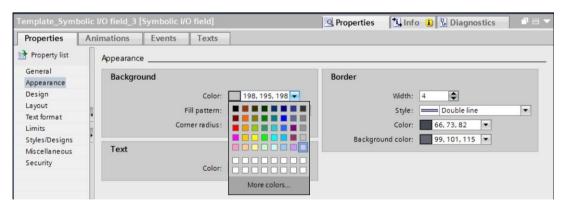
~ 1	Details view					Template_Symbolic I/O field_2 [Symbolic I/O field]				Properties Info 🔕 🖳 Diagnostics		
						Properties	nimations Events Texts General					
N	Name	Data type	Details	Comment		General						
•	-B7	Bool	%11.3	sensor part	^		Process		Contents			
	-88	Int	%IW64	sensor actu		Appearance						
	-K0	Bool	B %IO.1	main switch		Design	Tag: -KO			Text list: Text_list_main_switch 🔳 🥕		
	-M2	Bool	%Q0.3	cylinder -M	-	Layout	PLC tag: "-K0"	×	Visible	e entries: 3		
	-M3	Bool	%Q0.4	cylinder -M		Text format	Address:	Bool		·		
	-P1	Bool	%Q0.5	display "mai		Limits		0001				
01	-P2	Bool	%Q0.6	display ma		Styles/Designs	Bit number: 0					
01	-P3	Bool	%Q0.7	display aut		Miscellaneous						
10	-P4	Bool	%Q1.0	display em		Security	Mode					
01	-P5	Bool	%Q1.1	display aut			Mode: Output					
	-P6	Bool	%01.2	display cyli	~		Mode. Output					
5			III	>								

 $\rightarrow$  The connection of the "Text\_list\_automatic" is made using the  $\rightarrow$ 

"Memory\_Automatic\_Start\_Stop" tag from "MOTOR\_AUTO\_DB1[DB1]".

~	Details view	Template_Sym	bolic I/O field_3 [Symbolic I/O field]		Properties 1 Info	🔒 🗓 Diagnostics 👘 🗐 🚍 🥆
		Properties	Animations Events Texts			
	Name Offset	Property list	General			
-00	Sensor_end_of_conveyor	General	Process		Contents	
-	Setpoint_Capacity_Magazine_Plastic	Appearance				
	Reset_Counter_Workpieces_Plastic	Design	Tag: MOTOR_AUTO_DB_Me	nory_automatic 📃	Text list:	Text_list_automatic 🔳 🗡
-	Conveyor_motor_automatic_mode	Layout	PLC tag: MOTOR_AUTO_DB.Men	ory_automati 🗡	Visible entries:	3
-	Actual_Value_Magazine_plastic	Text format	Address:	Bool		
-	Memory_automatic_start_stop	Limits				
-01	Memory_conveyor_start_stop	Styles/Designs	Bit number: 0			
-	Memory_edge_detection	Miscellaneous				
-0	IEC_Timer_overrun	Security	Mode			
	IEC_Counter_plastic	/	Mode: Output	•		
<						

→ Under "Appearance" in "Properties", change the "Color" of "Background" to → "Gray" for → "Text\_list\_main\_switch" and → "Text\_list\_automatic".



→ Now switch to the "Animations" tab for → "Text\_list\_main\_switch" and  $\rightarrow$  "Text\_list\_automatic", select "Display" and click  $\rightarrow$  **a**"Add new animation".

Template_Symbolic I/O field_2	[Symbolic I/O field	l 🧕 🦉 P	<b>Properties</b>	🔄 Info	<b>Uiagnostics</b>	
Properties Animations	Events Tex	ts				
Ar	imation types					
Overview	Display					
40 Tag connections     Tag connections	Appearance		A Dynar	nize colors and	flashing	
Add new animation	Visibility	-		visibility dynam		
Movements			2			

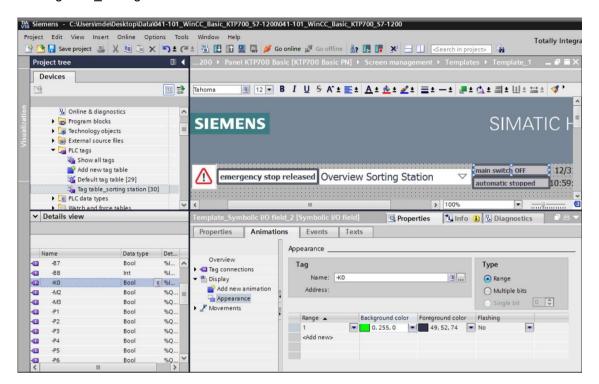
 $\rightarrow~$  In the displayed dialog, select  $\rightarrow$  "Appearance" and click  $\rightarrow$  "OK".

Add animation	×
Select the animation you want to add.	
Appearance	
Visibility	
	OK Cancel

→ Under "Appearance" of both "Symbolic IO fields", add a range with value  $\rightarrow$  "1" (signal state "High") and change the "Background color" to  $\rightarrow$  "Green".

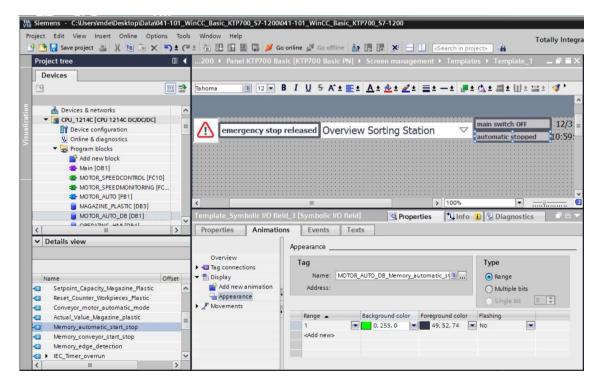
Template_Symbolic I/O fi	eld_2 [Symbolic I/O field]	<b>Properties</b>	1 Info	Diagnostics	
Properties Animati	ons Events Texts				
	Appearance				
Overview Tag connections Display Add new animation Appearance	Tag Name: Address:		1	Type  Range Multiple bits Single bit	\$
▶ _ Movements			ound color 52, 74 💌	Flashing No	

→ The connection of the "Text\_list\_main\_switch" is made again using the  $\rightarrow$  "-K0" tag from the "Tag table sorting station".



 $\rightarrow$  The connection of the "Text\_list\_automatic" is made using the

 $\rightarrow$  "Memory\_Automatic\_Start\_Stop" tag from "MOTOR\_AUTO\_DB1[DB1]".



→ The "Acquisition cycle" of all tags is also to be accelerated from 1 second to 100 milliseconds in the default tag table.

	B 2								8
Defa	ult tag table								
N	ame 🔺	Data type	Connection	PLC name	PLC tag	Addr	Access mode	Acquisition cycle	Source commen
	-A1	Bool	HMI_Connection_1	CPU_1214C	"-A1"		<symbolic a<="" th=""><th>100 ms</th><th>return signal en</th></symbolic>	100 ms	return signal en
	-81	Bool	HMI_Connection_1	CPU_1214C	"-B1"		<symbolic a<="" td=""><td>100 ms</td><td>sensor cylinder</td></symbolic>	100 ms	sensor cylinder
	-B2	Bool	HMI_Connection_1	CPU_1214C	*-B2*		<symbolic a<="" td=""><td>100 ms</td><td>sensor cylinder</td></symbolic>	100 ms	sensor cylinder
•	-83	Bool	HMI_Connection_1	CPU_1214C	"-B3"		<symbolic a<="" td=""><td>100 ms</td><td>sensor motor -N</td></symbolic>	100 ms	sensor motor -N
•	-B4	Bool	HMI_Connection_1	CPU_1214C	*-B4*		<symbolic a<="" td=""><td>100 ms</td><td>sensor part at s</td></symbolic>	100 ms	sensor part at s
•	-85	Bool	HMI_Connection_1	CPU_1214C	"-B5"		<symbolic a<="" td=""><td>100 ms</td><td>sensor metal p</td></symbolic>	100 ms	sensor metal p
•	-B6	Bool	HMI_Connection_1	CPU_1214C	"-B6"		<symbolic a<="" td=""><td>100 ms</td><td>sensor part in fi</td></symbolic>	100 ms	sensor part in fi
-	-87	Bool I	HMI_Connectio	CPU_1214C	*-B7*	-	<symboli td="" 💌<=""><td>100 ms</td><td>sensor part at e</td></symboli>	100 ms	sensor part at e
-	-КО	Bool	HMI_Connection_1	CPU_1214C	"-КО"		<symbolic a<="" td=""><td>100 ms</td><td>main switch "O</td></symbolic>	100 ms	main switch "O
•	MAGAZINE_PLASTIC_Plastic_Parts_Actual	Int	HMI_Connection_1	CPU_1214C	MAGAZINE_PL		<symbolic a<="" td=""><td>100 ms</td><td>Actual Value m</td></symbolic>	100 ms	Actual Value m
•	MOTOR_AUTO_DB_Memory_automatic_start_stop	Bool	HMI_Connection_1	CPU_1214C	MOTOR_AUTO		<symbolic a<="" td=""><td>100 ms</td><td>Memory used fo</td></symbolic>	100 ms	Memory used fo
•	OPERATING_HMI_automatic_start	Bool	HMI_Connection_1	CPU_1214C	OPERATING_H		<symbolic a<="" td=""><td>100 ms</td><td>HMI pushbuttor</td></symbolic>	100 ms	HMI pushbuttor
•	OPERATING_HMI_automatic_stop	Bool	HMI_Connection_1	CPU_1214C	OPERATING_H		<symbolic a<="" td=""><td>100 ms</td><td>HMI pushbuttor</td></symbolic>	100 ms	HMI pushbuttor
•	OPERATING_HMI_mode_selector	Bool	HMI_Connection_1	CPU_1214C	OPERATING_H		<symbolic a<="" td=""><td>100 ms</td><td>HMI mode sele</td></symbolic>	100 ms	HMI mode sele
•	OPERATING_HMI_reset_counter_plastic	Bool	HMI_Connection_1	CPU_1214C	OPERATING_H		<symbolic a<="" td=""><td>100 ms</td><td>HMI reset coun</td></symbolic>	100 ms	HMI reset coun
•	-Q3	Bool	HMI_Connection_1	CPU_1214C	"-Q3"		<symbolic a<="" td=""><td>100 ms</td><td>conveyor moto</td></symbolic>	100 ms	conveyor moto
•	SPEED_MOTOR_Speed_Actual_Value	Real	HMI_Connection_1	CPU_1214C	SPEED_MOTOR		<symbolic a<="" td=""><td>100 ms</td><td>Speed actual v</td></symbolic>	100 ms	Speed actual v
•	Tag_ScreenNumber	UInt	<nternal tag=""></nternal>		<undefined></undefined>			100 ms	
<	Add new>								

- → Before the visualization is downloaded to the panel, compile the CPU and panel again and save the project. (→ CPU\_1214C →  $\blacksquare$  → Panel KTP700 Basic →  $\blacksquare$  → Save project.)
  - → After successful compilation, the entire controller with the created program including the hardware configuration, as previously described in earlier modules, can be downloaded.

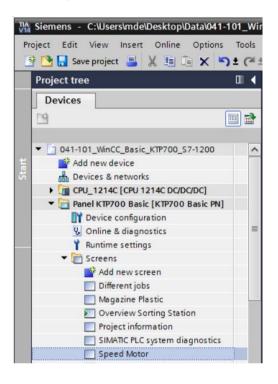


 $\rightarrow$  To download the visualization to the panel, follow the same procedure. Select the  $\rightarrow$  "Panel KTP700 Basic [KTP700 Basic]" folder and click the

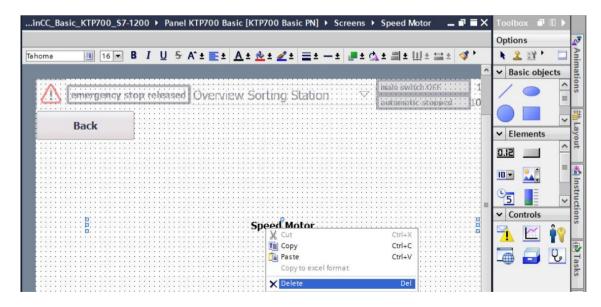
 $\rightarrow$  **III** "Download to device" button.

# 7.14 Bar graph display

 $\rightarrow$  Next, the setpoint is to be specified for the motor speed control and the actual value is to be displayed. To do this, open the  $\rightarrow$  "Speed Motor" screen with a double-click.



→ The text box in the center of the screen is to be removed by right-clicking on it and selecting
 → "Delete" in the displayed dialog.



 $\rightarrow$  To display the actual speed value graphically, use drag & drop to move the  $\rightarrow$  "Bar graph"

object from  $\rightarrow$  "Elements" in Toolbox to the middle of the screen.

KTP700_S7-1200 > Panel KTP700 Basic [KTP700 Basic PN] > Screens > Speed Motor 🛛 🗕 🖬 🗮 🗙	Toolbox 📑 🔳 🕨
	Options
Tahoma ■ 13 • B I U S A*± ≝± A± ± ± ± ± ± ± ± ± ± ± ± ± ± ± ± ±	k 🙎 🖬 🖬 🔭 🗖
<u>^</u>	✓ Basic objects
Cemergency stop: released Overview Sorting: Station	/ • • •
Back	Α 🚨
Dack	✓ Elements
	<u></u> 💷 🛄 51.0
	5
	✓ Controls
xty:: 373,222 :	🔨 🖆 🛉
	<b>-</b>

 $\rightarrow$  Under "General" in "Properties", change "Maximum scale value" to  $\rightarrow$  50 and "Minimum scale value" to  $\rightarrow$  -50.

Bar_1 [Bar]		Properties 🗓 Info 追 🗓 Diagnostics 💿 🗆 🥆
Properties	Animations Events Texts	
Property list	General	
General	Descent	
Appearance	Process	
Border type	Maximum scale 50	
Scales	value:	
Label	-x	Process tag:
Layout		PLC tag:
Text format		Address:
Limits/Ranges		Address:
Styles/Designs	Minimum scale -50	
Miscellaneous	value:	

→ For the process connection, select → "Program blocks" and the → "SPEED\_MOTOR[DB2]" data block below → "CPU\_1214C". Next, drag the → "Speed\_Actual\_Value" tag from the → Details view to the "Process tag" field.

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Negative_Speed	Miscellaneous	value:		-
Portal view Source	Speed Motor		🔜 ✔ The	project 041-101_WinCC_Basic_KTP

→ Under "Scales" in "Properties", select  $\rightarrow$   $\blacksquare$  "Show scale" and set "Divisions"  $\rightarrow$  2, "Marks label"  $\rightarrow$  1 and "Interval"  $\rightarrow$  10.

Bar_1 [Bar]					Rroperties	🚺 Info 🔒 🗓 Diagnostics	
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→ Under "Label" in "Properties", select  $\rightarrow$   $\blacksquare$  "Label" and set "Unit" $\rightarrow$  rpm and "Decimal places"

_	→	2.

value" for the description.

Bar_1 [Bar]			<b>Properties</b>	🗓 Info 🕕 📱 Diagnostics	
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Limits/Ranges	Unit:	rpm			
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Miscellaneous					

→ Under "Layout" in "Properties", change the position and size of the bar graph under → "Position & size". Above the bar graph, insert a → "Text field" A with text → "Speed actual

041-101\_WinCC\_Basic\_KTP700\_S7-1200 > Panel KTP700 Basic [KTP700 Basic PN] > Screens > Speed Motor \_ **= =** X Tahoma 🔳 13 ▼ B I U S A\*±≣± A± ½± ∠± ≣± −± ₽± ∆± ≛± Ш± ≌± 🚿 1≥± Q Back Speed actual value 50.00rpm 40.00 30.00 20.00 10.00 > 100% • (III) 🗓 Info 🤢 📱 Diagnostics **Properties** Events Properties Animations Texts Property list Layout \_ General ~ Position & size Style Appearance X: 270 ٦ H-H 110 \$ Border type Scale position: Right/down -Scales Y: 104 \$ 250 \$ Baralignment: Top • Label

→ To enable the speed setpoint to be specified, use drag & drop to move the → "IO field" object . To enable the speed setpoint to be specified, use drag & drop to move the → "IO field" object . To enable the speed setpoint to be specified, use drag & drop to move the → "IO field" object . To enable the speed setpoint to be specified, use drag & drop to move the → "IO field" object . To enable the speed setpoint to be specified, use drag & drop to move the → "IO field" object . To enable the speed setpoint to be specified, use drag & drop to move the → "IO field" object . To enable the speed setpoint to be specified, use drag & drop to move the → "IO field" object . To enable the speed setpoint to be specified, use drag & drop to move the → "IO field" object . To enable the speed setpoint to be specified, use drag & drop to move the → "IO field" object . To enable the speed setpoint to be specified, use drag & drop to move the → "IO field" object . To enable the speed setpoint to be specified, use drag & drop to move the → "IO field" object . To enable the speed setpoint to the right of the bar graph.

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 $\rightarrow$  Under "General" in "Properties", keep "Type"  $\rightarrow$  "Input/Output" and change the "Format pattern" to  $\rightarrow$  s99.99.

Texts				
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→ For the process connection, select → "Program blocks" and the → "SPEED\_MOTOR[DB2]" data block below → "CPU\_1214C".

Next, drag the  $\rightarrow$  "Speed\_Setpoint" tag from the  $\rightarrow$  Details view to the "Tag" field.

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	Name	Styles/Designs Miscellaneous	Туре	Leading zeros: Format pattern: \$99.99
	Speed_Actual_Value  Positive_Speed	Security	Mode: Input/output	
		Speed Motor		The project 041-101_WinCC_Basic_KTP

 $\rightarrow$  Under "Appearance" in "Properties", change the "Color" of "Background" to  $\rightarrow$  "Blue".

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Styles/Designs	•		Background color:	99, 101, 115 💌
Miscellaneous	Text			
Security	Color:			
	Unit:	More colors		

 $\rightarrow$  Under "Text format" in "Properties", change "Alignment" "Horizontal" to  $\rightarrow$  "Right".

I/O field_1 [I/O f	ield]				<b>Properties</b>	🚺 Info 📢	Diagnostics	
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- → Under "Layout" in "Properties", change the position and size of the IO field under → "Position & size".
- $\rightarrow$  Above the bar graph, insert a  $\rightarrow$  "Text field" A with text  $\rightarrow$  "Speed setpoint" for the description.

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- → The "Acquisition cycle" of the newly create tag is also to be changed from 1 second to 100 milliseconds in the default tag table.
- → Before the visualization is downloaded to the panel, compile the CPU and panel again and save the project. (→ Panel KTP700 Basic →  $\square$  →  $\square$  Save project.)
  - → To download the visualization to the panel, select the → "Panel KTP700 Basic [KTP700 Basic]" folder and click the →  $\blacksquare$  "Download to device" button.

### 7.15 Messages

A couple of alarm windows were already created when you used the wizard to create the Panel KTP700 Basic. We will now take a closer look at them.

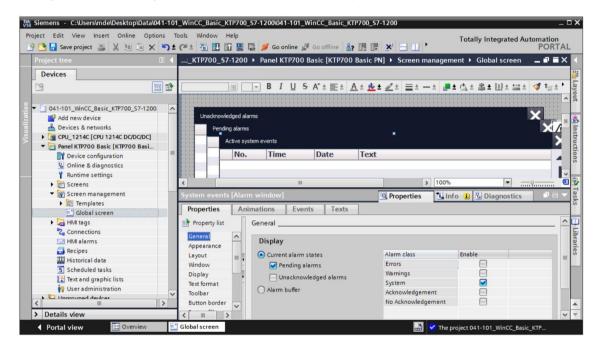
#### 7.15.1 General alarm settings

→ The first step is to make several settings for the display of alarms in Runtime. To do this, double-click the → "Runtime settings" folder in → "Panel KTP700 Basic". Under "General" in "Alarms", select → I alarm class colors", and under "System events", change → Display duration in seconds to "10".

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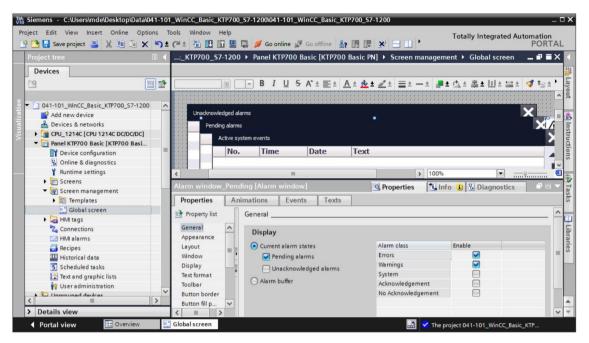
#### 7.15.2 Alarm window

→ For the alarm windows to be displayed in the foreground in every screen, a → "Global screen" is available in the → "Screen management" folder of → "Panel KTP700 Basic". Open this with a double-click. Three alarm windows have already been created in this screen. In the first alarm window→ "System events", I pending alarms" and the alarm class I system" are already selected under "General" in "Properties".



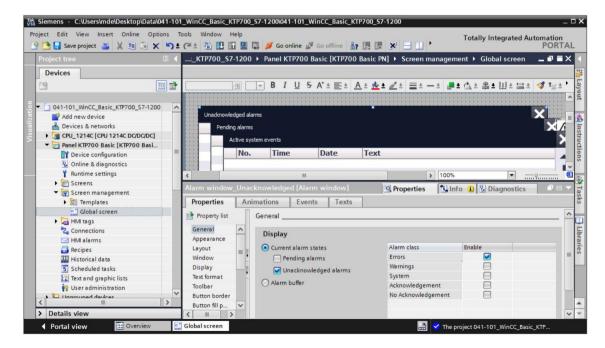
Note: System events will be automatically displayed in Runtime for ten seconds.

→ The → "Pending alarms" alarm window is the second alarm window in the "Global screen" screen. Select I "Pending alarms" under "General" in "Properties". Select I "Errors" and I "Warnings" as alarm classes.



**Note:** You will create alarm classes of types "Errors" and "Warnings" in the panel itself in subsequent steps.

→ The → "Unacknowledged alarms" alarm window is the third alarm window in the "Global screen" screen. Select I "Unacknowledged alarms" under "General" in "Properties". Select only I "Errors" here as the alarm classes.



### 7.15.3 Alarm indicator

→ In addition to the alarm windows, the "Global screen" screen also contains an → "Alarm indicator". Its purpose is to display an alarm window again, which the user hid by clicking it away. Under "General" in "Properties", select I "Errors: Pending messages", I "Errors: Acknowledged" and I "Warnings: Pending alarms" as the message classes.

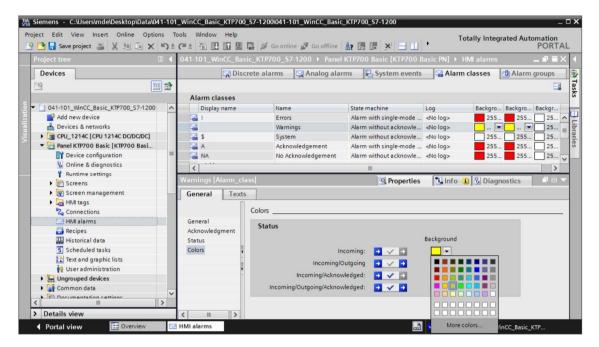
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→ Under → "Events", the "ShowAlarmWindow" function is already entered for the "Click" event. Change the → "Object name" for "Click when flashing" to "Alarm window\_Unacknowledged" so that this alarm window will be opened here.

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#### 7.15.4 Settings of alarm classes

→ The → "HMI alarms" menu item is available in → "Panel KTP700 Basic" for configuration of the alarm system and creation of customized alarms. Open this with a double-click. The alarm classes to be used are already created in the "Alarm classes" menu item. These can still be changed, however. For the → "Warnings" alarm class, change the background color for the "Incoming" and "Incoming/Outgoing" statuses to → "Yellow".



## 7.15.5 System events

 $\rightarrow$  You can have system events automatically imported in the "System events" menu item by clicking  $\rightarrow$  "Yes".

	C_Basic_KTP700_S7-1200   Panel KTP700 Basic [KTP700 Basic PN]   HMI alarms	
5	🖓 Discrete alarms 🛛 🖓 Analog alarms 🔤 System events 🖓 Alarm classes 🖽 Ala	rm group
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4	Do you want to import the system events? Apparently, no system events have been imported yet.	
	Yes No	
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iD 9999 10111 10112 30010 30011	Discrete alarms       Analog alarms       System events       Alarm classes       Alar         nts       Alarm text       Global: Unknown error %1,%2,%3,%4,%5,%6,%7,%8,%9.       Number         Recipe does not contain any data records.       Error writing a tag, error code: %1,%2.	
iD 9999 10111 10112 30010 30011 30012	Analog alarms       System events       Alarm classes       Alar         nts       Alarm text       Global: Unknown error %1,%2,%3,%4,%5,%6,%7,%8,%9.       Number         Recipe does not contain any data records.       Error writing a tag, error code: %1,%2.       Invalid value %1 in parameter %2, error code: %3.	
ip 9999 10111 10112 30010 30011 30012 50000	Analog alarms       System events       Alarm classes       Alar         nts       Alarm text       Global: Unknown error %1,%2,%3,%4,%5,%6,%7,%8,%9.       Number         Recipe does not contain any data records.       Error writing a tag, error code: %1,%2.       Invalid value %1 in parameter %2, error code: %3.         Invalid value %1 in parameter %2, valid range [%3 - %4], error code: %5.       Overflow: no data exchange with the PLC.	
iD 9999 10111 30010 30011 30012 50000 50001	Analog alarms       System events       Alarm classes       Alar         nts       Alarm text       Global: Unknown error %1,%2,%3,%4,%5,%6,%7,%8,%9.       Number         Recipe does not contain any data records.       Error writing a tag, error code: %1,%2.       Invalid value %1 in parameter %2, error code: %3.         Invalid value %1 in parameter %2, valid range [%3 - %4], error code: %5.       System events	
ID           9999           10111           10112           30010           30011           30012           50000           50001           70011	Analog alarms       System events       Alarm classes       Alar         nts       Alarm text       Global: Unknown error %1,%2,%3,%4,%5,%6,%7,%8,%9.       Number         Recipe does not contain any data records.       Error writing a tag, error code: %1,%2.       Invalid value %1 in parameter %2, error code: %3.         Invalid value %1 in parameter %2, valid range [%3 - %4], error code: %5.       Overflow: no data exchange with the PLC.         Overflow status ended: data exchange is running again.       Overflow status ended: data exchange is running again.	
iD           iD           9999           10111           10112           30010           30011           30012           50000           50001           70011           70016	Discrete alarms       Analog alarms       System events       Alarm classes       Alarm classes         nts         Alarm text       Global: Unknown error %1,%2,%3,%4,%5,%6,%7,%8,%9.       Number         Recipe does not contain any data records.       Error writing a tag, error code: %1,%2.         Invalid value %1 in parameter %2, error code: %3.         Invalid value %1 in parameter %2, valid range [%3 - %4], error code: %5.         Overflow: no data exchange with the PLC.         Overflow status ended: data exchange is running again.         Date/time could not be set, error code: %1,%2.	
ystem ever ID 9999 10111 10112 30010 30011 30012 50000 50001 70011 70016 70024	Alarm classes       Alarm classes       Alarm classes         nts       Alarm text       Global: Unknown error %1,%2,%3,%4,%5,%6,%7,%8,%9.       Number         Recipe does not contain any data records.       Error writing a tag, error code: %1,%2.       Invalid value %1 in parameter %2, error code: %3.         Invalid value %1 in parameter %2, valid range [%3 - %4], error code: %5.       Overflow: no data exchange with the PLC.         Overflow: status ended: data exchange is running again.       Date/time could not be set, error code: %1,%2.         Cannot select screen number %1.	
System ever	Discrete alarms       Analog alarms       System events       Alarm classes       Alarm classes         nts         Alarm text       Global: Unknown error %1,%2,%3,%4,%5,%6,%7,%8,%9.       Number         Recipe does not contain any data records.       Error writing a tag, error code: %1,%2.         Invalid value %1 in parameter %2, error code: %3.         Invalid value %1 in parameter %2, valid range [%3 - %4], error code: %5.         Overflow: no data exchange with the PLC.         Overflow status ended: data exchange is running again.         Date/time could not be set, error code: %1,%2.         Cannot select screen number %1.         Error in system function 'IncreaseValue': Tag range exceeded.	
System ever           ID           9999           10111           10112           30010           30011           50000           50001           70011           70016           70025	Analog alarms       System events       Alarm classes       Alar         nts       Alarm text       Global: Unknown error %1,%2,%3,%4,%5,%6,%7,%8,%9.       Number         Recipe does not contain any data records.       Error writing a tag, error code: %1,%2.       Invalid value %1 in parameter %2, error code: %3.         Invalid value %1 in parameter %2, error code: %3.       Overflow: no data exchange with the PLC.       Overflow: no data exchange with the PLC.         Overflow status ended: data exchange is running again.       Date/time could not be set, error code: %1,%2.       Cannot select screen number %1.         Error in system function 'IncreaseValue': Tag range exceeded.       Error in system function 'DecreaseValue': Tag range exceeded.	

#### 7.15.6 Analog alarms

→ Tags can be monitored for limits in "Analog alarms". Click "Add" to create a new alarm. For monitoring, select the → "SPEED\_MOTOR [DB2]" data block in → "CPU\_1214C" and drag the → "Speed\_Actual\_Value" tag from the → "Details view" to the "Trigger tag" field. Next, drag the → "Positive\_Speed\_Threshold\_Error" tag from the → Details view to the "Limit" field.

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ie I	B Devices & networks	^	ID	Alarm text Alarm class Trigger tag Limit	Limit
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	MOTOR_AUTO [FB1]				
	MAGAZINE_PLASTIC [DB3]				
	MOTOR_AUTO_DB [DB1] OPERATING_HMI [DB4]				
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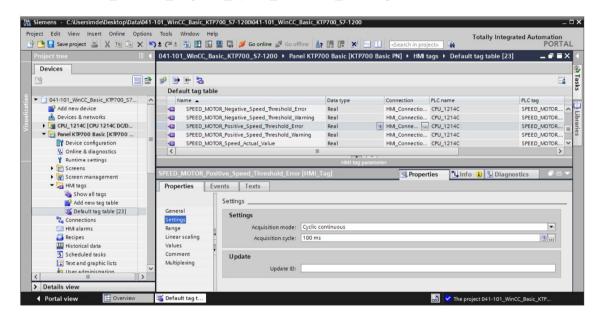
→ Enter the text → "Error threshold exceeded motor pos. speed" in the "Alarm text" column, select the "Alarm class" → "Errors" and → "Higher" for mode. Follow the same procedure to create the three other alarms of alarm classes "Warnings" and "Errors" shown below.

	5	Discrete al	larms 🛛 🖾 Analog alarms 🛛 🛃	System events 🛛 🖓 Alarm classes 🔂 Alar	m groups
• 🕑					5
Analog alarm	15				
ID	Alarm text	Alarm class	Trigger tag	Limit	Limit mod
1	Error threshold exceeded motor pos. speed	Errors	SPEED_MOTOR_Speed_Actual_Value	SPEED_MOTOR_Positive_Speed_Threshold_Error	Higher
2	Warning threshold exceeded motor pos. speed	Warnings	SPEED_MOTOR_Speed_Actual_Value	SPEED_MOTOR_Positive_Speed_Threshold_Warning	Higher
3	Error threshold underran motor neg. speed	Errors	SPEED_MOTOR_Speed_Actual_Value	SPEED_MOTOR_Negative_Speed_Threshold_Error	Lower
S 4	Warnung threshold underran motor neg. speed	Warnings	SPEED_MOTOR_Speed_Actual_Value	SPEED_MOTOR_Negative_Speed_Threshold_Warning	Lower
<add new=""></add>					

→ The tags relevant for the alarm system must be continuously updated cyclically. For this, open the → "Default tag table" of the panel and select the "SPEED\_MOTOR\_Positive\_Speed\_Threshold\_Error" tag.

You can change the  $\rightarrow$  "Acquisition mode" under "Settings" in "Properties" to  $\rightarrow$  "Cyclic continuous". Follow the same procedure to change and check the following tags: "SPEED\_MOTOR\_Speed\_Actual\_Value",

"SPEED\_MOTOR\_Positive\_Speed\_Threshold\_Warning", "SPEED\_MOTOR\_Negative\_Speed\_Threshold\_Error" "SPEED\_MOTOR\_Negative\_Speed\_Threshold\_Warning".



#### 7.15.7 Discrete alarms

 $\rightarrow$  Before you can create discrete alarms in the panel, you need a global tag with at least 16 bits in the CPU 1214C, which you will use to trigger the discrete alarms from the PLC. Here, you open the  $\rightarrow$  "OPERATING HMI[DB4]" data block in the  $\rightarrow$  "Program blocks" folder of "CPU 1214C" and create a global tag  $\rightarrow$  "Group signals01" of data type  $\rightarrow$  "Word".

💁 🔒 Save project 💄 🐰 🏥 🗊	-	-			_							PORT
roject tree		04	1-101	_WinCC_Basic_KTP700	_\$7-1200	CPU_121	I4C [CPU	1214C DC/DC	/DC] 🕨	Program b	locks ▶	OPERATING_HMI [DB4] 📃 🖬 🖬
Devices												
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			OPER	ATING_HMI								
041-101_WinCC_Basic_KTP700_S7	^		Na	me	Data type	Start value	Retain	Accessible f	Writa	Visible in	Setpoint	Comment
Add new device		1	•	Static								
Devices & networks		2	- 0	mode_selector	Bool	false						HMI mode selector manual(0) / automatic
CPU_1214C [CPU 1214C DC/D		3		automatic_start	Bool	false						HMI pushbutton automatic start
Device configuration	=	4	-0-	automatic_stop	Bool	true						HMI pushbutton automatic stop
V. Online & diagnostics		5	•	reset_counter_plastic	Bool	false						HMI reset counter workpieces plastic
<ul> <li>Program blocks</li> </ul>		6	-	group_signals01	Word	16#0						HMI group signals for discrete alarms
Add new block		7		<add new=""></add>								
- Main [OB1]												
MOTOR_SPEEDCONTROL												
MOTOR_SPEEDMONITORI												
MOTOR_AUTO [FB1]												
MAGAZINE_PLASTIC [DB3]												
MOTOR_AUTO_DB [DB1]												

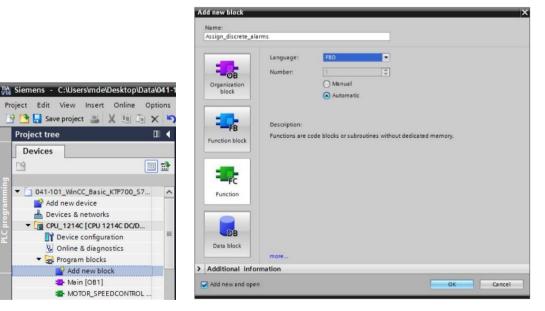
 $\rightarrow$  In the  $\rightarrow$  "Program blocks" folder, click  $\rightarrow$  "Add new block" to create



Project tree

Devices 100

Function  $\rightarrow$  "Assign\_discrete\_alarms".



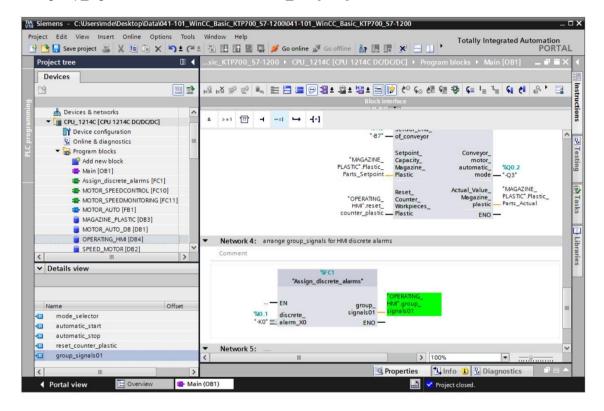
→ In the "Assign\_discrete\_alarms" function, create a local input tag → "discrete\_alarm\_X0" of data type → "Bool" and a local output tag → "group\_signals01" of data type → "Word".
 In the first network, program a simple 'f=l assignment of the → "discrete\_alarm\_X0" tag to the → "group\_signals01" tag.

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**Note:** The "Tag1.%X0" syntax is referred to as slice access in the TIA Portal. This enables, for example, bit-by-bit access to a tag of data type Byte, Word or DWord. If you need additional information on this, you can search the term "slice" in the STEP 7 online help.

→ Next, open the → "Main[OB1]" block in the "Program blocks" folder and call the → "Assign\_discrete\_alarms[FC1]" function → in "Network 4". Connect the input of the "Assign\_discrete\_alarms[FC1]" function with the **negated** global tag → "-K0" / %I0.1 / System "ON" (no) from the "Tag table\_Sorting station".

Connect the output of the "Assign\_discrete\_alarms[FC1]" function to the global tag  $\rightarrow$  "group\_signals01" from the "OPERATING\_HMI[DB4]" data block.



→ Return to → "HMI alarms" → "Discrete alarms" in "Panel KTP700 Basic". Click → "Add" to create a new alarm. Select the → "group\_signals01" tag you just created from the "OPERATING\_HMI[DB4]" data block.

Enter the text  $\rightarrow$  "Main switch OFF" in the "Alarm text" column, select the "Alarm class"  $\rightarrow$  "Warnings" and  $\rightarrow$  "0" for "Trigger bit". The "Trigger address" now displays "OPERATING HMI group signals01.x0".

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	Name									_	
	Acknowledgement	<b>_</b>									
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	Portal view 🗄 Overview 🖂	HMI al	arms					The project 041-101_1	WinCC_Basic_K1		

- → Before the visualization is tested, the "Acquisition cycle" of all newly created tags is to be accelerated again from 1 second to 100 milliseconds in the default tag table.
- → Before the visualization is downloaded to the panel, compile the CPU and panel again and save the project. (→ CPU\_1214C →  $\square$  → Panel KTP700 Basic →  $\square$  → Save project.)
  - → After successful compilation, the entire controller with the created program including the hardware configuration, as previously described in earlier modules, can be downloaded.

 $(\rightarrow CPU \ 1214C \rightarrow \blacksquare)$ 

→ To download the visualization to the panel, follow the same procedure. Select the → "Panel KTP700 Basic [KTP700 Basic]" folder and click the  $\rightarrow$   $\square$  "Download to device" button.

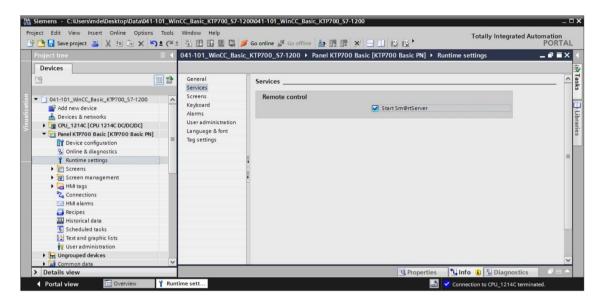
→ Analog alarms and discrete alarms will now be automatically displayed in the "Pending/Unacknowledged alarms" alarm window and in the "Alarm line" in Runtime. Details and help texts can be displayed in the alarm window and alarms can be acknowledged if necessary. If the alarm window has been closed, it can be displayed again by clicking the displayed alarm indicator. Various alarm classes appear in different colors.

W Unacknowl	edged alarms		· ·	main switch OFF	6/ 1 10 AI
No.	Time	Date	Text		
! 1	12:08:04 Pending alarn	AM 6/30/2017	Error thres	hold exceeded motor pos. speed	
-	Pending alarn	an			×
	No.	Time	Date	Text	
	1 1			Error threshold exceeded motor pos. speed	
	2	12:08:04 AM 12:06:46 AM			

## 7.16 Remote operation of Panel KTP700 Basic

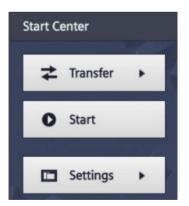
#### 7.16.1 Activating web services for Runtime

→ To enable remote control, the → "Runtime settings" must be opened with a double-click in the configuration for → Panel KTP700 Basic. Under → "Remote control" in "Services", select the → I start Sm@rtServer" option.



#### 7.16.2 WinCC Internet settings on Panel KTP700 Basic

→ Settings must also be made directly on the panel. Select → the "Settings" button in the "Start Center" immediately after switching on the power supply and starting the panel.



**Note:** You must select "Settings" in the "Start Center" quickly before Runtime automatically starts.



Internet

→ Under "Transfer, Network & Internet" click the Settings icon to navigate to the web server settings.

Start Center		
<b>↓</b> Transfer	Settings System	1
Start	Service & Date & Time Sounds System	
Settings	Commissioning Control/Info Transfer, Network & Internet	
	Network Transfer Settings	
	Display & Operation	

 $\rightarrow$  Select the following settings in the "Sm@rtServer" menu item.

Start Center		_
<b>₹</b> Transfer	Sm@rtServer	_
Start	Sm@rtServer ON/OFF ON	
	Start automatically after booting ON	
Settings	Close with Runtime OFF	
Internet Settings	Communication Settings	
Import Certificate	Accept Socket connection ON	
Certificate Store	Encrypt communication     OFF	

→ Under "Security Settings" and "Force Write Access", assign passwords (e.g. "sce") and select the settings shown here.

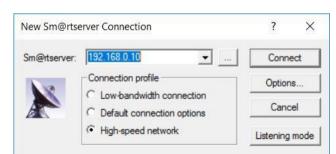
Start Center	Rechteckiges Ausschneiden
<b>≵</b> Transfer	Sm@rtServer
Start	Security Settings
	Enable empty passwords OFF
Settings	Password1: *******
Internet Settings	View only OFF
Import Certificate	Password2: ******
Certificate Store	View only OFF Force Write Access
	Enable force write access ON
	Password: ******

#### 7.16.3 Starting remote access to Panel KTP700 Basic

→ To use remote access to your panel, you can start the  $\rightarrow$  "Sm@rtClient" tool installed with the TIA Portal.



 $\rightarrow$  Enter the IP address of the device  $\rightarrow$  "192.168.0.10" and click on  $\rightarrow$  "Connect".



 $\rightarrow$  A window indicating the status of the connection is displayed as well as another window where you must enter the password you set previously in the panel  $\rightarrow$  "sce"  $\rightarrow$  "OK".

Smartclient Connection	n ×
Connecting to 192.168.0	).10
Status: Authentication sc	cheme requested.
	Hide
Standard VNC Authent	ication ×
	400 400 0 40
Sm@rtserver Host:	192.168.0.10
	Show Server Certificate
Thumbprint: 2E BB B5 F6 55 83 2F 90 User name:	Show Server Certificate 5 E9 D7 D0 D6 98 9F 9 8C 0F 6B 6B DB FE
Thumbprint: 2E BB B5 F6 55 83 2F 90	Show Server Certificate 5 E9 D7 D0 D6 98 9F 9 8C 0F 6B 6B DB FE

→ You then have the option of monitoring and operating the panel remotely and even changing the settings in Windows CE of the device.

Overview Sortin	ng Station		$\bigtriangledown$	6/28/20 3:16:15 F
Speed Motor	gazine Plastic	System screens		
		-86		
-84	-85	Metall/ metal	-8	
Rutsche/Slide	Förderband/Conv	eyor		Plastik/ plastic
-B3 Motor active		-B2		
Speed actual value	0.00 rpm	-B1		
				0

# 7.17 Archiving the project

Finally, you should archive the complete project. Select  $\rightarrow$  "Project"  $\rightarrow$  "Archive ..." in the menu. Create a folder in which you want to archive your project and save your project as file type 'TIA Portal project archive'. ( $\rightarrow$  Project  $\rightarrow$  Archive ...  $\rightarrow$  SCE\_EN\_041-101 WinCC Basic with KTP700 and S7-1200....  $\rightarrow$  Save)

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- 🔁 Open C Migrate project	trl+0	🛛 ┥:_Ba	sic_KTP700_\$7-1200	Panel KTP700 Basic	[KTP700 Basic PN]	Screens → O	verview Sorting Station	_ # = × <
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Start basic integrity check Upgrade						-86		: : : : : : : : : =
Print (	Ctrl+P			-B4 -B5		Metall/ metal	-	B7
C:\\041-101_WinCC_Basic_KTP700_S7-12 D:\\031-600_Global_Data_Blocks_S7-1				_				
	Alt+F4		Rutsche/Slide	Förd	lerband/Conveyor		<b></b>	Plastik/ plastic
Speed Motor	1031163							arie
System information				M1		-B2	Counter workpied	es plastic
System screens			-B3 Motor acti	ve		M4		Reset 💌
User administration		~ <				> 100	o/	
Details view	_	-			Q	Properties 1	Info 🗓 Diagnostics	
Portal view     Overview	0	Overview So					e project 041-101_WinCC_Bas	ic_KTP

# 8 Checklist

No.	Description	Checked
1	Program successfully changed in the CPU 1214C	
2	Successful compilation of the CPU 1214C without error message	
3	Successful download of the CPU 1214C without error message	
4	Process visualization successfully created for Touch Panel KTP700 Basic	
5	Successful compilation of the Touch Panel KTP700 Basic without error message	
6	Successful download of the Touch Panel KTP700 Basic without error message	
7	Switch on system (-K0 = 1) Cylinder retracted / feedback activated (-B1 = 1) EMERGENCY STOP (-A1 = 1) not activated AUTOMATIC mode (in panel) Automatic stop pushbutton not actuated (-S2 = 1) Briefly press the automatic start pushbutton (in panel) Sensor part at slide activated (-B4 = 1) Conveyor motor -M1 variable speed (-Q3 = 1) turns on and remains active The speed corresponds to the speed setpoint in the range of +/- 50 rpm	
8	Sensor at conveyor end activated (-B7 = 1) $\rightarrow$ -Q3 = 0 (after 2 seconds)	
9	Briefly press the automatic stop pushbutton (-S2 = 0 or in panel) $\rightarrow$ -Q3 = 0	
10	Activate EMERGENCY STOP (-A1 = 0) $\rightarrow$ -Q3 = 0	
11	Manual mode (in panel)→ -Q3 = 0	
12	Switch off system (-K0 = 0) $\rightarrow$ -Q3 = 0	
13	Cylinder not retracted (-B1 = 0) $\rightarrow$ -Q3 = 0	
14	Speed > Speed limit fault max. $\rightarrow$ -Q3 = 0	
15	Speed < Speed limit fault min. $\rightarrow$ -Q3 = 0	
16	Values and alarms are displayed on the panel	
17	Project successfully archived	

# 9 Exercise

### 9.1 Task description – Exercise

The following functions are to be added to the process visualization in this exercise:

The **"Overview Sorting Station"** overview screen will display the "Setpoint" and "Actual" "Plastic" workpieces count.

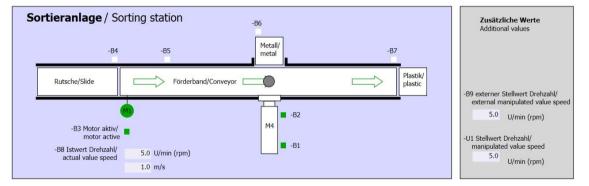
The **"Speed Motor"** screen will display the current speed and speed setpoint of the motor graphically and in IO fields. The speed setpoint can also continue to be specified here.

The error and warning thresholds for positive and negative motor speed are to be displayed and set here in IO fields. A red box in front of the IO fields indicates when a limit has been exceeded.

In the **"Magazine Plastic"** screen, the "Setpoint" and "Actual" count will be displayed graphically and in IO fields. The setpoint for the plastic parts can be specified in the range 0 to 20 in the IO field. The counter can also be reset here.

The emergency stop and the status of automatic mode is also to be monitored in the **alarm system.** If the emergency stop is triggered or automatic mode is stopped, a warning is to be displayed.

# 9.2 Technology schematic diagram



Here you see the technology schematic diagram for the task.

Figure 5: Technology schematic diagram

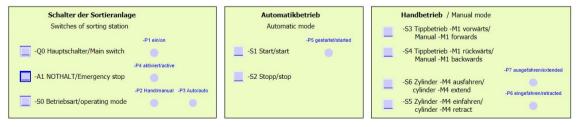


Figure 6: Operator panel

## 9.3 Reference table

		-		
DI	Туре	ID	Function	NC/NO
10.0	BOOL	-A1	Return signal emergency stop ok	NC
I 0.1	BOOL	-K0	Main switch "ON"	NO
10.2	BOOL	-S0	Mode selector manual (0) / automatic (1)	Manual = 0 Auto=1
10.3	BOOL	-S1	"Automatic start" pushbutton	NO
10.4	BOOL	-S2	Pushbutton automatic stop	NC
I 0.5	BOOL	-B1	Sensor cylinder -M4 retracted	NO
I 1.0	BOOL	-B4	Sensor part at slide	NO
l 1.3	BOOL	-B7	Sensor part at end of conveyor	NO
IW64	BOOL	-B8	Sensor actual motor speed +/-10V corresponds to +/- 50 rpm	

The following signals are required as global operands for this task.

DO	Туре	ID	Function	
Q 0.2	BOOL	-Q3	Conveyor motor -M1 variable speed	
QW 64	BOOL	-U1	Motor speed manipulated variable in both directions +/-10V corresponds to +/- 50 rpm	

#### Legend for reference list

- DI Digital input
- AI Analog input
- I Input
- NC Normally Closed
- NO Normally Open

- DO Digital output
- AO Analog output
- O Output

# 9.4 Planning

Plan the implementation of the task by yourself.

# 9.5 Checklist – Exercise

No.	Description	Checked
1	Program successfully changed in the CPU 1214C	
2	Successful compilation of the CPU 1214C without error message	
3	Successful download of the CPU 1214C without error message	
4	Process visualization successfully created for Touch Panel KTP700 Basic	
5	Successful compilation of the Touch Panel KTP700 Basic without error message	
6	Successful download of the Touch Panel KTP700 Basic without error message	
7	Switch on system (-K0 = 1) Cylinder retracted / return signal activated (-B1 = 1) EMERGENCY STOP (-A1 = 1) not activated AUTOMATIC mode (in panel) "Automatic stop" pushbutton not pressed (-S2 = 1) Briefly press "Automatic start" pushbutton (in panel) Sensor part at slide activated (-B4 = 1) Conveyor motor -M1 variable speed (-Q3 = 1) turns on and remains active The speed corresponds to the speed setpoint in the range of +/- 50 rpm	
8	Sensor at conveyor end activated (-B7 = 1) $\rightarrow$ -Q3 = 0 (after 2 seconds)	
9	Briefly press "Automatic stop" pushbutton (-S2 = 0 or in panel) $\rightarrow$ -Q3 = 0	
10	Activate EMERGENCY STOP (-A1 = 0) $\rightarrow$ -Q3 = 0	
11	Manual mode (in panel) $\rightarrow$ -Q3 = 0	
12	Switch off system (-K0 = 0) $\rightarrow$ -Q3 = 0	
13	Cylinder not retracted (-B1 = 0) $\rightarrow$ -Q3 = 0	
14	Speed > Speed limit fault max. $\rightarrow$ -Q3 = 0	
15	Speed < Speed limit fault min. $\rightarrow$ -Q3 = 0	
16	Values and alarms are displayed on the panel	
17	Project successfully archived	

# **10** Additional information

More information for further practice and consolidation is available as orientation, for example, Getting Started, videos, tutorials, apps, manuals, programming guidelines and trial software / firmware, under the following link:

siemens.com/sce/s7-1200

#### Preview "Additional information"

- Getting Started, Videos, Tutorials, Apps, Manuals, Trial-SW/Firmware
  - ↗ TIA Portal Videos
  - TIA Portal Tutorial Center
  - > Getting Started
  - ↗ Programming Guideline
  - Easy Entry in SIMATIC S7-1200
  - > Download Trial Software/Firmware
  - Technical Documentation SIMATIC Controller
  - ↗ Industry Online Support App
  - TIA Portal, SIMATIC S7-1200/1500 Overview
  - ↗ TIA Portal Website
  - ↗ SIMATIC S7-1200 Website
  - ↗ SIMATIC S7-1500 Website

# Notes

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# Notes

12

# SCE Learn-/Training Textbook

# Automation System SIMATIC S7-1200



#### TIA Portal Modules from Version V14 SP1

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TIA Portal Module 051-300 PID Controller	14
TIA Portal Module 051-201 High-Level Language Programming with SCL	13
TIA Portal Module 041-101 WinCC Basic with KTP700	12
<b>TIA Portal Module 031-600</b> Global Data Blocks	11
<b>TIA Portal Module 031-500</b> Analog Values	10
<b>TIA Portal Module 031-420</b> Diagnostics via Web	9
<b>TIA Portal Module 031-410</b> Basics of Diagnostics	8
TIA Portal Module 031-300 IEC Timers and IEC Counters	7
TIA Portal Module 031-200 Basics of FB Programming	6
TIA Portal Module 031-100 Basics of FC Programming	5
<b>TIA Portal Module 020-100</b> Process description of sorting station	4
<b>TIA Portal Module 011-101</b> Specified Hardware Configuration	3
TIA Portal Module 011-100 Unspecified Hardware Configuration	2
<b>TIA Portal Module 011-001</b> Firmware Update	1

#### Matching SCE Trainer Packages for these Learn-/Training Document

- SIMATIC S7-1200 AC/DC/RELAY (set of 6) "TIA Portal" Order no.: 6ES7214-1BE30-4AB3
   SIMATIC S7-1200 DC/DC/DC (set of 6) "TIA Portal"
- Order no.: 6ES7214-1AE30-4AB3
- Upgrade SIMATIC STEP 7 BASIC V14 SP1 (for S7-1200) (set of 6) "TIA Portal" Order no.: 6ES7822-0AA04-4YE5

Note that these trainer packages are replaced with successor packages when necessary. An overview of the currently available SCE packages is available at: siemens.com/sce/tp

#### Continued training

For regional Siemens SCE Continued Training, get in touch with your regional SCE contact: <u>siemens.com/sce/contact</u>

#### Additional information regarding SCE

siemens.com/sce

#### Information regarding use

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Use for industrial customer courses is explicitly not permitted. We do not consent to commercial use of the Learn-/Training Document.

We wish to thank the TU Dresden, particularly Prof. Dr.-Ing. Leon Urbas and the Michael Dziallas Engineering Corporation and all other involved persons for their support during the preparation of this Learn-/Training Document.

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# High-Level Language Programming with SCL and S7-1200

# 1 Objective

In this section, you will become familiar with the basic functions of the SCL high-level language. Test functions for eliminating logical programming errors will also be presented.

The SIMATIC S7 controllers listed in section 3 can be used.

# 2 Requirements

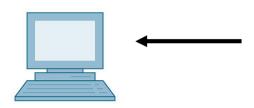
This section builds on the hardware configuration of a SIMATIC S7-1200. It can be implemented with any hardware configurations that have digital input and output cards. To implement this section, you can use the following project, for example:

"SCE\_EN\_011\_101\_Hardware\_Configuration\_CPU1214C.....zap14"

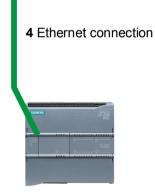
You should also be familiar with high-level language programming, such as Pascal.

# 3 Hardware and software required

- **1** Engineering Station: The requirements are hardware and operating system (for additional information, see Readme on the TIA Portal Installation DVD)
- 2 SIMATIC STEP 7 Basic software in the TIA Portal as of V14 SP1
- 3 SIMATIC S7-1200 controller, e.g. CPU 1214C DC/DC/DC Firmware V4.2.1 or higher
- 4 Ethernet connection between the engineering station and controller



1 Engineering station



3 SIMATIC S7-1200 controller



2 SIMATIC STEP 7 Basic (TIA Portal) as of V14 SP1

### 4 Theory

#### 4.1 SCL programming language

SCL (Structured Control Language) is a high-level, Pascal-based programming language that enables structured programming. The language corresponds to the "Structured Text" (ST) programming language specified in DIN EN-61131-3 (IEC 61131-3). In addition to high-level language elements, SCL contains typical elements of the PLC as language elements such as inputs, outputs, timers, block calls, etc. It supports the STEP 7 block concept and enables block programming in compliance with standards in addition to programming with Ladder Logic (LAD) and Function Block Diagram (FBD). This means SCL supplements and expands the STEP 7 programming software with its LAD and FBD programming languages.

You do not have to create every function yourself but can use pre-compiled blocks, such as system functions and system function blocks that are present in the CPU's operating system.

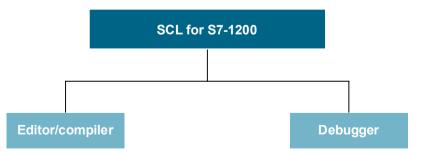
Blocks that are programmed with SCL can be mixed with LAD and FBD blocks. This means that a block programmed with SCL can call another block that is programmed in LAD or FBD. Accordingly, SCL blocks can also be called in LAD and FBD programs.

SCL networks can also be inserted in LAD and FBD blocks.

The SCL test functions can be used to find logical programming errors in an error-free compilation.

#### 4.2 SCL development environment

There is a development environment that is tailored to the specific properties of both SCL and STEP 7 for use and application of SCL. This development environment consists of an editor/compiler and a debugger.



#### Editor/compiler

The SCL editor is a text editor that can be used to edit any text. The main task of the SCL editor is the creation and editing of blocks for STEP 7 programs. A basic syntax check is performed during the input which makes it easier to avoid errors during programming. Syntax errors are displayed in different colors.

#### The editor offers the following options:

- Programming of an S7 block in the SCL language
- Convenient insertion of language elements and block calls using drag & drop
- Direct syntax check during programming
- Customization of the editor to meet your needs, e.g. color-coding for the different language elements according to syntax
- Checking of the finished block through compiling
- Display of all errors and warnings that occur during compiling
- Localization of error locations in the block, optionally with error description and information on troubleshooting

#### Debugger

The SCL debugger enables you to check a program while it is running in the automation system (AS) and thus find potential logical errors.

SCL provides two different test modes:

- Continuous monitoring
- Step-by-step monitoring

With "Continuous monitoring" you can test a group of instructions within a block. During the test, the values of the tags and parameters are displayed in chronological order and – if possible – updated cyclically.

With "Step-by-step monitoring" the logical program sequence is followed. You can run the program algorithm instruction-by-instruction and observe how the contents of the processed tags change in a result window.

The type of CPU you are using determines whether or not you can use "Step-by-step monitoring". The CPU must support the use of breakpoints. The CPU used in this document does not support breakpoints.

## 5 Task

#### 5.1 Example task – Tank volume

In the first part, you are to program the calculation of the tank volume.

#### 5.2 Expansion of the sample task

In the second part, the task is expanded and you are to program an error evaluation.

# 6 Planning

The tank is in the shape of a vertical cylinder. The filling level is measured with an analog sensor. For the first test, the filling level value should be available as a scaled value (in meters).

Global parameters, such as the diameter and height of the tank, are to be stored in a structured manner in a global data block "Data\_Tank".

The program for calculation of the volume should be written in a "Calculate\_Volume" function and the parameters are to use the unit 'meter' or 'liter'.

#### 6.1 Global data block "Data\_Tank"

The global parameters are stored in multiple structures in a global data block.
---------------------------------------------------------------------------------

Name	Data type	Start value	Comment
Dimensions	STRUCT		
Height	REAL	12.0	in meter
Diameter	REAL	3.5	in meter
measured_data	STRUCT		
filling_level_per	INT	0	value between 027648
filling_level_scal	REAL	0.0	range 012.0.
Volume	REAL	0.0	Volume of tank in liter
fault_flags	STRUCT		
calculate_volume	BOOL		fault == true
Scaling	BOOL		fault == true

Table 1: Parameters in the "Data\_Tank" data block

13

#### 6.2 "Calculate\_Volume" function

This block calculates the volume of the tank in liters.

In the first step, there is to be no check of the transferred parameters for reasonableness.

The following parameters are required for this step:

Input	Data type	Comment
Diameter	REAL	Diameter of cylindric tank in meter
Filling_level	REAL	Filling level of liquid in meter
Output		
Volume	REAL	Volume of liquid in the tank in liter

Table 2: Parameters for "Calculate\_Volume" function in the first step

The formula for calculating the volume of a vertical cylinder is used to solve the task. The conversion factor 1000 is used to calculate the result in liters.

$$V = \frac{d^2}{4} \bullet \pi \bullet h$$
 =>  $\# Volume = \frac{\# Diameter}{4} \bullet 3.14159 \bullet \# Filling_le vel \bullet 1000$ 

#### 6.3 Expansion of the "Calculate\_Volume" function

The second step checks whether the diameter is greater than zero. In addition, a test is to be performed to determine whether the filling level is greater than or equal to zero and less than or equal to the height of the tank.

In case of an error, the new parameter "er" is set to TRUE, and the "Volume" parameter is set to the value -1.

Input	Data type	Comment
Height	REAL	Height of cylindric tank in meter
Diameter REAL Diameter of cylindric tank in meter		Diameter of cylindric tank in meter
Filling_level	REAL	Filling level of liquid in meter
Output		
er	BOOL	fault flag; fault == true
Volume	REAL	Volume of liquid in the tank in liter

For this purpose, add the "er" and "Height" parameters to the interface.

Table 3: Parameters for "Calculate\_Volume" function in the second step

# 7 Structured step-by-step instructions

You can find instructions on how to implement the planning below. If you already have a good understanding of everything, it is sufficient to focus on the numbered steps. Otherwise, simply follow the steps of the instructions explained below.

#### 7.1 Retrieving an existing project

ightarrow Before you can start programming, you need a project with a hardware configuration.

(e.g. SCE\_EN\_011-101\_Hardware\_Configuration\_CPU1214C\_....zap14).

To retrieve an existing project, you must select the respective archive from the Project view under  $\rightarrow$  Project  $\rightarrow$  Retrieve. Confirm your selection with "Open".

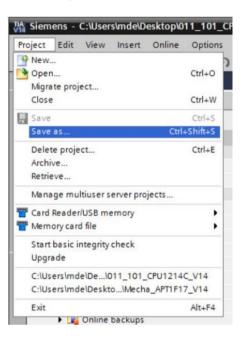
roject	Edit	View	Insert	Online	Options
New. Oper Migra		ert			Ctrl+O
Close					Ctrl+W
Save					Ctrl+S
Save	85			Ctrl	+Shift+S
Delet Archi	t <mark>e proje</mark> ve	ct			Ctrl+E
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	Reader ory care	/USB me d file	emory		;
Start Upgr		ntegrity	check		
D:IOF	C Work	shop Dz	tialla\TT/	abausteine A-Beispielp a_APT1F11	orojekt
Exit					Alt+F4

 $(\rightarrow \text{Project} \rightarrow \text{Retrieve} \rightarrow \text{Selection of a .zap archive} \rightarrow \text{Open})$ 

→ Next you can select the target directory to which you want to save the retrieved project. Confirm your selection with "OK". ( $\rightarrow$  Project  $\rightarrow$  Save as...  $\rightarrow$  OK)

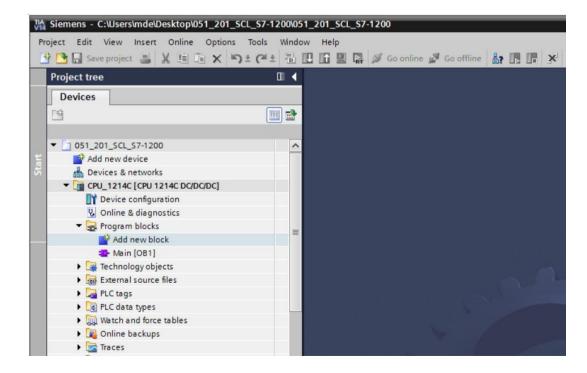
#### 7.2 Saving the project under a new name

→ You save the opened project under the name 051-201\_SCL\_S7-1200. ( $\rightarrow$  Project  $\rightarrow$  Save as ...  $\rightarrow$  051-201\_SCL\_S7-1200  $\rightarrow$  Save)



#### 7.3 Creating the "Data\_Tank" data block

 $\rightarrow$  In the Project view, navigate to  $\rightarrow$  the program blocks and create a new block by doubleclicking  $\rightarrow$  Add new block.



 $\rightarrow$  Now select a data block and enter the name.



Add new block					×
Name: Data_Tank					
Organization block	Type: Language: Number:	Global DB DB 1 Manual	▼ ▼		
Function block	Description: Data blocks (DE more	<ul> <li>Automatic</li> <li>Bs) save program data.</li> </ul>			
Function					
Data block					
> Additional infor	mation				
Add new and oper	1			ок	Cancel

 $\rightarrow$  Next, enter the names of the tags listed below with data type, start value and comment.

ý	Da				ctual values 🔒 Sna	apshot 🔤 🖏	Copysnap	shots to start va	lues 🧝	- 8- •		8
		Na	me		Data type	Start value	Retain	Accessible f	Writa	Visible in	Setpoint	Comment
1		-	St	atic								
2			•	dimensions	Struct							
3	-			height	Real	12.0						in meter
1				diameter	Real	3.5						in meter
5	-		•	measured_data	Struct							
5	-			filling_level_per	Int	0						range 027648
7	-			filling_level_scal	Real	0.0						range 012.0
3	-			volume_liquid	Real	0.0						in liter
)	-		•	fault_flags	Struct							
0				calculate_volume	Bool	false						fault == true
1	-			scaling	Bool	false						fault == true

# 7.4 Creating the "Calculate\_Volume" function

 $\rightarrow$  Next, add a function, enter the name and select the language.

Name: Calculate_Volume					
calculate_volume					
	Language:	SCL	-		
	Number:	1	\$		
-OB Organization		O Manual			
block		<ul> <li>Automatic</li> </ul>			
	Description:				
FB		ode blocks or subrout	tines without dedic	ated memory.	
Function block					
FC					
Function					
DB					
Data block	more				

#### 7.5 Specifying the interface of the "Calculate\_Volume" function

 $\rightarrow$  The top section of your programming view shows the interface description of your function.

3		à¢.	1	🕈 ± 🐛 🖹 溜 🖓 ± 😥	° ና 🖑 🖑 🖷	🥸 年 🗉 🖯	# '= '= <b>  ° \$  ¢! \$^ °° °° °°</b> 🔒	-
	Ca	alo	cul	ate_Volume				
		1	Na	me	Data type	Default value	Comment	
	•	-		Input				
2		1	•	<add new=""></add>				
3	-			Output				
ŧ.		1	•	<add new=""></add>				
5	•	•	•	InOut				
5				<add new=""></add>				
7	•	•	•	Temp				
3				<add new=""></add>				
9	-	•	•	Constant				
0			•	<add new=""></add>				
1	-	•	•	Return				
12	-			Calculate_Volume	Void			
	1	_	-	The second se			last the second s	
	Ŀ	IF		CASE FOR WHILE (**) REGION				
			_	and feetend and 1			[	

- $\rightarrow$  Create the following input and output parameters.
  - $(\rightarrow \text{Name} \rightarrow \text{Data type} \rightarrow \text{Comment})$

05	1_2	201	_SCL_S7-1200   CPU_12	214C [CPU 1214	C DC/DC/DC] ► Pr	ogram blocks 🔸 Calculate_Volume [FC1]	_∎■×
-	1		🖻 ± 🐛 Ѐ 🔠 🚟 ± 😥	(° 💊 🖑 🧐	1 TH 🍄 📢 🗐 1	■ 辩 != *= 110 い 01 02 02 02 00	
	Cal	cul	ate_Volume				
		Na	me	Data type	Default value	Comment	
1		•	Input				
2	-		Diameter	Real		diameter cylindric tank in meter	
3	-		Filling_level	Real		filling level of liquid in meter	
4			<add new=""></add>				
5		•	Output				
6			Volume	Real		volume of liquid in the tank in liter	
7			<add new=""></add>				
В		•	InOut				
9			<add new=""></add>				
10		•	Temp				
11			<add new=""></add>				
12	-	-	Constant				
13			<add new=""></add>				
14	-	•	Return				
15	-		Calculate_Volume	Void			

# 7.6 Programming the "Calculate\_Volume" function

 $\rightarrow$  Enter the program shown below. ( $\rightarrow$  Enter program)

			late Volume			i #i i i i i i i i i i i i i i i i i i	-
			me	Data type	Default value	Comment	
1	-	-	Input				1
2	-		Diameter	Real		diameter cylindric tank in meter	-
3	-		Filling_level	Real		filling level of liquid in meter	
È.			<add new=""></add>				
5	-	-	Output				
5	-	-	Volume	Real		volume of liquid in the tank in liter	1
	<						>
	IF		CASE FOR WHILE (**) REGION	1			

→ Now compile your program and check it for syntax errors. These are displayed in the Inspector window below the programming. Correct any errors and compile the program again.

	_SCL_S	7-12	0\051	201_SCL_S7-1200						
ect Edit View Insert Online Option							1	Totall	ly Ir	ntegrated Automation
🎦 🔚 Save project 📑 🐰 🏥 🗎 🗙	<b>9</b> ± (						Search in projects			PORT
roject tree	_ Ⅲ ◀		1200	CPU_1214C [CPU	1214C DC/DC/DC] >	Program blocks	› Calculate_Volume [FC1] 🛛 💻 🖬	=×		nstructions 📑 🗉
Devices									0	Options
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			Calcul	ate_Volume					5	Favorites
051_201_SCL_S7-1200	^		Na	me	Data type	Default value	Comment			Basic instructions
Add new device		1	- 🗈	Input				^		ame
📥 Devices & networks		2	- 13-	Diameter	Real		diameter cylindric tank in meter	=		Bit logic operations
CPU_1214C [CPU 1214C DC/DC/DC]		3	- 🗈	Filling_level	Real		filling level of liquid in meter			Timer operations
Device configuration		4		<add new=""></add>						+1 Counter operations
S Online & diagnostics		5	• 🗈	Output						Comparator operatio
<ul> <li>Program blocks</li> </ul>	=	6	• 🗈	Volume	Real	Ξ	volume of liquid in the tank in liter	_		1 Math functions
Add new block		7	<	<add new=""></add>		111		>		Move operations
Main [OB1]			_		P.	And hutbud		-		Conversion operation
Calculate_Volume [FC1]			15.5	CASE FOR WHILE (**)	REGION				•	Program control oper
Data_Tank [DB1] Eachnology objects		0		second has a mail second by the					•	Word logic operations
External source files		S I	1		iameter) / 4 * 3.14	59 * #Filling_1	evel * 1000;			Shift and rotate
PLC tags		Ec.	-							
PLC data types										
Watch and force tables			<	Ш		>	100%			
Conline backups						Q Properties	🚺 Info 🚯 😯 Diagnostics 📃	8.4		
🕨 🔀 Traces				Cross-referen					ь.	
Device proxy data						Energy Suite	Syntax		١.	
Program info		0		Show all messages	*				L.	
PLC alarm text lists		C	mpilin	g finished (errors: 0; warn	ings: 0)				L	
Local modules		1	Path		Description		Go to ?		<	111
Ungrouped devices		0	-	Program blocks			~	0 ^	>	Extended instruction
Common data		0		Calculate_Volume (F	C1) Block was success		×		>	Technology
Documentation settings		0			Compiling finished	(errors: 0; warnings	: 0)	=	-	33
Languages & resources	~							~		Communication

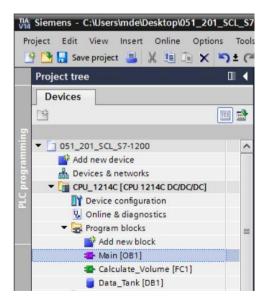
			<b>Properties</b>	🗓 Info 💧	🗓 🔽 Diagno	stics		•
Genera	al () Cross-references	Compile	Energy Suite					
34	Show all messages		-					
Compilin	g finished (errors: 0; warnings	: 0)						
! Path		Description			G	io to	? .	
	Program blocks					7		0 ^
0	Calculate_Volume (FC1)	Block was succe	ssfully compiled.			>		
<b>e</b>		Compiling finish	ed (errors: 0; warning	(0 s: 0				
								~
<								>

#### 7.7 **Programming the "Main [OB1]" organization block**

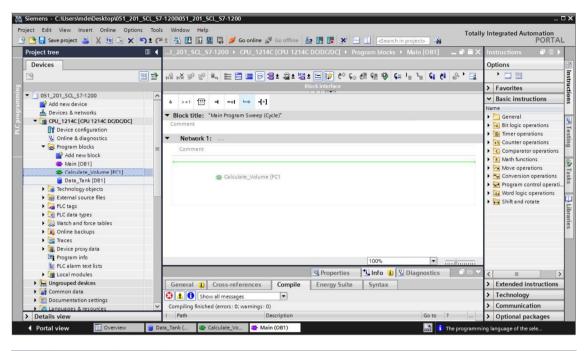
→ Before programming the "Main [OB1]" organization block, switch the programming language to FBD. To do this, click on "Main [OB1]" in the "Program blocks" folder.
 (→ CPU\_1214C[CPU 1214C DC/DC/DC] → Program blocks → Main [OB1] → Switch programming language → FBD)

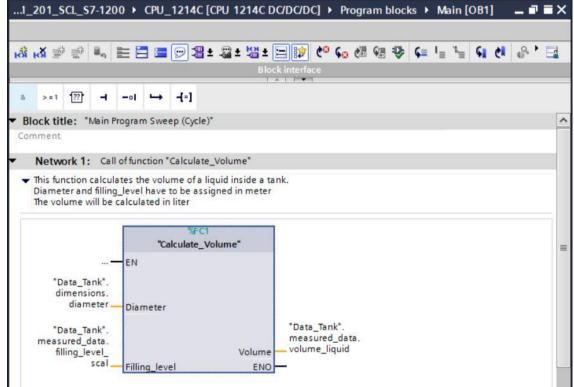
Ma Siemens - C:\Users\mde\Des	ktop\051_201_SCL_\$7	7-1200\051_201	_SCL_S7-1200								_ 🗆 X
Project Edit View Insert C	Dnline Options Tool		elp 🖳 🞇 💋 Go online	🖉 Go offline 🛔		earc	h in project>	Tot	ally I	Integrated Auto	PORTAL
Project tree	u 4	<b>7-1200</b> ▶	CPU_1214C [CPU 12	14C DC/DC/DC] 🕨	Program blocks	➤ Calculate	e_Volume [FC1]	_ • •	×	Instructions	
Devices										Options	- 1
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2		Calculate	Volume							Favorites	T
▼ CPU_1214C [CPU 1214		Name		Data type	Default value	Comment				<ul> <li>Basic instruct</li> </ul>	tions
Device configuration		1 💶 🔻 Inpu			_				^	lame	0
Doline & diagnosti	cs		Diameter	Real			ylindric tank in mete	er	=	Bit logic oper	rations
Program blocks			illing_level	Real		filling level	of liquid in meter			Timer operat	tions 🗳
Main [OB1]			/olume	Real		volume of	liquid in the tank in	liter		+1 Counter oper	
Calculate_Volu	Open			Ne of		volume on		incer		Comparator	operations
Data_Tank [DB1	X Cut	Ctrl-	+X new>						$\sim$	Math function	
	Lage Technology object:     Lage Copy     Lage External source file     Lage Paste		+C					>		Conversion c	12.4
			+V R WHILE (**) REGI	24						Program con	trol operati
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Co PLC data types	Rename		F2 ume := SQR(#Diam	eter) / 4 * 3.14	159 * #Filling_	level * 1000	);			Shift and rota	ate
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Traces	Download to device										ibr
Device proxy data	So online	Ctrl-	100			> 100%	•				arie
Program info	-	Ctria	FM		Q Properties	🗓 Info 追	2 Diagnostics				S
			Cross-references	Compile	Energy Suite	Syntax	]				
Local modules	Search in project	Ctrl	+F all messages	·	5,						
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Common data     Documentation settin	X Cross-references	F	11	Description			Go to	?		c III	>
Languages & resource	X Cross-reference info	irmation Shift+F	11 blocks	Description						Extended ins	
Online access	Call structure		ulate_Volume (FC1)	Block was success	fully compiled.						ductions
🕨 🣴 Card Reader/USB memory				Compiling finished	(errors: 0; warning	s: 0)			-		
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 $\rightarrow$  Now double-click the "Main [OB1]" organization block to open it.



→ Call the "Calculate\_Volume" function in the first network. Assign network title, comment and connect the parameters. (→ Call "Calculate\_Volume" → Assign network title → Write network comment → Connect parameters)





#### 7.8 Compiling and downloading the program

Save project

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→ Click the "Program blocks" folder and compile the entire program. After successful compilation, save your project and download it to the controller.

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	Block interface	> Favorites
051_201_SCL_S7-1200	a >=1 177 + -ol ↦ +=]	✓ Basic instructions
Add new device		Name
n Devices & networks	<ul> <li>Block title: "Main Program Sweep (Cycle)"</li> </ul>	A General
CPU_1214C [CPU 1214C DC/DC/DC]	Comment	Bit logic operations
Device configuration		Timer operations
Online & diagnostics	<ul> <li>Network 1: Call of function "Calculate_Volume"</li> </ul>	+1 Counter operations
▼ Program blocks =	<ul> <li>This function calculates the volume of a liquid inside a tank.</li> </ul>	Comparator operation
Add new block	Diameter and filling_level have to be assigned in meter The volume will be calculated in liter	■ ► 主 Math functions
- Main [OB1]	The volume will be calculated in liter	Move operations
Calculate_Volume [FC1]	%FC1	Conversion operation
Data_Tank [DB1]	"Calculate_Volume"	Program control opera
Technology objects		Word logic operations
External source files	EN	Shift and rotate
PLC tags	"Data_Tank".	
C data types	dimensions.	
Watch and force tables	diameter Diameter	
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🕨 🚰 Traces	measured_data. measured_data.	
Device proxy data	filling_levelVolumeVolume	
Program info	SC81 Filling level FNO	-
PLC alarm text lists		
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Engrouped devices	General 1 Cross-references Compile Energy Suite Syntax	> Extended instruction
Common data		> Technology
Documentation settings		
Languages & resources	Compiling finished (errors: 0; warnings: 0)	> Communication
Details view	I Path Description Go to ?	···· > Optional packages

 $\rightarrow$  Select PG/PC interface  $\rightarrow$  Select subnet  $\rightarrow$  Start search  $\rightarrow$  Load

	Device	Device type	Slot	Туре	Address	Subnet
	CPU_1214C	CPU 1214C DC/D	1 X1	PN/IE	192.168.0.1	PN/IE_1
		Type of the PG/PC inte		PN/IE		•
		PG/PC inte			Ethernet Connection (4)	
		Connection to interface/su	bnet:	Direct at s	lot '1 X1'	- •
		1st gat	eway:			
	Select target devi	ce: Device type	Interf	ace type	Show all compatib	Target device
	CPU_1214C	CPU 1214C DC/D PN/IE			192.168.0.1	CPU_1214C
й а	-	-	PN/IE		Access address	-
Flash LED						
ine status informat	ion:				Display only erro	<u>Start sear</u>
		th address 192.168.0.1.				
Scan completed.	1 compatible devices	of 1 accessible devices fou	ind.			
<b>Retrieving device</b>						

 $\rightarrow~$  Make a selection, if necessary  $\rightarrow~$  Load

tatus	1	Target	Message	Action
+0	2	▼ CPU_1214C	Ready for loading.	
	4	Protection	Protection from unauthorized access	
	0	Stop modules	The modules are stopped for downloading to device.	Stop all
	0	Device configurati	Delete and replace system data in target	Download to device
	0	Software	Download software to device	Consistent download
	0	Additional inform	There are differences between the settings for the project and the	Vverwrite all
	0	Text libraries	Download all alarm texts and text list texts	Consistent download

#### $\rightarrow$ Finish

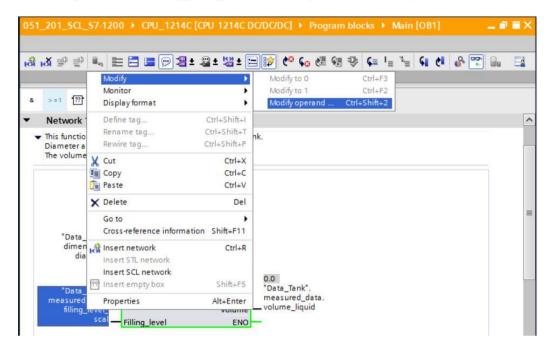
Status	1	Target	Message	Action
1	9	▼ CPU_1214C	Downloading to device completed without error.	
	4	Start modules	t modules Start modules after downloading to device.	Start all
<			1	

#### 7.9 Monitoring and testing the organization block

 $\rightarrow$  In the open OB1, click the  $\square$  icon to monitor the block.

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				Block interface					
>=1 [??]		→ -[-]						Monitorin	g on
Network 1:	Call of fu	nction *Calculate	e_Volume*						
		the volume of a l							
Diameter and The volume wi	illing_leve	el have to be ass lated in liter	igned in meter						
"Data_Tar dimensio				0.0					

→ Test your program by writing a value to the "Filling\_level\_scal" tag in the data block. ( $\rightarrow$  Right-click on "Filling\_level\_scal"  $\rightarrow$  "Modify" menu  $\rightarrow$  Modify operand)



 $\rightarrow$  Enter value 6.0  $\rightarrow$  OK

Modify			×
Operand:	"Data_Tank".measured_data.filling	Data type:	Real
Modify value:	6.0	Format:	Floating-point number
			OK Cancel

 $\rightarrow$  Check the result for correctness.

	_201_	_SCL_	\$7-1	200 )	CPU	_12140	C [CPU	1214	C DC	DC/DC		Prog				• 1	Main	[OE	31]				
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#### 7.10 Expansion of the "Calculate\_Volume" function

→ Open the "Calculate\_Volume" function, and insert a row in the output parameters by rightclicking the row in the interface.

 $(\rightarrow \text{Open "Calculate_Volume"} \rightarrow \text{Right-click on row 5} \rightarrow \text{Insert row})$ 

ġ?		📄 ± 嶋 📄 溜 🛛 ulate_Volume	± 😰 🤄 📢	e 🔚 📲 🐩	•₽ ⊊ ∃	≣ =≣ ## '≡ ''=  ∥≎ \$∥ ¢∥ (*   )	
	N	lame	Data typ	e	Default va	Comment	
	-	nput	31				
	-	Diameter	Real			diameter cylindric tank in meter	
	-	Filling_level	Real			filling level of liquid in meter	
	-	Output				· ·	
	A	Insert row Add row				volume of liquid in the tank in liter	
	X	Cut	Ctrl+X		-		>
Γ		Сору	Ctrl+C				
L	n	Paste	Ctrl+V				
L	×	Delete	Del	* 3.14159	* #Fillin	g_level * 1000;	
L		Rename	F2				
L	-	Update interface					
4		Go to next point of use	Ctrl+Shift+G				
		Go to definition	Ctrl+Shift+D				
1.	1	Cross-references	F11				

 $\rightarrow$  Enter the parameter "er" with data type BOOL and comment.

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			late_Volume	,			
		Na	me	Data type	Default va	Comment	
1	-	•	Input				~
2	-00		Diameter	Real		diameter cylindric tank in meter	-
3	-00		Filling_level	Real		filling level of liquid in meter	1
4	-	•	Output				
5	-		er	Bool	1	fault flag; fault == true	
6	-		Volume	Real		volume of liquid in the tank in liter	-

 $\rightarrow$  Follow the same steps to add the "Height" tag with data type Real and comment.

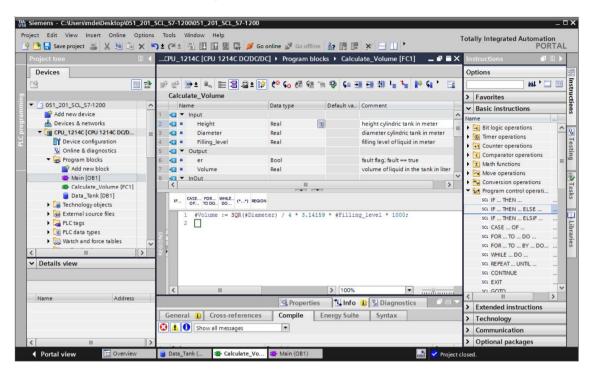
	•	CPL	J_1214C [CPU 1214C DC/D	IC/DC] → Program I	olocks 🕨 C	alculate_Volume [FC1] 🛛 🗕 🖬 🗖	×
1				) ¢° ६₀ १≣ ९≣ ⊺≣	₽ 6= -	■ 亜 翁 i= z=   o 61 64   , E	d
	Cal		late_Volume	Data type	Default va	Comment	Ì
1		•	Input				~
2	-		Height	Real		height cylindric tank in meter	
3	-		Diameter	Real		diameter cylindric tank in meter	
4	-		Filling_level	Real		filling level of liquid in meter	-
5	-	-	Output				
6	-		er	Bool		fault flag; fault == true	
7	-		Volume	Real		volume of liquid in the tank in liter	

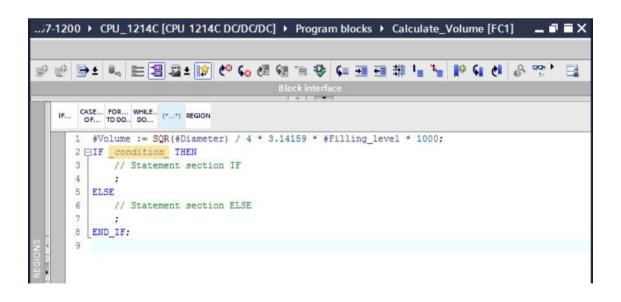
→ Then go to the "IF...THEN...ELSE" control statement from the "Program control operations" folder of Basic instructions.

 $(\rightarrow \text{Instructions} \rightarrow \text{Basic instructions} \rightarrow \text{Program control operations} \rightarrow "IF...THEN...ELSE")$ 

In	structions 📑	D		
Op	otions			- 8
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>	Favorites			Instructions
~	Basic instructions			suo
Na	me			
+	Bit logic operations		^	U
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+	Math functions		≡	
•	Move operations			R.
•	Conversion operations			H
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	SCL IF THEN			S
	SCL IF THEN ELSE			em
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	SCL FOR TO DO			ari
	SCL FOR TO BY DO			SB
	sci WHILE DO			
	SCL REPEAT UNTIL			
	SCL EXIT			

→ Then drag the "IF...THEN...ELSE" control statement to the second row of the program. ( $\rightarrow$  "IF...THEN...ELSE"  $\rightarrow$  drag & drop)





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- → Highlight the mathematical formula and move it onto the semicolon in front of the ELSE using drag & drop.
  - $(\rightarrow \text{Select} \rightarrow \text{drag \& drop})$

	200 → CPU_1214C [CPU 1214C DC/DC/DC] → Program blocks → Calculate_Volume [FC1] 🛛 🗕 🖬 🗮 🗙
ý í	· 글 · 씨, 돈 웹 월 · (*) (* 6) (# 영 · 영 · 우 · · · · · · · · · · · · · · ·
	Block interface
IF	CASE FOR WHILE (**) REGION
	<pre>1 #Volume := SQR(#Diameter) / 4 * 3.14159 * #Filling_level * 1000;</pre>
	2 PIF condition THEN
	3 // Statement section IF
	4
	5 ELSE
	6 // Statement section ELSE
	7 :
	8 END_IF;
SN -	9
8	
5	
/-1	200 🕨 CPU_1214C [CPU 1214C DC/DC/DC] 🕨 Program blocks 🕨 Calculate_Volume [FC1] 🛛 🗕 🖬 🗖 🗡

		▶ + 🐂 三國 월 + 😥 🧐 🕲 📾 📾 🗇 🚱 📾 🗃 🖓 👘 👬 👘 👘 📢 👘 🖏 📑
		Block interface
-	-	
	IF	CASE FOR WHILE (**) REGION
	1 2 3	2 DIF condition THEN 3 // Statement section IF
	4	#Volume := SQR(#Diameter) / 4 * 3.14159 * #Filling_level * 1000;
	5	5 ELSE
	6	5 // Statement section ELSE
	7	
_	8	END_IF;
SNOI	9	

 $\rightarrow~$  Complete the function and check your program by compiling it.

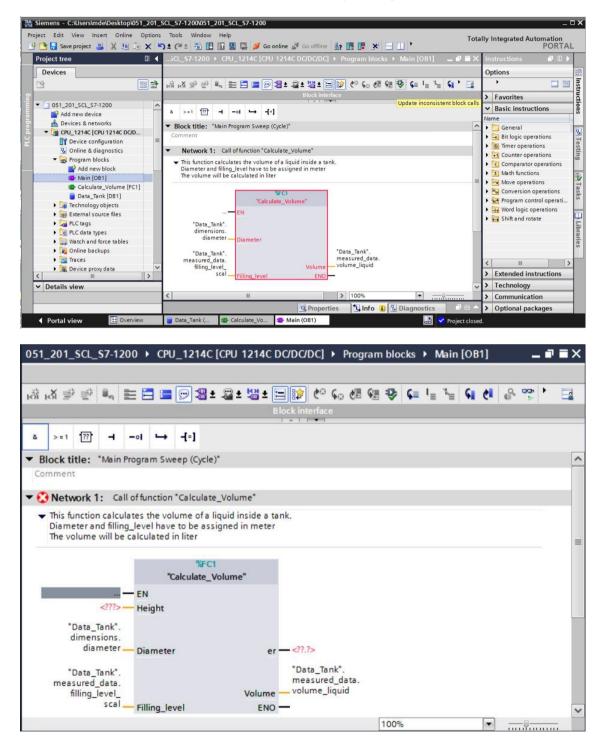
 $(\rightarrow \text{Complete program} \rightarrow \square)$ 

7-12	00	CPU_1214C [CPU 1214C DC/DC/DC]      Program blocks      Calculate_Volume [FC1]      □ ■ ■ ×
<b>⇒</b>		± 🐛 눈涸월± 😥 🥴 🕼 📾 🕾 😵 💶 표 🕸 님 🎽 🕪 위 (비 🔗 🙄 🗔
3	- iii	Block interface
IF.	CA	SE FOR WHILE (**) REGION F TO DO DO
	1 6	IF #Diameter > 0 AND #Filling_level >= 0 AND #Filling_level <= #Height THEN
	2	// Statement section IF
	3	<pre>#er := FALSE;</pre>
	4	#Volume := SQR(#Diameter) / 4 * 3.14159 * #Filling level * 1000;
	5	ELSE
	6	// Statement section ELSE
	7	<pre>#er := TRUE;</pre>
	8	#Volume := -1;
S S	9	END IF;
6101	10	

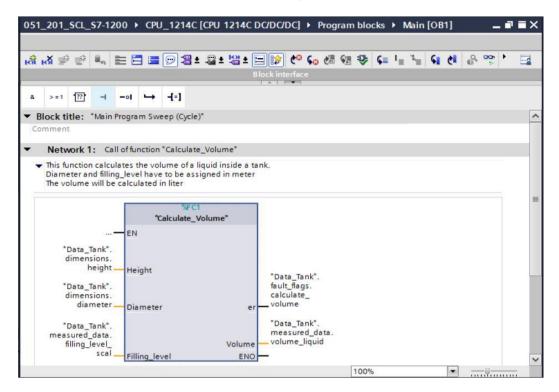
- → Comments can be added with "(\*\*)" as block comment and with "//" as row comment. You can now add comments to your program.
- ....7-1200 CPU\_1214C [CPU 1214C DC/DC/DC] Program blocks Calculate\_Volume [FC1] - - X Calculate\_Volume Name Data type Default va.. Comment 🕣 🔻 Input ~ height cylindric tank in meter Height Real ≡ diameter cylindric tank in meter Diameter Real Filling\_level Real filling level of liquid in meter ------🕣 🔻 Output 5 6 Bool fault flag; fault == true er volume of liquid in the tank in liter 7 Volume Real < > IF... CASE... FOR... WHILE.. (\*...\*) REGION 1 - (\* This function calculates the volume of a liquid inside a tank. 2 Input-parameters #Height, #Filling level and #Diameter have to be assigned in meter. 3 4 Output-parameter #Volume will be calculated in liter. In case of an error the fault flag output-parameter #er will be set TRUE 5 and the output-parameter #Volume will be -1. 6 7 An error occurs if the diameter is less than or equal 0 8 or the filling level is less than 0 or 9 the filling level is greater than the height of the tank. 10 \*) 11 GIF #Diameter > 0 AND #Filling\_level >= 0 AND #Filling\_level <= #Height THEN 12 // no fault 13 #er := FALSE; #Volume := SQR(#Diameter) / 4 \* 3.14159 \* #Filling\_level \* 1000; 14 15 ELSE 16 // fault #er := TRUE; 17 18 #Volume := -1; 19 END IF; 20 > 100% · IIII
- ( $\rightarrow$  Insert block comment starting with row 1  $\rightarrow$  Insert row comments in rows 12/16)

#### 7.11 Customizing the organization block

→ Open OB1 and update the inconsistent block calls by clicking  $rac{1}{2}$ . (→ Open OB1 →  $rac{1}{2}$ )



 $\rightarrow$  To do this, add the parameters "er" and "Height".



#### 7.12 Compiling, saving and downloading the program

→ Click the "Program blocks" folder, compile the entire program and then save it. After successful compilation and saving, download the project to the controller.

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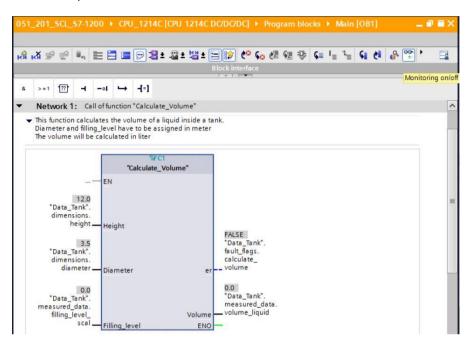
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Add new device		å	>=1	[??]	0	- →	-[=]					
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▼ CPU 1214C [CPU 1214C DC/DC/DC]		•	Netv	ork 1:	Call of	unction *	Calculate_Volu	me"				General
Device configuration		-	This fu	nction c	alculate	the volu	me of a liquid i	nside a tank.				Bit logic opera
Q Online & diagnostics	-		Diame	ter and	filling_le	vel have	to be assigned					Timer operatio
Program blocks			The vo	lume wi	ll be cal	ulated in	liter					+1 Counter opera
Add new block					_		%FC1				-	Comparator o
Hain [OB1]						***	Iculate Volume					± Math function:
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Technology objects				Data_Tar								Word logic ope
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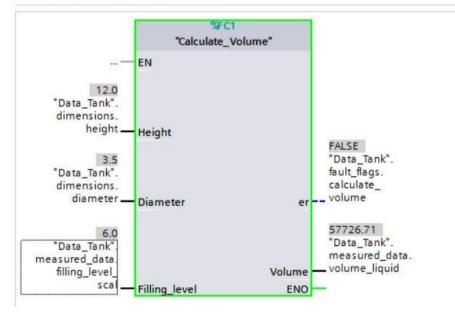
13

#### 7.13 Monitoring and testing the organization block

 $\rightarrow$  In the open OB1, click the  $\square$  icon to monitor the block.



- → Test your program by writing a value to the "Filling\_level\_scal" tag in the data block. (→ Right-click on "Filling\_level\_scal" → "Modify" menu → Modify operand → Enter value 6.0  $\rightarrow$  OK → Check)
  - Network 1: Call of function "Calculate\_Volume"
  - This function calculates the volume of a liquid inside a tank. Diameter and filling\_level have to be assigned in meter The volume will be calculated in liter

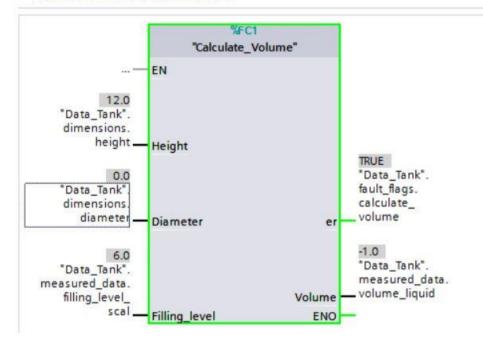


 $\rightarrow$  Now test if an error is output by setting the diameter to zero.

 $(\rightarrow \text{Right-click on "Diameter"} \rightarrow \text{"Modify" menu} \rightarrow \text{Modify operand} \rightarrow \text{Enter value } 0.0 \rightarrow \text{OK}$ 

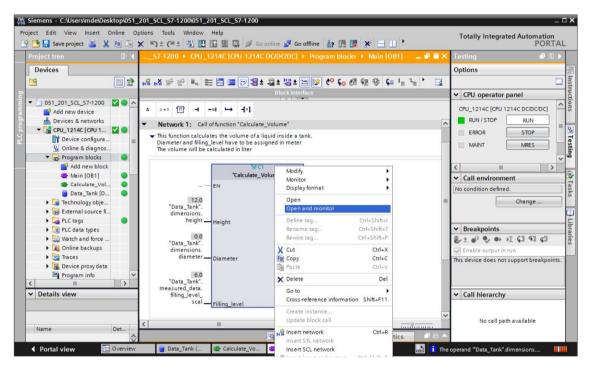
 $\rightarrow$  Check)

- Network 1: Call of function "Calculate\_Volume"
  - This function calculates the volume of a liquid inside a tank. Diameter and filling\_level have to be assigned in meter The volume will be calculated in liter



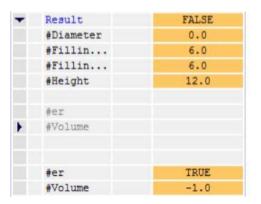
#### 7.14 Monitoring and testing the "Calculate\_Volume" function

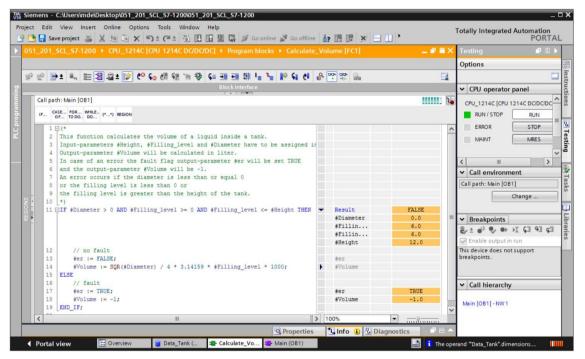
→ Finally, open and monitor the "Calculate\_Volume" function by right-clicking the function and selecting the "Open and monitor" menu command. (→ Right-click on function → Open and monitor)



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Ca	ll pat	h: Main [OB1]				11111.1
IF	C/	SE FOR WHILE (**) REGION				
		DF TO DO DO V / MEGOV				
	1 8	₽(*				
	2	This function calculates the volume of a liquid inside a tank.				
	3	Input-parameters #Height, #Filling_level and #Diameter have to be assigned in	r.			
	4	Output-parameter #Volume will be calculated in liter.				
	5	In case of an error the fault flag output-parameter #er will be set TRUE				
	6	and the output-parameter #Volume will be -1.				
	7	An error occurs if the diameter is less than or equal 0				
	8	or the filling level is less than 0 or				
	10	the filling level is greater than the height of the tank.				
-		<pre></pre>	Þ	Resu	1+	FALSE
	12	// no fault	-	nesu	10	TABJE
-	13	<pre>#er := FALSE:</pre>		#er		
	14	#Volume := SQR(#Diameter) / 4 * 3.14159 * #Filling level * 1000;	•	#Vol	ume	
	15	ELSE				
	16	// fault				
	17	<pre>#er := TRUE;</pre>		#er		TRUE
	18	#Volume := -1;		#Vol	ume	-1.0
	19	END IF;				

→ You can show the values of the individual tags of the IF query by clicking the black arrow  $\checkmark$ . (→  $\checkmark$ )

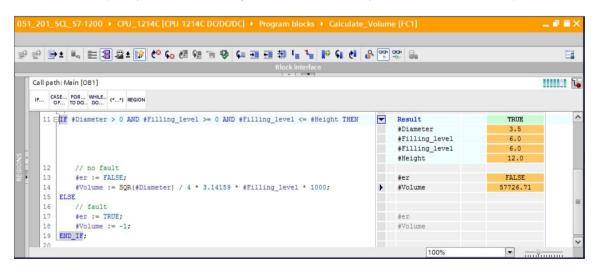




 $\rightarrow$  Right-click the tag to adjust the display format. ( $\rightarrow$  Right-click tag  $\rightarrow$  Display format  $\rightarrow$  Floating point)

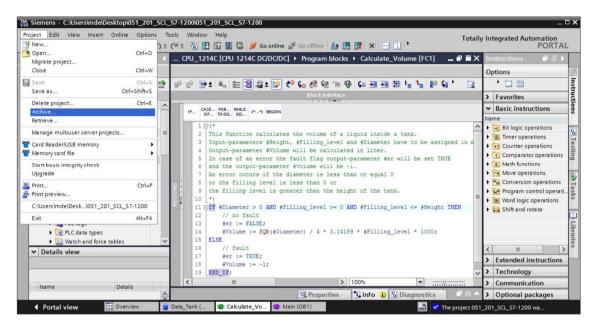
•	Result	FALSE	
	#Diameter	0.0	
	#Fillin	6.0	
	#Fillin	6.0	
	#Height	Display format	Automatic
	#er	Expand all	O Decimal
	#Volume	Collapse all	<ul> <li>Hexadecima</li> <li>Floating-point</li> </ul>
	#er	TRUE	
	#Volume	-1.0	
	#Volume	-1.0	
	#Volume	-1.0	
-	#Volume Result	-1.0 FALSE	
-			
2	Result	FALSE	
2	Result #Diameter	FALSE 0.0	
2	Result #Diameter #Filling_level	FALSE 0.0 6.0	
2	Result #Diameter #Filling_level #Filling_level	FALSE 0.0 6.0 6.0	
•	Result #Diameter #Filling_level #Filling_level #Height	FALSE 0.0 6.0 6.0	
2	Result #Diameter #Filling_level #Filling_level #Height #er	FALSE 0.0 6.0 6.0	
	Result #Diameter #Filling_level #Filling_level #Height #er	FALSE 0.0 6.0 6.0	

→ Now test the other branch of the IF branch by modifying the diameter in OB1 back to 3.5 meters. (→ Open OB1 → Modify diameter to  $3.5 \rightarrow$  Open and monitor function)



#### 7.15 Archiving the project

→ Finally, the complete project is to be archived. Select → "Project" → "Archive …" in the menu. Open the folder in which you want to archive your project and save it as file type "TIA Portal Project archive". (→ Project → Archive → TIA Portal Project archive → File name: SCE\_EN\_051-201 SCL\_S7-1200... → Archive)



## 8 Checklist

No.	Description	Checked
1	Successful compilation without error message	
2	Successful download without error message	
3	Modify operand (Diameter = 0.0) Result tag Volume= -1 Result tag "er" = TRUE	
4	Modify operand (Diameter = 3.5 and Level_scal = 0) Result Volume = 0 Result tag "er" = FALSE	
5	Modify operand (Filling_level_scal= 6.0) Result Volume = 57726.72 Result tag "er" = FALSE	
6	Modify operand (Filling_level_scal= 12.0) Result Volume = 115453.4 Result tag "er" = FALSE	
7	Modify operand (Filling_level_scal= 14.0) Result Volume = -1 Result tag "er" = TRUE	
8	Project successfully archived	

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## 9 Exercise

## 9.1 Task description – Exercise

In this exercise you are going to program a "Scaling" function. The program is to be generally applicable to any positive analog values. In our example task "Tank", the filling level is read by an analog sensor and stored as a scaled value in the data block using this function.

In case of an error, the block is to set the error flag "er" to TRUE and set the parameter "Analog\_scal" to zero as a result. An error exists when the "mx" parameter is less than or equal to "mn".

Input	Data type	Comment
Analog_per	INT	Analog value of the IO between 027648
mx	REAL	Maximum of the new scale
mn	REAL	Minimum of the new scale
Output		
er	BOOL	Error flag, no error = 0, error = 1
Analog_scal	REAL	Analog value scaled between mnmx In case of an error = 0

The function must contain the following parameters.

The following formula is used to solve the task:

$$#Analog\_scal = \frac{#Analog\_per}{27648} \bullet (\#mx - \#mn) + \#mn$$

An analog signal is required for this task. The operand used for this task must be entered in the PLC tag table.

Name	Data type	Address	Comment
B1	INT	%IW64	Filling level between 027648

## 9.2 Planning

Now solve this task on your own.

## 9.3 Checklist – Exercise

No.	Description	Checked
1	Operand added to PLC tag table	
2	Function FC: "Scaling" created	
3	Interface defined	
4	Function programmed	
5	"Scaling" function added to network 1 of OB1	
6	Input tags connected	
7	Output tags connected	
8	Successful compilation without error message	
9	Successful download without error message	
10	Analog value for filling level set to zero Result Filling_level_scal = 0 Result er = FALSE	
11	Analog value for filling level set to 27648 Result Filling_level_scal = 12.0 Result er = FALSE	
12	Analog value for filling level set to 13824 Result Filling_level_scal = 6.0 Result er = FALSE	
13	Modify operand (mx = 0.0) Result Filling_level_scal = 0 Result tag er = TRUE	
14	Project successfully archived	

## **10** Additional information

More information for further practice and consolidation is available as orientation, for example: Getting Started, videos, tutorials, apps, manuals, programming guidelines and trial software / firmware, under the following link:

#### siemens.com/sce/s7-1200

#### **Preview "Additional information"**

- Getting Started, Videos, Tutorials, Apps, Manuals, Trial-SW/Firmware
  - ↗ TIA Portal Videos
  - TIA Portal Tutorial Center
  - > Getting Started
  - ↗ Programming Guideline
  - ↗ Easy Entry in SIMATIC S7-1200
  - > Download Trial Software/Firmware
  - ↗ Technical Documentation SIMATIC Controller
  - ↗ Industry Online Support App
  - TIA Portal, SIMATIC S7-1200/1500 Overview
  - TIA Portal Website
  - ↗ SIMATIC S7-1200 Website
  - ↗ SIMATIC S7-1500 Website

## Notes

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## Notes


# SCE Learn-/Training Textbook

# Automation System SIMATIC S7-1200



#### TIA Portal Modules from Version V14 SP1

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<b>TIA Portal Module 051-300</b> PID Controller	14
<b>TIA Portal Module 051-201</b> High-Level Language Programming with SCL	13
TIA Portal Module 041-101 WinCC Basic with KTP700	12
<b>TIA Portal Module 031-600</b> Global Data Blocks	11
<b>TIA Portal Module 031-500</b> Analog Values	10
<b>TIA Portal Module 031-420</b> Diagnostics via Web	9
TIA Portal Module 031-410 Basics of Diagnostics	8
TIA Portal Module 031-300 IEC Timers and IEC Counters	7
TIA Portal Module 031-200 Basics of FB Programming	6
TIA Portal Module 031-100 Basics of FC Programming	5
<b>TIA Portal Module 020-100</b> Process description of sorting station	4
TIA Portal Module 011-101 Specified Hardware Configuration	3
TIA Portal Module 011-100 Unspecified Hardware Configuration	2
<b>TIA Portal Module 011-001</b> Firmware Update	1
	_

## Matching SCE Trainer Packages for these Learn-/Training Document

- SIMATIC S7-1200 AC/DC/RELAY (set of 6) "TIA Portal" Order no.: 6ES7214-1BE30-4AB3
- SIMATIC S7-1200 DC/DC/DC (set of 6) "TIA Portal" Order no.: 6ES7214-1AE30-4AB3
- Upgrade SIMATIC STEP 7 BASIC V14 SP1 (for S7-1200) (set of 6) "TIA Portal" Order no.: 6ES7822-0AA04-4YE5

Please note that these trainer packages are replaced with successor packages when necessary. An overview of the currently available SCE packages is provided at: <u>siemens.com/sce/tp</u>

### **Continued training**

For regional Siemens SCE continued training, please contact your regional SCE contact siemens.com/sce/contact

### Additional information regarding SCE

siemens.com/sce

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We wish to thank the TU Dresden, particularly Prof. Dr.-Ing. Leon Urbas and the Michael Dziallas Engineering Corporation and all other involved persons for their support during the preparation of this Learn-/Training Document.

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# **PID Controller for the SIMATIC S7-1200**

## 1 Goal

In this chapter, you will become acquainted with the use of software PID controllers for the SIMATIC S7-1200 with the TIA Portal programming tool.

The module explains the call-up, connection, configuration and optimization of a PID controller for the SIMATIC S7-1200. It also shows the steps for calling the PID controller in the TIA Portal and integrating it into a user program.

The SIMATIC S7 controllers listed in Chapter 3 can be used.

## 2 Prerequisite

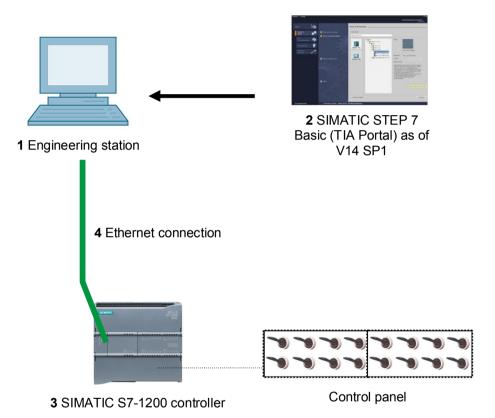
This chapter builds on the chapter Analog Values with the SIMATIC S7 CPU1214C DC/DC/DC. You can use the following project for this chapter, for example: "SCE\_EN\_031-500\_Analog\_Values\_S7-1200.zap14".

## 3 Required hardware and software

- 1 Engineering station: requirements include hardware and operating system (for additional information, see Readme on the TIA Portal Installation DVDs)
- 2 SIMATIC STEP 7 Basic software in TIA Portal as of V14 SP1
- 3 SIMATIC S7-1200 controller, e.g. CPU 1214C DC/DC/DC with ANALOG OUTPUT SB1232 signal board, 1 AO Firmware as of V4.2.1

Note: The digital inputs and analog inputs and outputs should be fed out to a control panel.

4 Ethernet connection between engineering station and controller



14

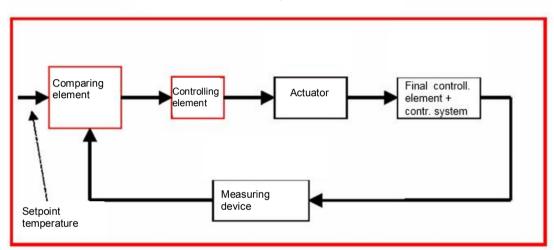
## 4 Theory of closed loop controls

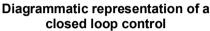
## 4.1 Tasks of closed loop controls

Closed loop control is a process in which the value of a variable is generated and maintained continuously through an intervention based on measurements of this variable.

This produces an action path that takes place in a closed loop – the control loop – because the process runs based on measurements of a variable that is, in turn, influenced by itself.

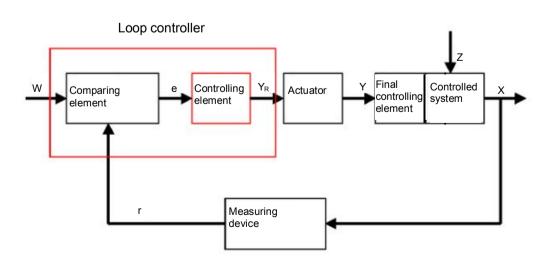
The variable to be controlled is continuously measured and compared with another preset variable of the same type. Depending on the result of this comparison, an adjustment of the variable to be controlled to the value of the preset variable is made.





## 4.2 Components of a control loop

The fundamental concepts of closed loop controls are explained in detail in the following. An overview based on a diagram is presented here to start.



#### 1. The controlled variable **x**

This is the actual "target" of the closed-loop control, namely the variable that is to be influenced or kept constant. In our example, this would be the room temperature. The instantaneous value of the controlled variable at a particular time is called the "actual value" at this time.

#### 2. The feedback variable r

In a control loop, the controlled variable is continuously checked to enable a response to unwanted changes. The measured quantity proportional to the controlled variable is called the feedback variable. In the "Heating" example, it would correspond to the measured voltage of the inside thermometer.

#### 3. The disturbance variable z

The disturbance variable is the variable that influences the controlled variable in an unwanted way and moves it away from the current setpoint. In the case of fixed setpoint control, this control is only necessary in the first place due to the existence of the disturbance variable. In the examined heating system, this would be, for example, the outside temperature or any other variable that causes the room temperature to move away from its ideal value.

#### 4. The setpoint w

The setpoint at a given time is the value that the controlled variable should ideally have at this time. Note that the setpoint may vary continuously in a slave control. In our example, the setpoint would be the currently desired room temperature.

#### 5. The comparing element

This is the point at which the current measured value of the controlled variable and the instantaneous value of the reference variable are compared. In most cases, both variables are measured voltages. The difference between the two variables is the "system error" e. This is passed to the controlling element and evaluated there (see below).

#### 6. The controlling element

The controlling element is the actual heart of a closed loop control. It evaluates the system error, thus the information regarding whether, how and how much the controlled variable deviates from the current setpoint, as an input variable and derives from this the **"Controller output variable"**  $Y_R$ , which is ultimately used to influence the controlled variable. In the heating system example, the controller output variable would be the voltage for the mixer motor.

The manner in which the controlling element determines the controller output variable from the system error is the main criterion of the closed-loop control.

#### 7. The actuator

The actuator is, so to speak, the "executive organ" of the closed loop control. It receives information from the controlling element in the form of the controller output variable indicating how the controlled variable is to be influenced and translates this into a change of the "manipulated variable". In our example, this would be the mixer motor controller.

#### 8. The final controlling element

This is the element of the control loop that influences the controlled variable (more or less directly) as a function of the **manipulated variable Y**. In the example, this would be the combination of the mixer, heating lines and radiators. The adjustment of the mixer (the manipulated variable) is made by the mixer motor (actuator) and influences the room temperature by means of the water temperature.

#### 9. The controlled system

The controlled system is the system containing the variable to be controlled, thus the living space in the heating example.

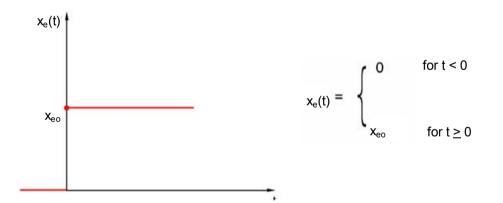
#### 10. The dead time

The dead time refers to the time that elapses from a change in the controller output variable until there is a measurable response in the controlled system. In the example, this would be the time between a change in the voltage for the mixer motor and a measurable change in the room temperature resulting from this.

### 4.3 Step function for analysis of controlled systems

To analyze the response of controlled systems, controllers and control loops, a uniform function for the input signal is used – the step function.

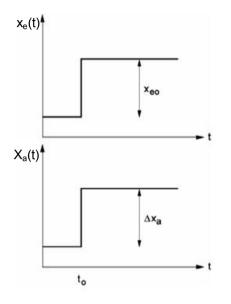
Depending on whether a control loop element or the entire control loop is being analyzed, the controlled variable x(t), the manipulated variable y(t), the reference variable w(t) or the disturbance variable z(t) can be assigned the step function. The input signal is often designated xe(t) and the output signal xa(t).



#### 4.4 Controlled systems with self-regulation

## 4.4.1 Proportional system without time delay

This controlled system is called a P system for short.



sudden change of the input variable at i t<sub>0</sub>

Controlled	variable/manipulated
variable:	

$$x = K_{ss} \cdot y$$
  
 $K_{ss} = \frac{\Delta x}{\Delta t} = \tan \alpha$   
K ss = K ss Proportional coefficient for a manipulated variable change:

Controlled variable/disturbance variable:

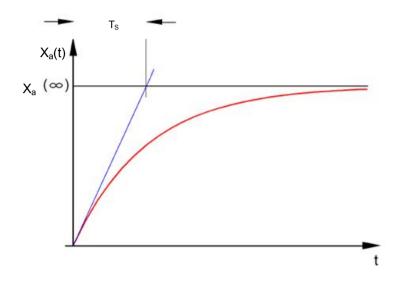
Δy

$x = K_{sz} \bullet z$	Ksz: Proportional value for a disturbance
52	variable change

Range:	$y_h = y_{max} - y_{min}$
Control range:	$\mathbf{x}_{h} = \mathbf{x}_{max} - \mathbf{x}_{min}$

## 4.4.2 Proportional system with time delay

This controlled system is called a P-T1 system for short.



Differential equation for a general input signal  $x_e(t)$ :

$$\mathsf{T}_{\mathsf{S}} \bullet \mathsf{x}_{\mathsf{a}}(t) + \mathsf{x}_{\mathsf{a}}(t) = \mathsf{K}_{\mathsf{PS}} \bullet \mathsf{x}_{\mathsf{e}}(t)$$

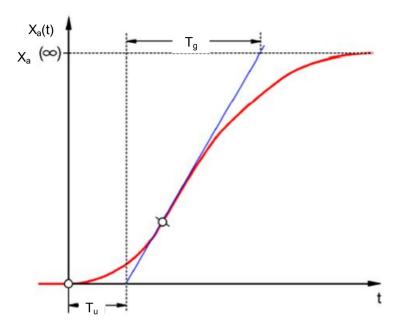
Solution of the differential equation for a step function at the input (step response)

$$x_a(t) = K_{PS} (1 - e^{-t/TS}) \cdot x_{eo}$$

T<sub>S</sub>: Time constant

### 4.4.3 Proportional system with two time delays

This system is called a P-T2 system for short.



Tu: Delay time Tg: Compensation time

The system is generated through the reaction-free series connection of two P-T1 systems that have the time constants TS1 and TS2.

#### Controllability of P-Tn systems:



With the increasing ratio Tu/Tg, the system becomes less and less controllable.

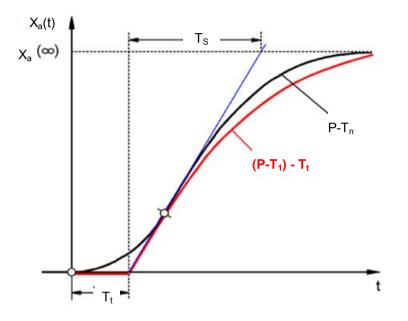
## 4.4.4 Proportional system with n time delays

This controlled system is called a P-Tn system for short.

The time response is described by an nth order differential equation. The step response characteristic is similar to that of the P-T2 system. The time response is described by Tu and Tg.

Substitute: An approximate substitution for the system with many delays is the series connection of a P-T1 system with a dead time system.

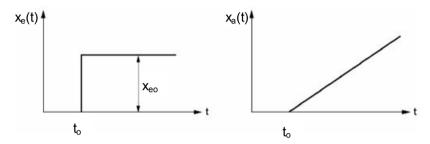
The following applies: Tt » Tu and TS » Tg.



## 4.5 Systems without self-regulation

This controlled system is called an I system for short.

After a disturbance, the controlled variable continues increasing steadily without striving for a fixed final value.

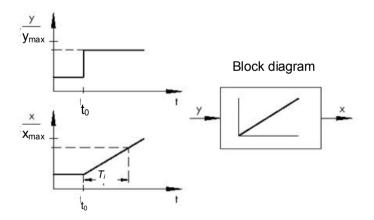


#### Example: Level control

For a tank with discharge outlet, whose incoming and outgoing flow rates are the same, there is a constant fill height. If the incoming or outgoing flow rate changes, the liquid level rises or falls. The level changes faster as the difference between the incoming flow rate and outgoing flow rate increases.

It is clear from this example that, in practice, the integral action has a limit in most cases. The controlled variable increases or decreases only until a system-inherent limit value is reached. A tank runs over or drains dry, pressure reaches the system maximum or minimum, etc.

The figure shows the time response of an I system to a step change in the input variable as well as the derived block diagram:



If the step function at the input changes to a function xe(t), then

 $x_a(t) = K_{IS} \int x_e(t) dt \implies$  integrating controlled system

 $K_{IS}$ : Integral coefficient of the controlled system

\* Figure from SAMSON Technical Information - L102 Controllers and Controlled Systems, Edition: August 2000 (<u>http://www.samson.de/pdf en/l102en.pdf</u>)

### 4.6 Basic types of continuous controllers

Discrete controllers that only switch one or two manipulated variables on and off have the advantage of simplicity. Both the controller itself and the actuator and final controlling element are simpler in nature and thus less expensive than continuous controllers.

Discrete controllers have several disadvantages, however. For one thing, when large loads such as large electric motors or cooling units must be switched, high load peaks may occur at switchon and overload the power supply, for example. For this reason, these often do not switch between "Off" and "On" but instead between full power ("full load") and a significantly lower power of the actuator or final controlling element ("base load"). Still, even with this improvement, a discrete closed-loop control is unsuitable for numerous applications. Consider an automobile engine whose speed is discreetly controlled. There would then be nothing between idle and full throttle. Apart from the fact that it would probably be impossible to properly transfer the forces from a sudden full-throttle to the road via the tires, such a vehicle would probably be unsuitable for road traffic.

Continuous controllers are therefore used for such applications. Theoretically, hardly any limits are placed on the mathematical relationship that establishes the controlling element between the system error and controller output variable. In practice, however, three classic basic types are differentiated. These will be described in more detail in the following.

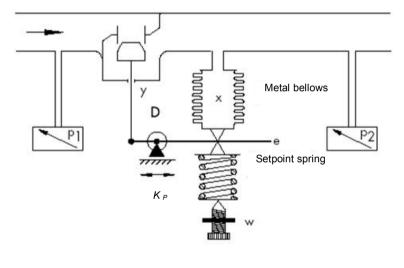
### 4.6.1 The proportional controller (P controller)

The manipulated variable y of a P controller is proportional to the measured error e. From this can be deducted that a P controller reacts to any deviation without lag and only generates a manipulated variable in case of system deviation.

The proportional pressure controller illustrated in the figure compares the force FS of the setpoint spring with the force FB created in the elastic metal bellows by the pressure p2. When the forces are off balance, the lever pivots about point D. This changes the position of the valve plug –and, hence, the pressure p2 to be controlled –until a new equilibrium of forces is restored.

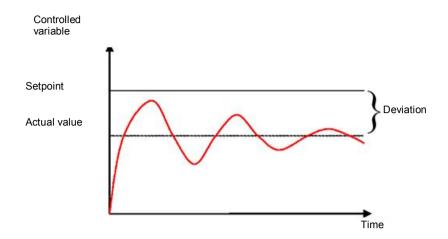
The dynamic behavior of the P controller after a step change in the error variable is shown in the figure. The amplitude of the manipulated variable y is determined by the error e and the proportional-action coefficient Kp:

To keep the control deviation as small as possible, as large a proportional-action coefficient as possible must be selected. An increase in the factor causes the controller to react faster, but if the value is too high there is a risk of overshooting and a large "hunting" tendency of the controller.



 $y = K_{P \cdot e}$ 

\* Figure and text from SAMSON Technical Information - L102 Controllers and Controlled Systems, Edition: August 2000 (<u>http://www.samson.de/pdf\_en/l102en.pdf</u>)



You see the response of the P controller in the diagram.

The advantages of this controller type lie, on the one hand, in its simplicity (in the simplest case, it can be implemented electronically with just a resistor) and, on the other hand, in its very prompt reaction compared to other controller types.

The main disadvantage of the P controller is its permanent system deviation. That is, the setpoint is never fully reached even over the long term. This disadvantage as well as the not yet ideal response speed cannot be minimized to a satisfactory extent through a larger proportional-action coefficient, because this leads to overshooting by the controller, or in other words an overreaction. In the worst case, the controller goes into a permanent oscillation in which the controlled variable is periodically moved away from the setpoint by the controller itself instead of by the manipulated variable.

The problem of permanent control deviation is best solved by an additional integral controller.

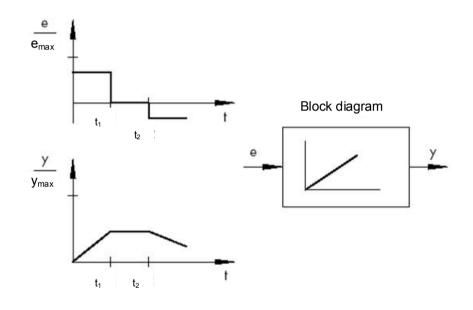
### 4.6.2 The integral controller (I controller)

Integral control action is used to fully correct system deviations at any operating point. As long as the error is nonzero, the integral action will cause the value of the manipulated variable to change. Only when reference variable and controlled variable are equally large –at the latest, though, when the manipulated variable reaches its system specific limit value (Umax, pmax, etc.)– is the control process balanced.

Mathematics expresses integral action as follows: the value of the manipulated variable is changed proportional to the integral of the error e.

$$y = K_i \int e \, dt$$
 with  $K_i = \frac{1}{T_n}$ 

How rapidly the manipulated variable increases/decreases depends on the error and the integral time.

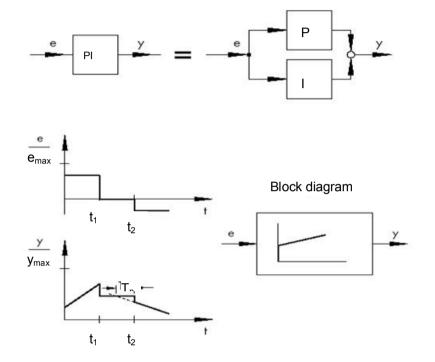


\* Figure and text from SAMSON Technical Information - L102 Controllers and Controlled Systems, Edition: August 2000 (<u>http://www.samson.de/pdf\_en/l102en.pdf</u>)

### 4.6.3 The PI controller

PI controllers are often employed in practice. In this combination, one P and one I controller are connected in parallel.

If properly designed, they combine the advantages of both controller types (stability and rapidity; no steady-state error), so that their disadvantages are compensated for at the same time.



The dynamic behavior is marked by the proportional-action coefficient Kp and the reset time Tn. Due to the proportional component, the manipulated variable immediately reacts to any error signal e, while the integral component starts gaining influence only after some time. Tn represents the time that elapses until the I component generates the same control amplitude that is generated by the P component (Kp) from the start. As with I controllers, the reset time Tn must be reduced if the integral-action component is to be amplified.

#### **Controller dimensioning:**

## By adjusting the Kp and Tn values, oscillation of the controlled variable can be reduced, however, at the expense of control dynamics.

PI controller applications: Fast control loops allowing no steady-state error

Examples: pressure, temperature. ratio control, etc.

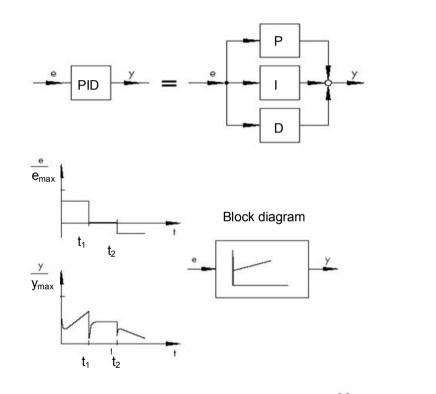
\* Figure and text from SAMSON Technical Information - L102 Controllers and Controlled Systems, Edition: August 2000 (<u>http://www.samson.de/pdf\_en/l102en.pdf</u>)

### 4.6.4 The derivative controller (D controller)

D controllers generate the manipulated variable from the rate of change of the error and not – – as P controllers — from their amplitude. Therefore, they react much faster than P controllers: even if the error is small, derivative controllers generate– by anticipation, so to speak –large control amplitudes as soon as a change in amplitude occurs. A steady-state error signal, however, is not recognized by D controllers, because regardless of how big the error, its rate of change is zero. Therefore, derivative-only controllers are rarely used in practice. They are usually found in combination with other control elements, mostly in combination with proportional control.

#### 4.6.5 The PID controller

If a D component is added to PI controllers, the result is an extremely versatile PID controller. As with PD controllers, the added D component –if properly tuned –causes the controlled variable to reach its setpoint more quickly, thus reaching steady state more rapidly.



$$y = K_p \cdot e + K_i \int e \, dt + K_D \, \frac{de}{dt} \quad \text{with} \quad K_i = \frac{K_p}{T_p}; \ K_D = K_p \cdot T_V$$

\* Figure and text from SAMSON Technical Information - L102 Controllers and Controlled Systems, Edition: August 2000 (<u>http://www.samson.de/pdf en/l102en.pdf</u>)

## 4.7 Controller tuning using the oscillation test

For a satisfactory control result, the selection of a suitable controller is an important aspect. It is even more important that the control parameters Kp, Tn and TV be appropriately adjusted to the system response. Mostly, the adjustment of the controller parameters remains a compromise between a very stable, but also very slow control loop and a very dynamic, but irregular control response which may easily result in oscillation, making the control loop instable in the end.

For nonlinear systems that should always work in the same operating point, e.g. fixed setpoint control, the controller parameters must be adapted to the system response at this particular operating point. If a fixed operating point cannot be defined, such as with follow-up control systems ñ, the controller must be adjusted to ensure a sufficiently rapid and stable control result within the entire operating range.

In practice, controllers are usually tuned on the basis of values gained by experience.

Should these not be available, however, the system response must be analyzed in detail, followed by the application of several theoretical or practical tuning approaches in order to determine the proper control parameters.

One approach is a method first proposed by Ziegler and Nichols, the so-called ultimate method. It provides simple tuning that can be applied in many cases. This method, however, can only be applied to controlled systems that allow sustained oscillation of the controlled variable.

For this method, proceed as follows:

- At the controller, set Kp and Tv to the lowest value and Tn to the highest value (smallest possible influence of the controller).
- Adjust the controlled system manually to the desired operating point (start up control loop).
- Set the manipulated variable of the controller to the manually adjusted value and switch to automatic operating mode.
- Continue to increase Kp (decrease Xp) until the controlled variable encounters harmonic oscillation. If possible, small step changes in the setpoint should be made during the Kp adjustment to cause the control loop to oscillate.
- Take down the adjusted Kp value as critical proportional-action coefficient Kp,crit. Determine the time span for one full oscillation amplitude as Tcrit, if necessary by taking the time of several oscillations and calculating their average.
- Multiply the values of Kp,crit and Tcrit by the values according to the table and enter the determined values for Kp, Tn and Tv at the controller.

	Kp	Τn	Τ <sub>ν</sub>
Р	0.50 x K <sub>p. crit.</sub>	-	-
PI	0.45 x K <sub>p. crit.</sub>	0.85 x T <sub>crit.</sub>	-
PID	0.59 x K <sub>p. crit.</sub>	0.50 x <i>T <sub>crit.</sub></i>	0.12 x <i>T</i> <sub>crit.</sub>

\* Figure and text from SAMSON Technical Information - L102 Controllers and Controlled Systems, Edition: August 2000 (<u>http://www.samson.de/pdf</u> en/l102en.pdf)

## 4.8 Controller tuning with T<sub>u</sub>-T<sub>g</sub> approximation

The tuning of the controlled systems will be performed here using the example of a P-T2 system.

#### T<sub>u</sub>-T<sub>g</sub> approximation

The Ziegler-Nichols method and the Chien, Hrones and Reswick method are based on the  $T_u$ - $T_g$  approximation in which the transfer coefficient of the system  $K_s$ , delay time  $T_u$  and balancing time  $T_q$  parameters are determined from the system step response.

The tuning rules, which are described below, are the result of experiments using analog computer simulations.

 $P-T_N$  systems can be described with sufficient accuracy with a so-called  $T_u-T_g$  approximation, that is, through approximation using a  $P-T_1-T_L$  system.

The starting point is the system step response with input step height K. The required parameters (transfer coefficient of the system  $K_s$ , delay time  $T_u$  and balancing time  $T_g$ ) are determined as shown in the figure.

The transfer function must be measured up to the final steady-stated value (K\*Ks) so that the transfer coefficient of the system Ks required for the calculation can be determined.

The main advantage of this method is that the approximation can also be used when an analytical description of the system is not possible.

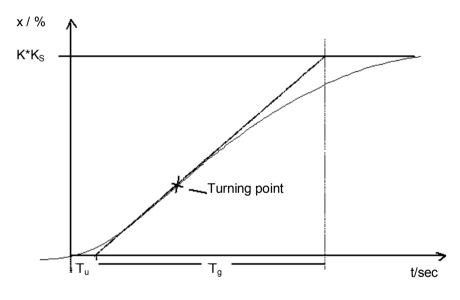


Figure: T<sub>u</sub>-T<sub>g</sub>-Approximation

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### 4.8.1 Tuning the PI controller according to the Ziegler-Nichols method

Based on experiments on  $P-T_1-T_L$  systems, Ziegler and Nichols have identified the following optimal controller adjustments for fixed setpoint control:

$$K_{PR} = 0.9 \quad \frac{T_g}{K_S T_u}$$

 $T_{N} = 3.33 T_{u}$ 

Use of these tuning values generally results in very good response to disturbances.

# 4.8.2 Tuning the PI controller according to the Chien, Hrones and Reswick method

Both the response to disturbances and response to setpoint changes were examined in order to achieve the most favorable controller parameters. Different values are yielded for the two cases. In addition, two different adjustments are specified in each case that meet different control performance requirements.

This resulted in the following adjustments:

• For response to disturbances:

Aperiodic transient reaction with the shortest duration

20% overshoot minimum oscillation period

$$K_{PR} = 0.6 \ \frac{T_g}{K_S T_u}$$

$$K_{PR} = 0.7 \frac{T_g}{K_s T_u}$$

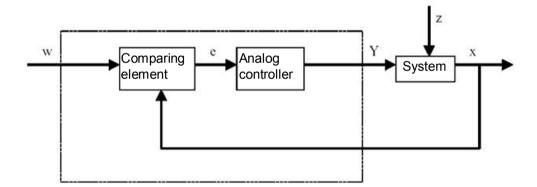
 $T_N = 4 T_u$ 

• For response to setpoint changes:

Aperiodic transient reaction<br/>with the shortest duration20% overshoot<br/>minimum oscillation period $K_{PR} = 0.35 \quad \frac{T_g}{K_S T_u}$  $K_{PR} = 0.6 \quad \frac{T_g}{K_S T_u}$  $T_N = 1.2 T_g$  $T_N = T_g$ 

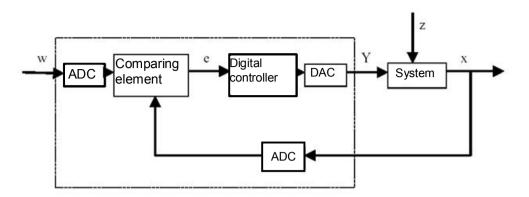
## 4.9 Digital controllers

Up to now, the main focus was on analog controllers, in other words, controllers that use the system error, which exists as an analog value, to derive the controller output variable in an analog manner. The diagram of this type of control loop is now well-known:



Often, however, it is advantageous to perform the actual evaluation of the system error digitally. For one thing, the relationship between the system error and controller output variable can be defined much more flexibly when it can be defined by an algorithm or formula that can be used in each case to program a computer than when it has to be implemented in the form of an analog circuit. For another, digital technology enables significantly greater integration of circuits so that multiple controllers can be accommodated in the smallest space. Finally, by dividing the computing time when there is a sufficient amount of computing capacity, it is even possible to use an individual computer as a controller for multiple control loops.

To enable digital processing of the variables, both the reference variable and the feedback variable are first converted to digital values in an analog-to-digital converter (ADC). These are then subtracted from one another by a digital comparing element and the difference is passed to the digital controlling element. Its controller output variable is then converted back to an analog value in a digital-to-analog converter (DAC). From the outside, the combined unit of converters, comparing element and controlling element resembles an analog controller.



We will examine the structure of a digital controller based on a diagram:

The advantages resulting from digital implementation of the controller are accompanied by various problems. For this reason, the size of some variables related to the digital controller must be chosen large enough to prevent the accuracy of the closed loop control from suffering too much from digitization.

Quality criteria for digital computers are:

The quantization resolution of the digital-to-analog converter

This specifies how fine the continuous value range is digitally mapped. The chosen resolution must be high enough that none of the finer points important for the closed loop control are lost.

The sampling rate of the analog-to-digital converter.

This is the frequency at which the analog values present at the converter are measured and digitized. This must be high enough that the controller can also still respond to step changes in the controlled variable in a timely manner.

The cycle time

Unlike an analog closed-loop controller, each digital computer works in clock cycles. The speed of the utilized computer must be high enough that a significant change of the controlled variable cannot occur during a single clock cycle (in which the output value is calculated and no input value is queried).

The performance of the digital controller must be high enough that its response is apparently as prompt and precise as an analog controller.

## 5 Task

In this chapter, a PID controller for speed control will be added to the program from chapter "SCE\_EN\_031-500 Analog Values\_S7-1200". The call-up of the "MOTOR\_SPEEDCONTROL" [FC10] function must be deleted for this.

## 6 Planning

The PID\_Compact technology object is available in the TIA Portal for closed loop controls.

For closed-loop control of the motor speed, this technology object replaces the "MOTOR\_SPEEDCONTROL" [FC10] block.

This will be carried out as an expansion of the "031-500\_Analog\_Values\_S7-1200" project. This project must be retrieved from the archive beforehand.

The call-up of the "MOTOR\_SPEEDCONTROL" [FC10] function must be deleted in the "Main" [OB1] organization block before the technology object can be called and connected in a cyclic interrupt OB.

The PID\_Compact technology object must then be configured and commissioned.

### 6.1 PID\_Compact closed-loop control block

The PID\_Compact technology object provides a PID controller with integrated tuning for proportional-action final controlling elements.

The following operating modes are possible:

- Inactive
- Pretuning
- Fine tuning
- Automatic mode
- Manual mode
- Substitute output value with error monitoring

Here, the connection, parameter assignment and commissioning of this controller will be for automatic mode

During commissioning we will use the integrated tuning algorithms and record the control response of the controlled system.

The PID\_Compact technology object is always called from a cyclic interrupt OB whose fixed set cycle time is 50 ms here.

The speed setpoint is set as a constant at the "Setpoint" input of the PID\_Compact technology object in revolutions per minute (range: +/- 50 rpm). The data type is 32-bit floating-point number (Real).

The actual speed value -B8 (sensor actual value speed of the motor +/-10V corresponds to +/- 50 rpm) will be entered at the "Input\_PER" input.

The output of the controller "Output\_PER" will then be connected directly with signal -U1 (manipulated value speed of the motor in 2 directions +/- 10V corresponds to +/- 50 rpm).

The controller will only be active as long as output -Q3 (conveyor motor -M1 variable speed) is set. If this is not set, the controller will be deactivated by connection of the "Reset" input.

## 6.2 Technology diagram

Here you see the technology diagram for the task.

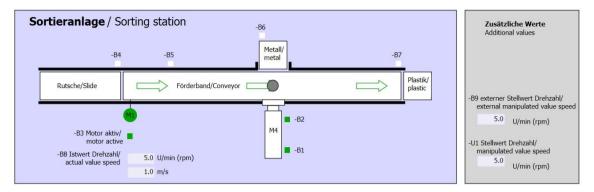


Figure 1: Technology diagram

Schalter der Sortieranlage Switches of sorting station	Automatikbetrieb Automatic mode	Handbetrieb / Manual mode -S3 Tippbetrieb -M1 vorwärts/ Manual -M1 forwards
-P1 eirion -P4 eirion -P4 aktiviert/active -P4 aktiviert/active -P4 aktiviert/active -P2 Hand/manual -P3 Auto/auto -P2 Hand/manual -P3 Auto/auto -P3 Etriebsart/operating mode	-51 Start/start	-54 Tippbetrieb -M1 rückwärts/ Manual -M1 backwards -P7 ausgefahren/extended -56 Zylinder -M4 ausfahren/ cylinder -M4 einfahren/ -55 Zylinder -M4 einfahren/ cylinder -M4 einfahren/

Figure 2: Control panel

## 6.3 Reference list

DI	Туре	Identifier	Function	NC/NO
1 0.0	BOOL	-A1	Return signal emergency stop OK	NC
I 0.1	BOOL	-K0	Main switch "ON"	NO
10.2	BOOL	-S0	Mode selector manual (0)/ automatic (1)	Manual = 0 Auto = 1
10.3	BOOL	-S1	Pushbutton automatic start	NO
I 0.4	BOOL	-S2	Pushbutton automatic stop	NC
I 0.5	BOOL	-B1	Sensor cylinder -M4 retracted	NO
l 1.0	BOOL	-B4	Sensor part at slide	NO
l 1.3	BOOL	-B7	Sensor part at end of conveyor	NO
IW64	BOOL	-B8	Sensor actual value speed of the motor +/-10V corresponds to +/- 50 rpm	

The following signals are required as global operands for this task.

DO	Туре	Identifier	Function	
Q 0.2	BOOL	-Q3	Conveyor motor -M1 variable speed	
QW 64	BOOL	-U1	Manipulated value speed of the motor in 2 directions +/- 10V corresponds to +/- 50 rpm	

#### Legend for reference list

- DI Digital Input
- AI Analog Input
- I Input
- NC Normally Closed
- NO Normally Open

- DO Digital Output
- AO Analog Output
  - Q Output

## 7 Structured step-by-step instructions

You can find instructions on how to carry out planning below. If you already have a good understanding of everything, it will be sufficient to focus on the numbered steps. Otherwise, simply follow the detailed steps in the instructions.

### 7.1 Retrieve an existing project

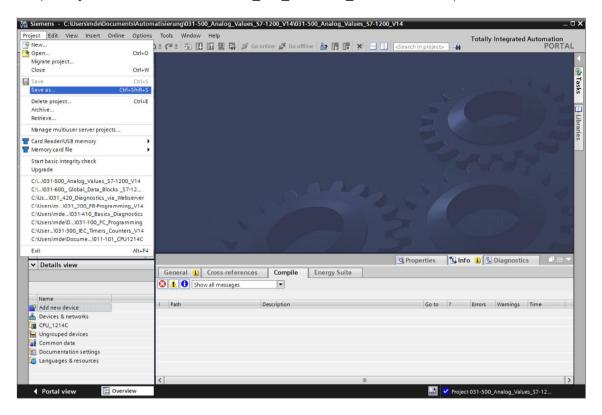
→ Before we can expand the "SCE\_EN\_031-500\_Analog\_Values\_S7-1200.zap14" project from chapter "SCE\_EN\_031-500 Analog Values\_S7-1200", we must retrieve this project from the archive. To retrieve an existing project that has been archived, you must select the relevant archive with → Project → Retrieve in the project view. Confirm your selection with Open. (→ Project → Retrieve → Select a .zap archive → Open)

Via Sieme	ens					
Project	Edit	View	Insert	Online	Options	Тс
📑 New 🎦 Open					Ctrl+0	) ±
Migra Close	te proj	ect			Ctrl+W	
Save Save	85			Ctrl	Ctrl+S +Shift+S	đ
Delete	e proje	ct			Ctrl+E	
Retrie	ve					
Mana	ge mu	ltiuser s	erver pro	jects		
	Reader bry car	USB me	emory		;	
Start I Upgra		ntegrity	check			

→ The next step is to select the target directory where the retrieved project will be stored. Confirm your selection with "OK".

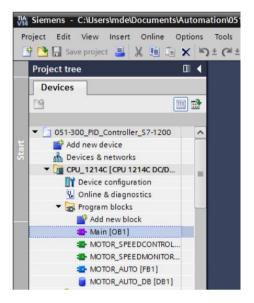
 $(\rightarrow \text{Target directory} \rightarrow \text{OK})$ 

→ Save the opened project under the name 051-300\_PID\_Controller\_S7-1200. ( $\rightarrow$  Project  $\rightarrow$  Save as ...  $\rightarrow$  051-300\_PID\_Controller\_S7-1200  $\rightarrow$  Save)



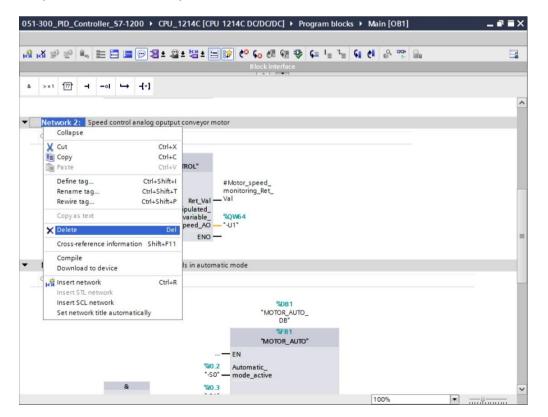
## 7.2 Call PID\_Compact controller in a cyclic interrupt OB

 $\rightarrow$  Open the "Main" [OB1] organization block with a double-click.

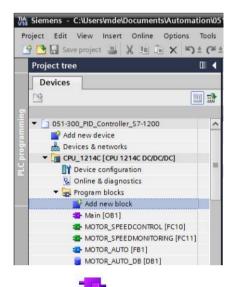


→ Delete Network 2 with the no longer needed call-up of the "MOTOR\_SPEEDCONTROL" [FC10] function.

 $(\rightarrow \text{Network } 2 \rightarrow \text{Delete})$ 



→ We need a cyclic interrupt OB for calling the PID\_Compact controller. Therefore, select the 'Add new block' item in the Program blocks folder.



→ Select select in the next dialog and rename the cyclic interrupt OB to: "Cyclic interrupt 50ms". Set the language to FBD and assign "50 ms" as the cyclic time. Select the "Add new and open" check box. Click "OK".

(→  $\blacksquare$  → Name: Cyclic interrupt 50ms → Language: FBD → Cyclic time (ms): 50 →  $\blacksquare$  Add new and open → OK)

Cyclic interrupt 50ms								
_	🖶 Program cycle	Language:	FBD					
	Startup	Number	30	1				
-OB	🔚 Time delay interrupt	Humber.		1				
Organization block	💶 Cyclic interrupt		🔘 Manual					
DIOCK	- Hardware interrupt		<ul> <li>Automatic</li> </ul>					
	🖶 Time error interrupt		50					
	Diagnostic error interrupt	Cyclic time (ms):	50					
	Pull or plug of modules	Description:						
-FB	Sack or station failure		OB allows you to s	tart				
Function	Time of day	programs at perio		LOTL				
	💶 Status	independently of cyclic program execution. The intervals can be defined in this dialog or						
	💶 Update	in the properties of						
	Profile	in the properties o						
	MC-Interpolator							
	MC-Servo							
	MC-PreServo							
	MC-PostServo							
Data block								
		more						
Additional inform								

→ The block is then directly opened. Enter meaningful comments and move the 'PID\_Compact' technology object to Network 1 using drag & drop.

 $(\rightarrow \text{Technology} \rightarrow \text{PID Control} \rightarrow \text{Compact PID} \rightarrow \text{PID}\_\text{Compact})$ 

		Progra	am block	ks 🕨 (	Cyclic	interr	upt 50ms	[OB30]	_ <b>-</b> = ×	Ins					
Devices										Op	tions				
5	1	Koi Koi	* *	B., 1	EE		- <b>3</b> ± 2	1 18 ±	= =			itil i	NT 🙆 🎙	5	
					1	Block in	terface			~	Favorites				
051-300_PID_Controller_S7-1200	^									-			1	1.00	
Add new device		& >	= 1 7?	-	-01	4	-[-]			8	>=1 ???	-	-01 +	-[-]	
📩 Devices & networks		- Bloc	k title:	Cvelie i	nterru	nt 50m									
<ul> <li>CPU_1214C [CPU 1214C DC/DC/DC]</li> </ul>		Comm		-Jene n	(included)					1					
Provice configuration		Comm	CTTC .												
S Online & diagnostics		▼ N	etwork 1	: Spe	ed co	ntrol m	otor conveyo	or with PID_	Compact						
🔻 🛃 Program blocks	=	Co	mment							-	Basic instructio				
Add new block										>	Extended instru	iction	5		
Cyclic interrupt 50ms [OB30]										~	Technology				
🖀 Main [OB1]										Nam	ne	1	Description		
MOTOR_SPEEDCONTROL [FC10]										+	Counting				
MOTOR_SPEEDMONITORING [FC11]	_									-	PID Control				
MOTOR_AUTO [FB1]	- 11										🕶 🛅 Compact PID	6			
MOTOR_AUTO_DB [DB1]											PID_Com	pact	Universal P	ID controller with in	tegrated tunin
System blocks											PID_3Step	p	PID controll	er with integrated t	uning for valv
Technology objects	- 11										PID_Temp	0	PID controll	er for temperature	
External source files											Motion Control				
PLC tags															
Cata types															
Watch and force tables															
Online backups															
Final Traces															
Device proxy data															
Program info										1					
PLC alarm text lists										<			- 10		

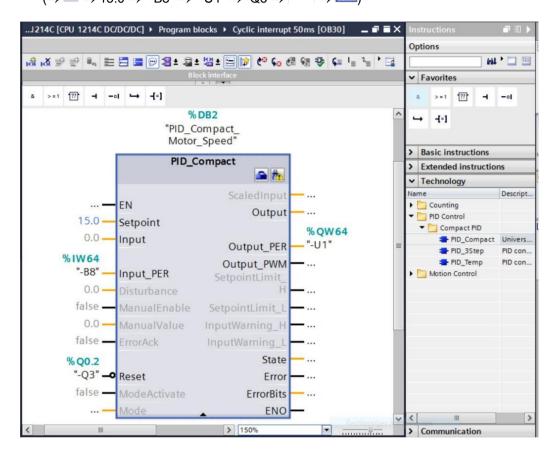
 $\rightarrow$  Assign a name for the instance data block and apply it with OK.

 $(\rightarrow \mathsf{PID}\_\mathsf{Compact}\_\mathsf{Motor}\_\mathsf{Speed} \rightarrow \mathsf{OK})$ 

Call options			×
Single instance	Data block Name Number	PID_Compact_Motor_Speed  PID_Compact_Motor_Speed  Manual  Automatic	
	If you call th block saves	e function block as a single instance, the function its data in its own instance data block.	
	more		
		OK Cancel	

→ Expand the view of the block by clicking the '▲' arrow. Interconnect this block as shown here with setpoint (constant: 15.0), actual value (global tag "-B8"), manipulated variable (global tag "-U1") and Reset input for deactivating the controller (global tag "-Q3"). Negate the 'Reset'

input. The configuration mask  $^{(\square)}$  of the controller can then be opened. ( $\rightarrow \rightarrow 15.0 \rightarrow "-B8" \rightarrow "-U1" \rightarrow -Q3 \rightarrow ^{-\circ I} \rightarrow ^{\square}$ )



- → There are 2 views for configuration of the controller: Parameter view and Functional view. Here we will use the easier-to-understand 'Functional view'.
  - $(\rightarrow$  Functional view)

		Functiona	al vie	W	Parameter view		
😤 🔝 🔡 🎼 🖓 Functional na	viga 💌 < no text filter > 🛛 🖉	<u>+</u>					
<ul> <li>All parameters</li> </ul>	Name in functional view	Name in DB		Start valu	M.,	M	Comment
<ul> <li>Configuration parameters</li> </ul>	Physical quantity	PhysicalQuantity	0	General			Selection of physical quan
<ul> <li>Basic settings</li> </ul>		PhysicalQuantity	0	0			Selection of physical quan
Controller type	Unit of measurement	PhysicalUnit	0	%			Selection of unit of measu
Input / output parameters		PhysicalUnit	0	0			Selection of unit of measu
Process value settings	Invert control logic	/InvertControl	0	FALSE			Enables inversion of contr
Advanced settings	Activate Mode after CPU restart	RunModeByStartup	0	TRUE			Activates the operating m
Commissioning parameters	Set Mode to	Mode	0	Manual	0	4	Selection of operating mo
Other parameters		Mode	0	4			Selection of operating mo

 $\rightarrow$  In the 'Basic settings', the 'Controller type' and the interconnection of the 'Input / output parameters' are entered. Set the values as shown here.

 $(\rightarrow \text{Basic settings} \rightarrow \text{Controller type} \rightarrow \text{Input / output parameters})$ 

roller_\$7-1200 > CPU_12	14C [C	PU 1214C DC/DC/DC] > Technology objects > PID_Compact_Motor_Speed [DB2] 🛛 🗕 🖬 🗮 🗙
		Service State Stat
😤 🖬 IJ		
Basic settings     Controller type     Input / output parameters     Process value settings     Process value limits     Process value scaling     Advanced settings     Process value monitoring     PWM limits     Output value limits	000000000000000000000000000000000000000	Basic settings Controller type Speed  I/min Invert control logic Activate Mode after CPU restart Set Mode to: Automatic mode
PID Parameters	0	Input / output parameters
	•	Setpoint:

→ In 'Process value settings' we scale to the range +/- 50 rpm and define the 'Process value limits' of +/- 45 rpm.

 $(\rightarrow$  Process value settings  $\rightarrow$  Process value limits  $\rightarrow$  Process value scaling)

	See Functional v	iew 🔛 Parameter view
° 11 II		
Basic settings     Controller type     Input / output parameters     Process value settings     Process value limits     Process value monitoring     PWM limits     Output value limits     PID Parameters	1/min Process value high limit: 45.0 1/min Process value low limit: 45.0 1/min	
	Input_PER: Enabled 50.0 1/min	
	Scaled low process value: -50.0 1/min -27648.0	Input_PE
	Low	High

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- → In the 'Advanced settings', a process value monitoring would be possible but we don't want to deal with that here.
  - $(\rightarrow \text{Advanced settings} \rightarrow \text{Process value monitoring})$

	Service Functional view	w Parameter view
😤 🗓 🔛		
• Basic settings		
Controller type	Process value monitoring	
Input / output parameters		
• Process value settings	1/min	
Process value limits		
Process value scaling	T	
<ul> <li>Advanced settings</li> </ul>		
Process value monitoring	Warning high limit: 3.402822E+ 1/min	
PWM limits		
Output value limits		
PID Parameters	Warning low limit: -3.402822E- 1/min	

→ In the 'Advanced settings' for 'PWM' (pulse width modulation), we will leave the default values since the output for this is not needed in our project.

 $(\rightarrow \text{Advanced settings} \rightarrow \text{PWM})$ 

roller_\$7-1200 > CPU_1214	C [CPU 1214C DO	C/DC/DC] • Technolo	ogy objects 🕨 Pl	D_Compact_Motor_Sp	oeed [DB2] 📃 🖬 🖬 🗙
				Functional view	Parameter view
😤 🛍 🔛					3
🕶 Basic settings 🛛 🥑					
Controller type 🥏	PWM limits _				
Input / output parameters 🥪					
🕶 Process value settings 🛛 🥑					
Process value limits  📀		Minimum ON time:	0.0 s	]	
Process value scaling  📀					
▼ Advanced settings		Minimum OFF time:	0.0 s	1	
Process value monitoring 🥪			L		
PWM limits 🔗					
Output value limits  📀					
PID Parameters 🥑					

→ In the 'Advanced settings', we define the 'Output value limits' of 0.0% to 100.0%. (→ Advanced settings → Output value limits)

roller_57-1200 V CPU_1214	C [CPU 1214C DC/DC/DC]  Technology	gy objects      PID_Compact_Motor_Sp     Functional view	beed [DB2] _ I = X
° n u			
Basic settings     Controller type     Input / output parameters	Output value limits		
Process value settings     Process value limits	Output value limits	%	
Process value scaling → Advanced settings Process value monitoring PWM limits Output value limits PID Parameters	Output value high limit: [	100.0 %	
	Output value low limit:	0.0 %	• t
	Reaction to error		
		Substitute output value while error is pendi	ng 🔽
	Substitute output value:	0.0 %	

→ In the 'Advanced settings', you will now also find a manual setting of the 'PID parameters'. Once we have changed the controller structure to 'PI', the configuration window is closed by clicking and we receive a finished product with a functional PID controller. This should, however, still be commissioned and tuned online during operation.

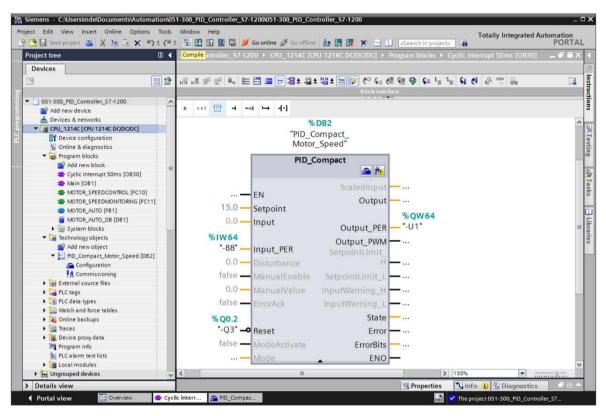
 $(\rightarrow \text{Advanced settings} \rightarrow \text{PID Parameters} \rightarrow \text{Controller structure: PI} \rightarrow \times)$ 

roller_\$7-1200 > CPU_12140	C [CPU 1214C DC/DC/DC]  ► Technology objects  ► P	PID_Compact_Motor_Sp	eed [DB2] 🛛 🗖 🗮 🗙
		Functional view	Parameter view
🕶 Basic settings 🛛 🥑			
Controller type 🥏	PID Parameters		
Input / output parameters  📀			
▼ Process value settings 🛛 📀	Enable manual entry		
Process value limits 🛛 📀			
Process value scaling 📀	Proportional gain:	1.0	
<ul> <li>Advanced settings</li> </ul>	Integral action time:	20.0 s	
Process value monitoring  📀	Derivative action time:	0.0 s	
PWM limits 🥑	Derivative delay coefficient:	0.2	
Output value limits  📀			
PID Parameters 🥑	Proportional action weighting:	1.0	
	Derivative action weighting:	1.0	
	Sampling time of PID algorithm:	1.0 s	
	Tuning rule		
	Controller structure:	PI 🗸	
		PID	
		PI	

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### 7.3 Save and compile the program

→ To save your project, click the  $\boxed{\Box}$  Save project button in the menu. To compile all blocks, click the "Program blocks" folder and select the  $\boxed{\Box}$  icon for compiling in the menu. (→  $\boxed{\Box}$  Save project → Program blocks →  $\boxed{\Box}$ )

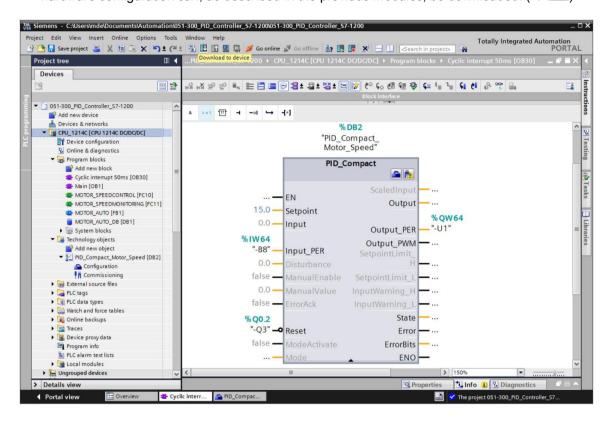


→ The "Info", "Compile" area shows which blocks were successfully compiled.

				Q Pro	pertie		i Info 追	🖁 Diagno	stics	
G	eneral 1 Cross-references	Compile	Energy Suite	Syntax						
3	🗼 🕕 Show all messages	-								
Co	mpiling finished (errors: 0; warnings: 2)									
	Path	Description	n		Go to	?	Errors	Warnings	Time	
L	Tuning	Tuning has	s not been started yet		>				2:33:09 PM	
0		Block was	successfully compiled	l.					2:33:09 PM	
2	<ul> <li>Program blocks</li> </ul>				~		0	0	2:33:09 PM	
0	Cyclic interrupt 50ms (OB30)	Block was	successfully compiled	l.	~				2:33:09 PM	
2	Main (OB1)	Block was	successfully compiled	Ι.	~				2:33:11 PM	
1		Compiling	finished (errors: 0; wa	minas: 2)					2:33:12 PM	

### 7.4 Download the program

 $\rightarrow$  After successful compilation, the complete controller with the created program including the hardware configuration can, as described in the previous modules, be downloaded. ( $\rightarrow$   $\blacksquare$ )

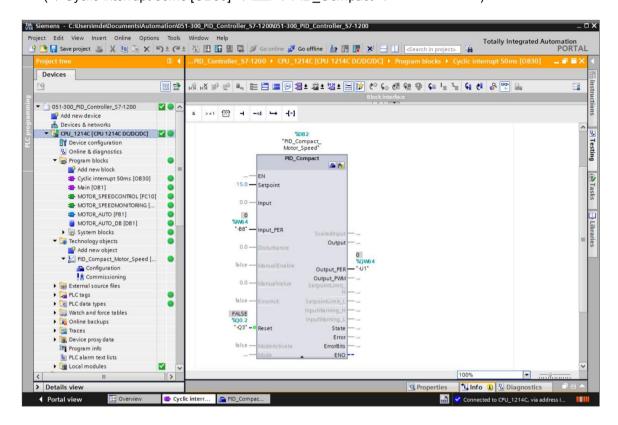


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### 7.5 Monitor PID\_Compact

→ Click the Monitoring on/off icon <sup>™</sup> to monitor the state of the blocks and tags when testing the program. At the first start of the CPU, however, the 'PID\_Compact' controller is not yet tuned. We still have to start the tuning by clicking the '!<sup>†</sup> Commissioning' icon.
 (→ Cyclic interrupt 50ms [OB30] → <sup>™</sup> → PID\_Compact → !<sup>†</sup> Commissioning)

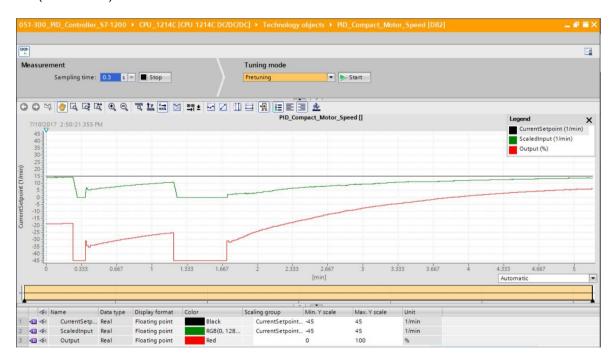


→ If we click Start under 'Measurement', the values of the setpoint (Setpoint), actual value (ScaledInput) and manipulated variable (Output) can be displayed and monitored in a diagram. (→ Start)

D51-300_PID_Controller_S7-1200  → CPU_1214C [CPU 1214C DC/	/DC/DC] 🕨 Technology a	objects   PID_Compact_Mo	tor_Speed [DB2]	_ # #>
aa. ≻				<b>=</b>
Measurement	Tuning mode			
Sampling time: 0.3 s 💌 🗲 Start		💌 🕨 Start		
Starts the measurement of t				
• • 약 중 다 다 다 • • • * * * * * * * * * • • •		*		
45 1 40 35 30 25		Motor_Speed [] (no data)		Legend CurrentSetpoint (1/min) ScaledInput (1/min) Output (%)
Multi 202 205 205 205 205 205 205 205 205 205				
-43 1		[ms]		Automatic
Image: Color     Color       Image: Color     Image: Color       Image: Color <td< td=""><td>Scaling group CurrentSetp  CurrentSetpoint</td><td></td><td>Unit 1/min 1/min %</td><td></td></td<>	Scaling group CurrentSetp  CurrentSetpoint		Unit 1/min 1/min %	
	Tuning status and on	line status of controller		

 $\rightarrow$  The measurement can be stopped again by clicking '

 $(\rightarrow \blacksquare \text{Stop})$ 



#### 7.6 PID\_Compact pretuning

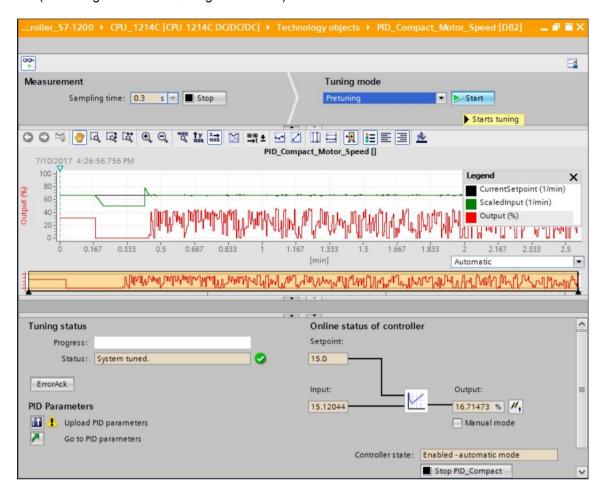
The pretuning determines the process response to a step change of the output value and searches for the turning point. The PID parameters are calculated from the maximum slope and the dead time of the controlled system. The optimal PID parameters are obtained when you perform pretuning and fine tuning.

The more stable the actual value is, the easier and more accurately the PID parameters can be determined. Actual value noise is acceptable as long as the actual value rise is significantly greater than the noise. This is most likely the case in "Inactive" or "Manual mode" operating mode. The PID parameters are backed up before they are recalculated.

#### The following requirements must be met:

- The "PID\_Compact" instruction is called in a cyclic interrupt OB.
- ManualEnable = FALSE
- Reset = FALSE
- PID\_Compact is in "Manual mode", "Inactive" or "Automatic mode" operating mode.
- The setpoint and actual value are within the configured limits (see "Process value monitoring" configuration).
- The difference between setpoint and actual value is greater than 30 % of the difference between the process value high limit and low limit.
- The difference between setpoint and actual value is > 50 % of the setpoint.

→ 'Pretuning' is selected as the 'Tuning mode' and this is then started. (→ Tuning mode → Pretuning → > Start)



→ The pretuning starts. The current work steps and any errors that occur are shown in the "Tuning status" field. The progress bar shows the progress of the current work step.

easurement Sampling time: 0.3 s 💌 🔳 Stop		Tunin	g mode		* Stop		
		Fretur	iirig				
				1			
7/10/2017 4:26:56.756 PM	PID_0	Compact_Motor_S	ipeed []				
100 - Y 80 -					Legend		×
60-1					Scaledinp	tpoint (1/min) ut (1/min)	)
40		_			Output (%		
20 0							
0 2 4 6	8 1	0 12	14	16	18 20	22	
		[s]			Automatic		
uning status		Online st	tatus of con	troller			
Progress: 00000000000000000000000000000000000	999	Setpoint:					
Status: Pretuning in progress.	0	15.0	<u> </u>				
ErrorAck							
		Input:			Output:		
1D Parameters		0.0			0.0 %	-	
Upload PID parameters					Manual mode		
Go to PID parameters					bled - pretuning		

### 7.7 PID\_Compact fine tuning

The fine tuning generates a constant, limited oscillation of the actual value. The PID parameters are optimized for the operating point based on the amplitude and frequency of this oscillation. All PID parameters are recalculated from the results. The PID parameters resulting from fine tuning generally produce a better response to setpoint changes and disturbances than the PID parameters from pretuning. The optimal PID parameters are obtained when you perform pretuning and fine tuning.

PID\_Compact automatically attempts to generate an oscillation that is greater than the actual value noise. The fine tuning is influenced only slightly by the stability of the actual value. The PID parameters are backed up before they are recalculated.

#### The following requirements must be met:

- The "PID\_Compact" instruction is called in a cyclic interrupt OB.
- ManualEnable = FALSE
- Reset = FALSE
- The setpoint and actual value are within the configured limits.
- The control loop is stable at the operating point. The operating point is reached when the actual value is equal to the setpoint.
- No disturbances are expected.
- PID\_Compact is in "Manual mode", "Inactive" or "Automatic mode" operating mode.

#### The fine tuning runs as follows when started in automatic mode:

When you want to improve the existing PID parameters by tuning them, start the fine tuning from automatic mode.

PID\_Compact uses the existing PID parameters for controlling until the control loop is stable and the requirements for fine tuning are met. Only then does the fine tuning start.

#### The fine tuning runs as follows when started in inactive or manual mode:

When the requirements for pretuning are met, pretuning is started. PID\_Compact uses the determined PID parameters for controlling until the control loop is stable and the requirements for fine tuning are met. Only then does the fine tuning start. If pretuning is not possible, PID\_Compact responds as configured in Response to error.

If the actual value is already too close to the setpoint for pretuning, an attempt is made to reach the setpoint with minimum or maximum output value. This can cause increased overshoot.

→ 'Fine tuning' is selected as the 'Tuning mode' and this is then started. (→ Tuning mode → Fine tuning →  $\triangleright$  Start)

20	
Measurement Sampling time: 0.3 s 💌 🔳 Stop	Tuning mode Fine tuning Stop
🕽 🖸 🎮 🚰 🗔 🗔 🕄 🔍 🔍 🥰 🗽 🖾 🖼 🛨 🖃	Z III ⊟ III E ≡ ▲ mpact_Motor_Speed []
Image: Non-State State St	
0-1 0 0.167 0.333 0.5 0.667 0.833 1 1.16	57 1.333 1.5 1.667 1.833 2 2.167 2.333 2.5 [min] Automatic
	Online status of controller Setpoint:
Status: Fine tuning in progress.	15.0 Input: Output: 13.2071 37.60203 % //1 Manual mode
Go to PID parameters	Controller state: Enabled - fine tuning

→ The fine tuning starts. The current work steps and any errors that occur are shown in the "Tuning status" field. If the self-tuning was completed without error message, the PID parameters have been tuned. The PID controller switches to automatic mode and uses the tuned parameters. The tuned PID parameters are retained at a Power ON and restart of the CPU. You can download the PID parameters from the CPU to your project with the '<sup>1</sup>/<sup>1</sup>/<sup>1</sup>

Tuning status			Online status of controlle	er	^
Progress:			Setpoint:		
Status:	System tuned.		15.0		
ErrorAck			Input:	Output:	=
PID Sends the F	PID parameters from the CPU to the project	it.	14.99928	31.15715 % 📈	
🚹 🚹 Upload	PID parameters			📃 Manual mode	
👗 Go to Pl	D parameters				
			Controller state:	Enabled - automatic mode	
				Stop PID_Compact	~

button. ( $\rightarrow$  )

→ The PID paran (→ <mark>♪</mark> )	neters in the configuration can be displayed by clicking '
Tuning status Progress: Status: System tuned. ErrorAck PID Parameters Switches to "PID parameters" d Go to PID parameters	Online status of controller
Basic settings     Controller type     Input / output parameters      Process value settings	PID Parameters
Process value limits Process value scaling Advanced settings Process value monitoring PWM limits Output value limits PID Parameters	
	Tuning rule Controller structure: PI

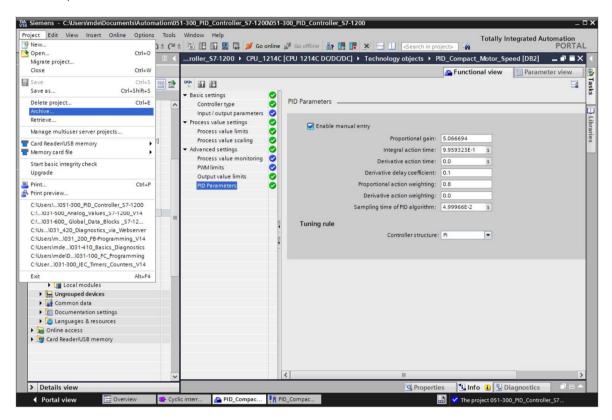
 $\rightarrow$  As the final step, the online connection should be disconnected and the complete project should be saved.



### 7.8 Archive the project

→ Now we want to archive the complete project. Select the → 'Archive ...' command in the → 'Project' menu. Select a folder where you want to archive your project and save it with the file type "TIA Portal project archive".

 $(\rightarrow$  Project  $\rightarrow$  Archive  $\rightarrow$  TIA Portal project archive  $\rightarrow$  051-300\_PID\_Control\_S7-1200....  $\rightarrow$  Save)



## 8 Checklist

No.	Description	Completed
1	Cyclic interrupt OB Cyclic interrupt 50ms [OB30] successfully created.	
2	PID_Compact controller in cyclic interrupt OB Cyclic interrupt 50ms [OB30] called and connected.	
3	Configuration of the PID_Compact controller performed.	
4	Compiling successful and without error message	
5	Download successful and without error message	
6	Pretuning successful and without error message	
7	Fine tuning successful and without error message	
8	Switch on station (-K0 = 1) Cylinder retracted / Feedback activated (-B1 = 1) EMERGENCY OFF (-A1 = 1) not activated AUTOMATIC mode (-S0 = 1) Pushbutton automatic stop not actuated (-S2 = 1) Briefly press the automatic start pushbutton (-S1 = 1) Sensor part at slide activated (-B4 = 1) then Conveyor motor M1 variable speed (-Q3 = 1) switches on and stays on. The speed corresponds to the speed setpoint in the range +/- 50 rpm	
9	Sensor part at end of conveyor activated (-B7 = 1) $\rightarrow$ -Q3 = 0 (after 2 seconds)	
10	Briefly press the automatic stop pushbutton (-S2 = 0) $\rightarrow$ -Q3 = 0	
11	Activate EMERGENCY OFF (-A1 = 0) $\rightarrow$ -Q3 = 0	
12	Manual mode (-S0 = 0) $\rightarrow$ -Q3 = 0	
13	Switch off station (-K0 = 0) $\rightarrow$ -Q3 = 0	
14	Cylinder not retracted (-B1 = 0) $\rightarrow$ -Q3 = 0	
15	Speed > Motor_speed_monitoring_error_max $\rightarrow$ -Q3 = 0	
16	Speed < Motor_speed_monitoring_error_min $\rightarrow$ -Q3 = 0	
17	Project successfully archived	

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## 9 Additional information

More information for further practice and consolidation is available as orientation, for example: Getting Started, videos, tutorials, apps, manuals, programming guidelines and trial software / firmware, under the following link:

www.siemens.com/sce/s7-1200

#### Preview "Additional information"

- Getting Started, Videos, Tutorials, Apps, Manuals, Trial-SW/Firmware
  - ↗ TIA Portal Videos
  - TIA Portal Tutorial Center
  - > Getting Started
  - ↗ Programming Guideline
  - ↗ Easy Entry in SIMATIC S7-1200
  - > Download Trial Software/Firmware
  - ↗ Technical Documentation SIMATIC Controller
  - ↗ Industry Online Support App
  - TIA Portal, SIMATIC S7-1200/1500 Overview
  - ↗ TIA Portal Website
  - ↗ SIMATIC S7-1200 Website
  - ↗ SIMATIC S7-1500 Website

## Notes

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## Notes




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SIMATIC Technical Documentation siemens.com/simatic-docu

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