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APPLICATION EXAMPLE

PROFINET system redundancy with the SINAMICS G220 and SIMATIC S7-410

SINAMICS G220 / SIMATIC S7-410 / SIMATIC PCS 7

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1. Introduction

1.1. Overview

The converter of the SINAMICS G220 family support PROFINET S2 system redundancy. Thanks to S2 system redundancy, operation of the system is guaranteed even in the event of a defect or replacement of a controller, thus reducing downtimes.

The prerequisite for S2 system redundancy is a so-called S7-410 fault-tolerant system, also referred to as an H system. An S7-410 fault-tolerant system consists of 2 fault-tolerant controllers - the primary and backup CPU - that synchronize via fiber optics. If one controller fails, the other automatically takes over.

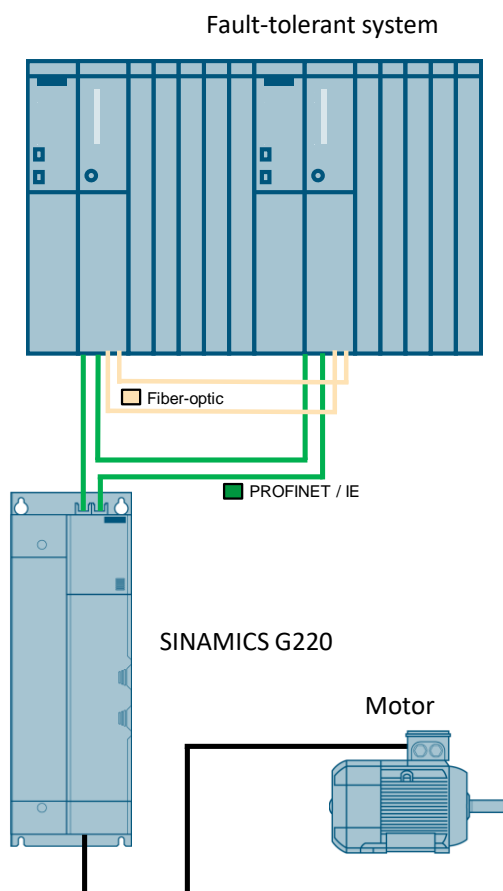
1.2. Principle of operation

S2 system redundancy

S2 system redundancy refers to a method of improving the reliability and fault-tolerance of a system. In an S2 redundant system, there are two identical components working in parallel. If one component fails, the other automatically assumes its function to ensure uninterrupted operation.

This example describes S2 system redundancy, in which a SINAMICS G220 is operated as a PROFINET device on a fault-tolerant system without the use of additional hardware.

Schematic diagram



Advantages

- No plant downtime in the event of a controller failure
- Hot-swappable components during operation
- Changes to the configuration during operation
- Automatic synchronization after replacement of components

Limitations of SINAMICS

- PROFINET-IRT is not supported
- No simultaneous operation of Shared Device and system redundancy
- Maximum of 2 cyclic PROFINET connections
- System redundancy only via the PROFINET X150 interface
- While switching from one controller to the other, the setpoints of the last connection remain frozen and valid.

Limitations on the engineering system

Startdrive does not yet support the direct configuration of the drive as a client on a redundant system. Therefore, the SINAMICS G220 must be integrated into the redundant system via a GSDML file in the project.

Limitations of the S7-410 fault-tolerant system

Limitations of the S7-410 H-System can be found in the system manual "SIMATIC PCS 7 Process Control System CPU 410 Process Automation V8" ([3](#)).

Required knowledge

Basic knowledge of PCS 7 and SINAMICS G220 is required.

1.3. Components used

The following hardware and software components were used to create this application example:

Component	Quantity	Item number	Note
SIMATIC PCS 7 CPU 410 Redundant Bundle	1	6ES7656-6C...-....	With Sync Modules
SINAMICS G220	1	6SL4112-0DA11-0AA0	Firmware V6.2
SIMATIC PCS 7 V9.1 SP2	1	6ES7658-4XX68-0YT8	Engineering License required
Startdrive V19	1	6SL3072-4KA02-0XG5	Engineering software for SINAMICS drives

You can obtain the listed components from the [Siemens Industry Mall](#), for example.

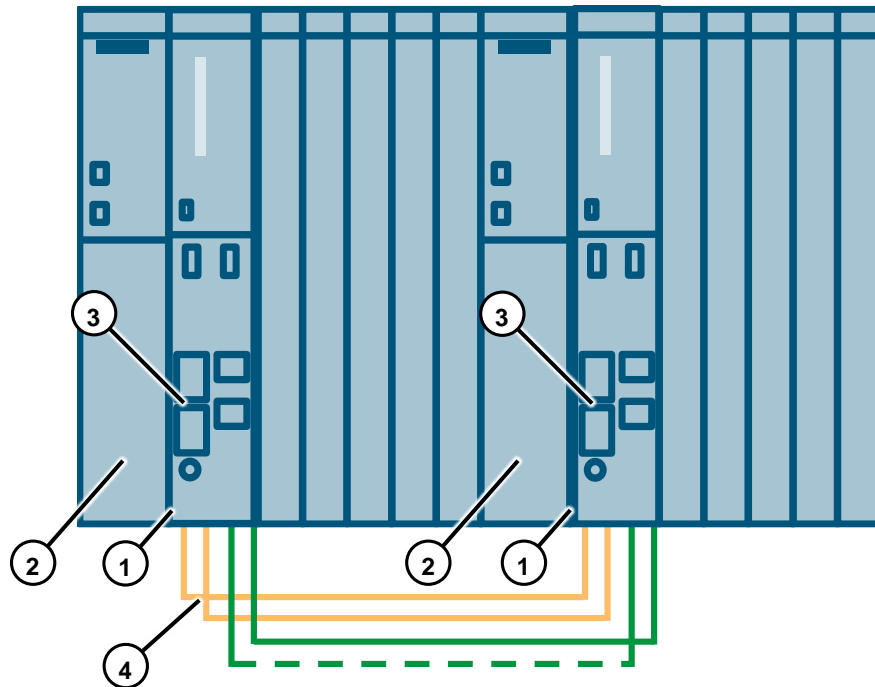
This application example consists of the following components:

Component	File name	Note
Documentation	109932875_S2_Systemredundancy_S7-410H_G220_DOC_V10_en.pdf	This document
Example project	109932875_S2_Systemredundancy_S7-410H_G220_PROJ_V10.zip	Example project for PCS 7 V9.1 SP2

2. Engineering

2.1. Hardware setup

The following images show the hardware setup and the wiring of the application:



S7-410H (1)

The S7-410H redundant system should be mounted either on one shared rail or on two separate mounting rails. You will connect the two CPUs with fiber-optic cables to two synchronization modules in each CPU. Set up the PROFINET ring via the CPUs' X8 P1 R and X8 P2 R PROFINET interface.

Power supply (2)

The load current power supply (PM) supplies the system power supply (PS) and core modules (CPU) with DC 24 V. For peripheral power supplies, we recommend the devices of the SIMATIC series. These devices can be mounted on the mounting rail.

Synchronization modules (S7-410H only) (3)

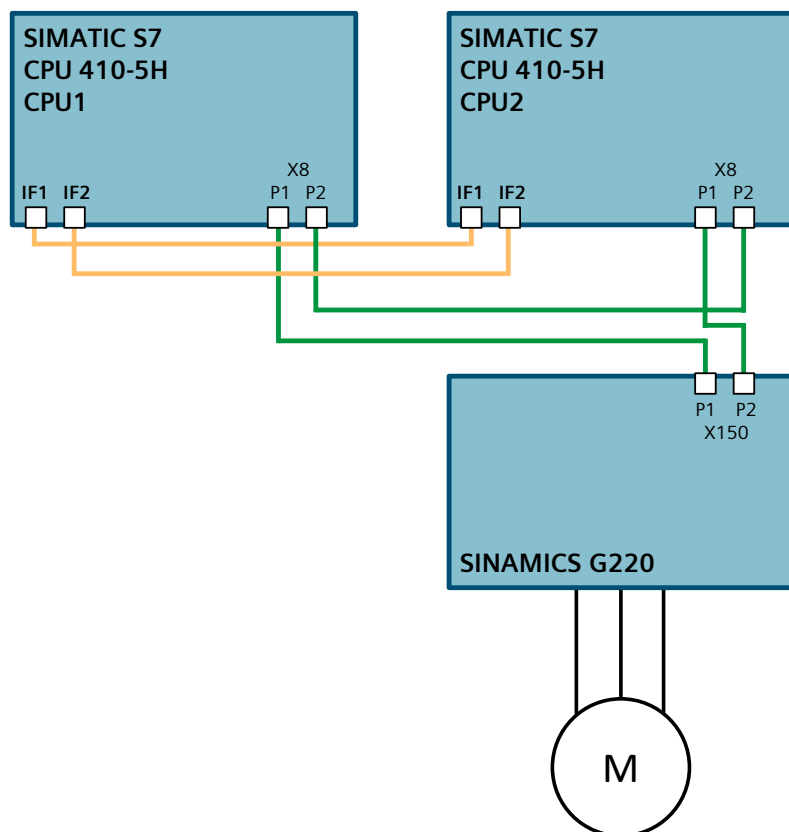
You will create two redundancy connections between the H CPUs with fiber-optic cables using a total of four synchronization modules (two in each H CPU).

Fiber-optic cables (S7-410H only) (4)

You will connect the two synchronization modules for each CPU with a pair of fiber-optic cables.

2.2. Topology

In order to integrate the SINAMICS G220 into the system via PROFINET, the application example will use the following topology:

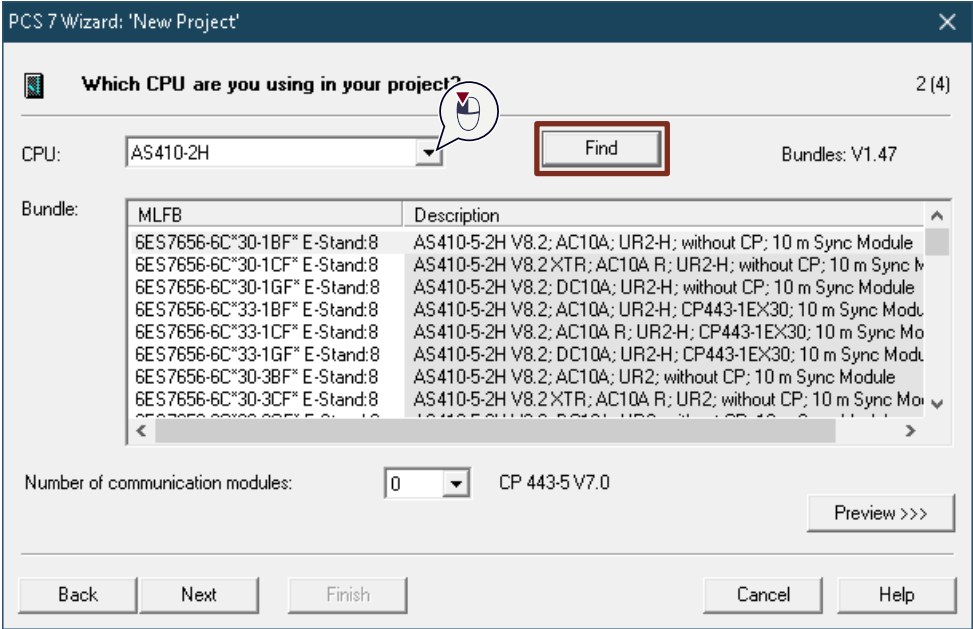


2.3. Configuration

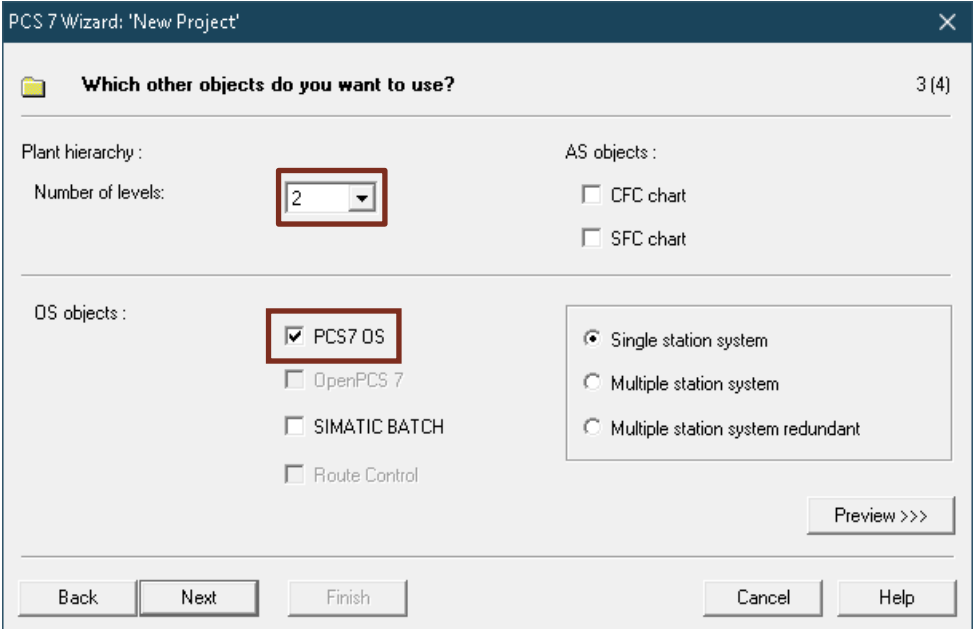
2.3.1. Configuration of the SIMATIC H system

Follow the steps below to configure the SIMATIC S7 H system in PCS 7:

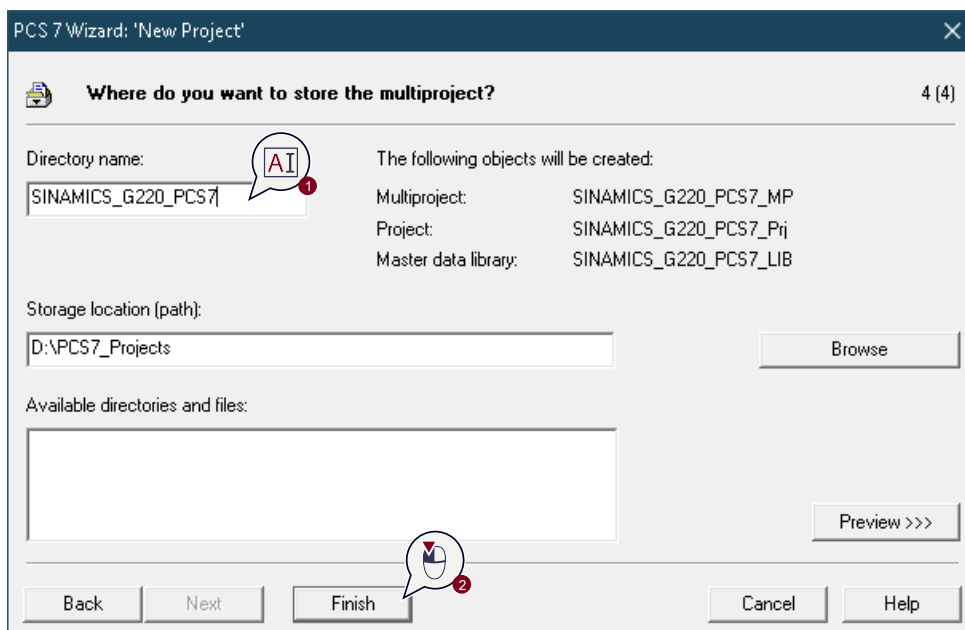
1. Create a new PCS 7 project with the PCS 7 Wizard and select an AS410-2H or enter the part number of your fault-tolerant S7-410H.



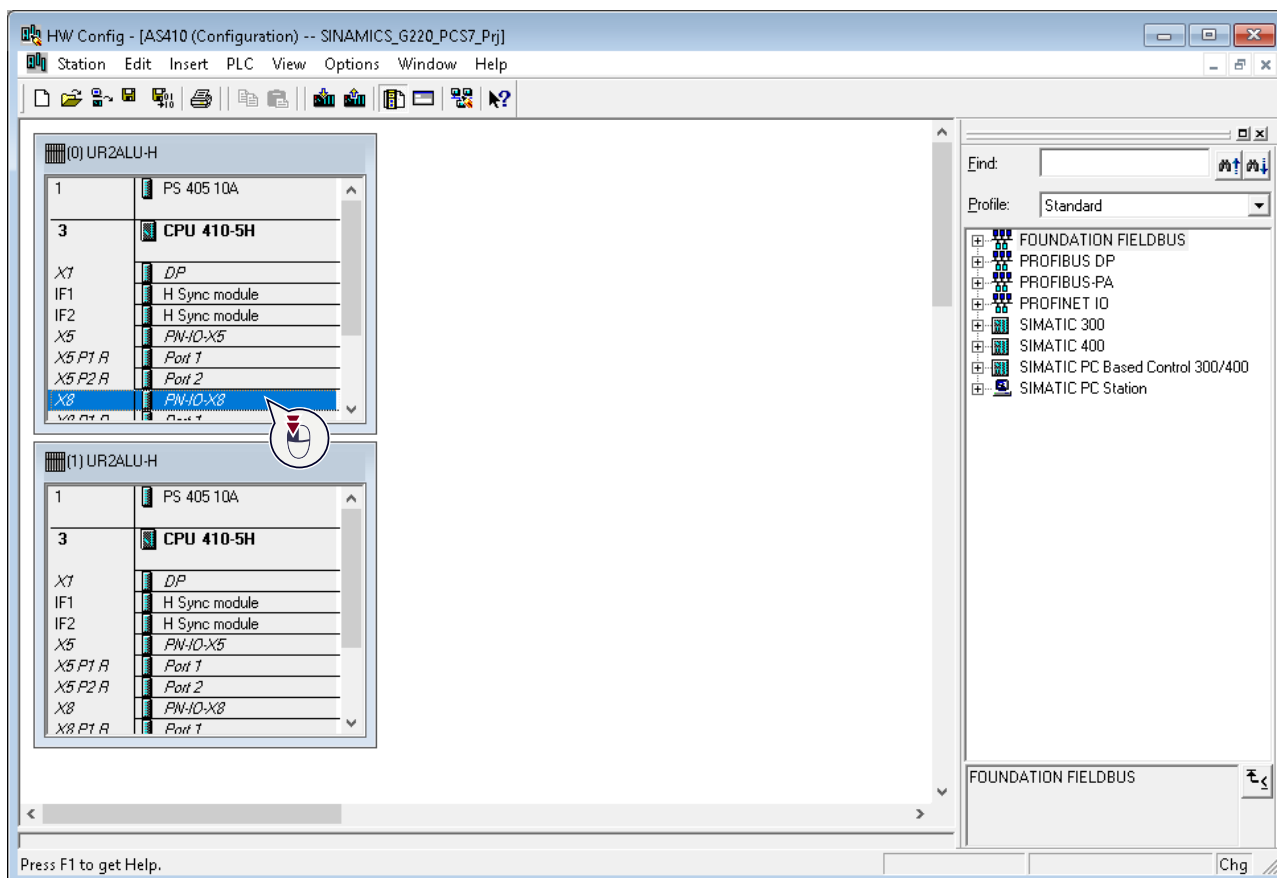
2. After that, specify how many hierarchy levels you want your project to have. In addition, you can select here whether an OS should be created.



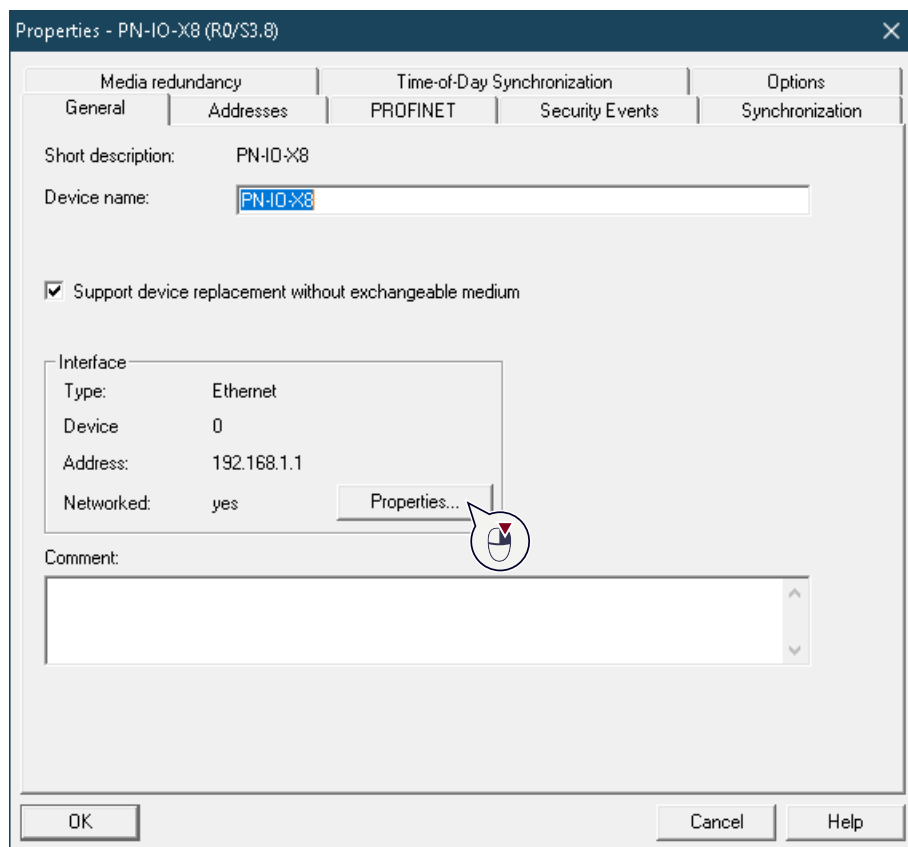
3. Then give the project a name (1) and exit the wizard (2).



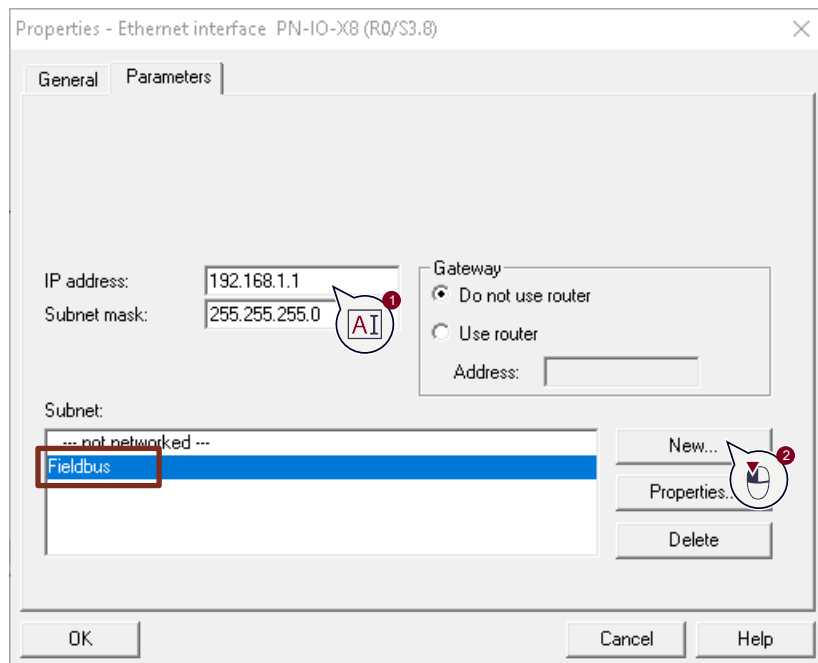
4. Assign the IP address for the first controller of the S7-410 H system by selecting the hardware configuration (HW Config) and open the properties of the X8 PROFINET interface of the first SIMATIC S7 controller.



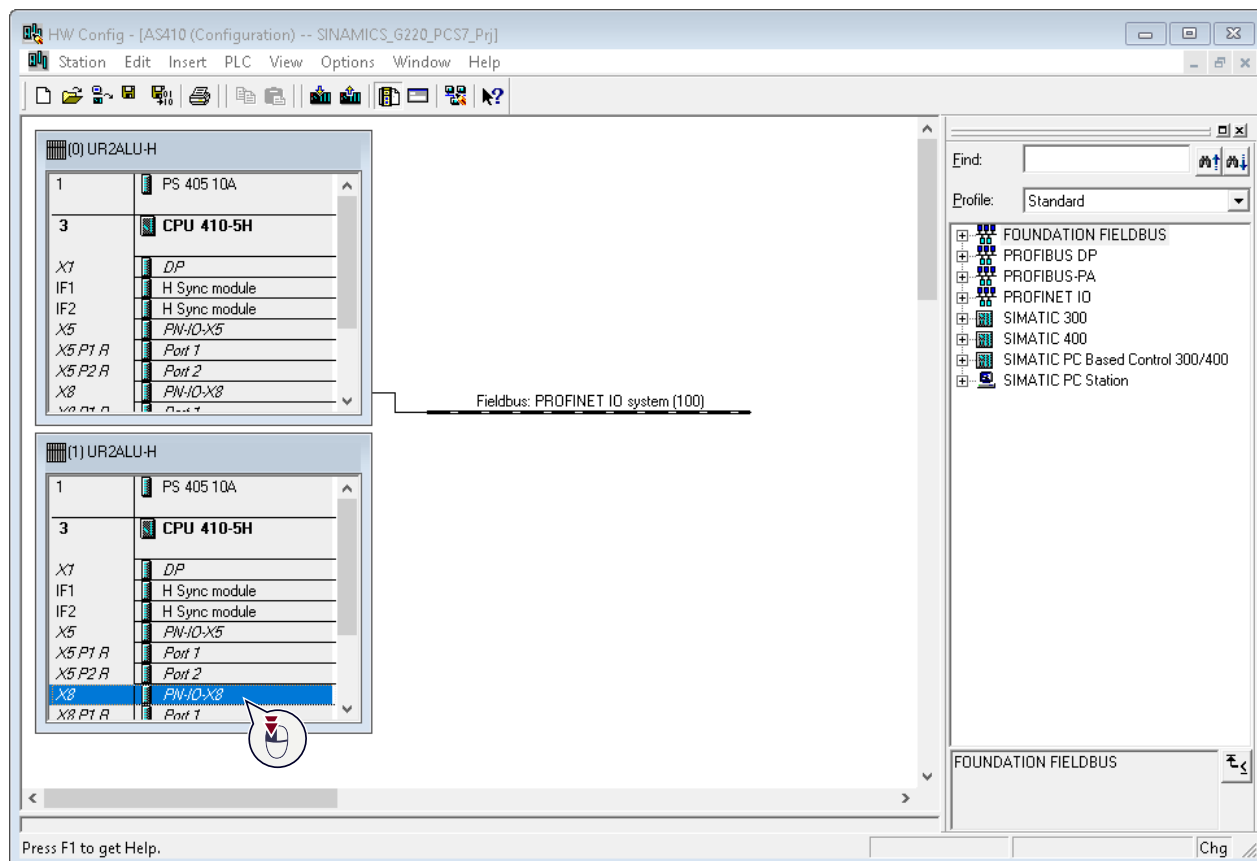
5. Use the "General > Interface" tab to open the properties of the PROFINET interface.



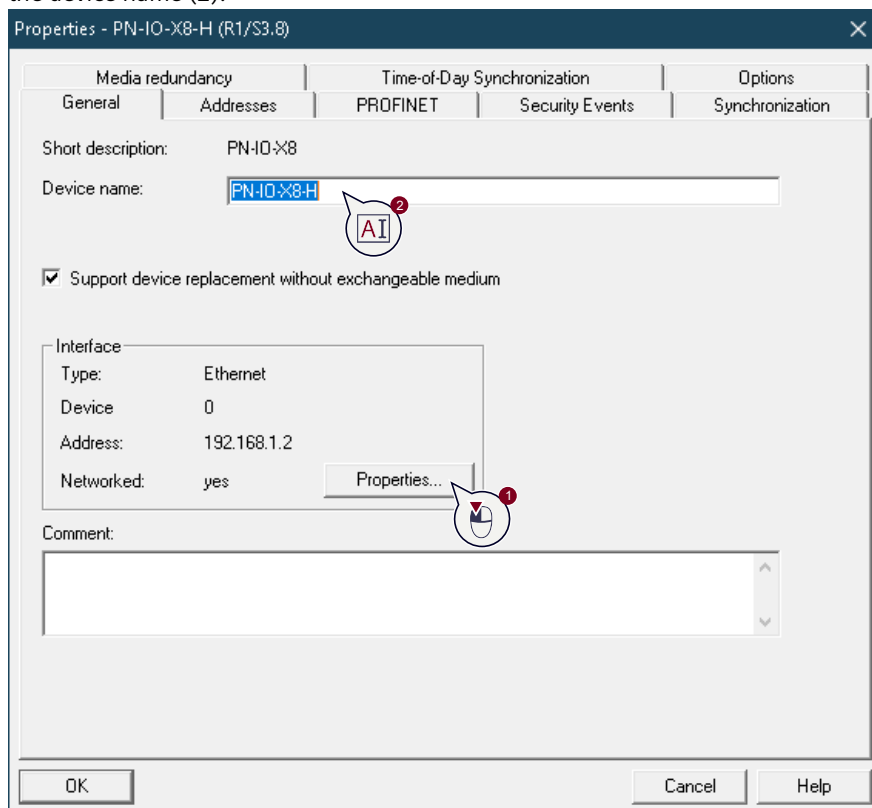
6. Enter the desired IP address here (1). In this example, we will use 192.168.1.1. Then create a new subnet (2) and give it a descriptive name. Assign the subnet to the IP address.



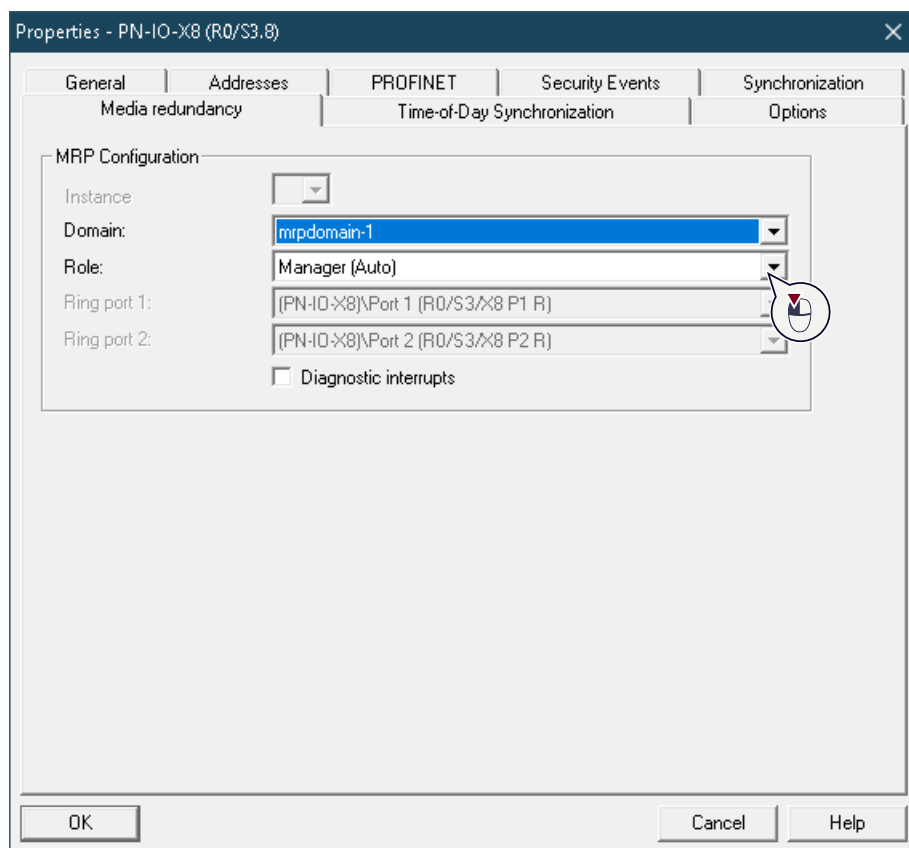
7. Assign the IP address for the second controller of the S7-410 H system by opening the HW Config and opening the properties of the X8 PROFINET interface of the second SIMATIC S7 controller.



8. Use the "General > Interface" tab to open the properties of the PROFINET interface. Then enter the desired IP address (1). In this example, we'll use 192.168.1.2. Assign the previously created subnet to the IP address. Be sure to change the device name (2).



9. Configure the MRP ring by selecting the "Manager (Auto)" role under "Media redundancy" in the properties of the X8 interfaces.



2.3.2. Configuration of the SINAMICS G220 drive

The SINAMICS G220 drive cannot be integrated directly into PCS 7. Instead, a GSDML file is used to integrate the drive to the redundant system.

NOTE

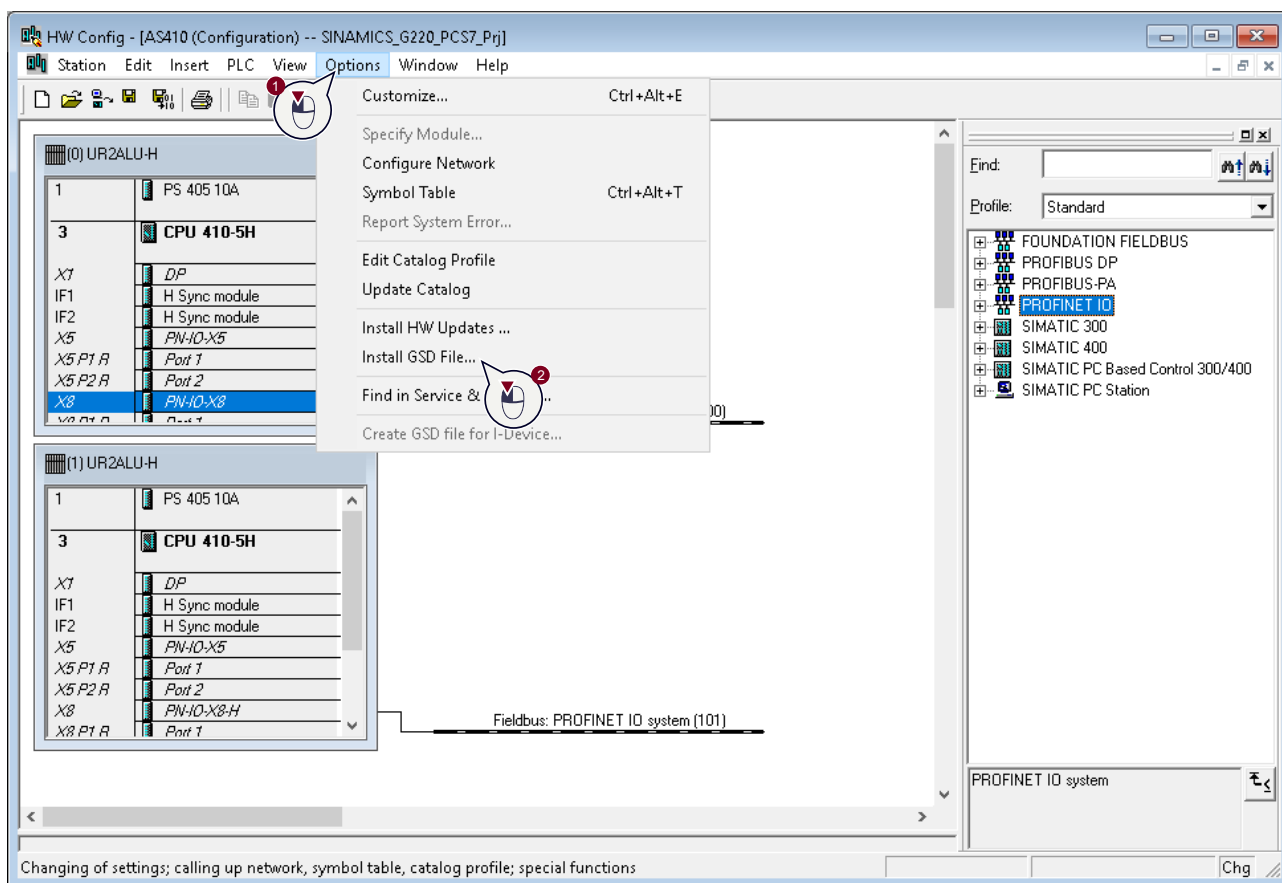
The GSDML file for the frequency converter can be found in the downloads for article: "SINAMICS G220 PROFINET GSDML":

<https://support.industry.siemens.com/cs/ww/en/view/109901084>

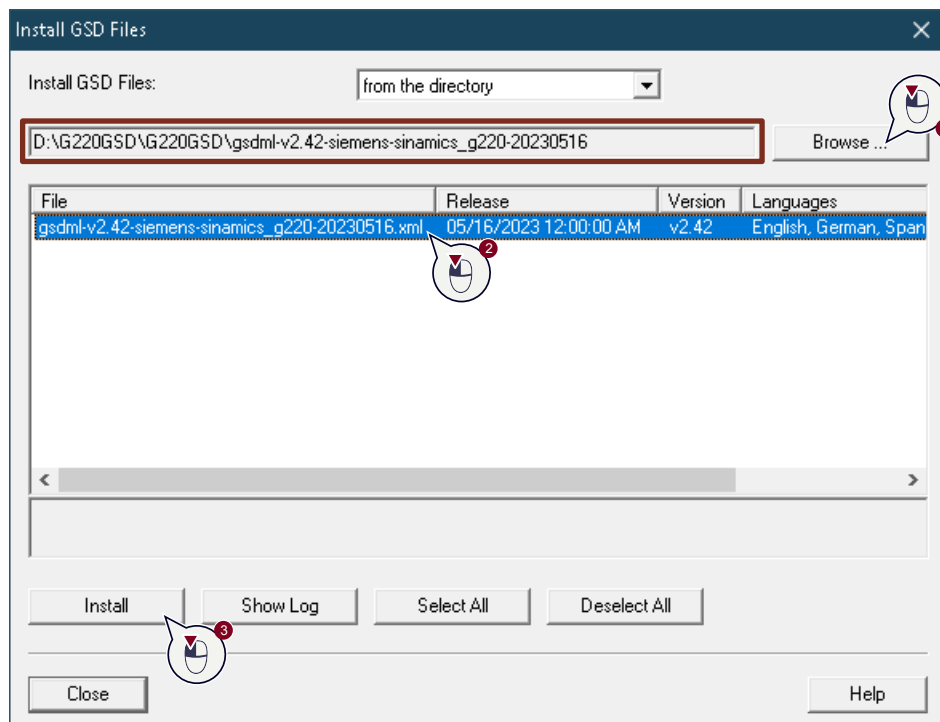
This example assumes basic configuration of the SINAMICS G220 drive is already complete. Only the steps which are necessary beyond that in order to integrate the SINAMICS G220 into the redundant system will be explained.

Install the GSDML file

1. Download the GSDML file from the link above and extract the file.
2. Open SIMATIC Manager and the prepared multiproject.
3. Open the HW Config of the CPU.
4. In the HW Config, click on "Options > Install GSD File...".

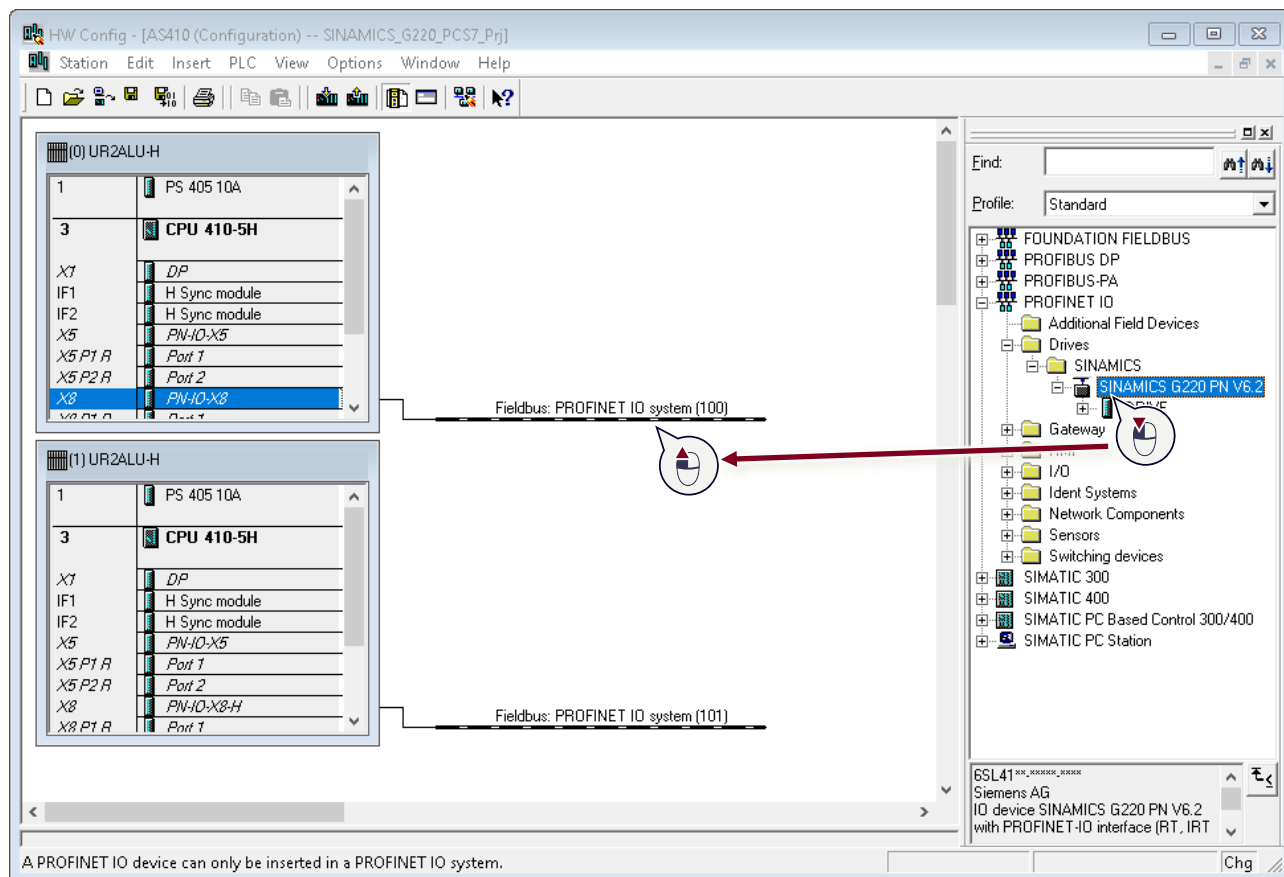


- Click on "Browse" (1) and select the extracted folder containing the GSDML files of the SINAMICS G220. After that, select the desired file (2) and install the GSD file (3).



Configure the G220 hardware

- Drag the GSDML for the SINAMICS G220 with the corresponding firmware version from the "Standard" hardware catalog under "PROFINET IO > Drives > SINAMICS" and into the HW Config.



2. From the "DRIVE" list, drag and drop the telegram used into slot 1.3 of the "DRIVE" module. This application example uses standard telegram 20.

The screenshot shows the HW Config software interface for a SINAMICS G220-PN drive. The hardware rack (UR2ALU-H) is configured with a PS 405 10A power supply in slot 1 and a CPU 410-5H in slot 3. The fieldbus diagram shows two PROFINET IO systems (100 and 101) connected to the drive. The module list on the left shows the configuration for the CPU 410-5H, including DP, H Sync modules, and PN-IO modules. The telegram selection pane on the right shows a list of telegrams, with 'Standard telegram 20, PZD-2/6' highlighted. A red arrow points from this telegram to slot 1.3 of the DRIVE module in the hardware rack.

Slot	Module	Order number	I Address	Q address	Diagno...	C...	A...
X150 P2 R	Port 2				16360*		
1	DRIVE				16360*		
1.1	Module Access Point				16360*		Full
1.2							
1.3	Standard telegram 20, PZD-2/6		512...523	512...515			Full
1.4							

Standard telegram 20: Closed-loop speed control, process industry, NAMUR, PZD length 2/6 words, gsdml-v2.42-siemens-sinamics_g220-

3. Open the properties of the G220 and modify the device name (1). In this application example, it is "G220". Also assign a suitable IP address (2); our example uses "192.168.1.3".

Properties - G220

General Identification Redundancy Shared Access

Short description: SINAMICS-G220-PN
IO device SINAMICS G220 PN V6.2 with PROFINET-IO interface (RT, IRT and acyclic communication, clock synchronization, PROFIsafe, Shared Device, system redundancy S2)

Order no./ firmware: 6SL41 *** / V6.2

Family: SINAMICS

Device name: G220

GSD file: gsdml-v2.42-siemens-sinamics_g220-20230516.xml

Change release number...

Node in PROFINET IO system

Device number: 1 PROFINET IO system (100)

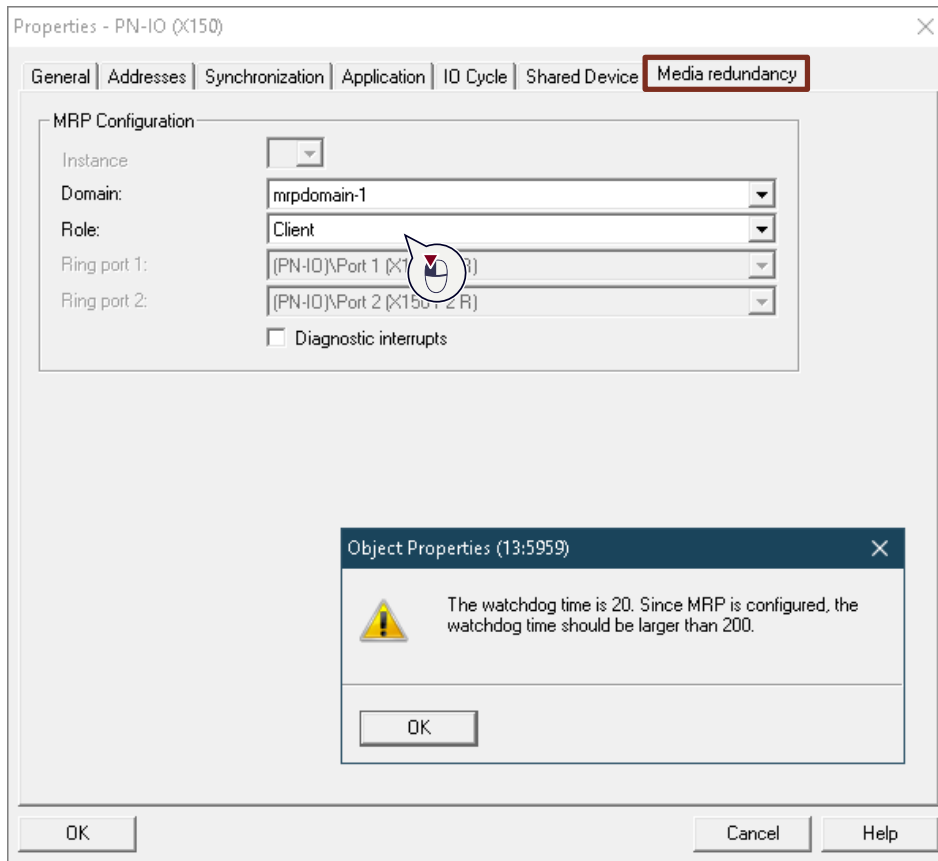
IP address: 192.168.1.3 Ethernet...

☒ Assign IP address via IO controller
☐ Configuration via PDM

Comment:

OK Cancel Help

4. Switch to the "Media redundancy" tab of the G220 and assign the role "Client". Due to the configuration of the MRP ring, the "watchdog time" must be adjusted.



ATTENTION

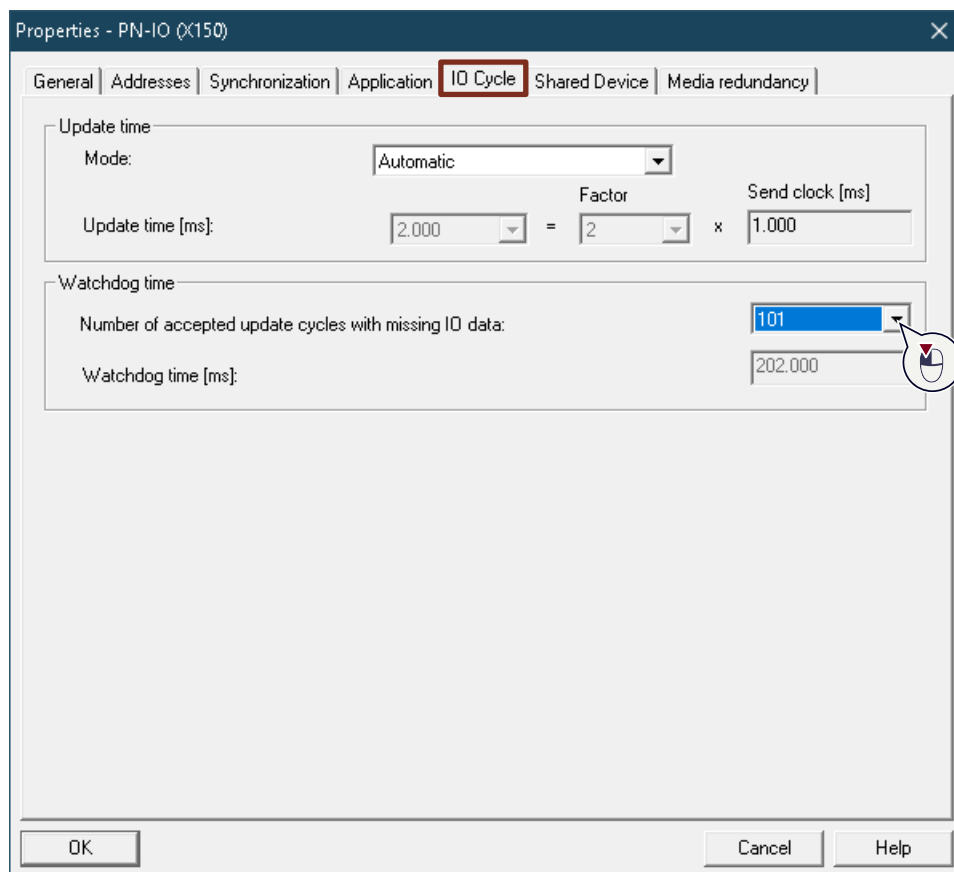
Improper configuration of an MRP ring can lead to the risk of accidents and damage to the system!

This is due to the watchdog time and the fact that the motor continues to run until the watchdog time is up.

If this is not acceptable, it is recommended to set up S2 redundancy without an MRP ring. This can reduce the risk of accidents.

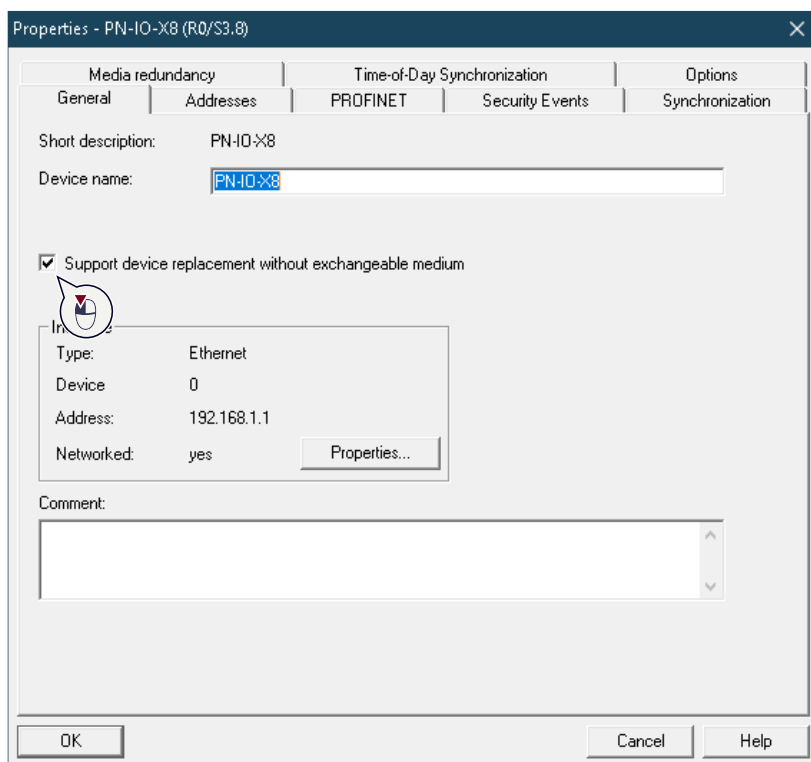
It is of paramount importance that all safety precautions are taken to ensure the safety of the people involved. If you have any questions or concerns, please consult a professional or experts in the field.

5. Open the "IO Cycle" tab and adjust the value to achieve a "Watchdog time" greater than 200.

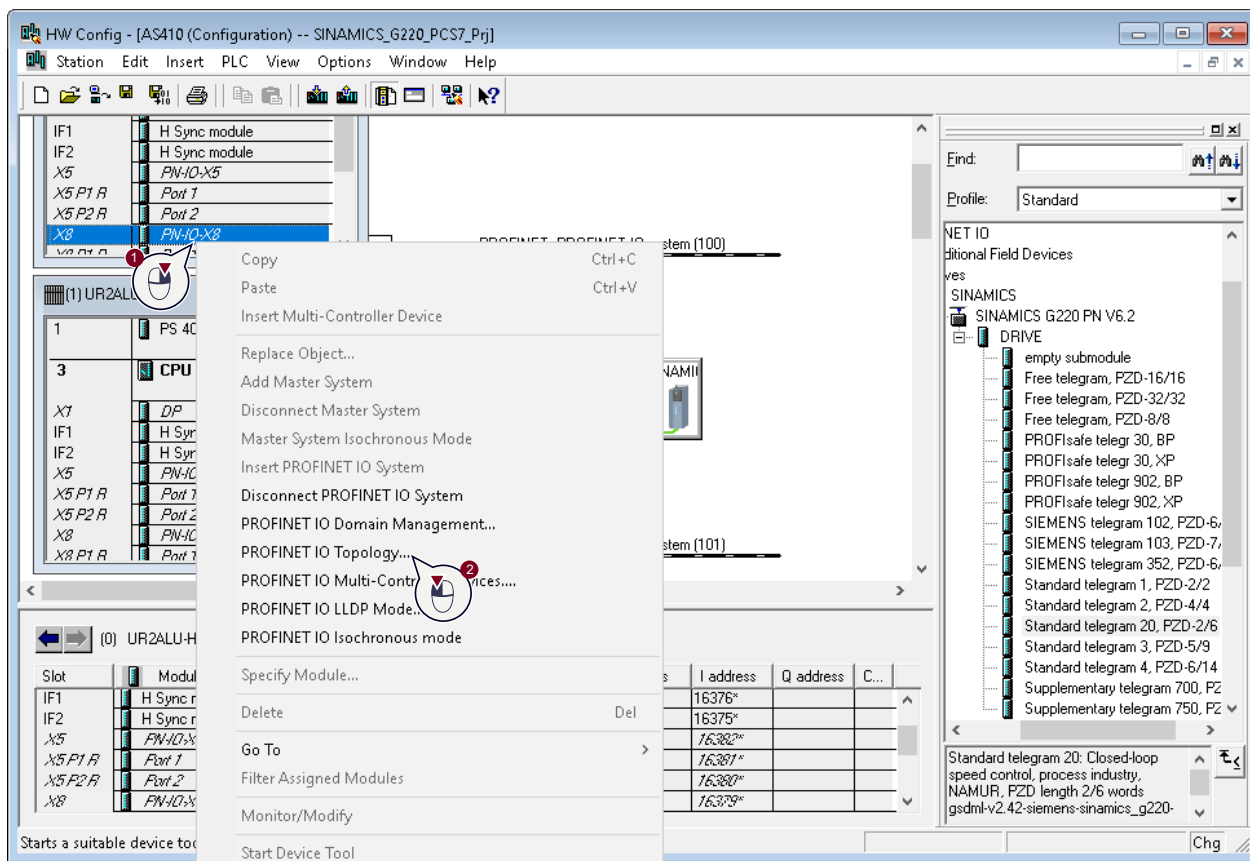


Automatic device name configuration

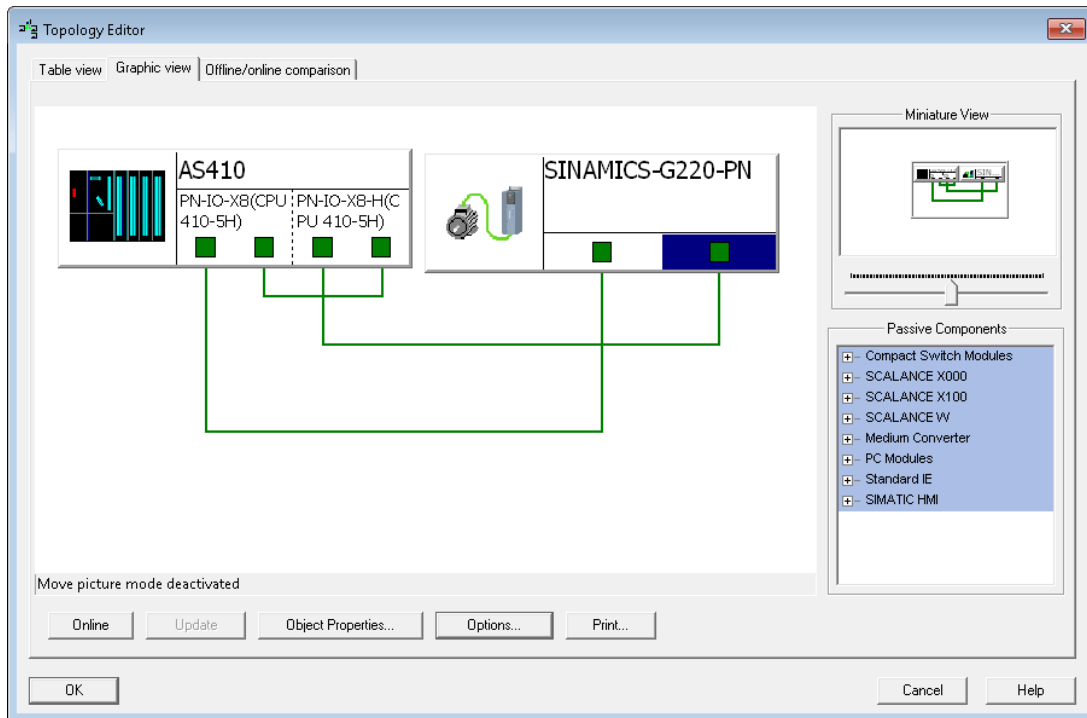
1. Open the object properties of the CPU interface that the SINAMICS G220 drive system is connected to.
2. Tick the "Support device replacement without exchangeable medium" checkbox.



3. Right-click on the interface to which the drive system is connected (1) to open the context menu and open the "PROFINET IO Topology..." (2).



4. Switch to the "Graphic view" tab. Connect the individual component interfaces to each other according to the physical connection of your system via drag and drop.



5. Confirm your topology configuration with "OK".
6. Save and compile the HW Config and download it to the H system.
7. You can use the online mode in the HW Config to verify that the name has been transferred correctly.

NOTE To verify that the target topology and actual topology are identical, you must select the Ethernet network adapter with access to the fieldbus. Select it in the PG/PC interface. You can then check the target and actual topology in the Topology Editor using the "Online" button.

NOTE Topology configuration is only possible within a subproject, i.e. the stations with a common PROFINET network must be located in the same subproject.

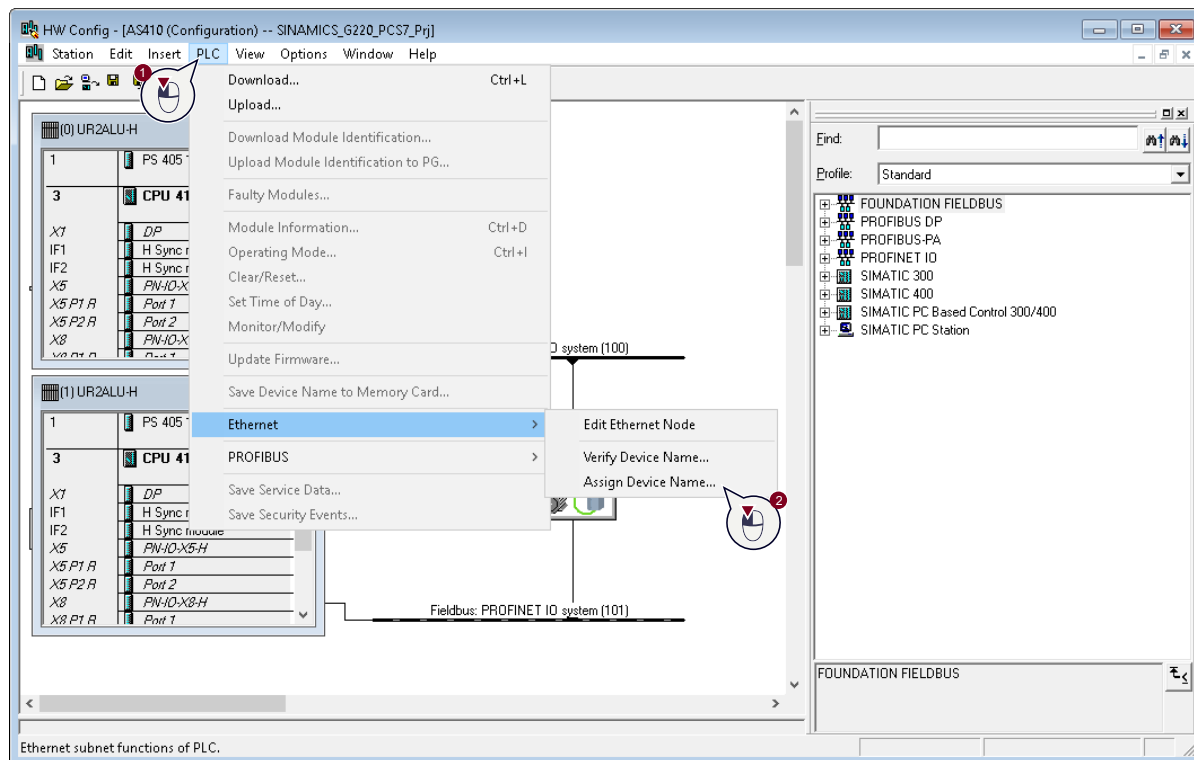
Manual device name configuration

The device name can be manually transferred to the drive system. In order to have direct access to the drive, the ES and the drive system must be on the same physical network. The following options are available:

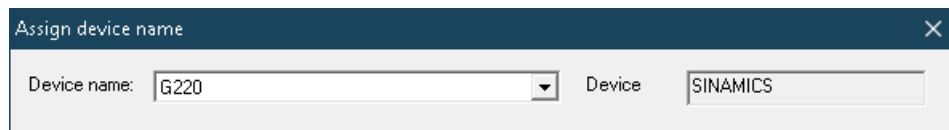
- Use of a Service Bridge.
- Unplugging and re-inserting the PROFINET interface for direct access to the drive system.

In this application example, the ES is connected to the PROFINET interface of the CPU via the plant bus.

1. Plug the network cable of the ES/single station into the fieldbus.
2. In the menu of SIMATIC Manager, click on "Options > Set PG/PC Interface...".
3. Select the Ethernet network adapter that you have connected to the fieldbus.
4. Select the PROFINET system in the HW Config and then click on "PLC > Ethernet > Assign Device Name" in the menu.



5. In the "Device name" drop-down menu, select the name of the G220 that you have assigned to the drive.



6. Then select the appropriate drive from the "Available devices" list.
7. Click "Assign name".

NOTE

You can filter the list by device type. To do this, check the "Show only devices of the same type" checkbox.

8. Click "Close" to close the window.

NOTE

You can use the "Accessible nodes" menu in SIMATIC Manager to check whether the name has been correctly transferred to the drive system.

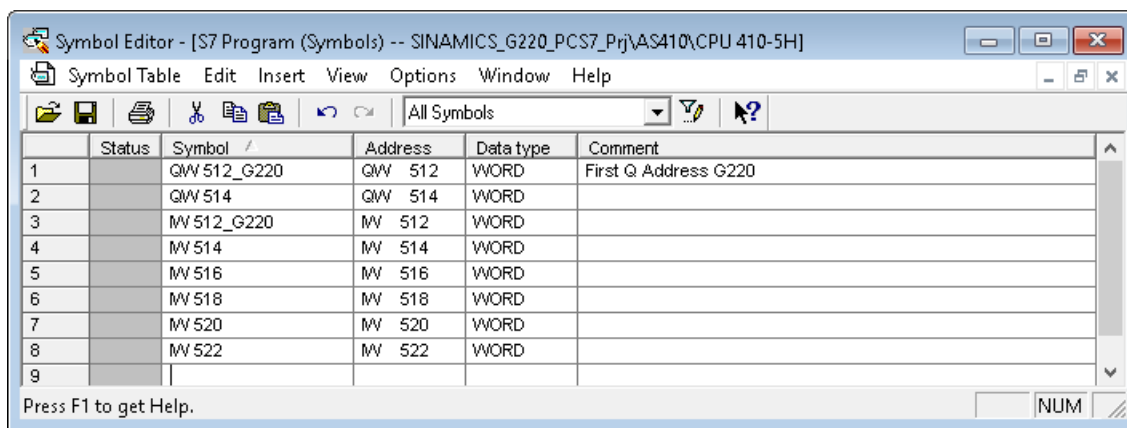
9. Reconnect the ES to the plant bus of your PLC and change the PG/PC interface back if necessary. For example, to "PC Internal (Local)".

2.3.3. Symbol table

1. Open the symbol table.
2. In the "Symbol" column, create the symbolic names for the input and output tags.
3. Assign the 2 "output words" and 6 "input words" tags to the symbolic names.

Standard telegram type 20 contains the following values:

Word	Output word	Input word
1	Control word	Status word
2	Speed setpoint	Speed actual value
3		Motor current
4		Torque
5		Power
6		Namur messages or freely configurable analog value

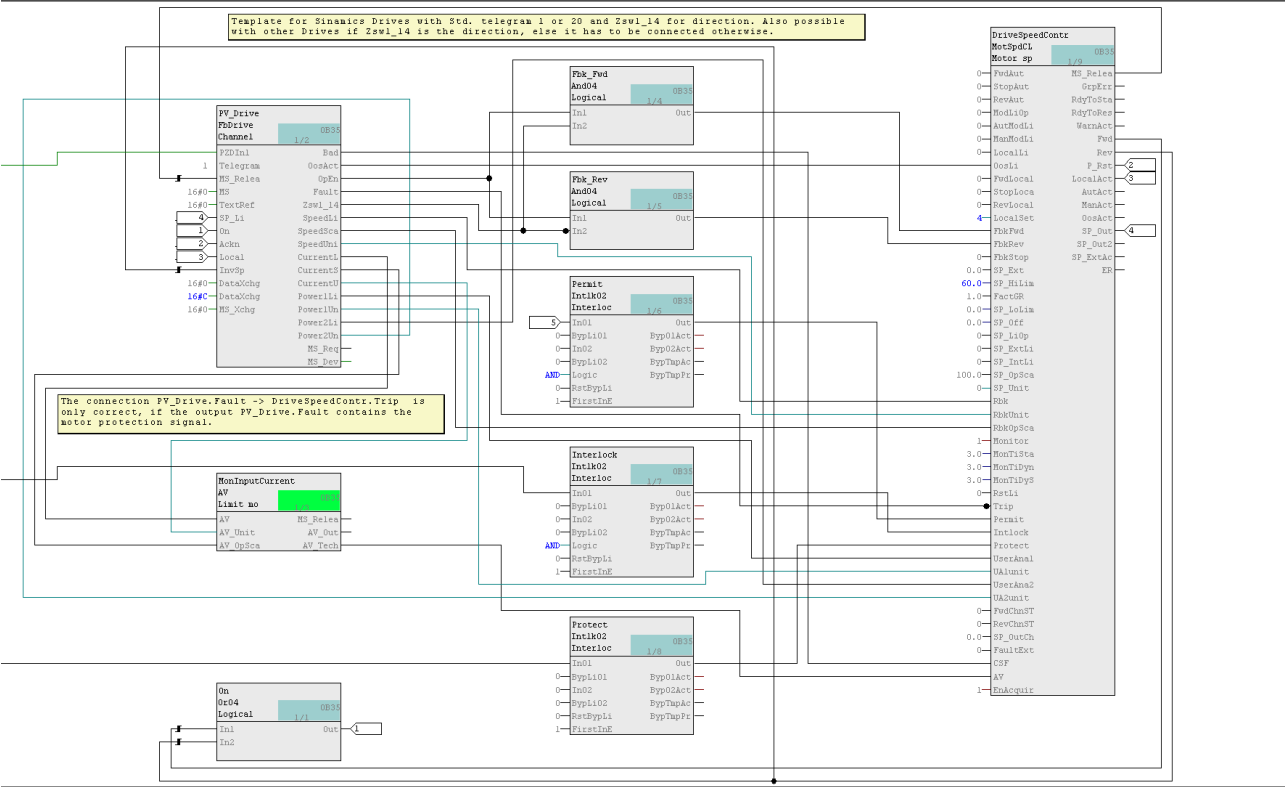


4. Save the changes and close the symbol table.
5. Open & compile the HW Config.

2.4. CFC engineering

Preface

This application example uses the "Drive" template from the Advanced Process Library (APL) to quickly and easily integrate the drive into the program. The template already contains the blocks "FbDrive" and "MotSpdCL", as well as all necessary connections. It thus offers a ready-to-use automation solution. The "Interlock", "Permit" and "Protect" interlock blocks are also inserted and connected. You can delete them as needed if you don't need these features. After inserting the template from the library into the PLC program, you will need to connect the input "PZDIn1" at the "FbDrive" block with the first input word "ZSW1" of the frequency converter and set a telegram type. The rest of the signal connections are done by the compiler.

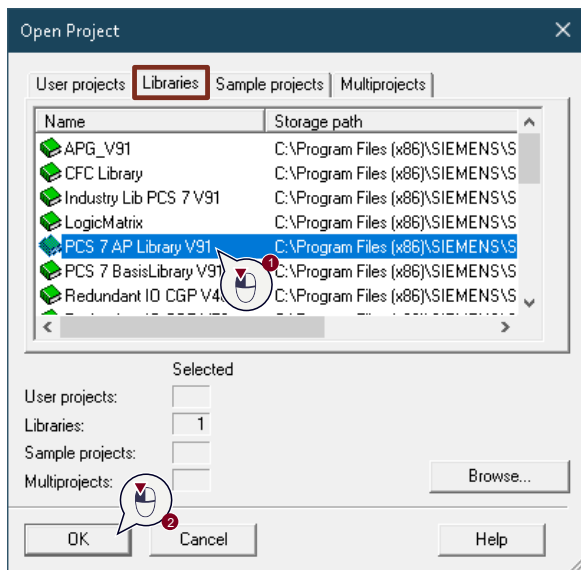


NOTE This application example offers only a simple standardized solution to enable a quick start.

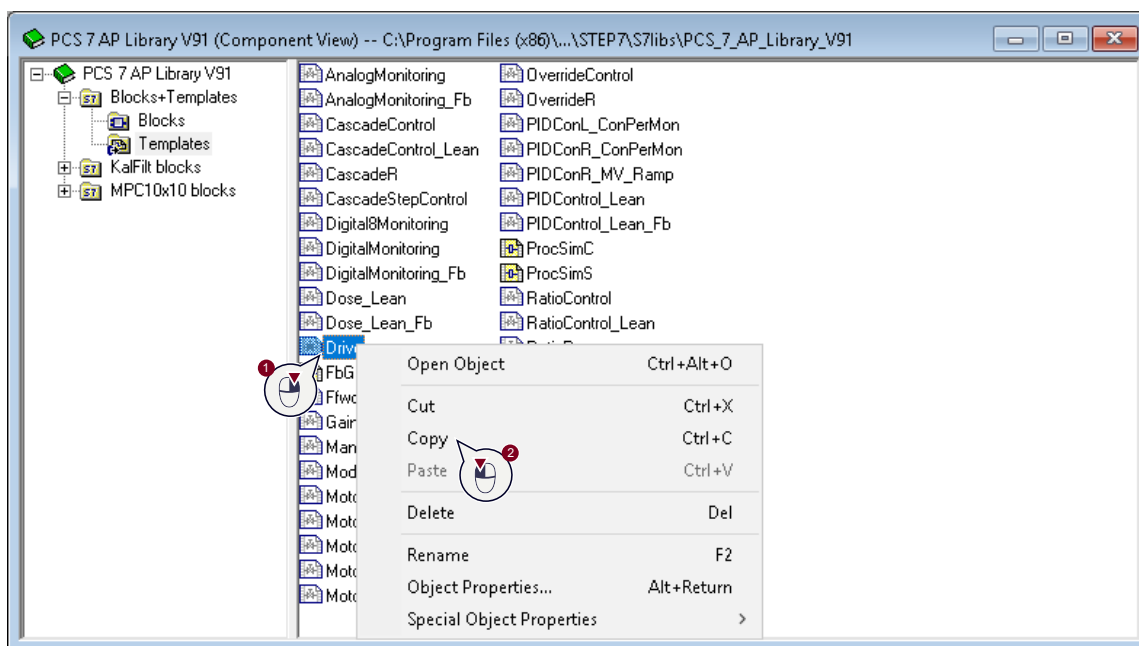
NOTE The parameterization of the drive system is not part of this application example.

2.4.1. Configuration

1. Switch to SIMATIC Manager.
2. In the menu bar, select "File > Open...".
3. Go to the "Libraries" tab and select the "PCS 7 AP Library V91" library (1) and confirm the dialog with "OK" (2).



4. In the PCS 7 Advanced Process Library V91, select the "Templates" folder. Highlight the "Drive" template, open its context menu and select "Copy".



5. Go to your master data library, then to "Process Tag Types" and paste the copied template by right-clicking "Paste". The copied template is now available in your project.
6. Copy the template from your master data library into your plant hierarchy and assign a plant designation for the chart.

Configure the MotSpdCL block

1. Open the CFC.
2. Open the object properties of the "MotSpdCL" block.
3. Give your drive a meaningful name and a suitable description.
4. Change to the "I/Os" tab.
5. In the "Identifier" column, assign texts according to the table below so that they appear properly in the faceplate in the OS.

Input name	Identifier
UserAna1.Value	Torque
UserAna2.Value	Power
AV_Out.Value	Current

6. (Optional) Also, set the "IdleTime" to 0 if you don't need it for your application.
(Optional) If necessary, delete the "Interlock", "Permit" and "Protect" blocks that are not required in the example.

ATTENTION **Improper project engineering and incorrect operation can lead to the risk of accidents and damage to the system!**

In order to ensure proper and safe operation of your system, it is necessary to integrate various protection mechanisms into the program depending on the drive, system design and area of application; you must also parameterize the MotSpdCL block and the drive appropriately.

The necessary program structure and the necessary parameterization of the blocks in your project may therefore differ from the application example.

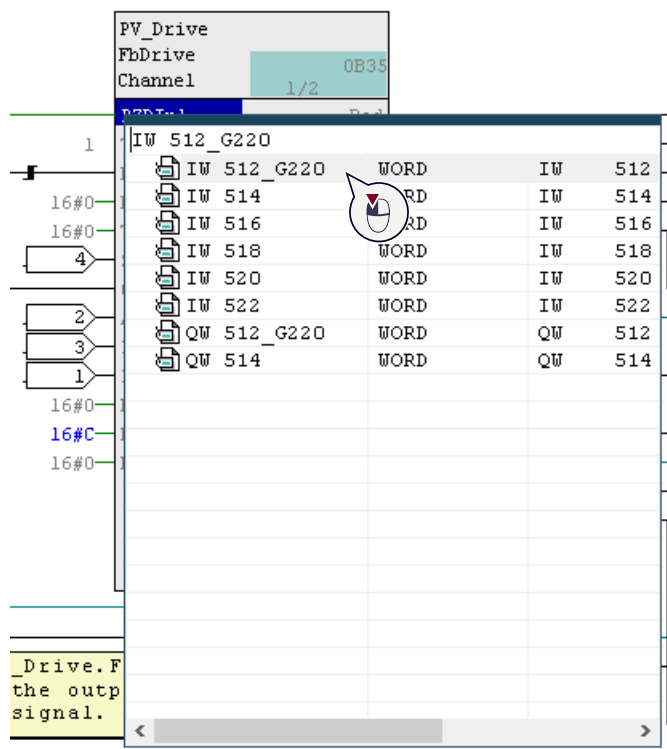
Failure to do so could result in the risk of accidents and damage to the plant.

For more information about the MotSpdCL block and its settings and feature bits, see the PCS 7 Advanced Process Library Manual.

<https://support.industry.siemens.com/cs/ww/en/view/109812806>

Interconnect FbDrive

1. In the CFC chart, select the input "PZDIn1" of the "FbDrive" block. Right-click on the context menu and select "Interconnection to Address...".
2. Select the first input word of the G220, in this case "IW 512_G220".
All other input and output words are automatically connected by the driver generator during compilation.



3. At the "telegram" block parameter, set telegram 20 by setting the value to "20".

NOTE

For more information about FbDrive, see the PCS 7 Advanced Process Library manual.
<https://support.industry.siemens.com/cs/ww/en/view/109812806>

2.4.2. Process value scaling and units

The setpoint speed "STW2" and the actual speed "ZSW2" are transmitted as integers in the range from 0 to 16384. In PCS 7, the raw value is scaled to a process value at the "FbDrive" driver block.

There are a few places in the CFC in PCS 7 where you can scale the process value. Some of these include:

Block	Connector	Description
FbDrive	PZDIn2Unit	Unit of the actual value
	PZDIn2Scale.High	Upper limit of the actual value
	PZDIn2 Scale.Low	Lower limit of the actual value
	SPLiScale.High	Maximum setpoint
	SPLiScale.Low	Minimum setpoint
MotSpdCl	SP_HiLim	Upper setpoint limit
	SP_LoLim	Lower setpoint limit
	SP_OpScale.High	Upper limit for bar chart display
	SP_OpScale.Low	Lower limit for bar chart display
	SP_Unit	Unit for the label on the faceplate

The values PZDIn2, PZDIn2Scale and PZDIn2Unit are transmitted to the MotSpdCL block via the connectors "SpeedLink", "Speedscale" and "SpeedUnit".

NOTE Adjust the scaling to suit your application. For pump and fan applications with the G220, values in percent or in revolutions per minute are recommended.

Code	Unit	Description
1077	Hz	Hertz
1082	1/s	Revolutions per second
1083	1/min	Revolutions per minute
1342	%	Percent

NOTE Units of measurement in PCS 7 are coded according to the IEC 611582 standard. A complete list of all units of measurement can be found in the APL manual:
<https://support.industry.siemens.com/cs/ww/en/view/109812806/156301357579>

Compiling and downloading to the PLC

1. In the CFC chart, select "Compile".
2. Select "Entire program" and check the box "Generate module drivers".
3. Download the PLC.
4. Close the CFC.

3. Downloading and operating the OS

1. Compile the OS.

When compiling the OS, the motor symbol and the corresponding faceplates are automatically generated.

2. Open the WinCC application.

3. Configure the computer name with "Computer".

4. Use the "OS-Project Editor" to configure your OS layout.

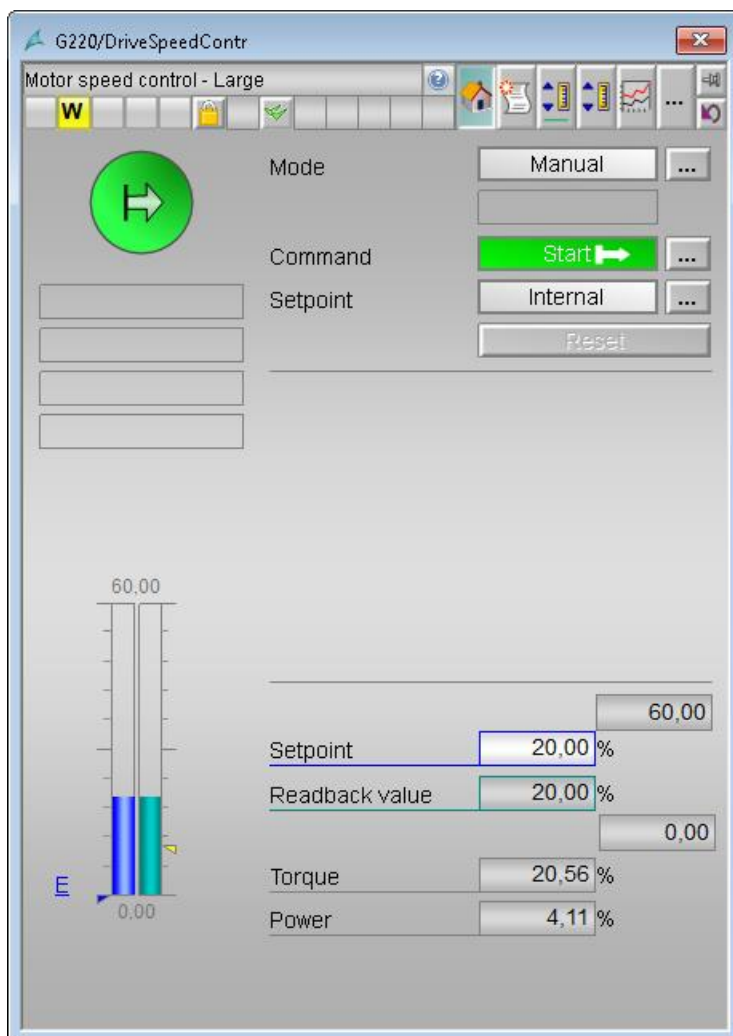
5. Download the OS.

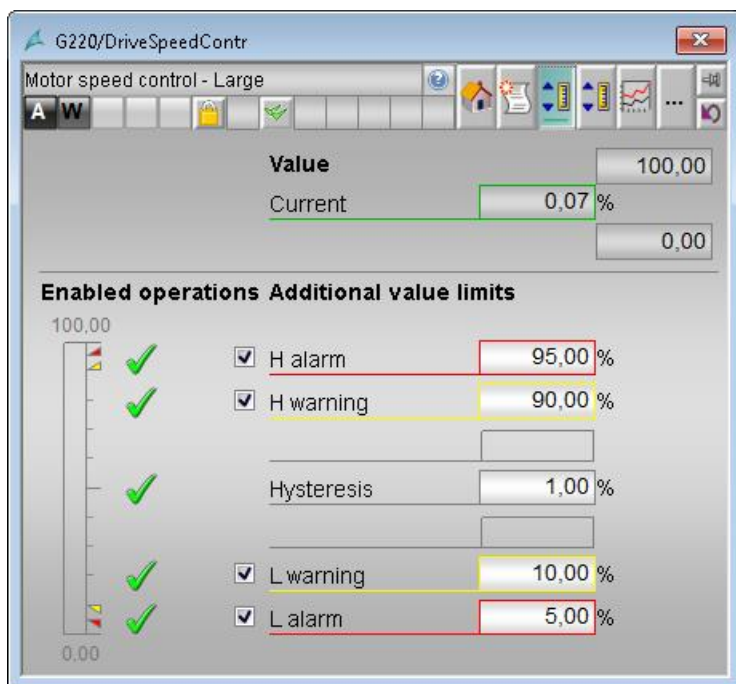
Monitoring and control

The SINAMICS G220 is monitored and controlled via the MotSpdCL faceplate.

In addition to the motor status, the faceplate displays other measured values:

- Readback
- Torque
- Power
- Motor current





NOTE

Error messages are forwarded from the channel block "FbDrive" to the motor block "MotSpdCL". The error messages are displayed in the faceplate of the motor and in the motor symbol.

Start the drive

1. Start the OS runtime.
2. Switch to the screen containing the block icon.
3. Set a setpoint and start the motor with the Forward command.

4. Appendix

4.1. Service and support

SiePortal

The integrated platform for product selection, purchasing and support - and connection of Industry Mall and Online support. The SiePortal home page replaces the previous home pages of the Industry Mall and the Online Support Portal (SIOS) and combines them.

- **Products & Services**
In Products & Services, you can find all our offerings as previously available in Mall Catalog.
- **Support**
In Support, you can find all information helpful for resolving technical issues with our products.
- **mySieportal**
mySiePortal collects all your personal data and processes, from your account to current orders, service requests and more. You can only see the full range of functions here after you have logged in.

You can access SiePortal via this address: sieportal.siemens.com

Technical Support

The Technical Support of Siemens Industry provides you fast and competent support regarding all technical queries with numerous tailor-made offers – ranging from basic support to individual support contracts.

Please send queries to Technical Support via Web form: support.industry.siemens.com/cs/my/src

SITRAIN – Digital Industry Academy

We support you with our globally available training courses for industry with practical experience, innovative learning methods and a concept that's tailored to the customer's specific needs.

For more information on our offered trainings and courses, as well as their locations and dates, refer to our web page:

siemens.com/sitrain

Industry Online Support app

You will receive optimum support wherever you are with the "Industry Online Support" app. The app is available for iOS and Android:



4.2. Links and literature

No.	Topic
\1\	Siemens Industry Online Support https://support.industry.siemens.com
\2\	Link to the article page of the application example https://support.industry.siemens.com/cs/ww/en/view/109932875
\3\	Manual: SIMATIC PCS 7 Process Control System CPU 410 Process Automation V8 https://support.industry.siemens.com/cs/ww/en/view/109826184
\4\	Download: SINAMICS G220 PROFINET GSDML https://support.industry.siemens.com/cs/ww/en/view/109901084

4.3. Change documentation

Version	Date	Change
V1.0	03/2023	First edition