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PROFINET-system redundancy with SINAMICS drives

<https://support.industry.siemens.com/cs/ww/en/view/109744811>

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1 Task

Introduction

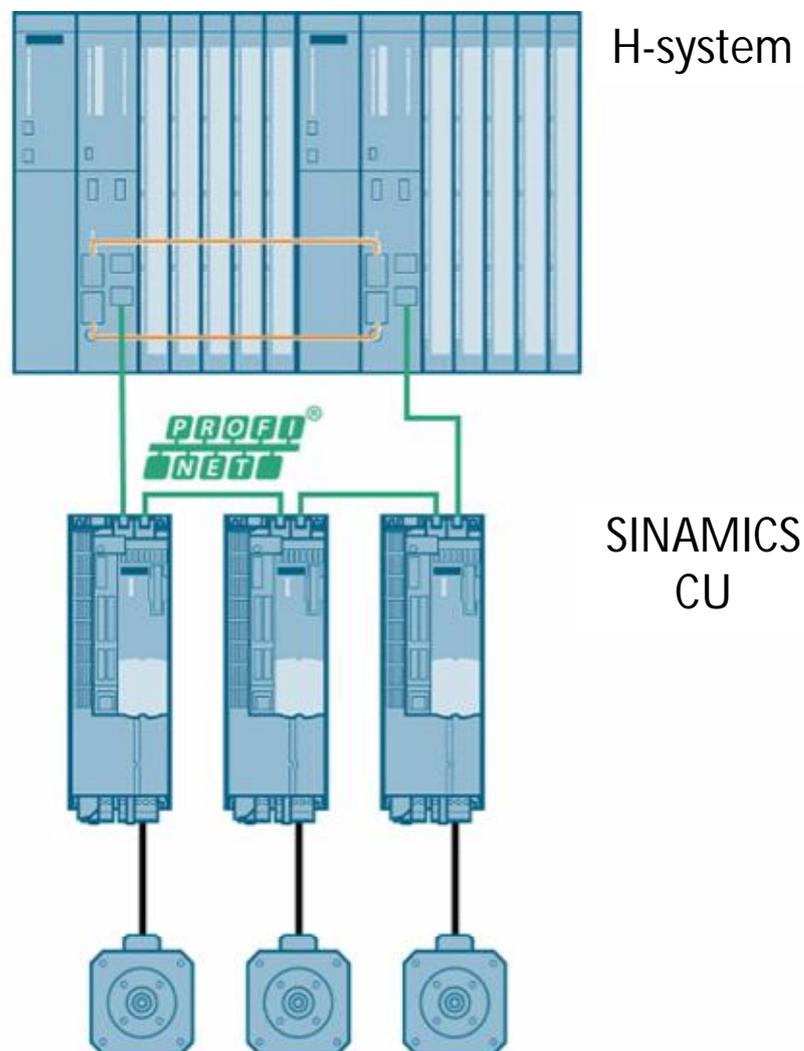
Thanks to SINAMICS S120, G130, G150 and S150 PROFINET Control Unit, the assembly of system-redundant systems (S2-system redundancy) is possible.

Precondition for system-redundant systems is a so-called H-system. The H-system consists of 2 fault-tolerant controls – master and reserve CPU – which are constantly synchronized via fiber-optic cables. If one controller fails, the other automatically takes on the job. This reduces system downtimes.

Overview of the automation task

The figure below provides an overview of the automation task.

Figure 1-1 Task overview



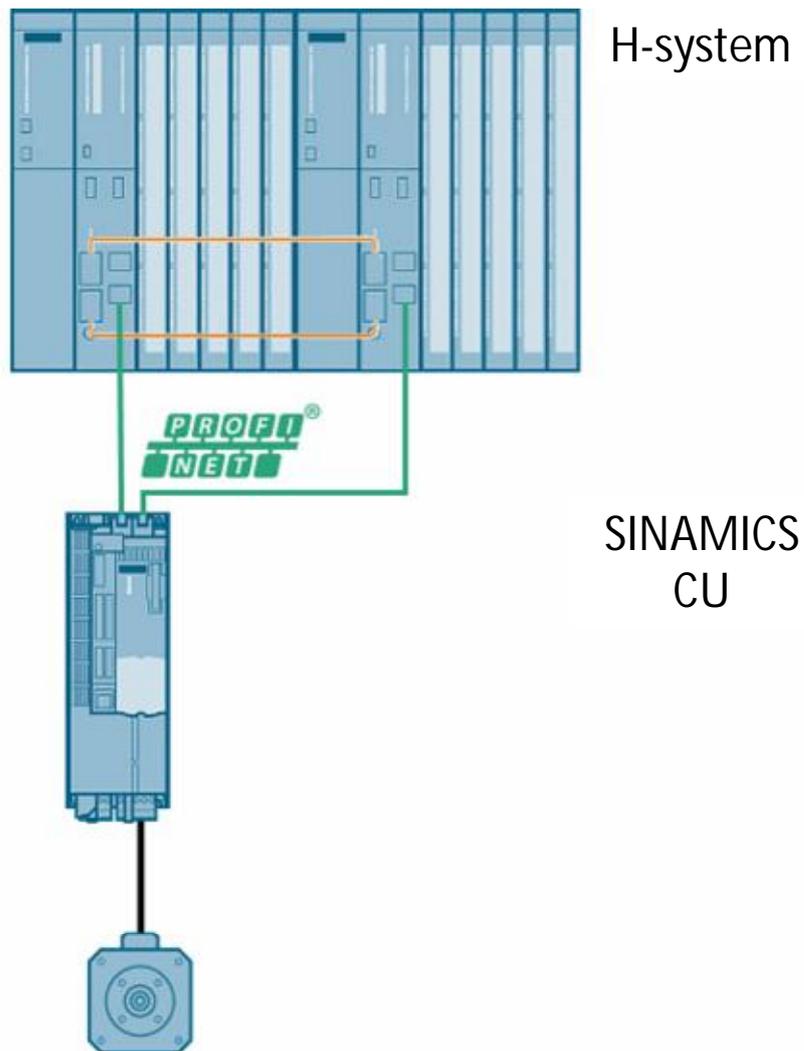
2 Solution

2.1 Solution overview

Schema

The following figure displays the most important components of the solution:

Figure 2-1 Solution overview



Benefits

- No system downtime in the case of a controller failure
- Component replacement possible during ongoing operation
- Configuration changes possible during ongoing operation
- Automatic synchronization after replacing components

Restrictions

- PROFINET-IRT is not supported
- No simultaneous operation of Shared Device and Shared I-Device
- Maximum 2 cyclical PROFINET connections
- System redundancy only via the onboard interface of SINAMICS S120 PROFINET Control Unit
- For the duration of switching from one controller to the other, the setpoints of the last connection remain frozen and valid.

Knowledge required

Basic knowledge of SINAMICS drives and H-Systems is assumed.

2.2 Hardware and Software Components

2.2.1 Validity

This application example is valid for

- STEP 7 (where necessary a hardware update)
- SINAMICS S120 as of FW >= V4.8

2.2.2 Used components

The application was generated with the following components:

Hardware components

Table 2-1 Hardware components

Component	No.	Article number	Note
CPU 412-5H PN/DP	2	6ES7412-5HK06-0AB0	Rack: UR2-H
SINAMICS S120 CU310-2 PN/DP	1	6SL3040-1LA01-0AA0	Firmware V4.8
Training case	1	6ZB2480-0AD00	Servo motor with Drive-Clq is used

Standard software components

Table 2-2 Software components

Component	No.	Article number	Note
STEP 7	1	-	-
STARTER	1	-	-

Sample files and projects

The following list includes all files and projects that are used in this example.

Table 2-3 Sample files

Component	Note
109744811_Systemredundancy_v10.zip	<This zip file includes the STEP 7 project.>
109744811_Systemredundancy_v10_en.pdf	This document.

3 Basics

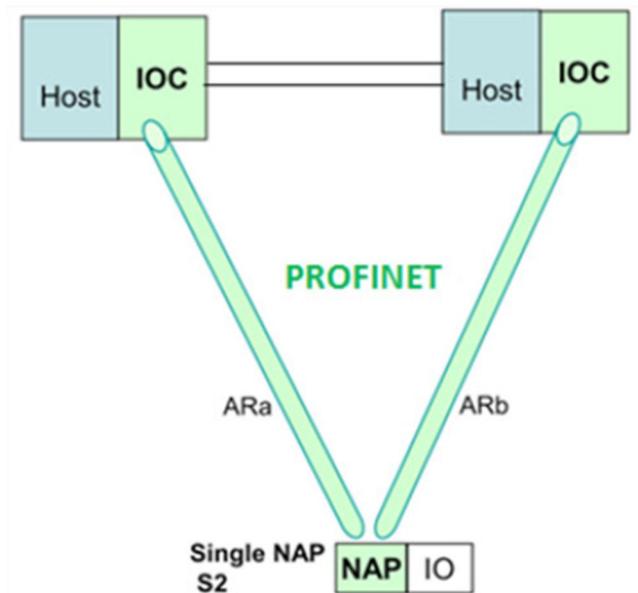
3.1 System and media redundancy

System redundancy

With system redundancy a PROFINET device is initiating more than one communication relation to a redundant controller. Thereby it is distinguished between different forms of system redundancy.

In this example only S2-system redundancy is used which describes a compact PROFINET device that can be operated with a highly available system without any additional hardware.

Figure 3-1 S2-system redundancy

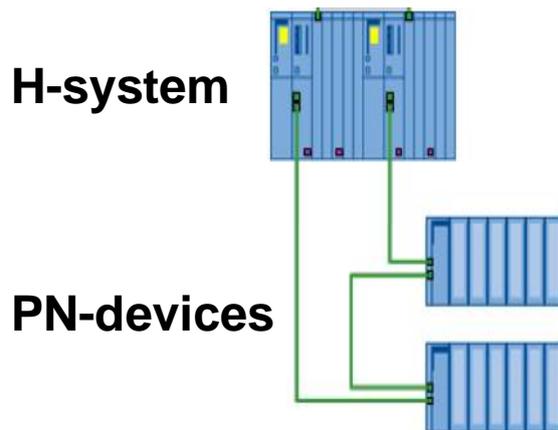


3.1 System and media redundancy

Requirement for realizing the system redundancy is the application of an H system. The H system consists of two fault-tolerant controllers (master and reserve CPU). If one H-CPU fails, the other automatically takes over.

System redundancy is a connection of IO devices via PROFINET (PN devices), for which there is a communication connection between each PN device and each of both H-CPU's (see picture below).

Figure 3-2 System redundancy



The IO devices need to support the system redundancy; otherwise, they can be operated in the same network, however only one of both H-CPU's can be assigned (unilateral periphery).

The used topology (line, star, ring) plays no role for the system redundancy. This distinguishes the system redundancy from the media redundancy.

System redundant periphery is often also referred to as switched periphery. This does **not** refer to the fault tolerance between I/O groups or systems.

An example for switched periphery (system-redundant periphery) are PN devices, which support the system redundancy and can be assigned to an H system (e.g. ET 200M, SINAMICS CU320-2PN, etc..). In contrast, the ET 200S, for example, can only be assigned to an H-CPU unilaterally (no H system).

Media redundancy

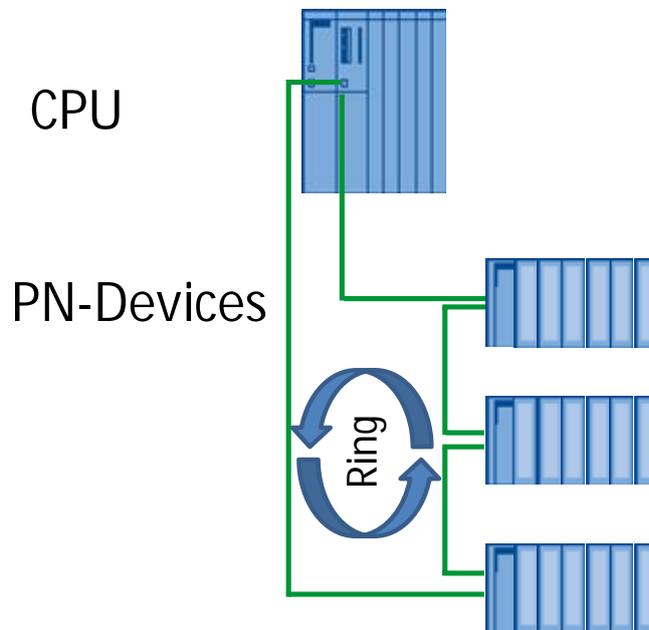
Media redundancy ensures the network availability and contributes to increasing the plant availability.

The ring topology is used here. The media redundancy protocol (MRP) ensures that when one transmission path fails, an alternative communication path is available.

For media redundancy with MRP, one device is the media redundancy manager (MRM), all other devices are redundancy clients. In the picture below, the CPU is the MRP-Manager.

In the case of a failed connection, the MRM selects the alternative communication path.

Figure 3-3 Media redundancy



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Context

System and media redundancy have no mutual impact on each other.

3.2 PN design versions

The following PN module design versions are available:

- **Single-channel, one-sided configuration with standard availability**
With the single-channel, one-sided design, single PN devices are available. The PN devices are located in only one subsystem, and are only addressed by this subsystem.
However, in redundant mode, both CPUs are interconnected via the redundant link and thus execute the user program identically.
- **Single-channel, switched configuration with enhanced availability**
Switched single-channel distributed configurations contain only single PN devices, but they can be addressed by both subsystems.
- **Redundant dual-channel configuration with maximum availability**
A redundant dual-channel configuration contains two sets of the I/O modules which can be addressed by both subsystems.

The SINAMICS S120 drive is realized as single-channel, switched configuration with enhanced availability in this application example.

3.3 Specific blocks for S7-400H

In addition to the blocks supported both in the S7-400 and S7-400H systems, the S7-400H software provides further blocks which you can use to influence the redundancy functions.

You can react to redundancy errors of the S7-400H using the following organization block:

- OB 70, I/O redundancy errors
- OB 72, CPU redundancy errors

SFC 90 "H_CTRL" can be used to influence fault-tolerant systems as follows:

- You can disable interfacing in the master CPU.
- You can disable updating in the master CPU.
- You can remove, resume or immediately start a test component of the cyclic self-test.
- You can execute a programmed master to standby changeover. The following changeovers are possible:
 - The current standby CPU becomes a master CPU.
 - The CPU in rack 0 becomes a master CPU.
 - The CPU in rack 1 becomes a master CPU.

Note

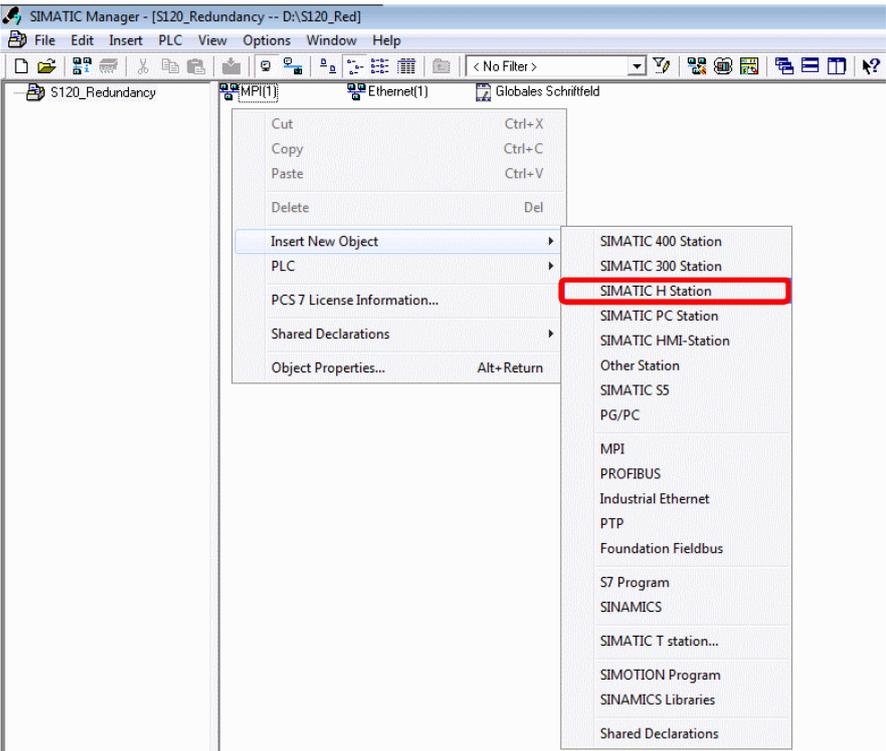
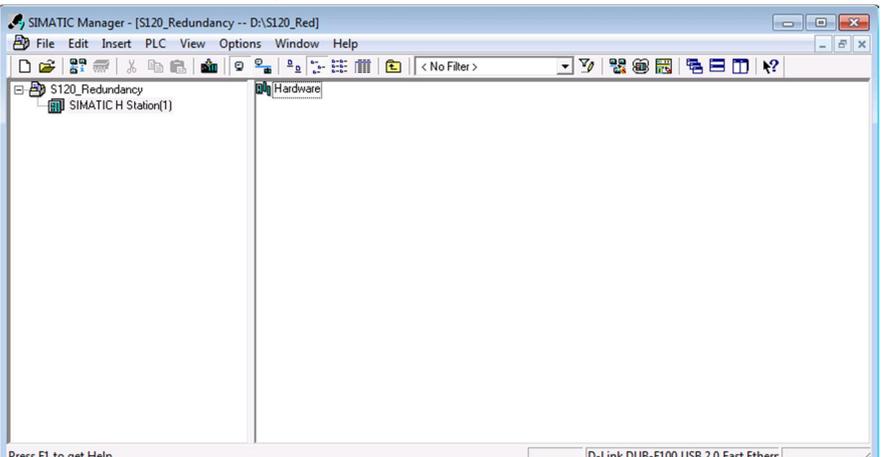
Always download these error OBs to the S7-400H CPU: OB 80, OB 82, OB 83, OB 85, OB 86, OB 88, OB 121 and OB 122.

If you do not download these OBs, the fault-tolerant system goes into STOP when an error occurs.

4 Configuration and Programming

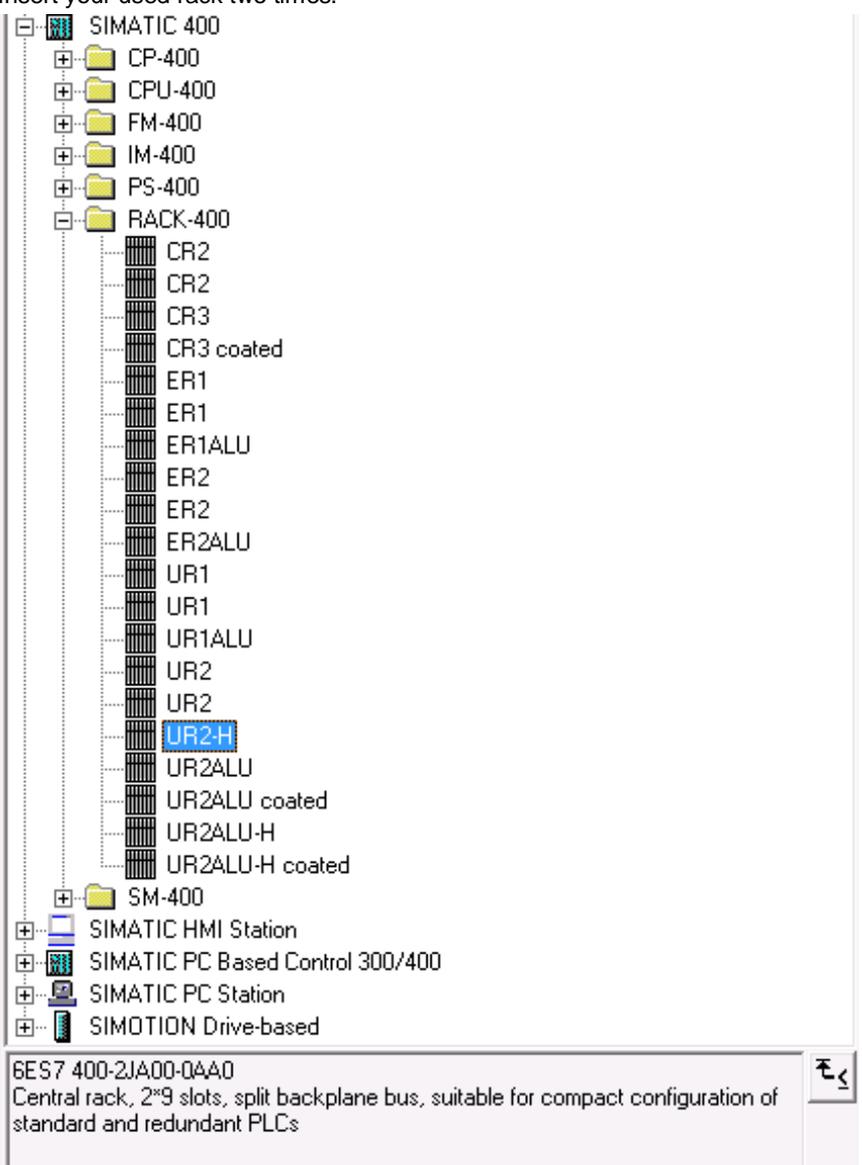
4.1 HW Config of SIMATIC H-CPUs

Table 4-1 Configuration SIMATIC H-CPU

No.	Action
1.	Create a new STEP7 project.
2.	<p>Insert a new SIMATIC H Station.</p>  <p>The screenshot shows the SIMATIC Manager interface with a context menu open over the 'Hardware' folder. The menu items include Cut, Copy, Paste, Delete, Insert New Object, PLC, PCS 7 License Information..., Shared Declarations, and Object Properties... The 'Insert New Object' sub-menu is expanded, showing options like SIMATIC 400 Station, SIMATIC 300 Station, SIMATIC H Station (highlighted with a red rectangle), SIMATIC PC Station, SIMATIC HMI-Station, Other Station, SIMATIC S5, PG/PC, MPI, PROFIBUS, Industrial Ethernet, PTP, Foundation Fieldbus, S7 Program, SINAMICS, SIMATIC T station..., SIMOTION Program, SINAMICS Libraries, and Shared Declarations.</p>
3.	<p>Open the Hardware-config.</p>  <p>The screenshot shows the SIMATIC Manager interface with the 'Hardware' configuration window open. The 'Hardware' window displays a tree view with 'SIMATIC H Station(1)' selected under the 'Hardware' folder. The status bar at the bottom indicates 'Press F1 to get Help.' and 'D-Link DUB-E100 USB 2.0 Fast Etherr'.</p>

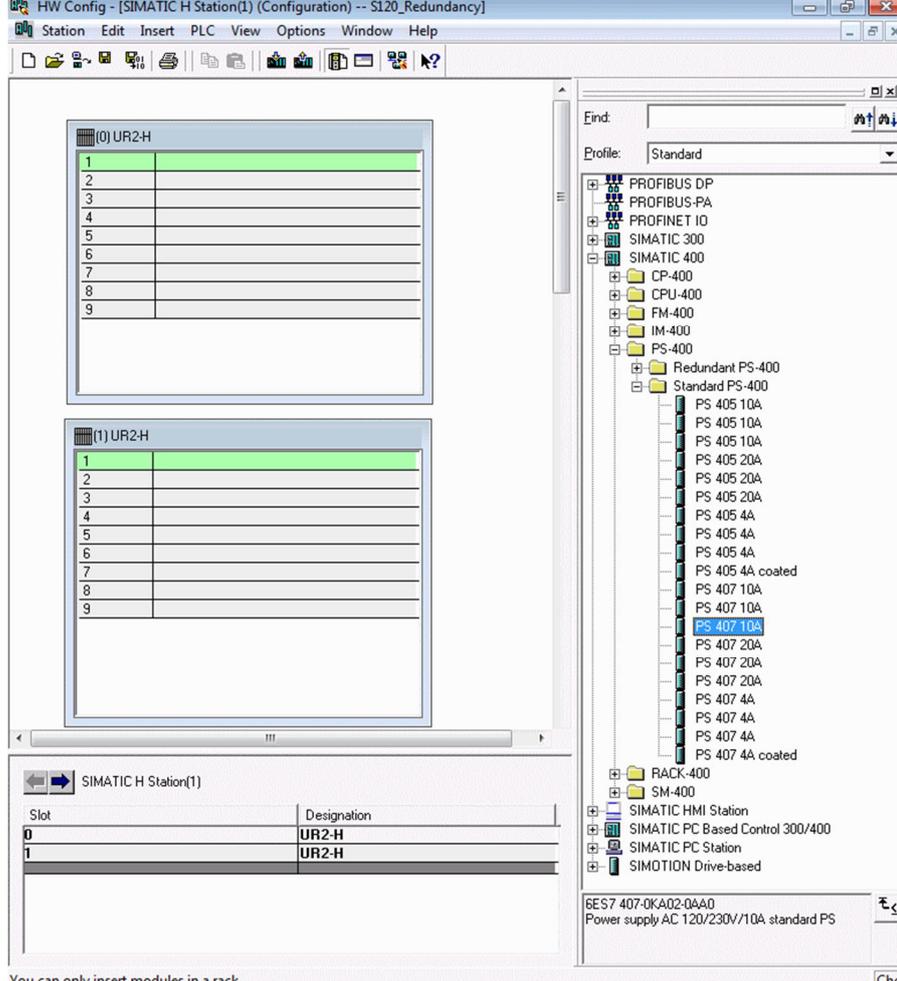
4 Configuration and Programming

4.1 HW Config of SIMATIC H-CPU's

No.	Action
4.	<p>Insert your used rack two times.</p>  <p> SIMATIC 400 CP-400 CPU-400 FM-400 IM-400 PS-400 RACK-400 CR2 CR2 CR3 CR3 coated ER1 ER1 ER1ALU ER2 ER2 ER2ALU UR1 UR1 UR1ALU UR2 UR2 UR2-H UR2ALU UR2ALU coated UR2ALU-H UR2ALU-H coated SM-400 SIMATIC HMI Station SIMATIC PC Based Control 300/400 SIMATIC PC Station SIMOTION Drive-based </p> <p> 6ES7 400-2JA00-0AA0 Central rack, 2*9 slots, split backplane bus, suitable for compact configuration of standard and redundant PLCs </p>

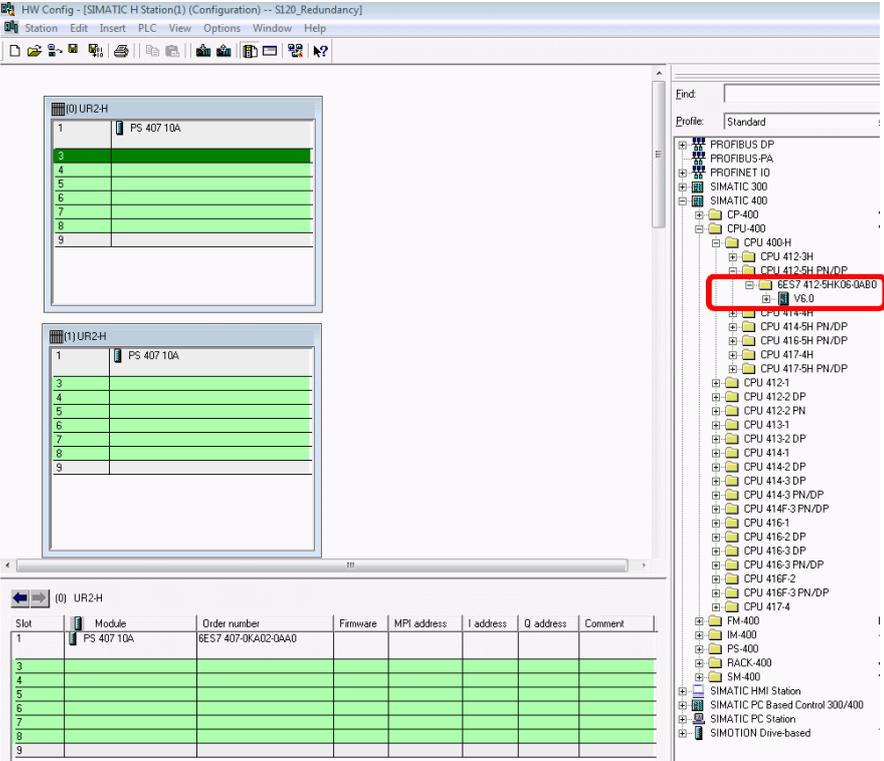
4 Configuration and Programming

4.1 HW Config of SIMATIC H-CPU

No.	Action
5.	<p>Drag &drop your used power supply into both racks respectively.</p>  <p>The screenshot displays the SIMATIC HW Config interface. On the left, two racks are shown: rack (0) and rack (1), both labeled 'UR2-H'. Each rack has 9 slots, with slot 1 highlighted in green. On the right, a component catalog is visible, showing a tree structure of hardware components. Under 'PS-400', 'Redundant PS-400', and 'Standard PS-400', the component 'PS 407 10A' is selected and highlighted in blue. Below the catalog, a table shows the selected component details: '6ES7 407-0KA02-0AA0 Power supply AC 120/230V/10A standard PS'. At the bottom of the window, a status bar reads 'You can only insert modules in a rack.'</p>

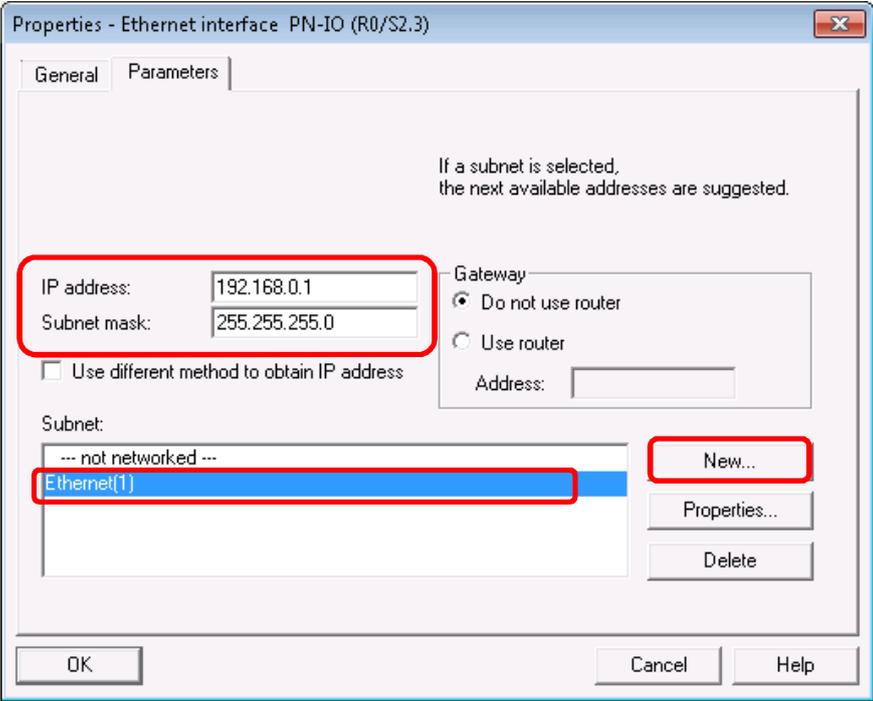
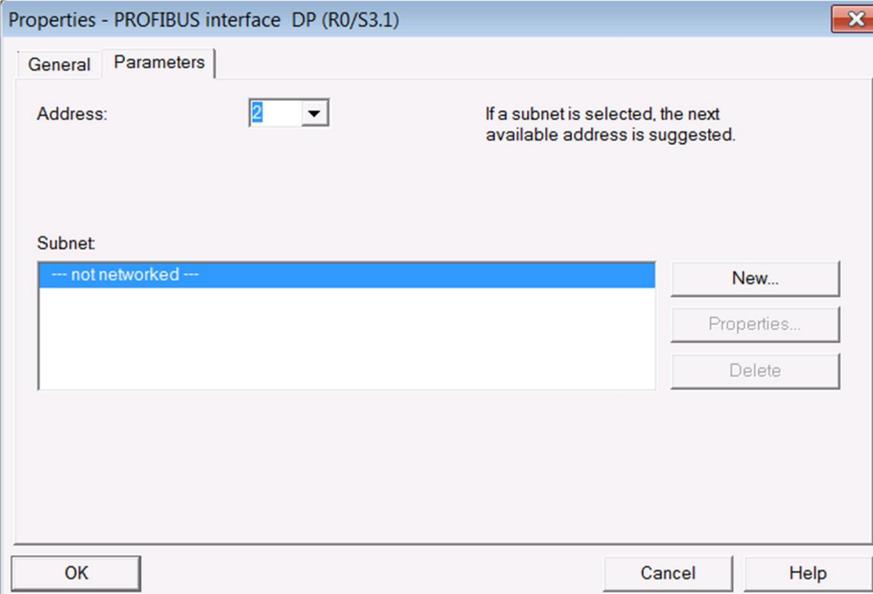
4 Configuration and Programming

4.1 HW Config of SIMATIC H-CPU's

No.	Action																																																																								
6.	<p>Afterwards insert your CPUs (here: SIMATIC CPU 412-5H PN/DP V6.0) into both racks.</p>  <p>The screenshot shows the HW Config interface with two racks, (0) UR2-H and (1) UR2-H, each containing a PS 407 10A module in slot 1. The component catalog on the right shows the 'SIMATIC 400' folder expanded to 'CPU 412-5H PN/DP', with the 'V6.0' sub-entry highlighted in red.</p> <table border="1"> <thead> <tr> <th>Slot</th> <th>Module</th> <th>Order number</th> <th>Firmware</th> <th>MPI address</th> <th>I address</th> <th>Q address</th> <th>Comment</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>PS 407 10A</td> <td>6ES7 407-0KA02-0AA0</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>3</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>4</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>5</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>6</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>7</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>8</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>9</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>	Slot	Module	Order number	Firmware	MPI address	I address	Q address	Comment	1	PS 407 10A	6ES7 407-0KA02-0AA0						3								4								5								6								7								8								9							
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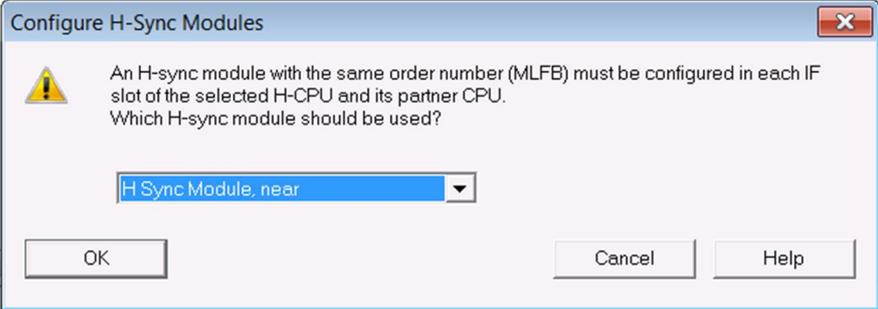
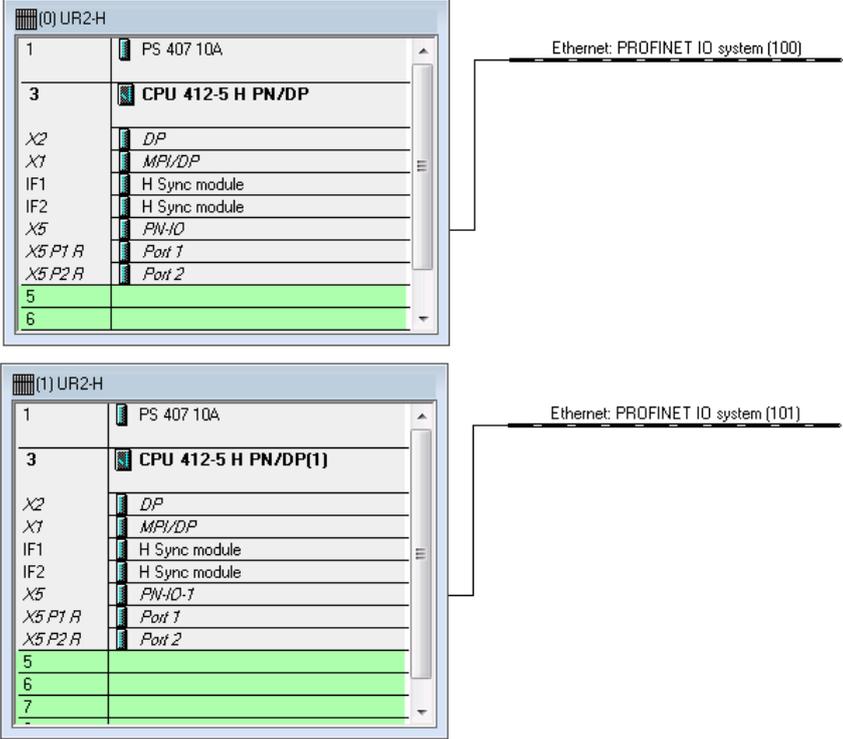
4 Configuration and Programming

4.1 HW Config of SIMATIC H-CPUs

No.	Action
7.	<p>Create a new Ethernet subnet and assign an IP address. (here: 192.168.0.1 / 255.255.255.0).</p>  <p>Properties - Ethernet interface PN-IO (R0/S2.3)</p> <p>General Parameters</p> <p>If a subnet is selected, the next available addresses are suggested.</p> <p>IP address: 192.168.0.1 Subnet mask: 255.255.255.0</p> <p><input type="checkbox"/> Use different method to obtain IP address</p> <p>Gateway <input checked="" type="radio"/> Do not use router <input type="radio"/> Use router Address: </p> <p>Subnet: --- not networked --- Ethernet(1)</p> <p>New... Properties... Delete</p> <p>OK Cancel Help</p> <p>PROFIBUS properties don't have to be parameterized. Confirm with OK.</p>  <p>Properties - PROFIBUS interface DP (R0/S3.1)</p> <p>General Parameters</p> <p>Address: 2</p> <p>If a subnet is selected, the next available address is suggested.</p> <p>Subnet: --- not networked ---</p> <p>New... Properties... Delete</p> <p>OK Cancel Help</p>

4 Configuration and Programming

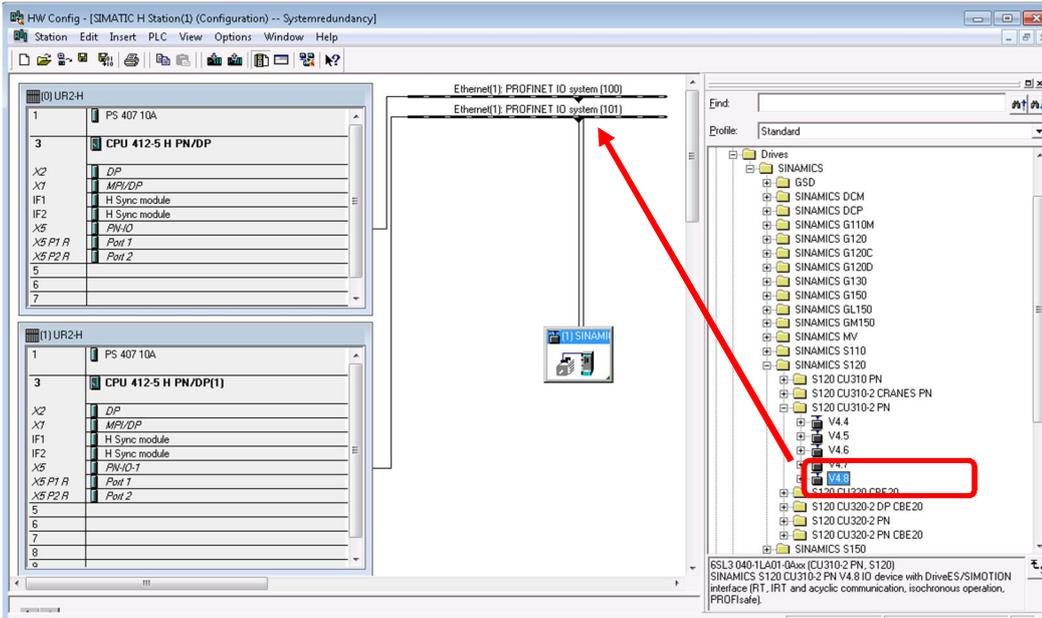
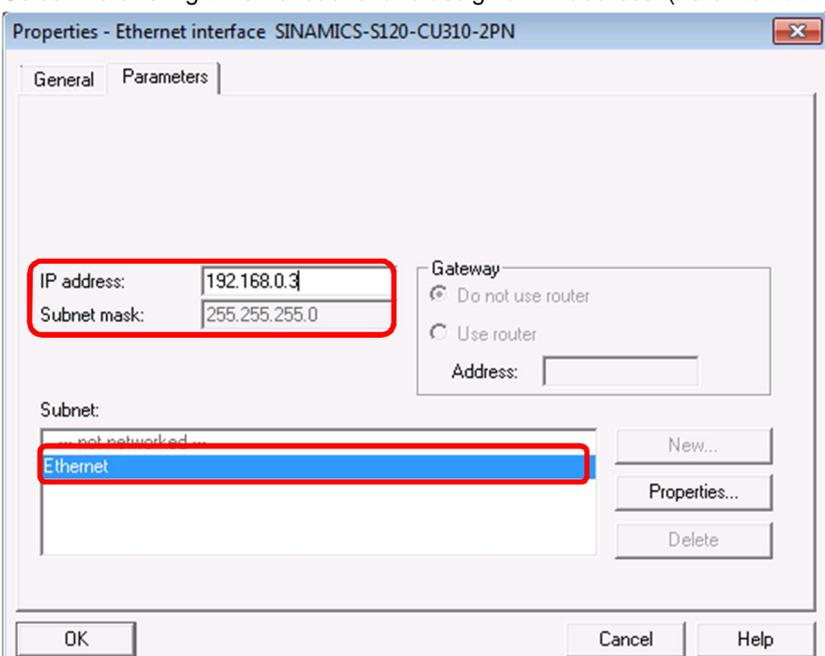
4.1 HW Config of SIMATIC H-CPU

No.	Action
8.	<p>Configure your H-Sync module:</p>  <p>Configure CPU1 respectively and assign an IP-address and subnet mask(here: 192.168.0.2 / 255.255.255.0).</p>
9.	<p>Now there are two racks, two CPUs and two PROFINET systems configured.</p> 

4.2 HW Config of SINAMICS drive

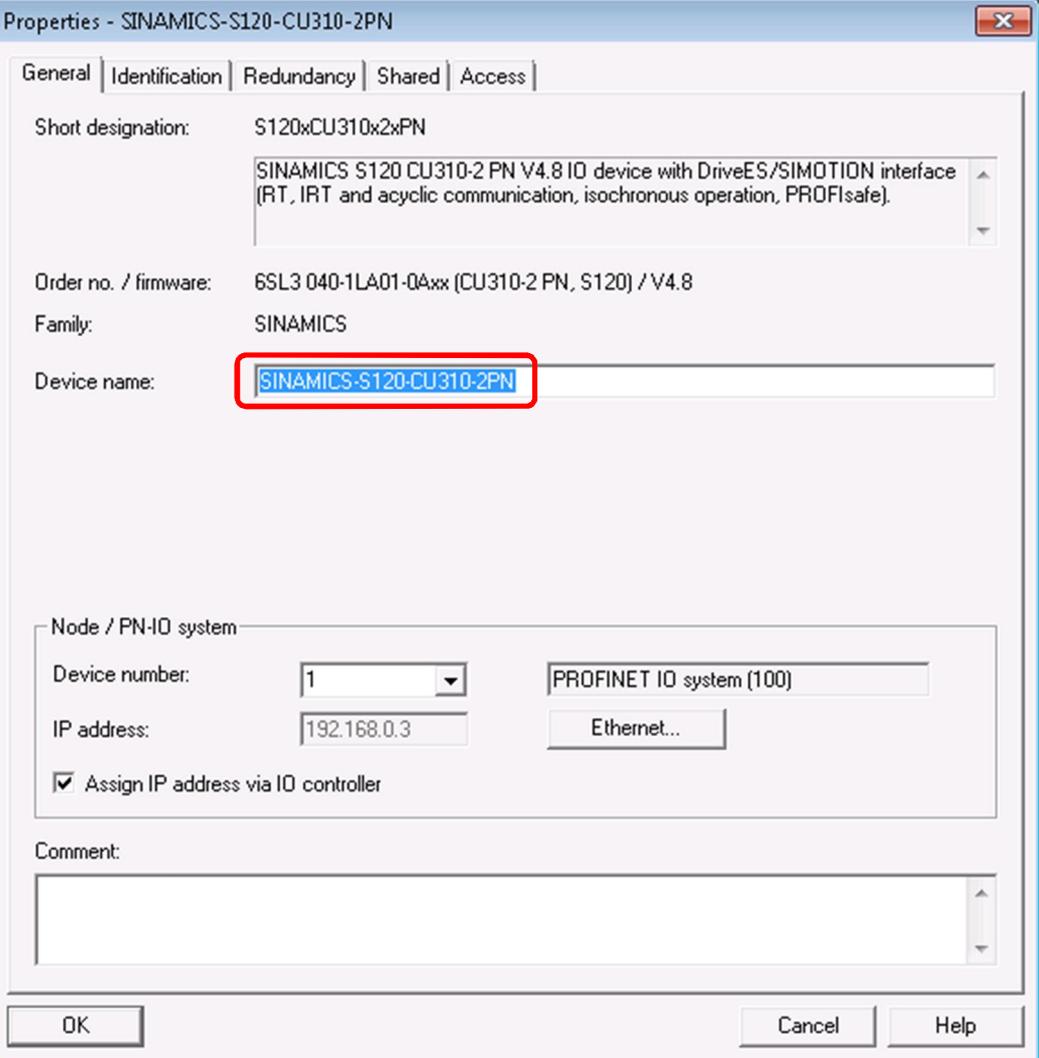
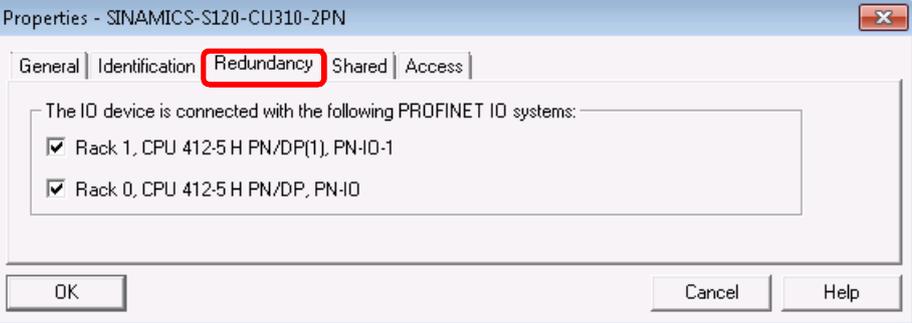
The SINAMICS drive can be configured with the OM (ObjectManager, Drive ES BASIC, hardware catalog) or with the help of a GSD file. In the application example the drive is configured via the OM.

Table 4-2 HW Config SINAMICS drive

No.	Action
1.	<p>Drag the SINAMICS drive CU310-2 PN V4.8 to one of the existing PROFINET networks.</p>  <p>The screenshot shows the HW Config interface. On the left, there are two rack configurations for UR2H units. The top rack (0) contains a PS 407 10A and a CPU 412-5 H PN/DP. The bottom rack (1) contains a PS 407 10A and a CPU 412-5 H PN/DP(1). In the center, there are two Ethernet subnets labeled 'Ethernet(1): PROFINET IO system (100)'. On the right, a tree view shows the 'Drives' folder expanded to 'SINAMICS S120'. A red arrow points from the 'S120 CU310-2 PN V4.8' drive in the tree to the 'Ethernet(1): PROFINET IO system (100)' subnet. A red box highlights the 'V4.8' version in the tree.</p>
2.	<p>Select the existing Ethernet subnet and assign an IP address. (here: 192.168.0.3).</p>  <p>The screenshot shows the 'Properties - Ethernet interface SINAMICS-S120-CU310-2PN' dialog box. The 'Parameters' tab is active. The 'IP address' field is set to '192.168.0.3' and the 'Subnet mask' is '255.255.255.0'. The 'Gateway' section has 'Do not use router' selected. The 'Subnet' list shows 'Ethernet' selected. A red box highlights the IP address and subnet mask fields. Another red box highlights the 'Ethernet' entry in the subnet list.</p>

4 Configuration and Programming

4.2 HW Config of SINAMICS drive

No.	Action
3.	<p>Double-click the added SINAMICS drive to open the properties window. Define the device name (here: „SINAMICS-S120-CU310-2PN“).</p>  <p>Check in the tab „Redundancy“, if the SINAMICS is connected with both PROFINET systems.</p> 

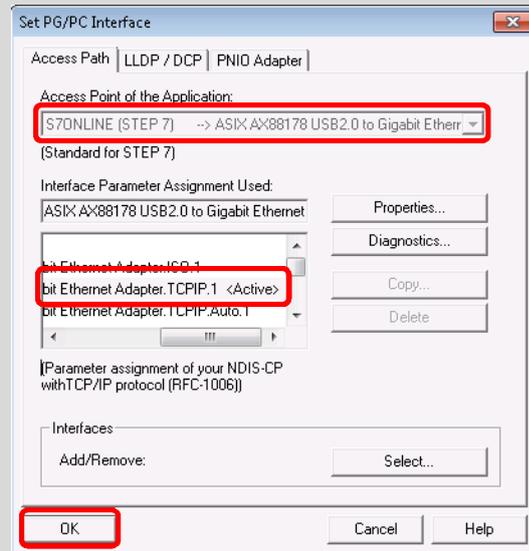
4 Configuration and Programming

4.2 HW Config of SINAMICS drive

Note

For the steps described in the following, a functional connection is required between the engineering PC and the hardware being used!

In SIMATIC Manager, using the menu item "Options > Set PG/PC Interface..." open the window to set the PG/PC interface. There, for the access point "S7ONLINE", select the network card of your engineering PC that you are using with the supplement "TCPIP.1" (not "TCPIP.Auto.1").



No.	Action
4.	<p>The device name must then be assigned to the SINAMICS drive. For this purpose mark the PROFINET IO system. Open the window for the name assignment with "PLC > Ethernet > Assign Device Name".</p>

4 Configuration and Programming

4.2 HW Config of SINAMICS drive

5. Select the device name configured in HW config using the drop-down menu (1). Then select the SINAMICS drive from the list of available devices (2) and assign the device name using the "Assign name" (3) button.

Assign device name

Device name: SINAMICS-S120-CU310-2PN Device: SINAMICS

Available devices:

IP address	MAC address	Device type	Device name
00-1F-F8-05-25-3D	SINAMICS	sinamics-s120-cu310-2pn	

Assign name

Node flashing test

Duration (seconds): 3

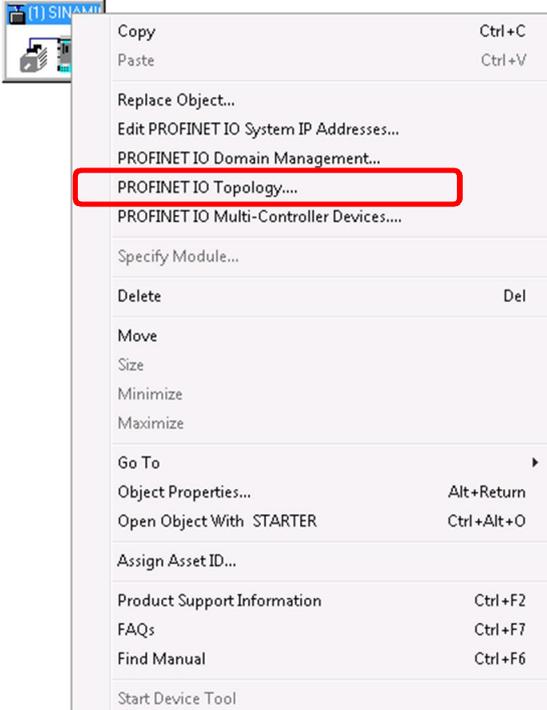
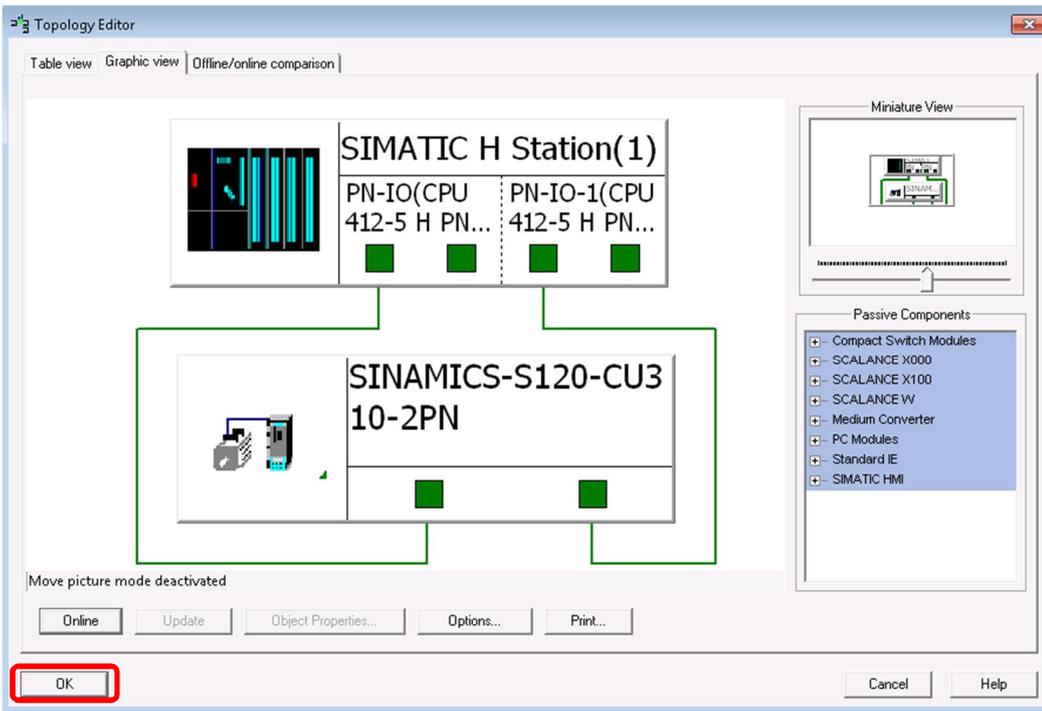
Flashing on Flashing off

Show only devices of the same type Display only devices without names

Update Export... Close Help

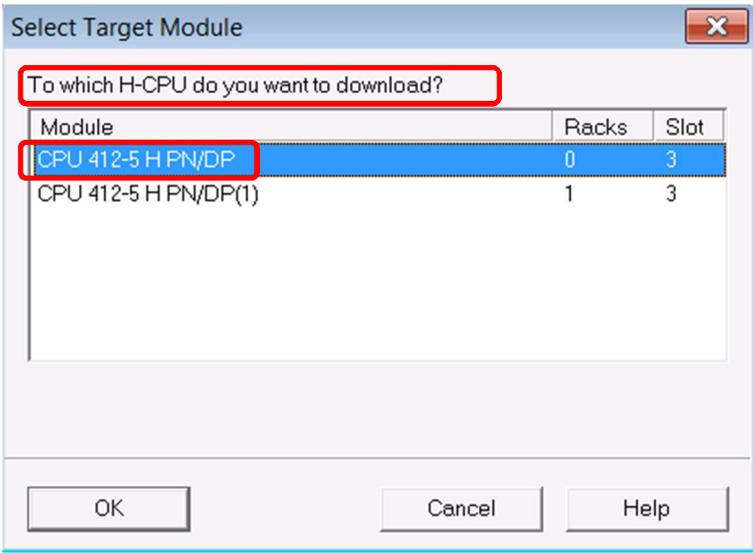
4.3 Configuration of topology

Table 4-3 Configuration of topology

No.	Action
1.	<p>Open the topology via rightclick on the SINAMICS in HW-config.</p> 
2.	<p>Connect both ports 1 of the H-CPU's with port 1 and port 2 of your SINAMICS CU.</p>  <p>Confirm with OK.</p>

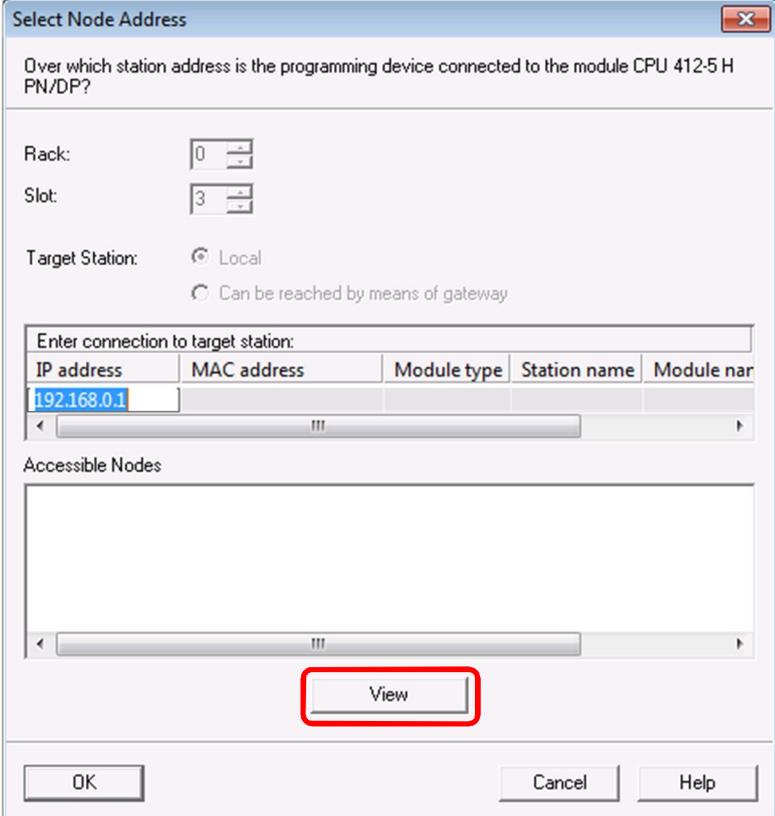
4.4 Download of HW-Config

Table 4-4 Download of HW-Config

No.	Action
1.	Save and compile the HW Config. 
2.	Download it into the SIMATIC CPU. 
3.	To do this, select the corresponding target device, and confirm your selection using the "OK" button. 

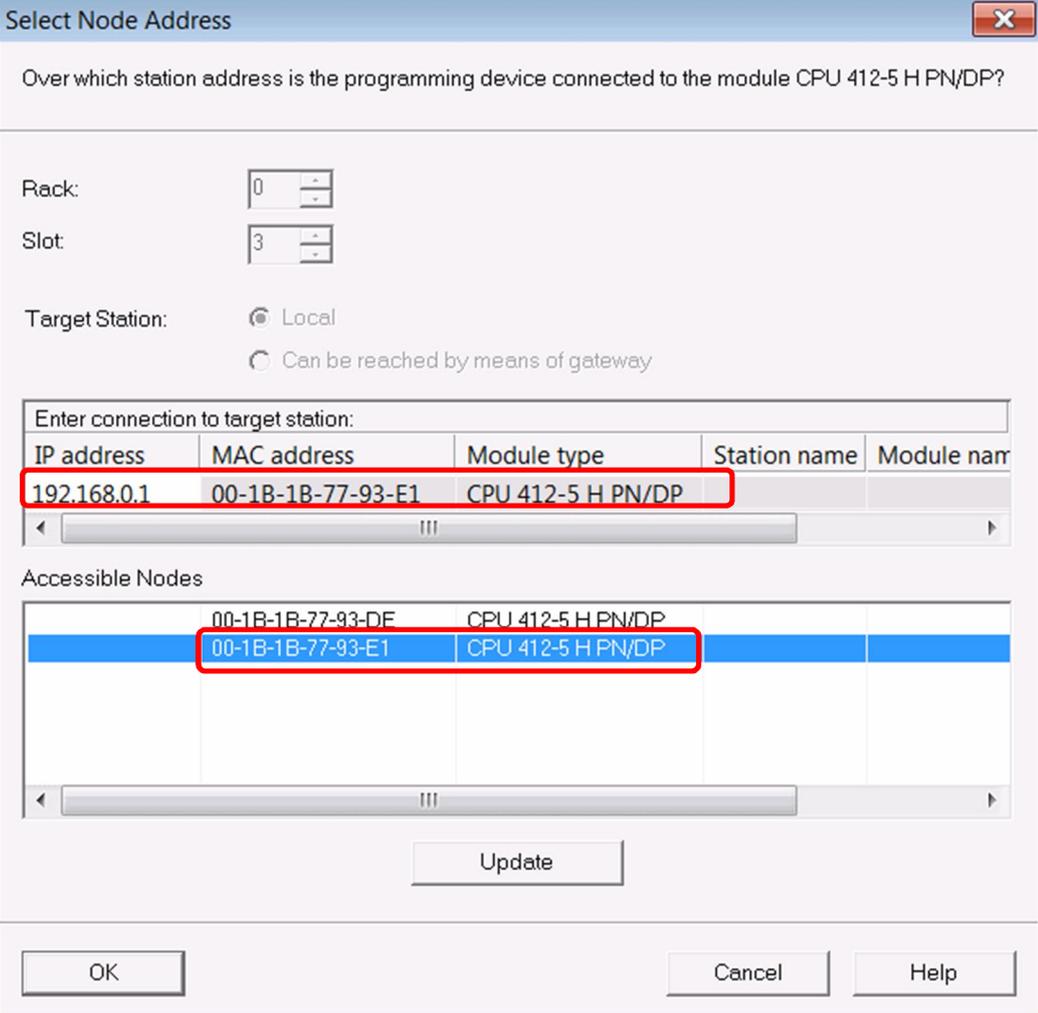
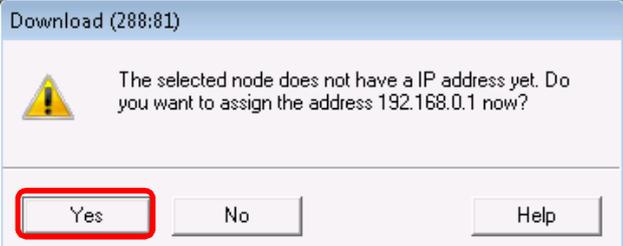
4 Configuration and Programming

4.4 Download of HW-Config

No.	Action										
4.	<p>If the SIMATIC CPU is still in the factory setting (i.e. the IP address is 0.0.0.0), a download is only possible after assigning the IP address configured in HW Config. Browse through the network for controllers that can be accessed by pressing the "View" button.</p>  <p>Select Node Address</p> <p>Over which station address is the programming device connected to the module CPU 412-5 H PN/DP?</p> <p>Rack: 0 Slot: 3</p> <p>Target Station: <input checked="" type="radio"/> Local <input type="radio"/> Can be reached by means of gateway</p> <p>Enter connection to target station:</p> <table border="1"><thead><tr><th>IP address</th><th>MAC address</th><th>Module type</th><th>Station name</th><th>Module name</th></tr></thead><tbody><tr><td>192.168.0.1</td><td></td><td></td><td></td><td></td></tr></tbody></table> <p>Accessible Nodes</p> <p>View</p> <p>OK Cancel Help</p>	IP address	MAC address	Module type	Station name	Module name	192.168.0.1				
IP address	MAC address	Module type	Station name	Module name							
192.168.0.1											

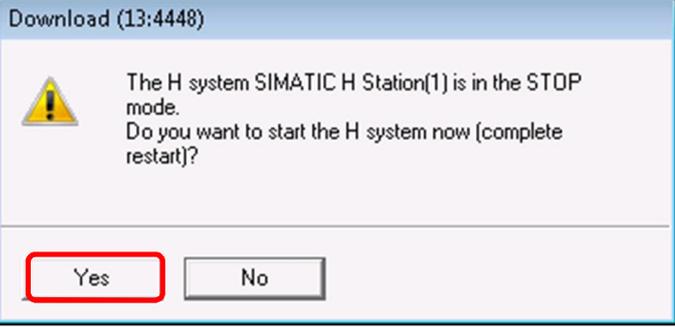
4 Configuration and Programming

4.4 Download of HW-Config

No.	Action
	<p>All of the controllers that can be accessed are displayed. Select the corresponding controller by identifying it based on its MAC address and confirm your selection by pressing the "OK" button.</p>  <p>Note</p> <p>First reset the interface of the controller to the factory settings, if the SIMATIC CPU already has an IP address, which does not match the IP address configured in HW Config! ("PLC > Ethernet > Edit Ethernet Node > Browse > Select CPU > OK > Reset")</p>
5.	<p>Confirm the following message with "Yes", to assign the IP address configured in HW Config to the controller (192.168.0.1) (permanent IP address!).</p> 

4 Configuration and Programming

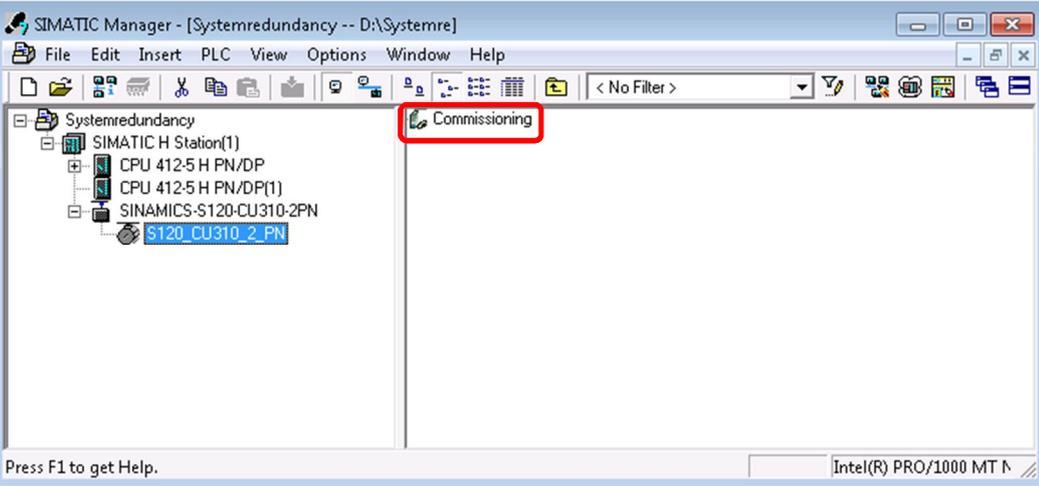
4.4 Download of HW-Config

No.	Action
6.	<p>Then switch the SIMATIC CPU back into the "RUN" operating state.</p>  <p>The H system SIMATIC H Station(1) is in the STOP mode. Do you want to start the H system now (complete restart)?</p> <p>Yes No</p>

4.5 Configuration of SINAMICS drive

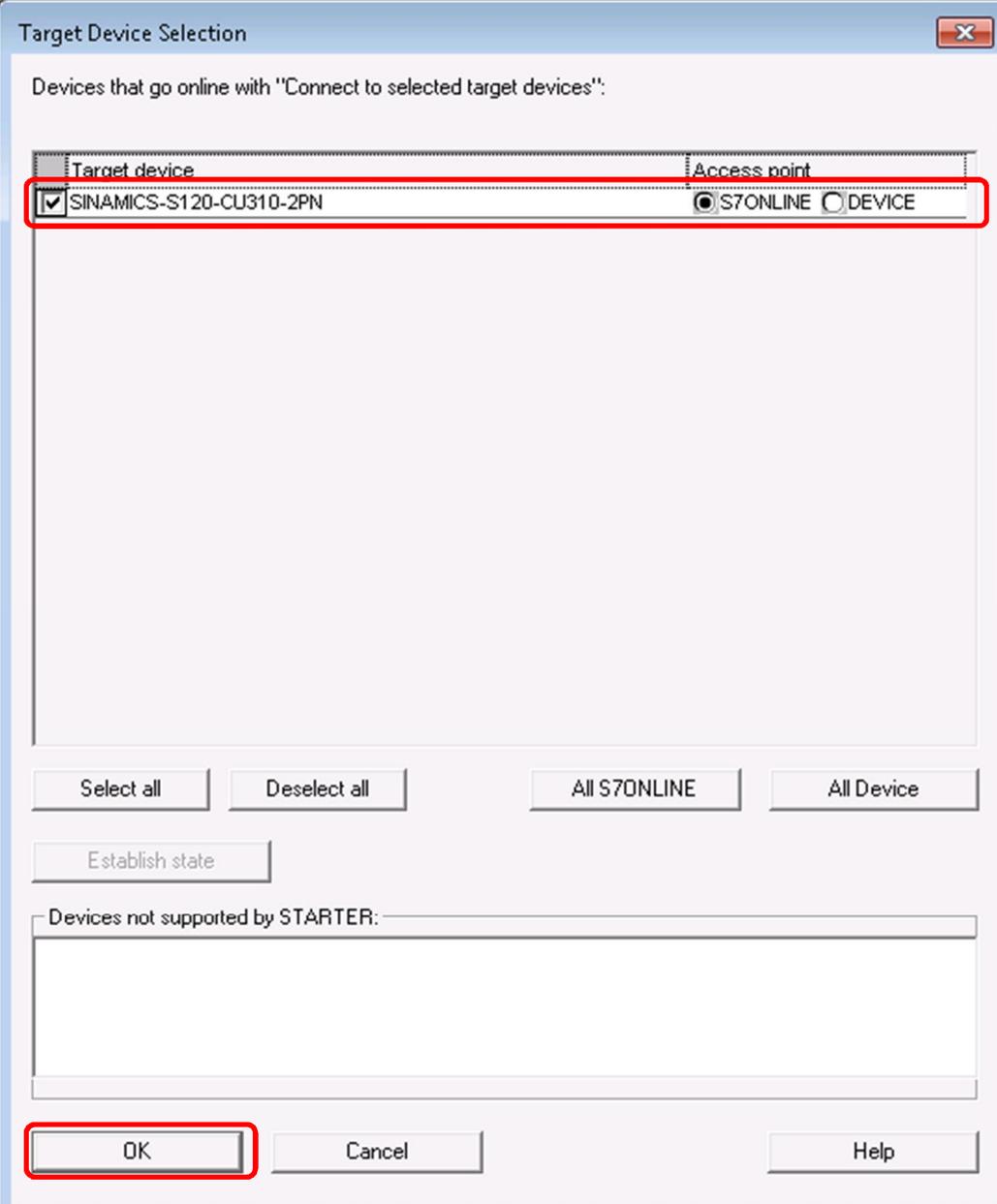
The standard configuration of the SINAMICS drive with the STARTER engineering system is shown below.

Table 4-5 Configuration SINAMICS drive

No.	Action								
1.	<p>Open the current project in the STARTER engineering system from the SIMATIC Manager.</p>  <p>The screenshot shows the SIMATIC Manager interface. The project tree on the left includes 'Systemredundancy', 'SIMATIC H Station(1)', two 'CPU 412-5 H PN/DP' units, and a 'SINAMICS-S120-CU310-2PN' unit. A 'Commissioning' button is highlighted with a red rectangle in the top right area of the main workspace.</p>								
2.	<p>Establish an online connection to the SINAMICS drive.</p>  <p>Note To establish an online connection, the network card of the engineering PC being used must be in the same IP subnet as the target device. Ensure that this precondition is complied with and if required adapt the IP configuration of your network card!</p> <p>Example</p> <table border="0"> <tr> <td>• IP address of the target device</td> <td>192.168.0.2</td> </tr> <tr> <td> subnet mask</td> <td>255.255.255.0</td> </tr> <tr> <td>• IP address of the engineering PC</td> <td>192.168.0.99</td> </tr> <tr> <td> subnet mask</td> <td>255.255.255.0</td> </tr> </table>	• IP address of the target device	192.168.0.2	subnet mask	255.255.255.0	• IP address of the engineering PC	192.168.0.99	subnet mask	255.255.255.0
• IP address of the target device	192.168.0.2								
subnet mask	255.255.255.0								
• IP address of the engineering PC	192.168.0.99								
subnet mask	255.255.255.0								

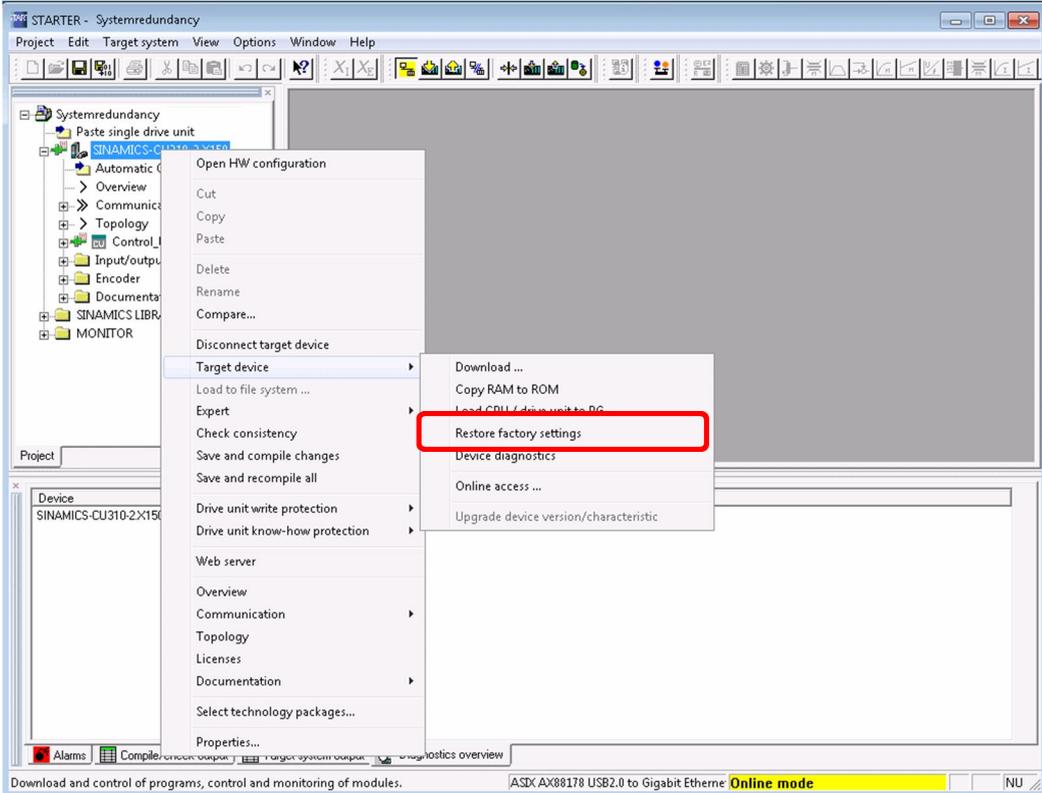
4 Configuration and Programming

4.5 Configuration of SINAMICS drive

No.	Action				
3.	<p>Select the configured SINAMICS drive (set the checkmark in the checkbox) and confirm your selection by pressing the "OK" button.</p>  <p>Target Device Selection</p> <p>Devices that go online with "Connect to selected target devices":</p> <table border="1"><thead><tr><th>Target device</th><th>Access point</th></tr></thead><tbody><tr><td><input checked="" type="checkbox"/> SINAMICS-S120-CU310-2PN</td><td><input checked="" type="radio"/> S7ONLINE <input type="radio"/> DEVICE</td></tr></tbody></table> <p>Select all Deselect all All S7ONLINE All Device</p> <p>Establish state</p> <p>Devices not supported by STARTER:</p> <p>OK Cancel Help</p>	Target device	Access point	<input checked="" type="checkbox"/> SINAMICS-S120-CU310-2PN	<input checked="" type="radio"/> S7ONLINE <input type="radio"/> DEVICE
Target device	Access point				
<input checked="" type="checkbox"/> SINAMICS-S120-CU310-2PN	<input checked="" type="radio"/> S7ONLINE <input type="radio"/> DEVICE				

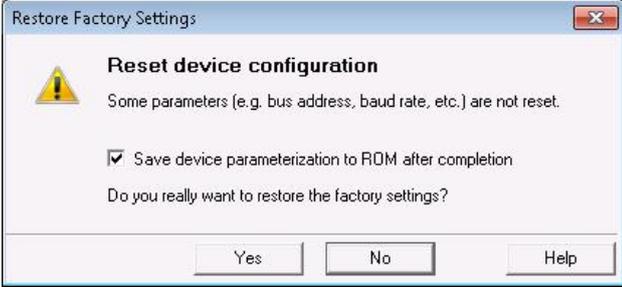
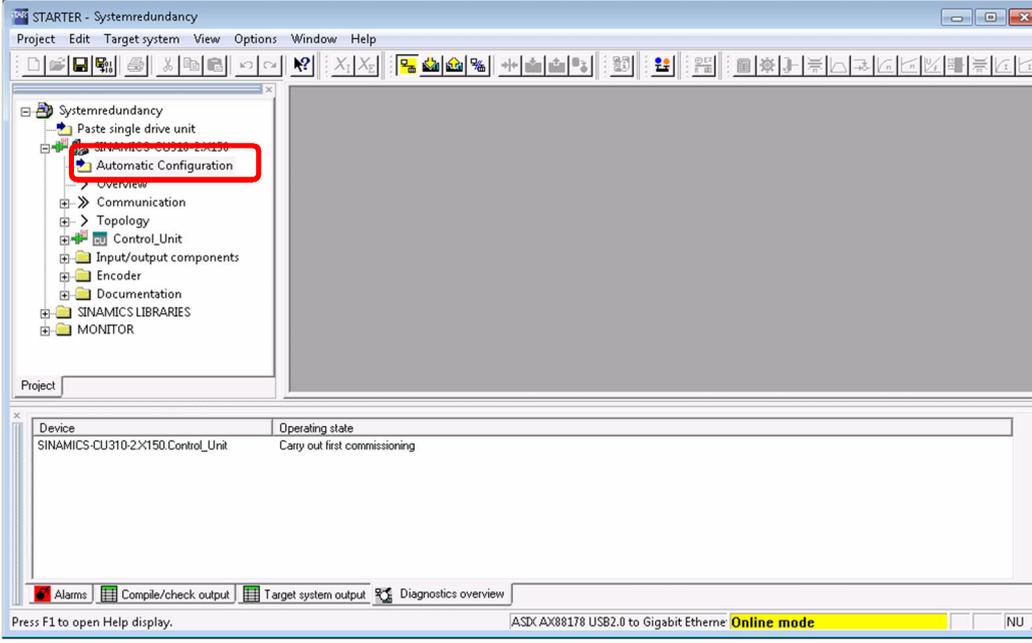
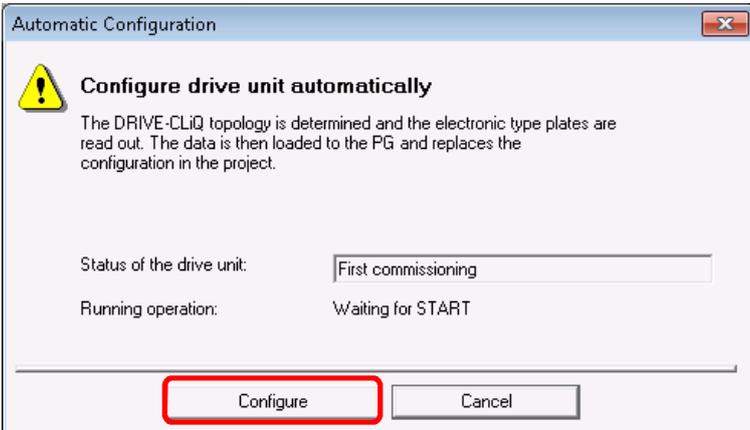
4 Configuration and Programming

4.5 Configuration of SINAMICS drive

No.	Action
4.	<p>After this, restore the factory settings at the SINAMICS (if this has still not been done).</p>  <p>The screenshot shows the Siemens STARTER software interface. The main window displays a project tree on the left with 'SINAMICS-CU310-2X15' selected. A context menu is open over this selection, and the 'Target device' sub-menu is also open. Within this sub-menu, the 'Restore factory settings' option is highlighted with a red rectangular box. Other options in the sub-menu include 'Download ...', 'Copy RAM to ROM', 'Load CPU / drive unit to PC', 'Device diagnostics', 'Online access ...', and 'Upgrade device version/characteristic'. The status bar at the bottom indicates 'ASDX AX0178 USB2.0 to Gigabit Ethernet Online mode'.</p>

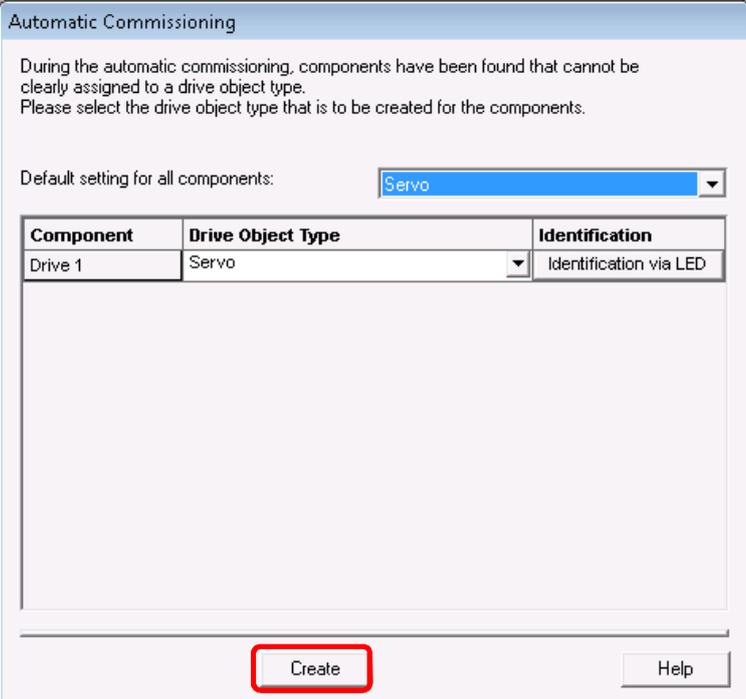
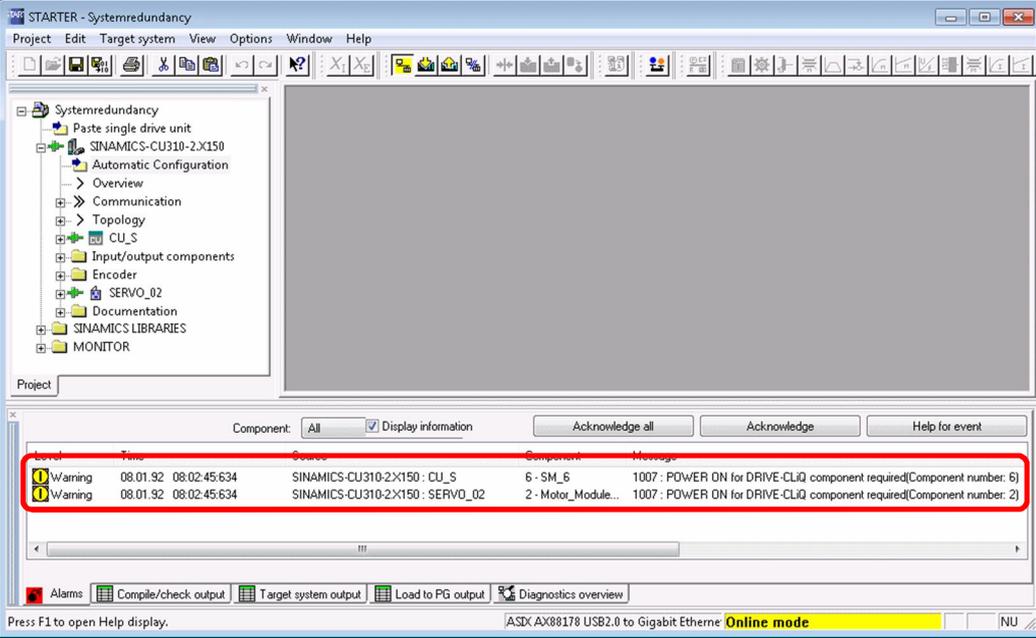
4 Configuration and Programming

4.5 Configuration of SINAMICS drive

No.	Action
5.	<p>Confirm the following message with "Yes". The drive is then reset to the factory settings.</p> 
6.	<p>Afterwards carry out the automatic configuration of the drive.</p> 
7.	<p>Start the configuration by pressing the "Configure" button. The Drive-CLiQ topology of the drive is read out.</p> 

4 Configuration and Programming

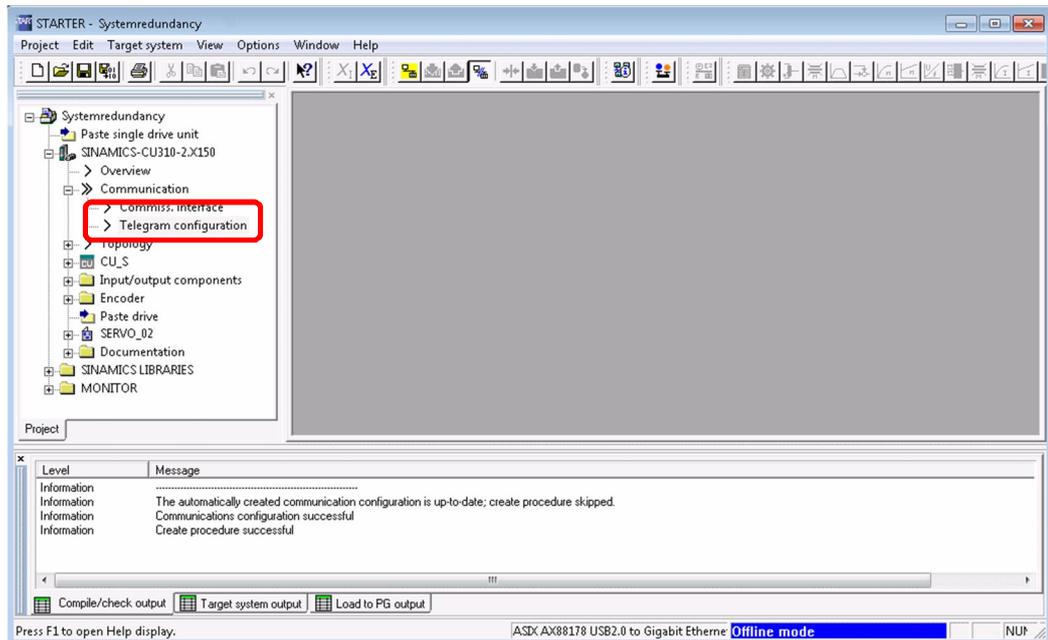
4.5 Configuration of SINAMICS drive

No.	Action
8.	<p>A servo motor is used in the SINAMICS training case.</p> 
9.	<p>If the firmware version of the drive has changed compared to the last commissioning, after the automatic configuration it may be necessary to "Power OFF/ON" the drive to update the firmware of the Drive-CLiQ components</p>  <p>Note</p> <p>Before "Power OFF/ON" execute the "RAM to ROM" function at the drive to save the previous configuration in a non-volatile way.</p> 

4 Configuration and Programming

4.5 Configuration of SINAMICS drive

10. Open the drive telegram configuration using the menu item "Communication > Telegram configuration".



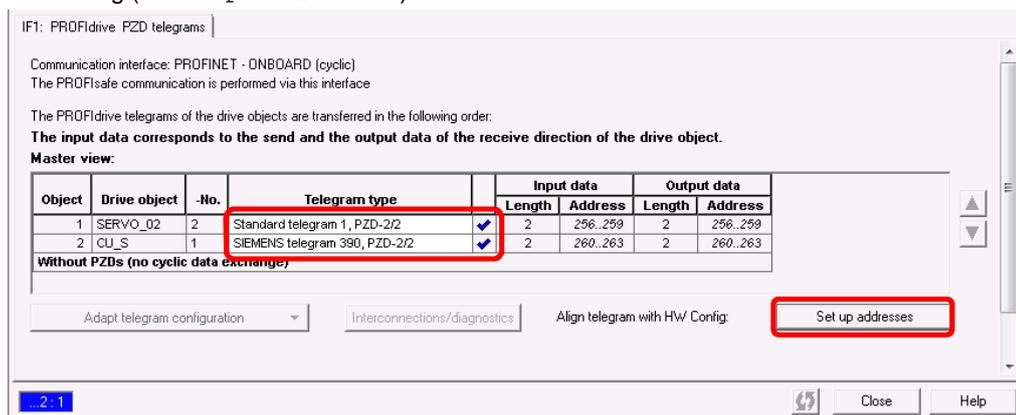
Note

Carry out the following steps that are described offline!

11. The following telegrams are used for cyclic communication between the controller and drive in the sample project:

- SERVO_02 Standard telegram 1, PZD-2/2
- CU_S SIEMENS telegram 390, PZD-2/2

Set these telegrams in the drive telegram configuration and align the telegram configuration with HW Config ("Set up addresses").

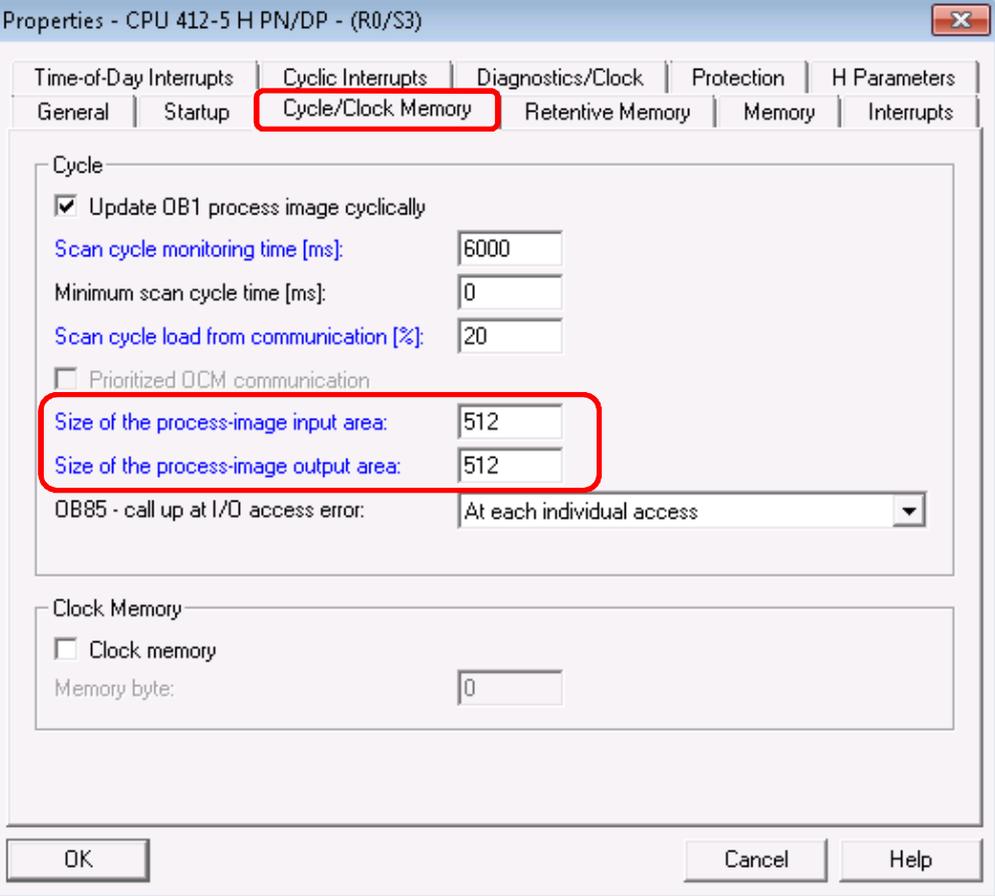


Note

Confirm the message that follows with "Yes". A blue tick after the telegrams indicates that the telegram configuration has been successfully aligned with HW Config.

4 Configuration and Programming

4.5 Configuration of SINAMICS drive

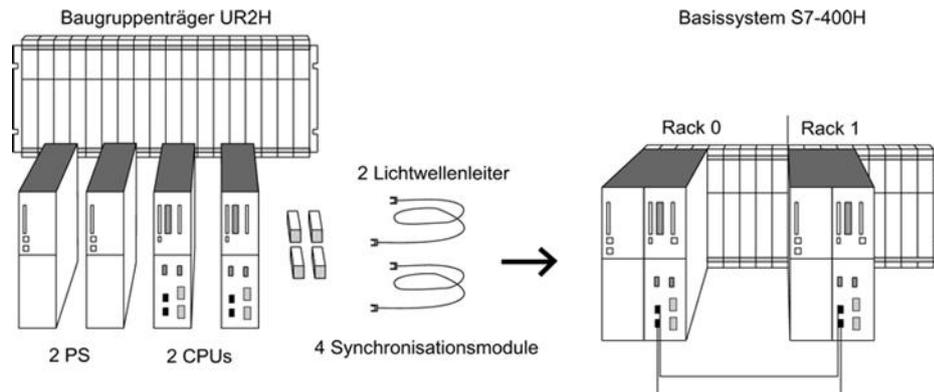
No.	Action
12.	<p>Change to the HW Config of the SIMATIC CPU, and check the size of the process image of the controller (double click on the CPU > tab "Cycle/Clock Memory").</p>  <p>Note If required, adapt the size of the process image of the inputs and outputs so that the input and output data of the SINAMICS drive telegrams are completely inside of the process image of the controller!</p>
13.	<p>Save and compile the configuration of the SINAMICS drive in STARTER and in the HW Config of the SIMATIC CPU.</p> 
14.	<p>Establish an online connection with the drive.</p> 
15.	<p>Download to the SINAMICS drive and load HW Config into the controller.</p> 
16.	<p>Execute the "RAM to ROM" function in the drive to save its configuration in a non-volatile way.</p> 
17.	<p>The communication between the SIMATIC CPU and SINAMICS drive has therefore been configured.</p>

5 Installation and Commissioning

5.1 Installation of hardware

Following pictures show the hardware and the topology of the hardware.

Figure 5-1 Hardware



Central processing units

The two CPUs are the heart of the S7-400H. Use the switch on the rear of the CPU to set the rack numbers. In the following sections, we will refer to the CPU in rack 0 as CPU 0, and to the CPU in rack 1 as CPU 1.

Note

An incorrectly set rack number prevents online access and the CPU might not start up

Rack for S7-400H

The UR2-H rack supports the installation of two separate subsystems with nine slots each, and is suitable for installation in 19" cabinets.

You can also set up the S7-400H in two separate racks. The racks UR1 and UR2 are available for this purpose.

Power supply

You require one power supply module from the standard range of the S7-400 for each HCPU, or to be more precise, for each of the two subsystems of the S7-400H.

To increase availability of the power supply, you can also use two redundant power supplies in each subsystem.

Synchronization modules

The synchronization modules are used to link the two CPUs. They are installed in the CPUs and interconnected by means of fiber-optic cables.

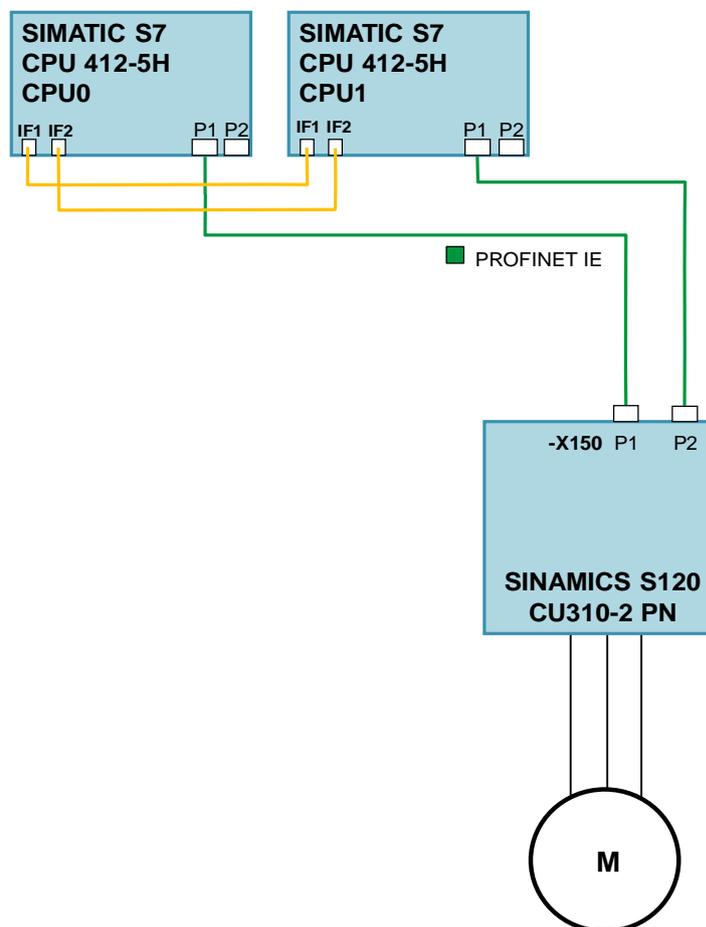
There are two types of synchronization modules: one for distances up to 10 meters, and one for distances up to 10 km between the CPUs.

A fault-tolerant system requires 4 synchronization modules of the same type.

Fiber-optic cable

The fiber-optic cables are used to interconnect the synchronization modules for the redundant link between the two CPUs. They interconnect the upper and lower synchronization modules in pairs.

Figure 5-2 Interconnection



Note The port interconnection must correspond to your STEP7 configuration.

5.2 Commissioning

Overview

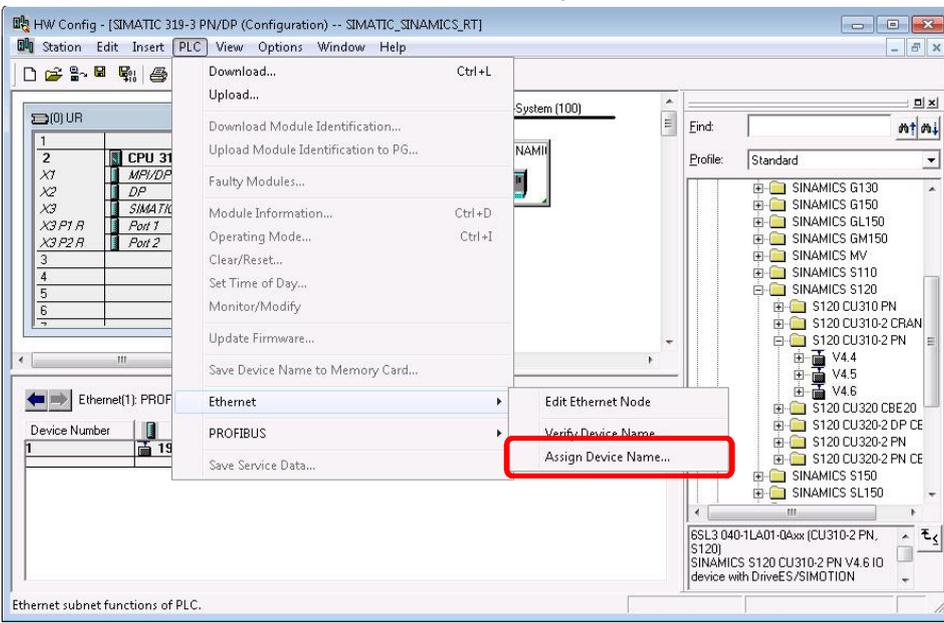
An executable sample project is included in the zip archive "109744811_Systemredundancy_v10.zip".

Commissioning of the sample project

The steps described in the following must be performed to commission the sample project.

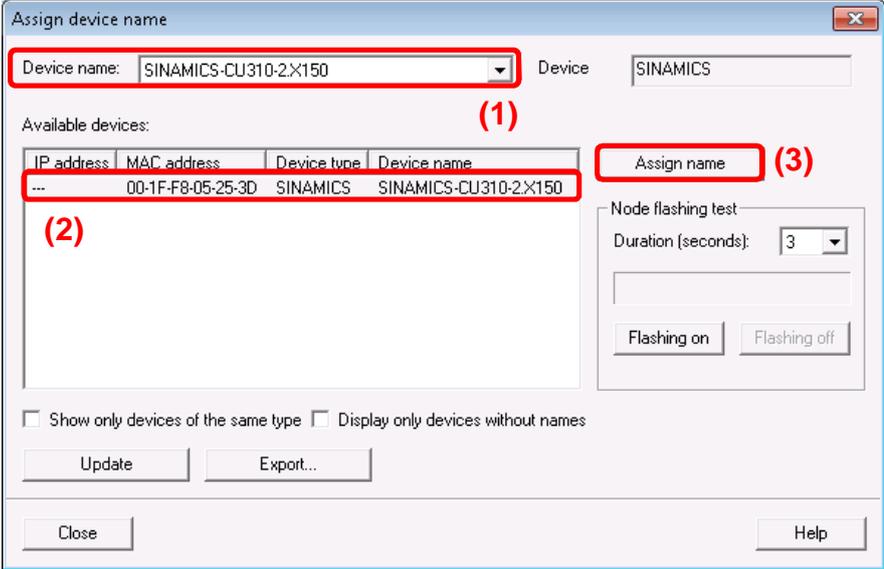
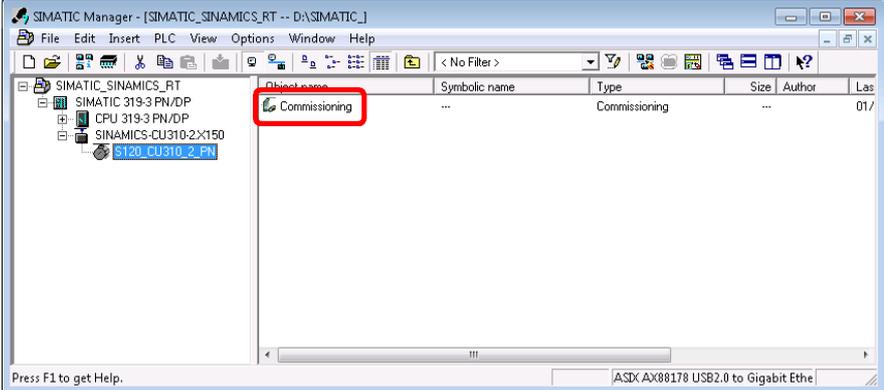
Table 5-1 Commissioning

No.	Action
1.	All hardware components are available and interconnected.
2.	All PROFINET components are networked and accessible from the engineering system.
3.	The Ethernet interface of the engineering system is configured correctly and is working. <u>Example</u> IP address: 192.168.0.99 subnet mask: 255.255.255.0
4.	Start the STEP 7 SIMATIC Manager engineering system.
5.	Retrieve the sample project "109744811_Systemredundancy_v10.zip".
6.	Open the HW Config of the SIMATIC CPU.
7.	Download the HW Config and all blocks from the block container into the controller.
8.	Carry out a node initialization of the SINAMICS drive. To do this, change to HW Config of the controller and select the PROFINET network. Using the menu item "PLC > Ethernet > Assign Device Name..." open the window to assign a name.



5 Installation and Commissioning

5.2 Commissioning

No.	Action
9.	<p>Select the device name configured in HW Config using the drop-down menu (1). Then select the SINAMICS drive from the list of available devices (2) and assign the device name using the "Assign name" (3) button.</p>  <p>Note Only IO devices are listed here. IO controllers receive their device name by downloading the HW Config.</p>
10.	<p>As an alternative, the Primary Setup Tool (PST) can also be used to perform the node initialization. The PST can be downloaded at the following link. http://support.automation.siemens.com/WW/view/en/19440762</p>
11.	<p>Start the STARTER engineering system from the project in the SIMATIC Manager.</p> 
12.	<p>Establish an online connection with the SINAMICS drive.</p> 
13.	<p>Download the configuration of the drive into the target device.</p> 
14.	<p>Then execute the "RAM to ROM" function.</p> 
15.	<p>The sample project is now ready for operation.</p>

6 Operating the sample project

6.1 Controlling the servo motor

In the sample project, the cyclic communication between SIMATIC CPU and SINAMICS drive is implemented in OB1. The OB1 contains the user program subsequently described.

Table 6-1 Control of the servo motor

No.	Action
1.	<div style="border: 1px solid gray; padding: 2px;"> <p>Network 1: User program</p> <p>Speed calculation, drive control and failure reset</p> </div> <pre> // speed calculation L "N_SOLL_USER" MD100 L 6.000000e+003 /R L 1.638400e+004 W#16#4000 *R TRUNC T "N_SOLL" MW110 U "boMove" MO.0 SPEN S002 </pre> <p>The user must specify the speed setpoint used to operate the servo motor ("N_SOLL_USER"). The calculation of the speed setpoint is based on the specified definitions of the PROFIdrive profile. 6000 rpm corresponds to the value "W#16#4000". The calculated speed is then buffered so that it can be further accessed ("N_SOLL"). The servo motor is operated with the calculated speed and is stopped again by setting the "boMove" flag.</p> <p>Note The rated speed of the servo motor installed in the training case is 6000 rpm. The maximum speed is 10000 rpm.</p>

6 Operating the sample project

6.1 Controlling the servo motor

No.	Action
2.	<pre> // drive control L W#16#47E → 2#0000_0100_0111_1110 T MW 10 L "N_SOLL" MW110 T "N_SOLL_Drive" AW258 L "ZSW1_Drive" EW256 L W#16#211 → 2#0000_0010_0001_0001 UW L W#16#211 ==I SPEN S001 L W#16#47F → 2#0000_0100_0111_1111 T MW 10 S001: L MW 10 T "STW1_Drive" AW256 SPA S003 </pre> <p>If flag "boMove" is controlled to a value of "1", then the required releases are set in control word 1 ("STW1") of the servo motor (W#16#47E), so that it can be moved.</p> <p>To ensure that the motor is only moved when all releases required are actually present, its status word 1 ("ZSW1") is compared with a constant word that represents the required releases (W#16#211).</p> <p>Only when status word 1 ("ZSW1") matches this value, the bit in control word 1 ("STW1") is set, that switches on the servo motor (W#16#47F). The servo motor is then moved with the speed setpoint entered by the user.</p>
3.	<pre> S002: L 0 T "N_SOLL_Drive" AW258 L W#16#400 → 2#0000_0100_0000_0000 T "STW1_Drive" AW256 // failure reset U "boReset" M1.0 SPEN S003 L W#16#480 → 2#0000_0100_1000_0000 T "STW1_Drive" AW256 S003: NOP 0 </pre> <p>The speed setpoint of the servo motor is 0 rpm as long as the "boMove" flag is not controlled to a value of "1".</p> <p>In control word 1 ("STW1"), only bit 10 ("Control by PLC") is set (W#16#400).</p> <p>If faults are active, flag "boReset" can be controlled to a value of "1".</p> <p>As a consequence, in control word 1 ("STW1") of the servo motor additionally bit 7 ("Acknowledge faults") is set, which acknowledges the fault (W#16#480). In this case, flag "boMove" must have the value "0"!</p>

6 Operating the sample project

6.1 Controlling the servo motor

Note

The structure of the relevant (standard) telegram (i.e. STW1, NSOLL_B, etc.) is defined in the PROFIdrive profile. You can find further information about this at the following link:

[SINAMICS S120 / S150 List Manual](#) (Chapter 2.9)

Note

The following addresses are used in the sample project to control the SINAMICS drive:

- AW 256 Control word 1 ("STW1")
- AW 258 Speed setpoint ("NSOLL_B")
- EW 256 Status word 1 ("ZSW1")

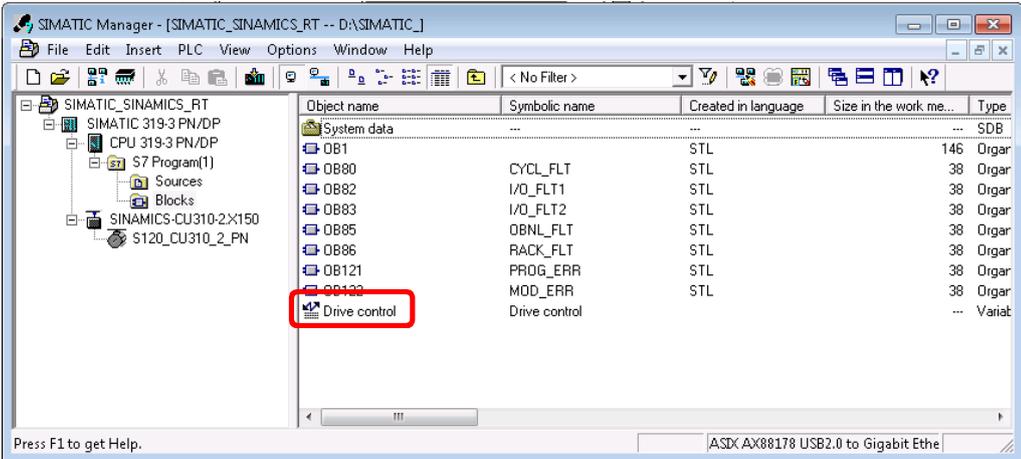
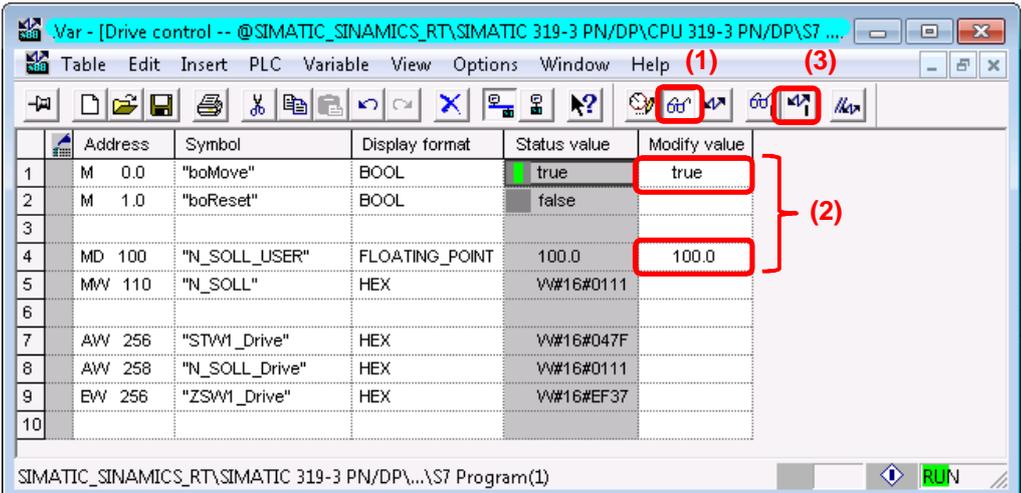
Slot	Module	Order number	I Address	Q address	Diagnostic Address
0	SINAMICS-S120-CU310-2PN	6SL3 040-1LA01-0AAx			8175*
X150	PN+Q				8174*
X150 P1 R	Port 1				8173*
X150 P2 R	Port 2				8172*
1	DO SERVO				8171*
1.1	Module Access Point				8171*
1.2					
1.3	Standard Telegramm 1, P~		256...259	256...259	
1.4					
2	DO Control Unit				8170*
2.1	Module Access Point				8170*
2.2	ohne PROFIsafe				8169*
2.3	SIEMENS Telegramm 390, ~		260...263	260...263	

6.2 Operation

The sample project is operated using the variable table "Drive control" of the SIMATIC CPU in the SIMATIC Manager.

Here, the user can enter the set point speed for the servo motor as well as switching the motor on and off. Possibly upcoming faults of the servo motor can also be acknowledged.

Table 6-2 Operation

No.	Action																																																							
1.	<p>Open the variable table "Drive control", which is located in the block container of the SIMATIC CPU.</p> 																																																							
2.	<p>In the variable table, switch to the online view using button "Monitor variable" (1). Then enter the required speed setpoint in column "Modify value" into flag double word MD100 (unit: rpm) and the value "true" or "1" into flag M0.0 (2). Activate the values by using the button "Activate modify values" (3).</p>  <table border="1"> <thead> <tr> <th>Address</th> <th>Symbol</th> <th>Display format</th> <th>Status value</th> <th>Modify value</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>M 0.0</td> <td>"boMove"</td> <td>BOOL</td> <td>true</td> </tr> <tr> <td>2</td> <td>M 1.0</td> <td>"boReset"</td> <td>BOOL</td> <td>false</td> </tr> <tr> <td>3</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>4</td> <td>MD 100</td> <td>"N_SOLL_USER"</td> <td>FLOATING_POINT</td> <td>100.0</td> </tr> <tr> <td>5</td> <td>MW 110</td> <td>"N_SOLL"</td> <td>HEX</td> <td>W#16#0111</td> </tr> <tr> <td>6</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>7</td> <td>AW 256</td> <td>"STW1_Drive"</td> <td>HEX</td> <td>W#16#047F</td> </tr> <tr> <td>8</td> <td>AW 258</td> <td>"N_SOLL_Drive"</td> <td>HEX</td> <td>W#16#0111</td> </tr> <tr> <td>9</td> <td>EW 256</td> <td>"ZSW1_Drive"</td> <td>HEX</td> <td>W#16#EF37</td> </tr> <tr> <td>10</td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>	Address	Symbol	Display format	Status value	Modify value	1	M 0.0	"boMove"	BOOL	true	2	M 1.0	"boReset"	BOOL	false	3					4	MD 100	"N_SOLL_USER"	FLOATING_POINT	100.0	5	MW 110	"N_SOLL"	HEX	W#16#0111	6					7	AW 256	"STW1_Drive"	HEX	W#16#047F	8	AW 258	"N_SOLL_Drive"	HEX	W#16#0111	9	EW 256	"ZSW1_Drive"	HEX	W#16#EF37	10				
Address	Symbol	Display format	Status value	Modify value																																																				
1	M 0.0	"boMove"	BOOL	true																																																				
2	M 1.0	"boReset"	BOOL	false																																																				
3																																																								
4	MD 100	"N_SOLL_USER"	FLOATING_POINT	100.0																																																				
5	MW 110	"N_SOLL"	HEX	W#16#0111																																																				
6																																																								
7	AW 256	"STW1_Drive"	HEX	W#16#047F																																																				
8	AW 258	"N_SOLL_Drive"	HEX	W#16#0111																																																				
9	EW 256	"ZSW1_Drive"	HEX	W#16#EF37																																																				
10																																																								

6 Operating the sample project

6.2 Operation

No.	Action
3.	<p>The speed "N_SOLL_USER" entered by the user is scaled according to the definitions of the PROFIdrive profile and entered at the servo motor as speed setpoint. Further, the required releases are set in control word 1 ("STW1") of the drive to move it.</p> <p>Note The speed setpoint can also be changed if the servo motor is already in operation, i.e. flag "boMove" is set.</p>
4.	<p>By setting flag "boReset", possible faults present at the servomotor can be acknowledged.</p> <p>Note Pending faults can be acknowledged only when the servomotor is not operational, i.e. the "boMove" flag must not be set! Further it should be noted that flag "boReset" is not automatically reset to the value "0". This must be done manually after the acknowledgement of the faults!</p>

7 Further notes, tips and tricks, etc.

Further information

Further information about PROFINET System redundancy can be found in following manuals in SIOS:

- System manual "SIMATIC Fault-tolerant systems S7-400H"
(<https://support.industry.siemens.com/cs/ww/en/view/82478488>)
- Configuration Examples for S7-400H with PROFINET SIMATIC S7-400H as of V6.0
(<https://support.industry.siemens.com/cs/ww/en/view/90885106>)
- SINAMICS S120 Function Manual Drive Functions
(<https://support.industry.siemens.com/cs/ww/en/view/109740020>)

8 Related literature

Table 8-1

	Topic
\1\	Siemens Industry Online Support https://support.industry.siemens.com
\2\	Download page of this entry https://support.industry.siemens.com/cs/ww/en/view/109744811
\3\	SINAMICS S120 Function Manual Drive Functions https://support.industry.siemens.com/cs/ww/en/view/109740020
\4\	Configuration Examples for S7-400H with PROFINET SIMATIC S7-400H as of V6.0 https://support.industry.siemens.com/cs/ww/en/view/90885106
\5\	System manual "SIMATIC Fault-tolerant systems S7-400H" https://support.industry.siemens.com/cs/ww/en/view/82478488

9 Contact

Siemens AG
 Industry Sector
 I DT MC PMA APC
 Frauenaauracher Strasse 80
 91056 Erlangen
 Germany
 mailto: profinet.team.motioncontrol.i-dt@siemens.com

10 History

Table 10-1

Version	Date	Modifications
V1.0	03/2017	First version