SIEMENS

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Speed control of a SINAMICS S120 with S7-300/400 (STEP 7 V5) via PROFINET IRT (isochronous)

SINAMICS S

http://support.automation.siemens.com/WW/view/en/53477498

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http://support.automation.siemens.com/WW/view/en/50203404

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1 Task

1.1 Overview

A drive shall be moved speed-controlled.

For this purpose the drive is operated as IO device on an IO controller. In addition there is the demand of having special control-related duties. This is the reason, why a communication via PROFINET IRT (isochronous) is configured between controller and drive.

This makes it possible to exchange equidistant data between the devices. With this equidistant cycle the devices can be synchronized and their application can be operated isochronously.

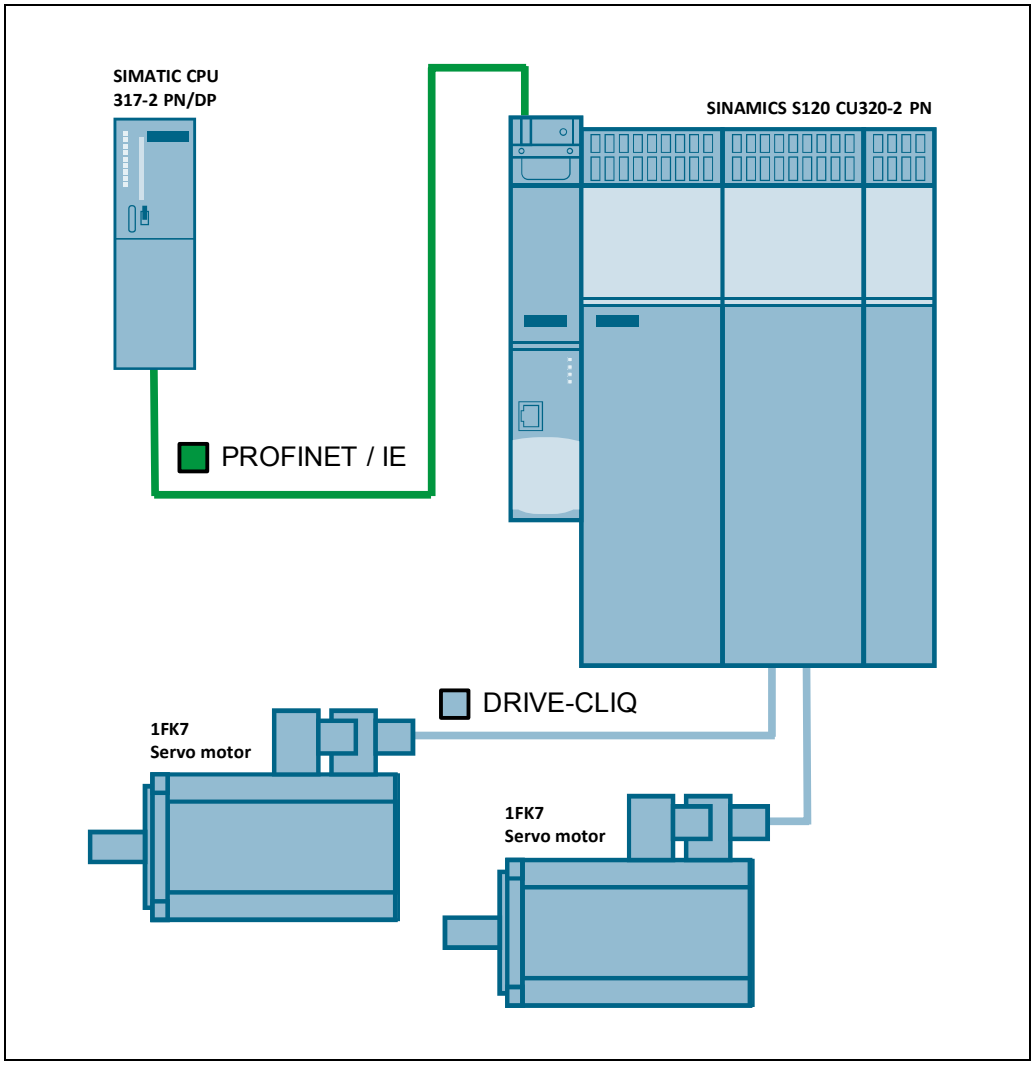
2 Solution

2.1 Overview

Schema

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

Figure 2-1



In this application description it is shown, how a SINAMICS S120 can be moved speed-controlled by means of a SIMATIC S7-300/400 (STEP 7 V5). For this purpose a communication via PROFINET IRT (isochronous) is configured between controller and drive.

The SIMATIC CPU sets the required releases in order to move the two motors of the SINAMICS drive speed-controlled. By means of the OB61 isochronous execution level, the control word ("STW1") as well as the speed setpoint ("NSOLL_B") is sent from the CPU to the drive.

The status word ("ZSW1") as well as the actual speed value ("NIST_B") is returned by the drive. Upcoming drive errors are acknowledged by the SIMATIC controller via application.

A sign-of-life monitoring is also implemented in the OB61 by application. For this purpose the bits 12 to 15 ("master sign-of-life") in control word 2 ("STW2") are incremented and sent to the drive. If the drive has received the master sign-of-life once completely, the generation of its own sign-of-life ("slave sign-of-life") is started and is returned to the controller in the status word 2 ("ZSW2").

Advantages

This application offers you the following advantages:

- Equidistant data exchange between SIMATIC controller and SINAMICS drive based on the isochronous communication (PROFINET IRT).
- Easy control of the SINAMICS drive.
- Easy composition because of standardized technology.
- The existing system can be expanded quick and easy.

Delimitation

This application does not include a description of:

- the general drive functions of the SINAMICS S120
- the SIMATIC S7-300/400

Knowledge required

Basic knowledge of the configuring of SIMATIC controllers with the STEP 7 engineering system and the configuring of SINAMICS drives with STARTER respectively SIMOTION SCOUT is assumed.

Supplementary conditions

- **SIMATIC F-CPU: clock-synchronized mode (OB6x) and safety mode**

  In the document "IO-Controller_PROFINET_functions_en.pdf" of the article http://support.automation.siemens.com/WW/view/en/44383954 is written that when using a SIMATIC F-CPU the "clock-synchronized mode" (OB6x) is only supported in standard mode (without safety program).

  However under certain conditions it is possible to activate the clock-synchronized mode (standard program in OB6x) and the safety mode ("F-CALL") at the same time.

  It is absolutely necessary to avoid the updating of the process image partition while the safety program is executed (see program example in chapter 4.6).

NOTE If the process image partition is not updated in each OB6x cycle, the S7 application (standard program in OB6x) is not really clock-synchronized!

2.2 Hardware and software components used

The sample project was created with the following components.

Hardware components

Table 2-1

Component	Qty	MLFB / order number	Note
SIMATIC CPU 317-2 PN/DP	1	6ES7317-2EK14-0AB0	V3.2.6
SINAMICS S120 CU320-2 PN	1	6SL3040-1MA01-0AA0	V4.4.2
SIMOTION D435 training case	1	6ZB2470-0AE00	

Note The sample project was created with the hardware components listed here.

Alternatively, other components with the same function may be used. A different parameter assignment and different wiring of the components may be required.

Standard software components

Table 2-2

Component	MLFB / order number	Note
STEP7	6ES7810-4CC10-0YA5	V5.5 HF4
STARTER	6SL3072-0AA00-0AG0	V4.2
Drive ES Basic	6SW1700-5JA00-4AA0	V5.4 SP5
Alternatively SIMOTION SCOUT	6AU1810-1BA42-1XE0	V4.2 SP1

Sample files and projects

Table 2-3

Component	Note
53477498_PN_IRT_SIMATIC_SINAMICS_V1_2.zip	STEP7 project
53477498_SIMATIC_SINAMICS_PROFINET_IRT_V2_0_en.pdf	This document

Supplementary conditions

To configure an isochronous communication, the following software and hardware versions are required.

Table 2-4

Component	Version	Note
STEP7	As from V5.5 HF4	
STARTER	As from V4.2	
Drive ES Basic	As from V5.4 + SP5	
SIMOTION SCOUT	As from V4.2.1.0	Alternative to STARTER and Drive ES BASIC
Firmware for S7-300 CPU	As from V3.2	
Firmware for S7-400 CPU	As from V6.0	
Firmware for SINAMICS	As from V4.4	

2.3 Alternative solution

Drive connection via PROFINET RT

Because no isochronous communication is required in many applications, a drive connection via PROFINET RT may suffice. An isochronous communication is normally required when the controller performs closed-loop control tasks (e.g. with a SIMOTION controller).

NOTE Further information concerning the drive connection via PROFINET RT can be obtained from the following article.

http://support.automation.siemens.com/WW/view/en/38844967

3 Basic information

3.1 PROFINET communication

In addition to the MAC address and IP address, PROFINET uses additionally a device name to identify the PROFINET devices. This device name must be unique within the PROFINET network.

3.1.1 Device name

During the commissioning phase a device name is assigned to each PROFINET device by the engineering system (HW Config, NetPro, STARTER, SCOUT, Primary Setup Tool). The device name can be assigned by different ways:

- IO-Controller
  - Engineering Software (HW Config, NetPro, STARTER, SCOUT, Primary Setup Tool)
  - By downloading the HW Config
  - By user program (system function `_setNameOfStation()` for SIMOTION)
- IO-Device
  - Engineering Software (HW Config, NetPro, STARTER, SCOUT, Primary Setup Tool)
  - From IO-Controller via topology-based initialization

The device name will be stored in the device (on MMC or CF card). When replacing this device (e.g. in case of malfunction), this device must be initiated using the device name of the replaced device. For this step more possibilities are available:

- By plugging the MMC or CF card (if available)
- Engineering software (HW Config, NetPro, STARTER, SCOUT, Primary Setup Tool)
- Topology-based initialization by the IO-Controller itself. For this the PROFINET interface must be in factory settings.

It means the new device can assume the function of the replaced device without changing the configuration.

3.1.2 Assign device name via HW Config

Open HW Config and select the PROFINET IO-System. Click in menu under „PLC > Ethernet" onto "Assign Device Name…". The dialog assign device name will appear. All configured device names are in dropdown box listed. All recognized PROFINET devices via Network interface are shown under available devices. IO-Controllers are not shown here, because they will get the device name by downloading the HW Config explicit.

Figure 3-1

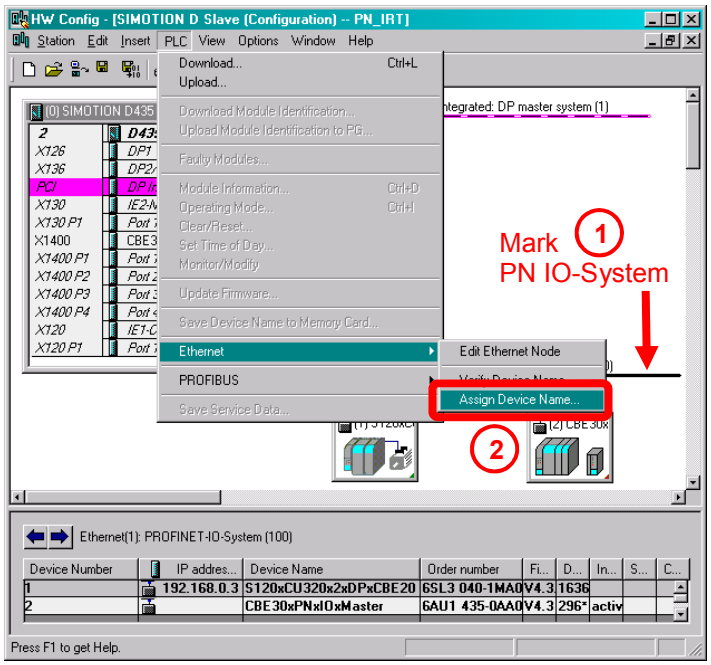
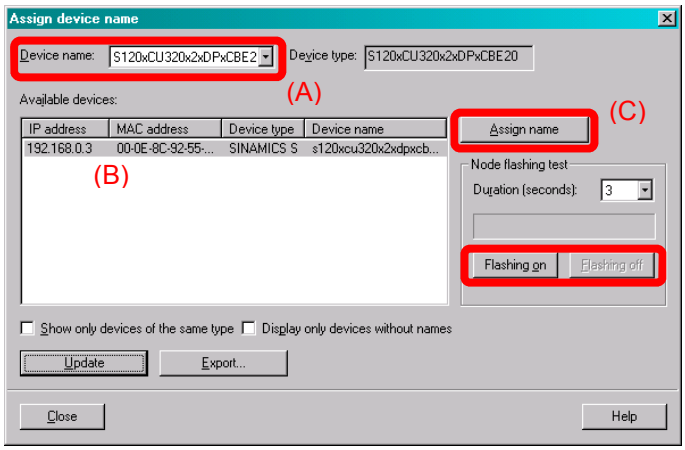


Figure 3-2



Select the configured device name (A) and select the corresponding device (B) and click on “Assign name” (C). The device name will be transferred to the device.

If the device identification is not clear you can activate the flashing of a specified LED. Select the device and click on “Flashing on” to activate the function. Depending on the device type following LED will start flashing:

Table 3-1

Device	LED
SIMATIC	LINK-LEDs
SIMOTION	SF-LED
SINAMICS S120	RDY-LED
SINAMICS G120	RDY-LED

3.1.3 SINAMICS: Assign device name via parameters

The device name of a SINAMICS drive can also be specified offline via parameters in the expert list of the CU. By using the STARTER / SCOUT functionality “Load to file system” afterwards the configuration can be transferred directly to the CF card via card reader or to the drive via download of the offline configuration. The device name will be activated in the drive and stored non-volatile after the next run-up (Power OFF/ON required!).

NOTE Beside the device name, also the IP address and the subnet mask of the drive have to be specified correctly in the expert list of the CU, because these will also be activated in the drive and stored non-volatile after the next run-up.

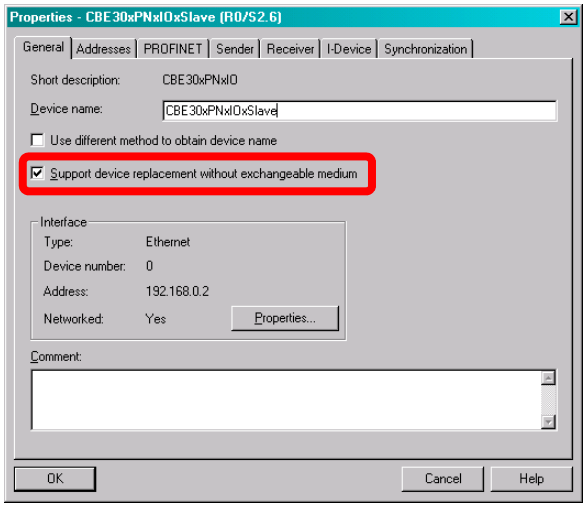
For the assignment of the device name, the IP address and the subnet mask, proceed as follows:

1. Open the expert list of the CU in the STARTER / SCOUT project.
2. Depending on which PROFINET interface of the drive you are using (onboard PROFINET interface or CBE20), proceed as follows:
   - **Settings for the onboard PROFINET interface**
     - Enter the drives’ device name from HW Config into parameter p8920.
     - Enter the drives’ IP address from HW Config into parameter p8921.
     - Enter the drives’ subnet mask from HW Config into parameter p8923.
     - Set parameter p8925 to the value “[2] Save and activate configuration”.
   - **Settings for the CBE20**
     - Enter the drives’ device name from HW Config into parameter p8940.
     - Enter the drives’ IP address from HW Config into parameter p8941.
     - Enter the drives’ subnet mask from HW Config into parameter p8943.
     - Set parameter p8945 to the value “[2] Save and activate configuration”.
3. Save the changes carried out in the project. Afterwards mark the drive in the project tree and open its context menu via right clicking. Choose the option “Load to file system”.
4. Choose the option “Save normally” as type of saving and click on the button “Select target…”. Choose the path of the card reader and start the transmission of the configuration via the button “OK”.
5. After the successful transmission of the configuration and subsequent run-up of the drive the device name, the IP address as well as the subnet mask is taken over from the parameters and stored non-volatile.

3.1.4 Topology-based initialization

The device name can be assigned by the PROFINET IO-Controller itself. With the checkbox “Support device replacement without exchangeable medium” the PROFINET feature topology-based initialization is activated. This feature is activated by default.

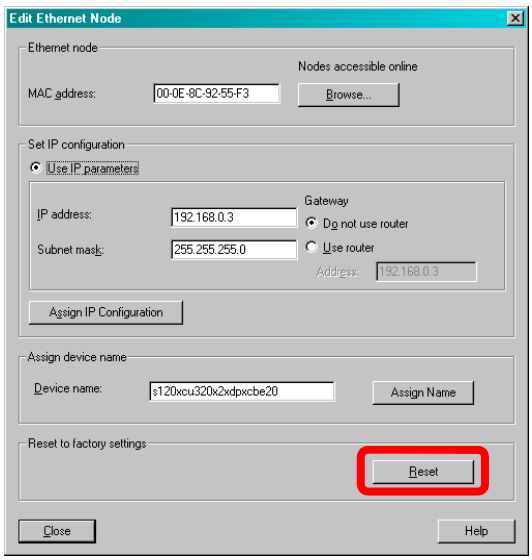
Figure 3-3



This properties window will open by double clicking on the PN interface of the IO-Controller in HW Config.

Please observe that **the PN interface of IO-Device must be in factory settings** to support this function (in this state the interface has the IP address = 0.0.0.0 and an empty device name = „“). To reset the PROFINET interface to factory settings open HW Config and click on „PLC > Ethernet > Edit Ethernet Node > Reset“ (see following figure).

Figure 3-4



3.1.5 Device name assignment rules

The device name has to follow the rules of DNS (Domain Name System). Following possibilities for DNS names are given:

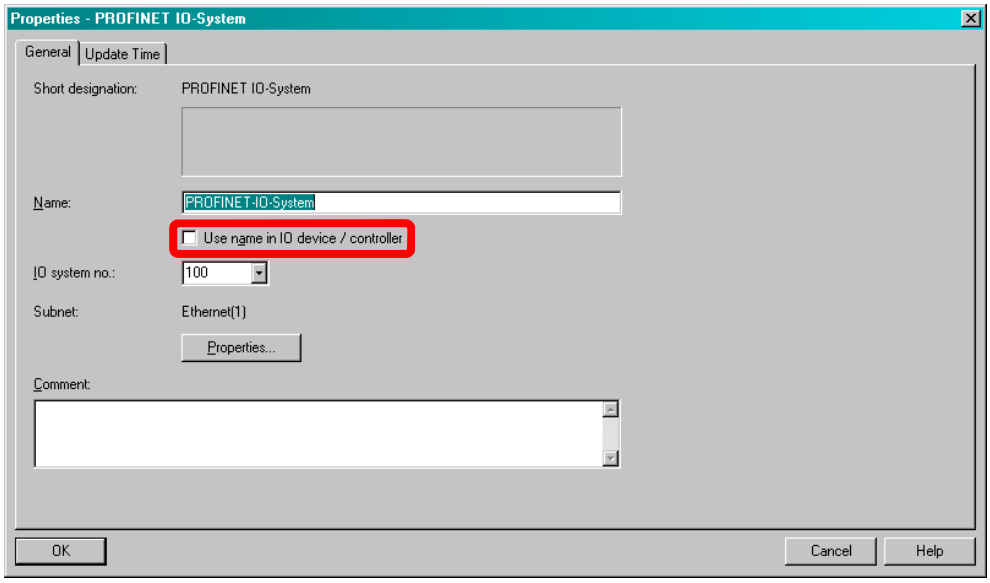
- Letters (a..z),
- Numbers (0..9) and the signs
- Minus (-) and
- Dot (.) are allowed.

The dot divides the device name into labels. The device name can include more labels, for example:

<CPU name>.<Interface number >.<Name of IO-System>…

- *<Interface number>*, if the device has more than one PN interfaces available (e.g. “X150”)
- *<Name of IO-System>*, optional and configured by HW Config (see Figure 3-5).
- Each label must start with a letter and doesn’t end with minus or a dot.
- The maximum length of one label is 63 characters.

Figure 3-5



Observe also following additional rules:

- The maximum total length is 127 characters (incl. minus and dot)
- The device name may only include lower case. On the device upper case are replaced through lower case.
- Do not use umlauts (ä, ö, ü)
- Do not use special characters ! " § $ % & / ( ) = ? * ' _ : ; > < , # + | ~ \ }] [{
- Do not use blanks
- The device name does not start with "port-xyz" (x, y, z = 0..9).
- **Do not use the minus sign on SIMOTION controllers. Up from SIMOTION SCOUT Version 4.3 this limitation is raised.**

3.1.6 IP address

PROFINET uses IP addresses for establishing the PROFINET IO communication and for NRT (Non Real Time Communication e. g. TCP, UDP, S7 communication).

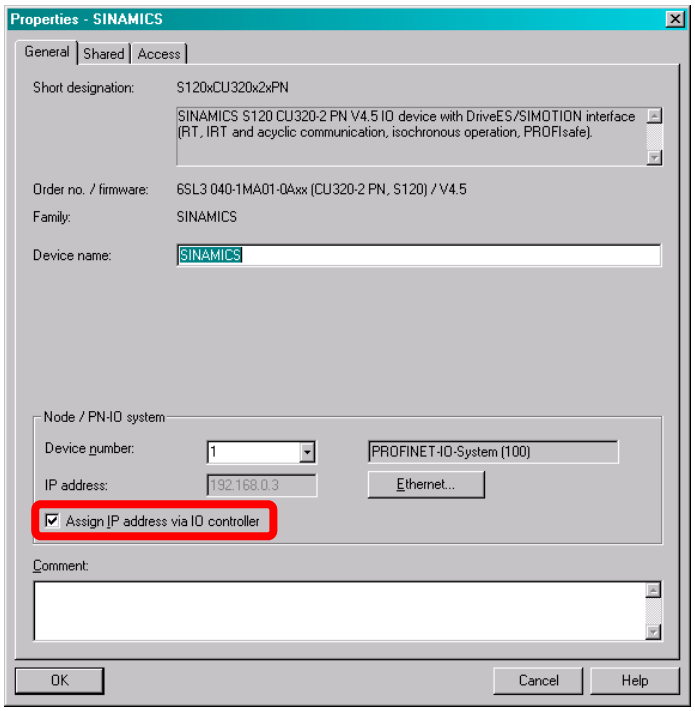
The IP address is also needed to go online to the device. It is recommenced to assign an IP address to each PROFINET IO-Device during startup of a project commissions. To do this you have more possibilities:

- IO-Controller
  - Engineering software (HW Config, NetPro, STARTER, SCOUT, Primary Setup Tool)
  - Download of HW Config, please observe the current active IP address of the device!
- IO-Device
  - Engineering software (HW Config, NetPro, STARTER, SCOUT, Primary Setup Tool)

In a PROFINET IO-System it is possible to receive the IP address from the IO-Controller. This feature is activated by default.
For this a correct working PROFINET connection between IO-Controller and IO-Device is required and the active device name must be the same as in the HW Config. Figure 3-6 shows the configuration of a SINAMICS S120. The device with device name “SINAMICS” will get the IP address 192.168.0.3 and the same subnet mask as the IO-Controller.

If the device doesn’t receive the IP information from IO-Controller it is maybe not possible to go online with the engineering software (e. g. Starter or SCOUT). In this case assign a fixed IP to the device.

Figure 3-6

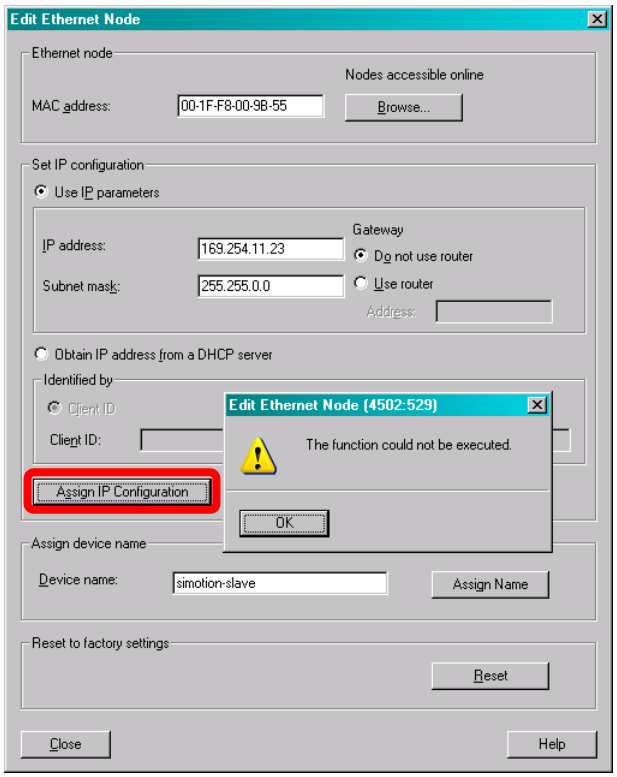


The received IP address from IO-Controller is just a temporary address (till next power OFF/ON of the device). The received address is higher prior as a fixed set IP address via engineering software.
After power ON the IP address must be received from IO-Controller first. If the address will not receive, the IP address set by the engineering system or the default IP address 0.0.0.0 (default setting of the PN interface) will be active.
An IP address assigned by any engineering software is permanently saved.

If you disable the function „Assign IP address via IO-Controller" the fixed IP address will be used. The IO-Controller will not assign the configured IP address.

The IP address in the device must be unique. Please observe that the IP addresses used by PN interfaces (e.g. X150) and the IP addresses of the standard Ethernet interfaces (e.g. X127) must be in different IP subnets. For example: If you assign an IP address 169.254.11.23 to the PN interface X150 so the device will report an error if the standard Ethernet interface X127 is still assigned to 169.254.11.22 (default IP address of X127).

Figure 3-7



3.1.7 Send clock for IRT communication

- The send clock for the IRT communication can be configured to a value ranging between 250 µsec and 4.0 msec.
  - Up from firmware V4.5 of SINAMICS S120 the minimum send clock time of the onboard PN interface is 250 µsec.
  - By using the CBE20 the minimum send clock time is 500 µsec.
  - Please refer also to the SIMOTION documentation “Communication.pdf” Chapter 4.2.2.3 “Overview of the possible bus cycle clocks”.
- Up from SIMOTION V4.1 SP1 the send clock of the isochronous PROFIBUS interfaces must be equal to the servo cycle clock. This also applies to PROFIBUS Integrated (SINAMICS Intergrated). Maybe the servo cycle clock or PROFIBUS send clock must be a multiple of the PROFINET IO send clock.
- Isochronous applications (e.g. ServoTask) are synchronized to the send clock or a multiple of the send clock. The cycle reduction is configured in the SIMOTION SCOUT under “Set system cycle clocks…“.

3.1.8 Isochronous mode

Isochronous mode means that the application (e.g. ServoTask of SIMOTION or OB6X of SIMATIC) is synchronized with the PROFINET IRT send clock. For this PROFINET IRT (High Performance = RTC3) is absolutely needed.

With a SIMOTION controller the synchronization of the application with the communication send clock will be handled as follow:

- As Sync-Master the synchronization will be handled automatically, but if the Sync-Master is configured as IRT I-Device the synchronization must be done manually like an Sync-Slave
- A Sync-Slave must always be synchronized with the send clock. This has to be done in the StartupTask with following system function:

```
i32RetValue := _enableDpInterfaceSynchronizationMode(
  dpInterfaceSyncMode := AUTOMATIC_INTERFACE_SYNCHRONIZATION
  );
```

If a SIMOTION controller is synchronized it can be checked by the LED SY (X150) respectively by the green LED on the CBE30 or CBE30-2.

- Green flashing = not synchronized
- Green continuous = synchronized

A check of the system variable `stateOfDpInterfaceSynchronization = DP_INTERFACES_SYNCHRONIZED` is also possible.

If a SINAMCIS device is synchronized you can check the LED PN (X150) respectively by the green LED on the CBE20.

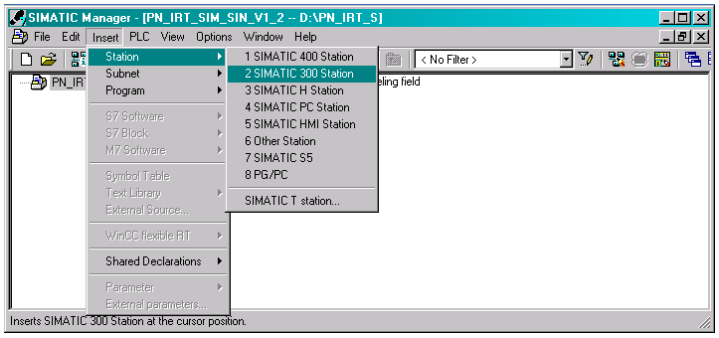
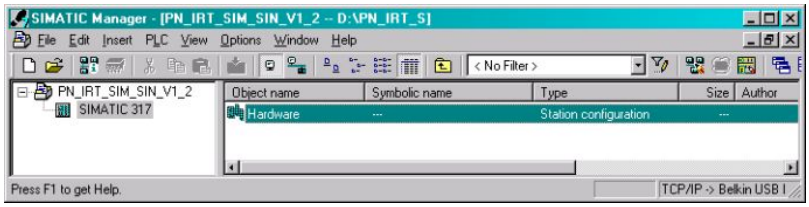
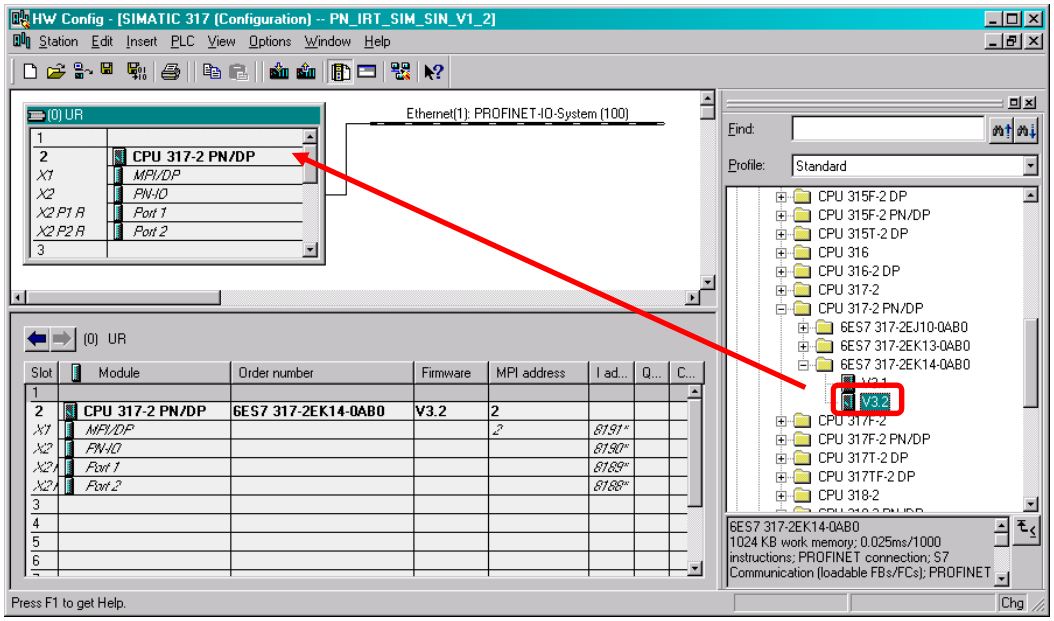
- Green flashing = not synchronized
- Green continuous = synchronized

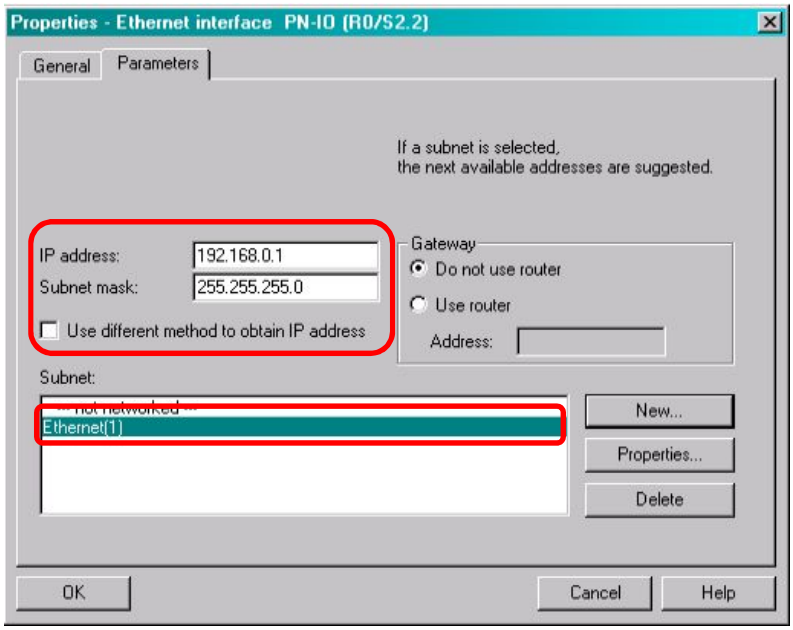
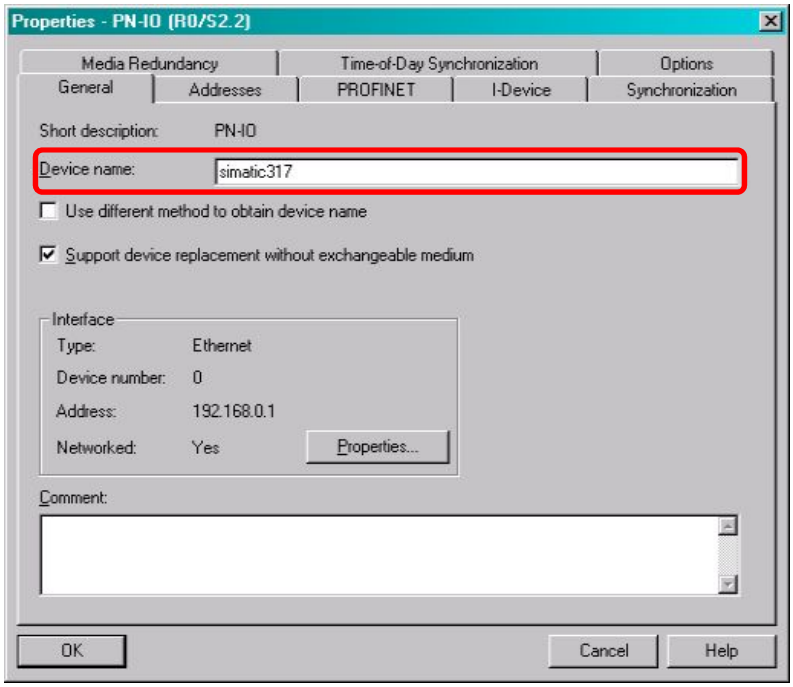
4 Configuration and programming

4.1 HW configuration of the SIMATIC CPU

In the application example a SIMATIC CPU 317-2 PN/DP with the following configuration is used.

Table 4-1

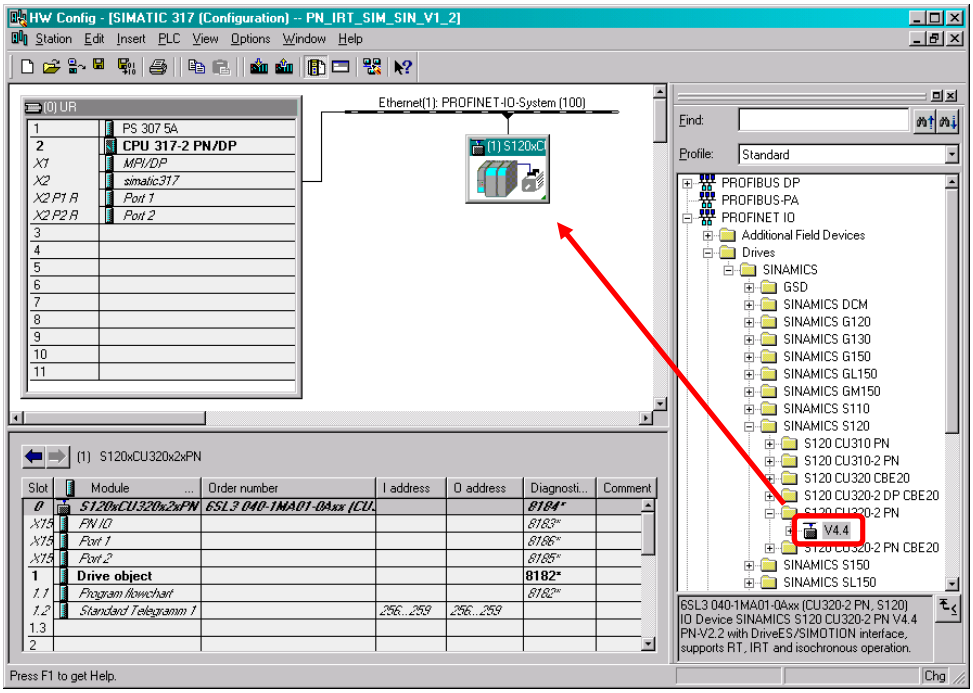
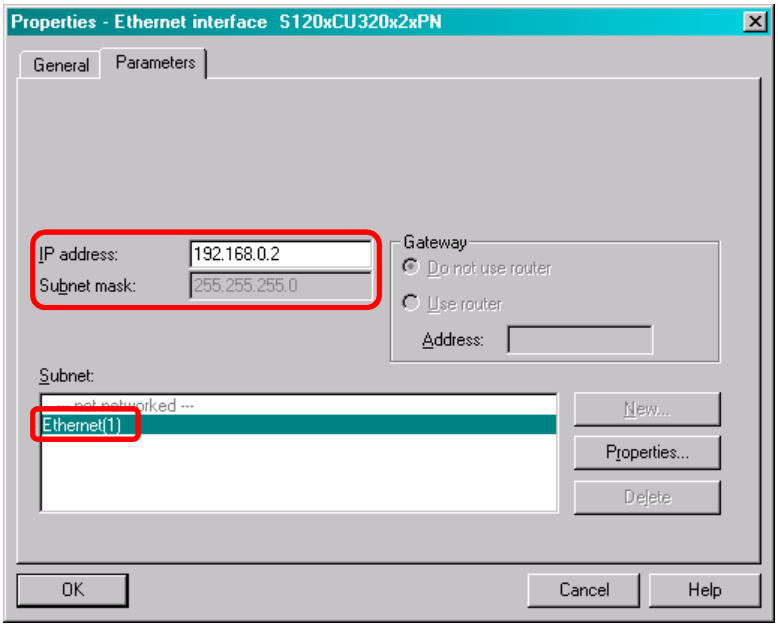
No.	Action
1.	Open the STEP 7 SIMATIC Manager engineering system to create a new project. Add a new `SIMATIC 300 station`. 
2.	Open the HW configuration. 
3.	A SIMATIC CPU 317-2 PN/DP V3.2 is used in the sample project.  Pressing the F4 key automatically arranges the modules present in the HW configuration.

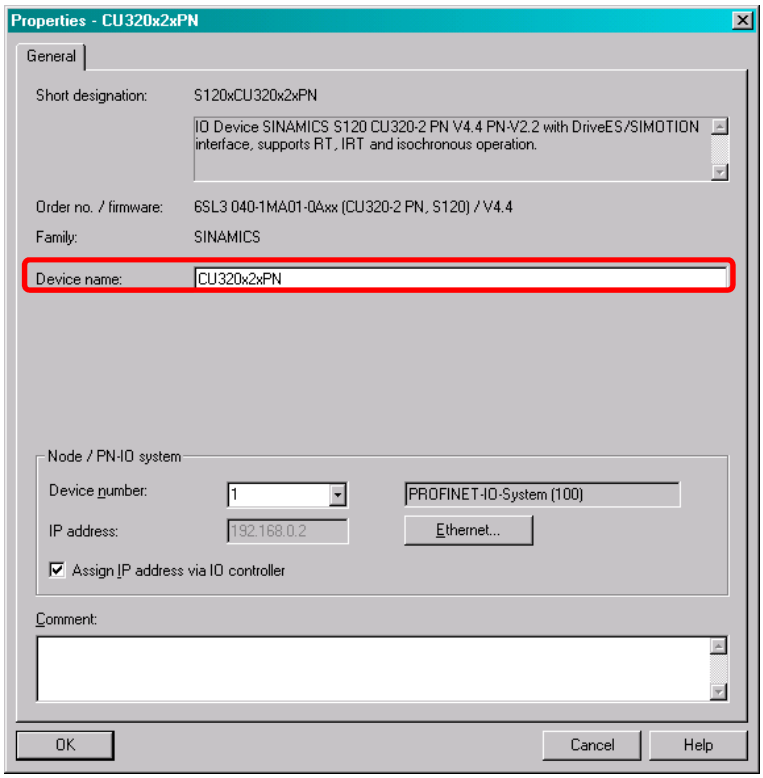
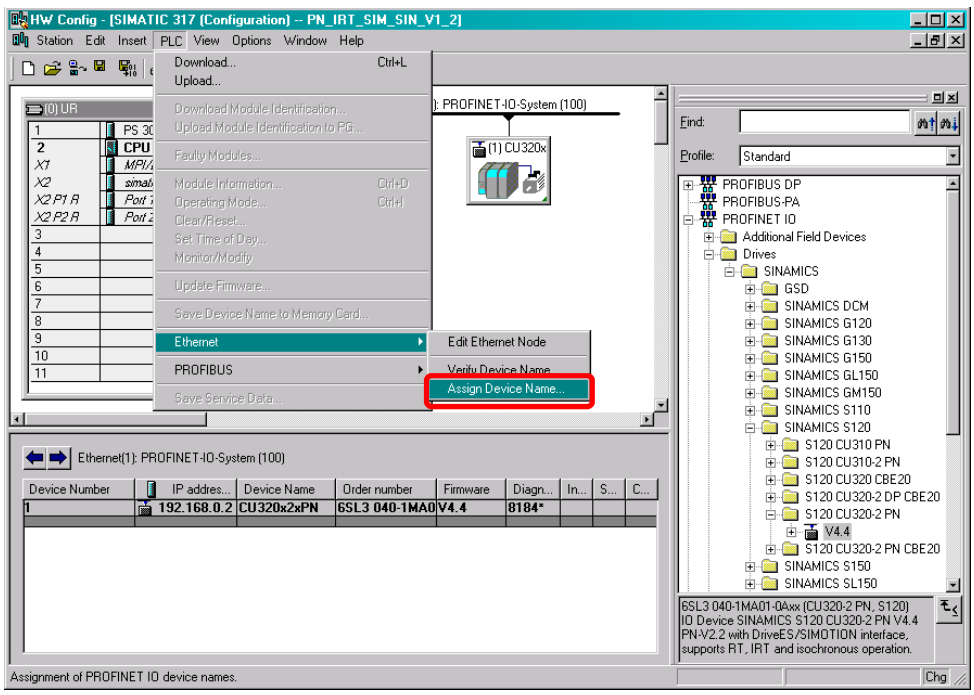
No.	Action
4.	Create a new Ethernet subnet and assign an IP address. 
5.	Double-click the PROFINET interface ("PN-IO") to open the properties window. Define the device name. The device name is "simatic317" in the sample project. 

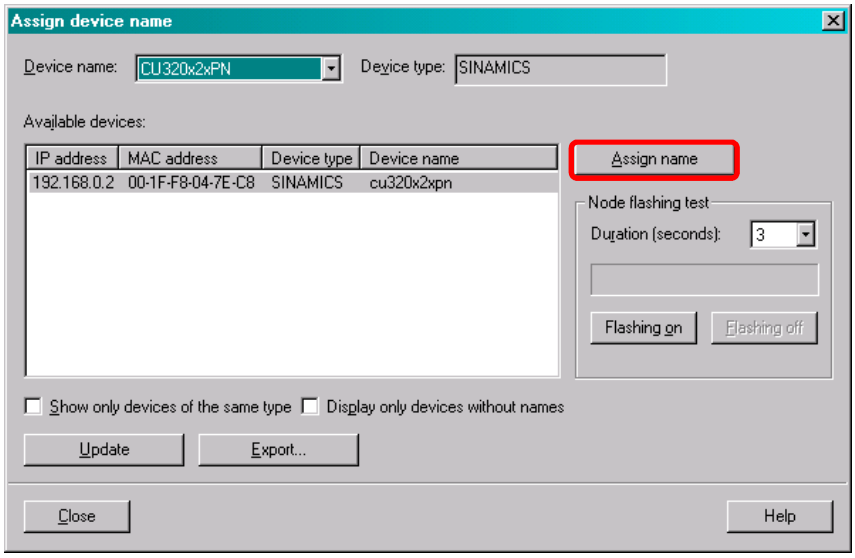
4.2 HW configuration of the SINAMICS drive

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

No.	Action
1.	Drag the SINAMICS drive `CU320-2 PN V4.4` to the existing PROFINET network. 
2.	Select the existing Ethernet subnet and assign an IP address. 

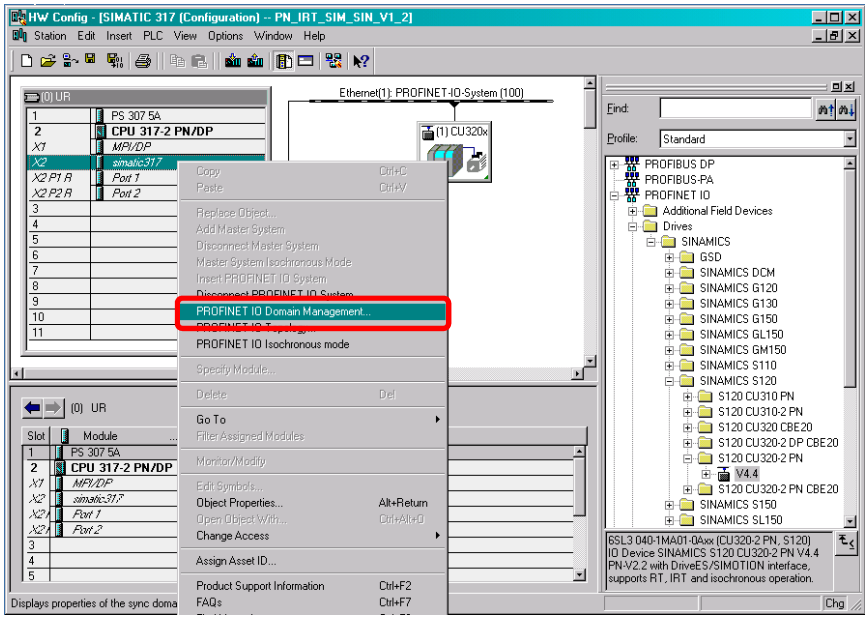
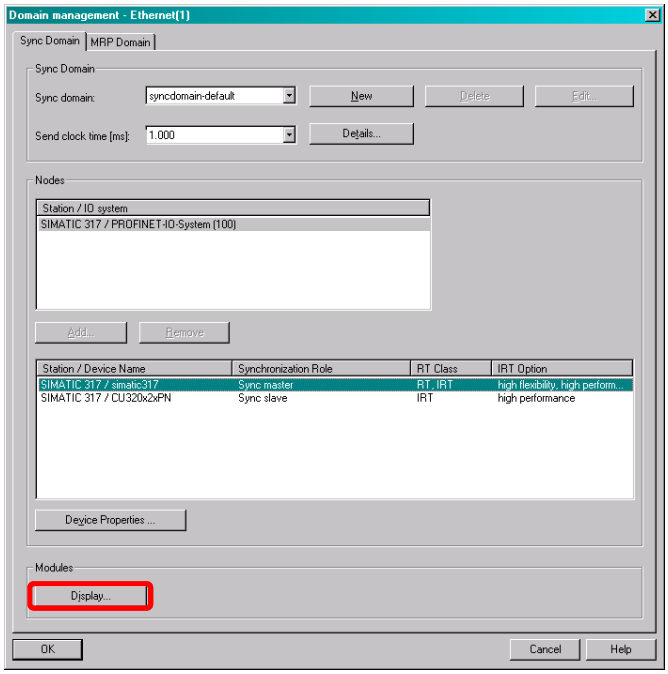
No.	Action
3.	Double-click the added SINAMICS drive to open the properties window. Define the device name (e.g. "CU320x2xPN"). 
4.	The device name must then be assigned to the SINAMICS drive. For this purpose mark the PROFINET IO system. Open the window for the name assignment with "PLC > Ethernet > Assign Device Name". 

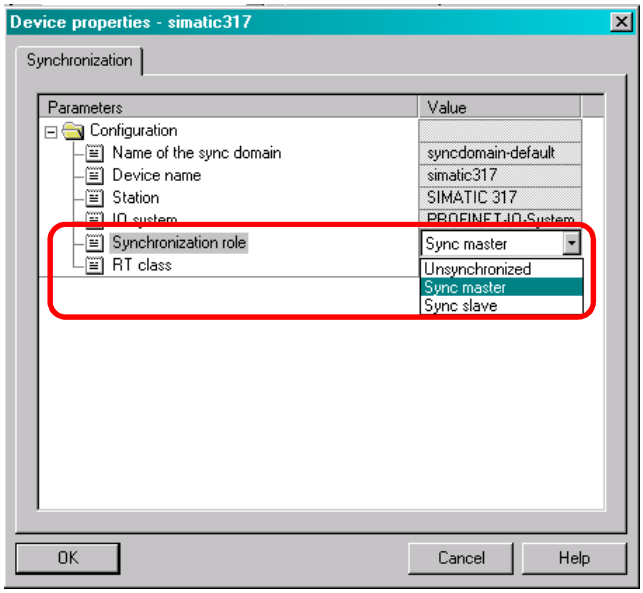
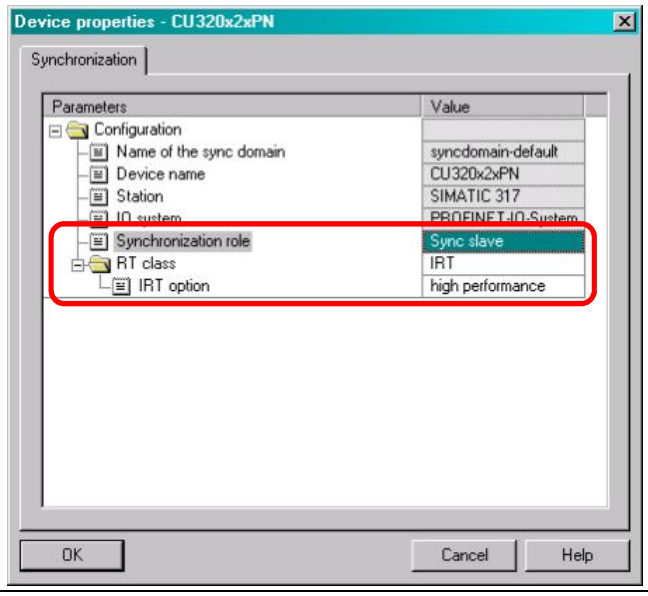
No.	Action
5.	Mark the SINAMICS drive and click the "Assign name" button to assign the name ("CU320x2xPN") configured in the HW Config. 

4.3 Configuration of the isochronous communication

To communicate isochronously, PROFINET IRT must be enabled. To do this, the PN interfaces must be synchronized and the PROFINET topology configured.

Table 4-3

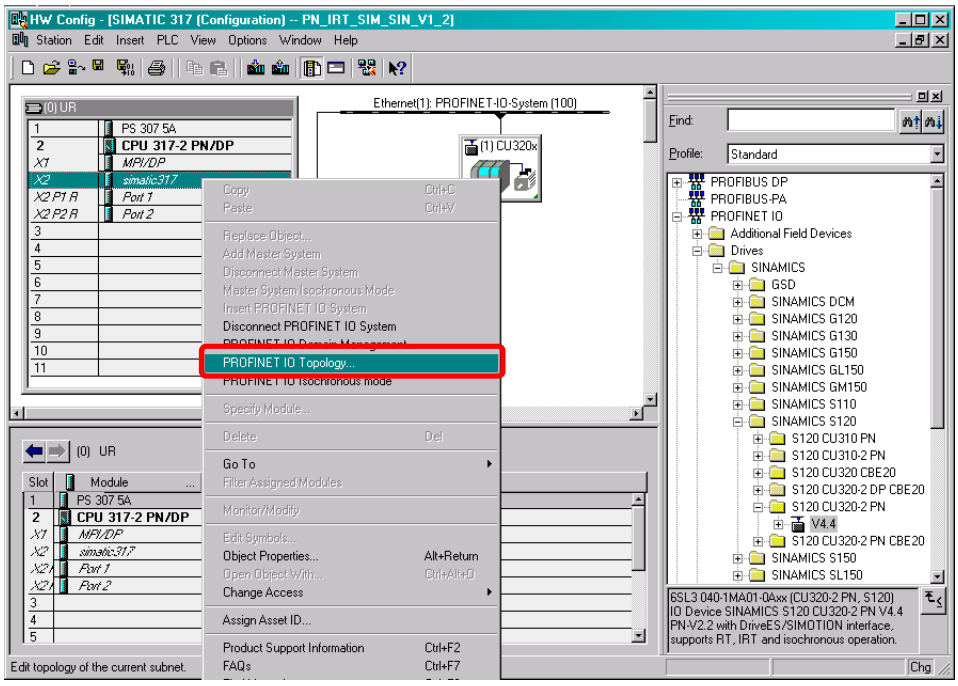
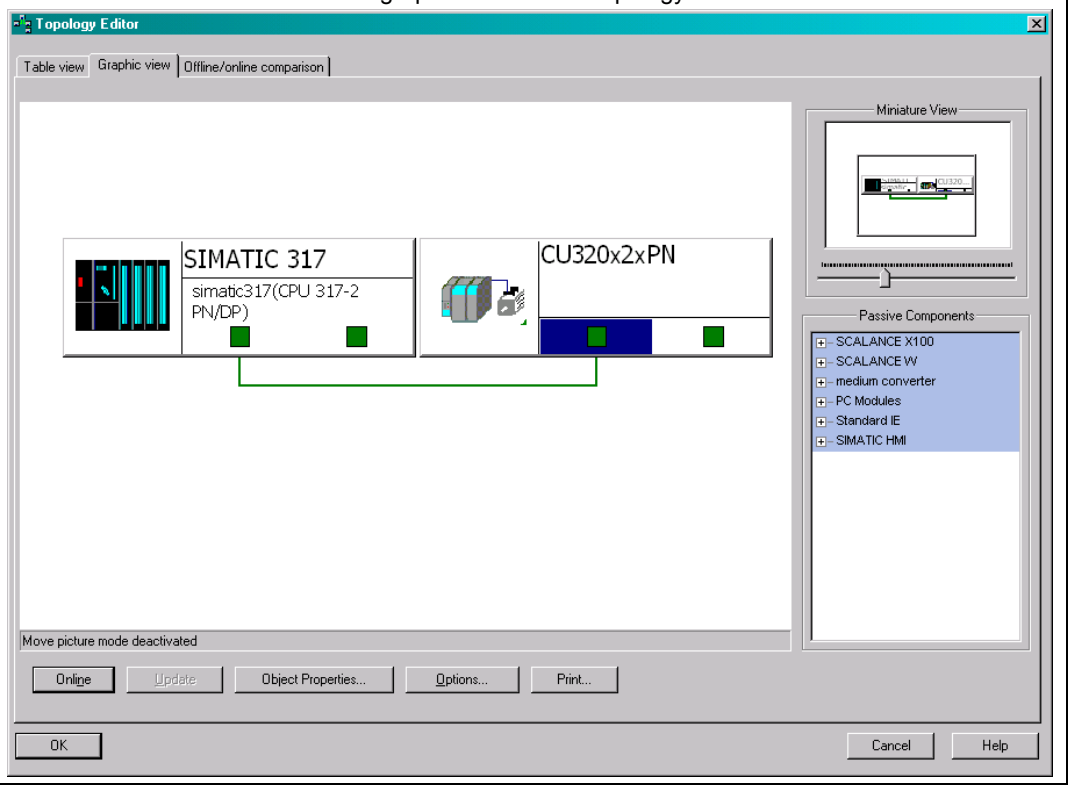
No.	Action
1.	Open the "PROFINET IO Domain Management" in the context menu of the PROFINET interface of the SIMATIC CPU. 
2.	Mark the SIMATIC CPU respectively the SINAMICS drive and open their properties. 

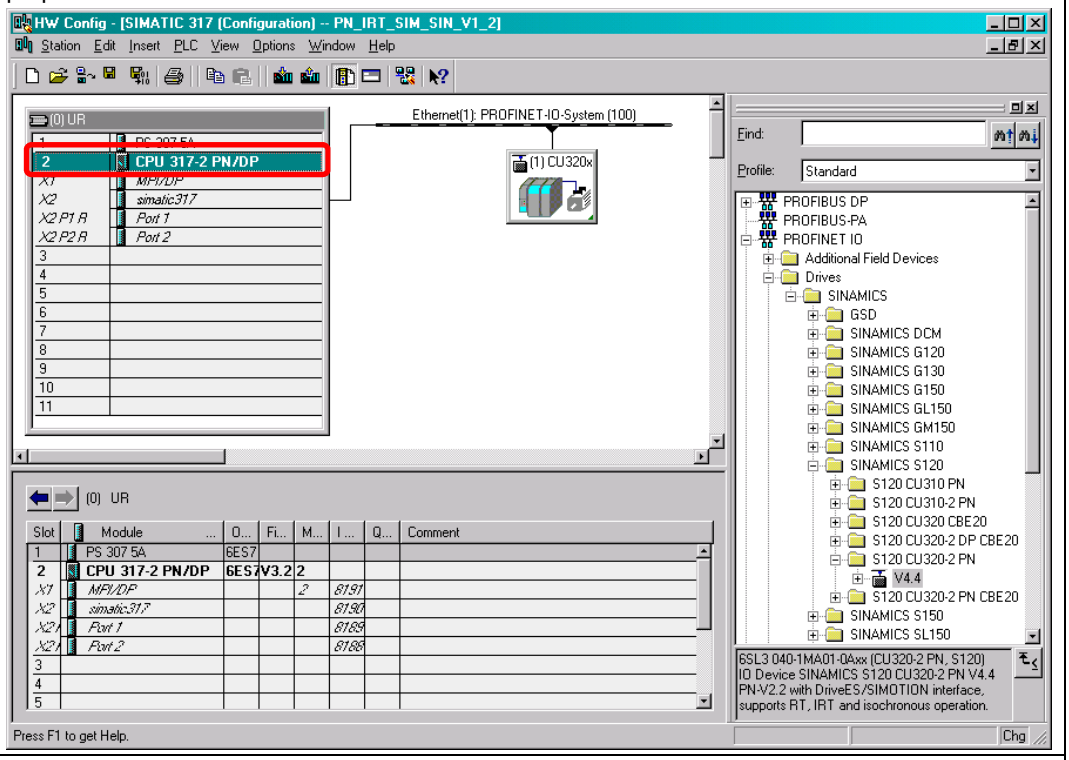
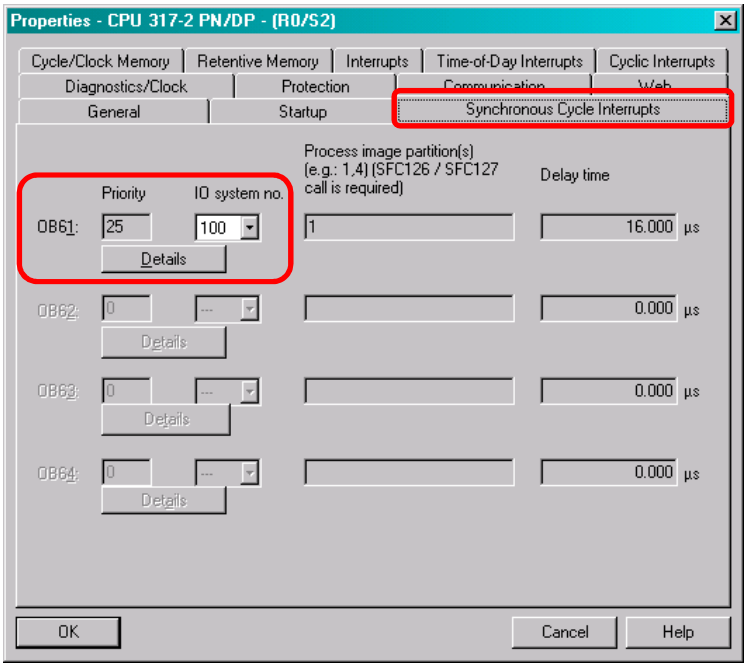
No.	Action
3.	Set the "Sync master" option as synchronization role for the SIMATIC CPU. Only one Sync-master is permitted in each PROFINET network. 
4.	The SINAMICS drive is parameterized as "Sync slave". A sync slave synchronizes itself to the associated Sync-master in the PROFINET network. Ensure that "high performance" is selected for the IRT options. 

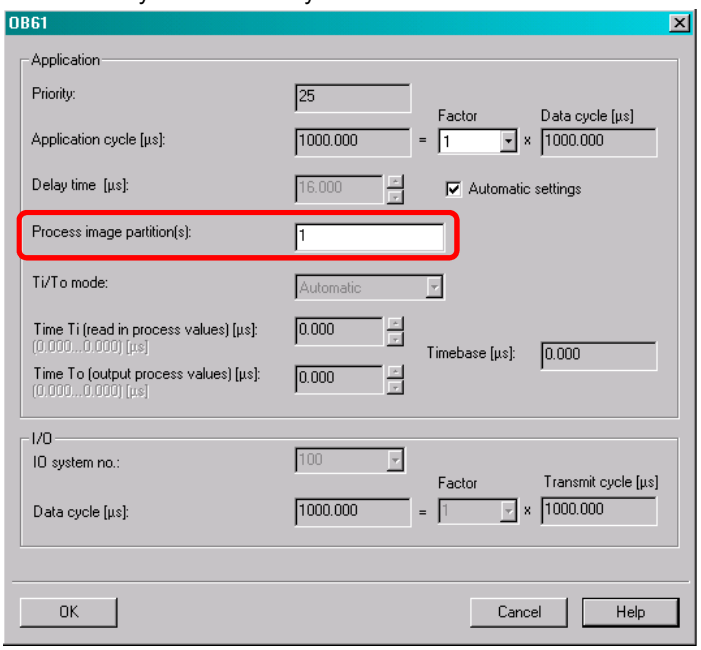
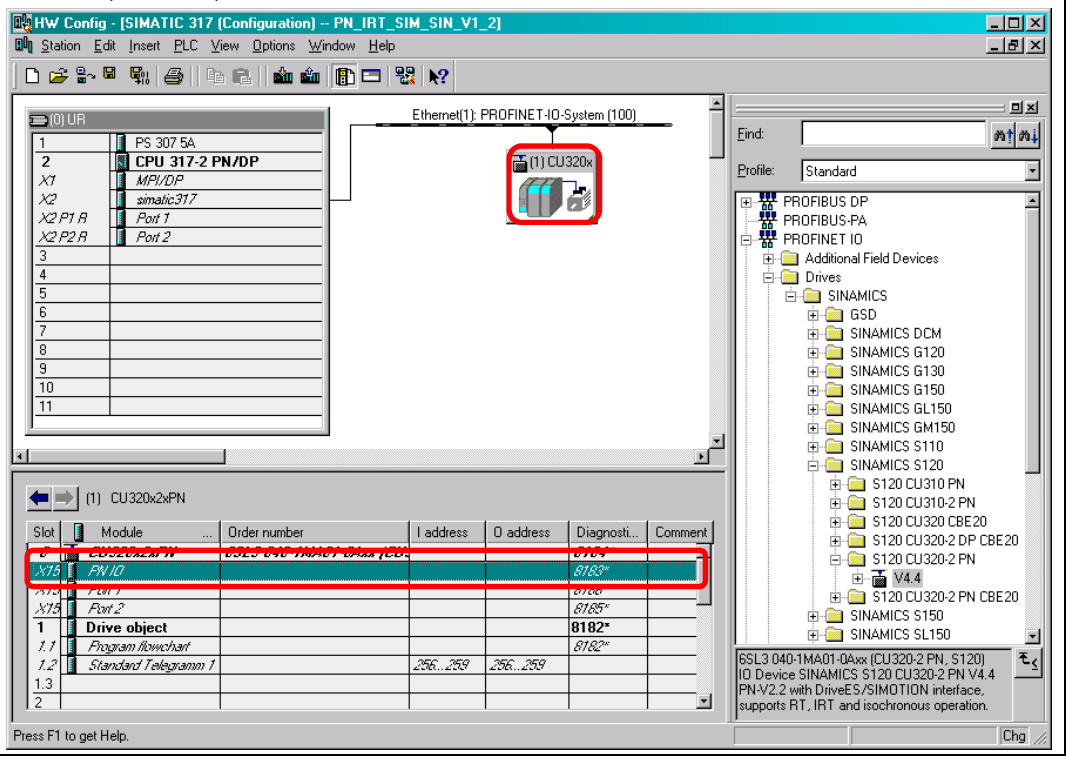
Note

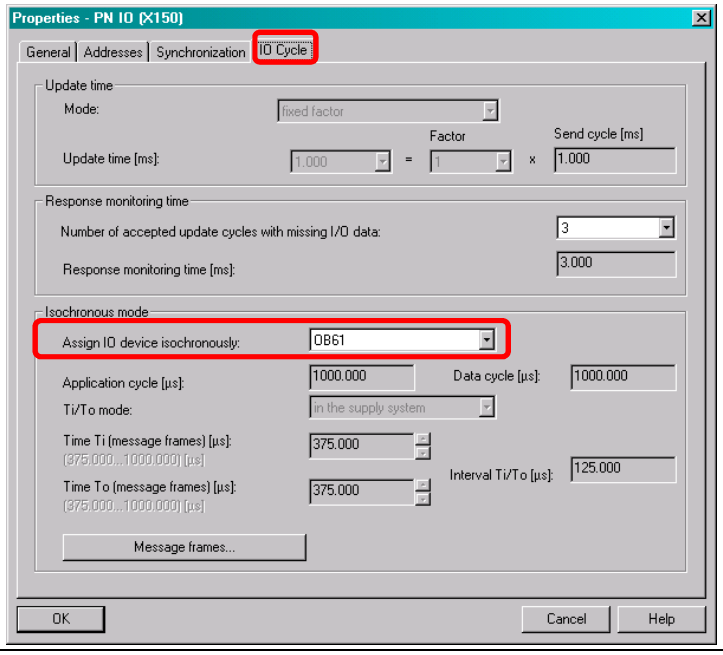
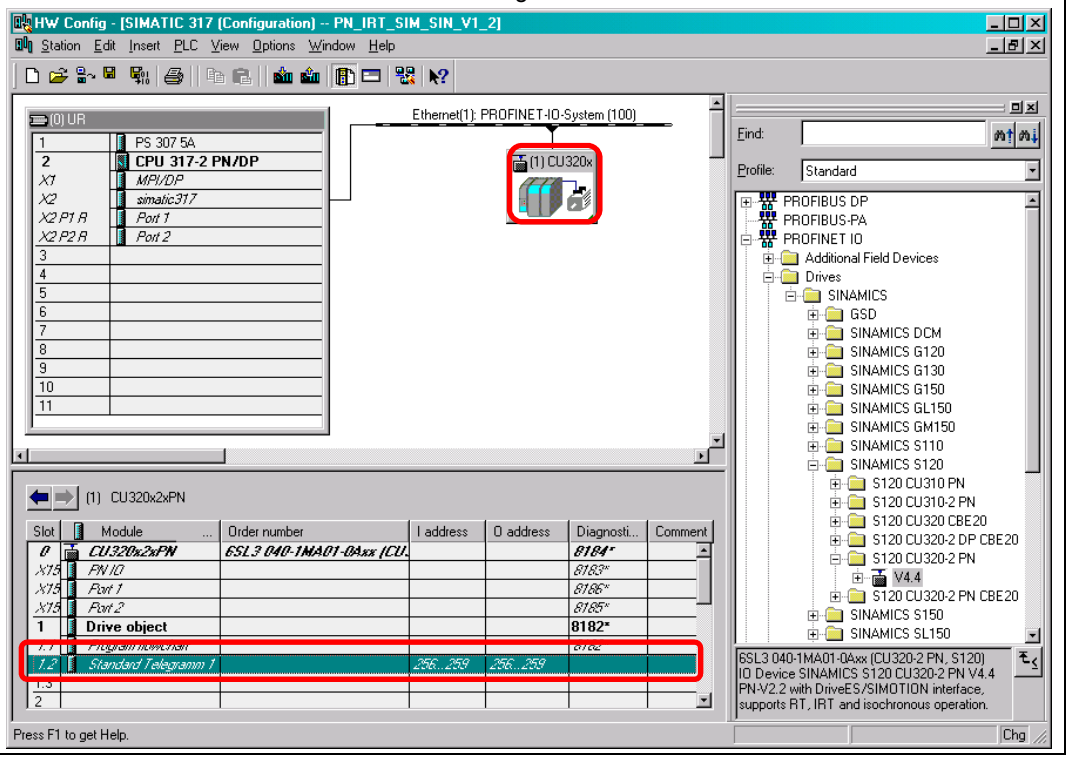
IRT "high flexibility" cannot be used for isochronous applications.
Further information can be found at the following link:

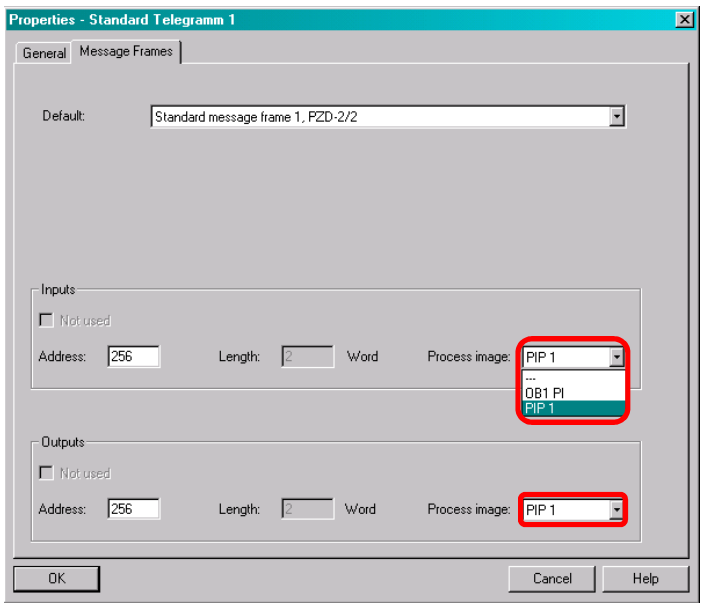
Function manual SINAMICS S120 (chapter 10.3.3)

No.	Action
5.	The topology must be configured for PROFINET IRT. Open the "PROFINET IO Topology" in the context menu of the PROFINET interface of the SIMATIC CPU. 
6.	In the example project, port 1 of the SIMATIC CPU is connected with port 1 of the SINAMICS drive. Create the connection in the graphic view of the Topology Editor. 

No.	Action
7.	To operate the PROFINET network and the associated stations isochronously, they must be assigned to the isochronous OB61 execution level. For this purpose open the SIMATIC CPU properties. 
8.	Switch to the "`Synchronous Cycle Interrupts`" tab. Select in the OB61 settings the number of the PROFINET IO system that shall be operated isochronously (here: "`100`", see previous figure). 

No.	Action
9.	Select in the detailed properties, the process image partitions the OB61 shall have access to (here: "PIP 1"). The inputs/outputs assigned to the process image are then refreshed isochronously with the bus cycle. 
10.	To operate the SINAMICS drive isochronously, mark it and open the properties of the PROFINET interface ("PN IO"). 

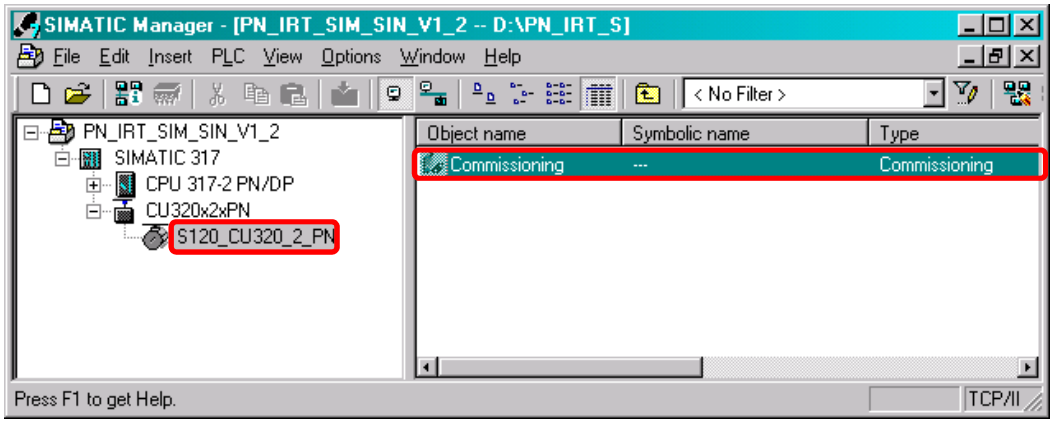
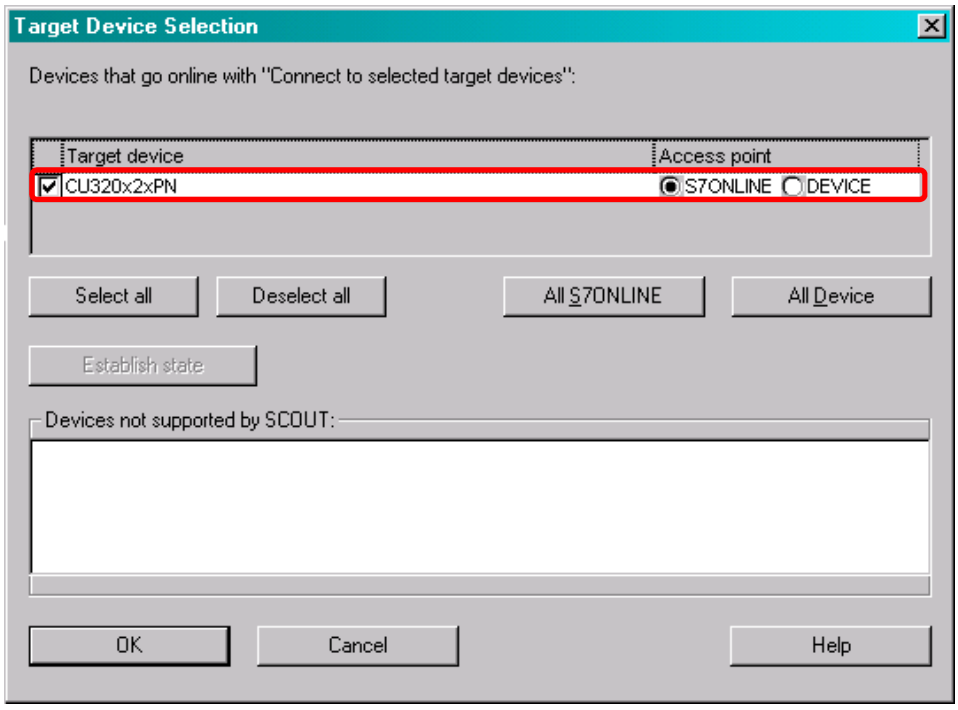
No.	Action
11.	Switch to the "IO cycle" tab and select the OB61 as isochronous execution level for the SINAMICS drive. 
12.	Open the properties window of "Standard Telegram 1" that is created by default for the addition of the SINAMCIS drive to the HW Config. 

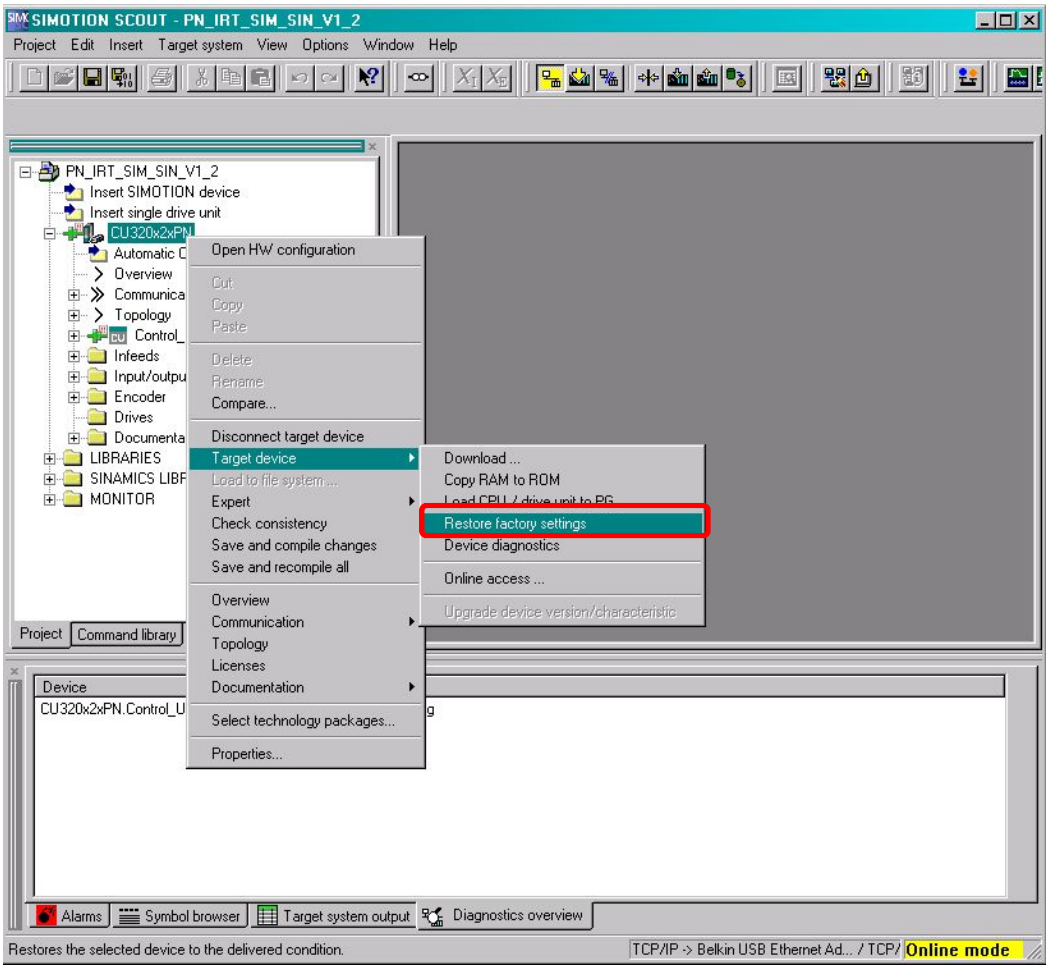
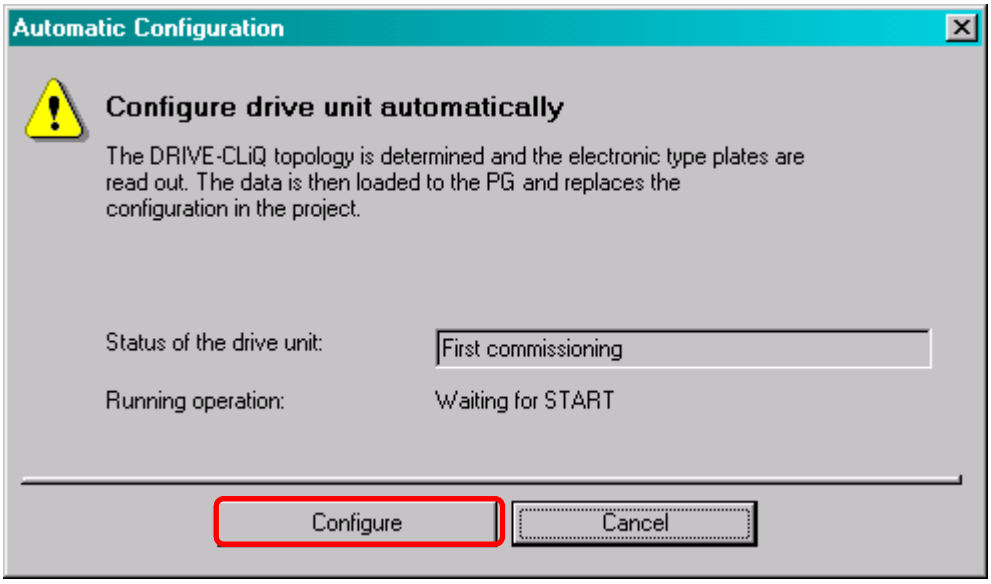
No.	Action
13.	Assign the input/output addresses of the message frame to the process image partition 1 ("PIP 1") in order to save and compile the HW Config. 
14.	Save and compile the HW Config. 
15.	Download the HW Config to the SIMATIC CPU. 

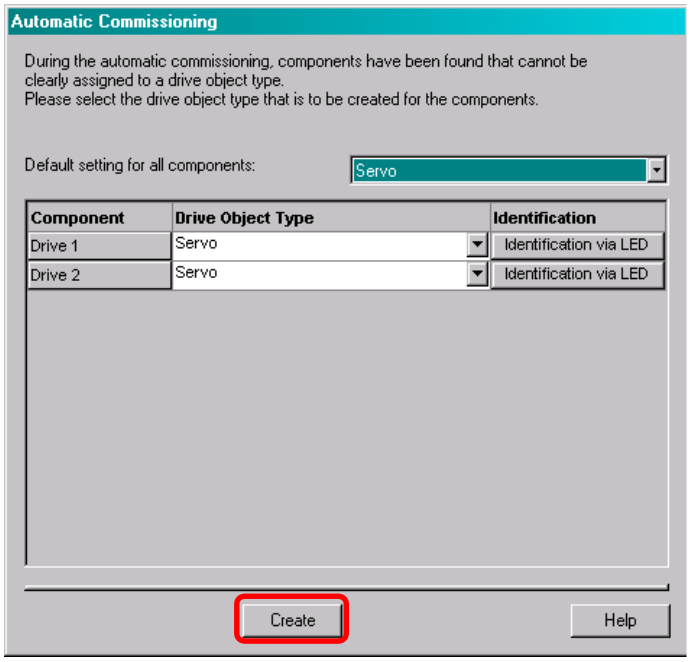
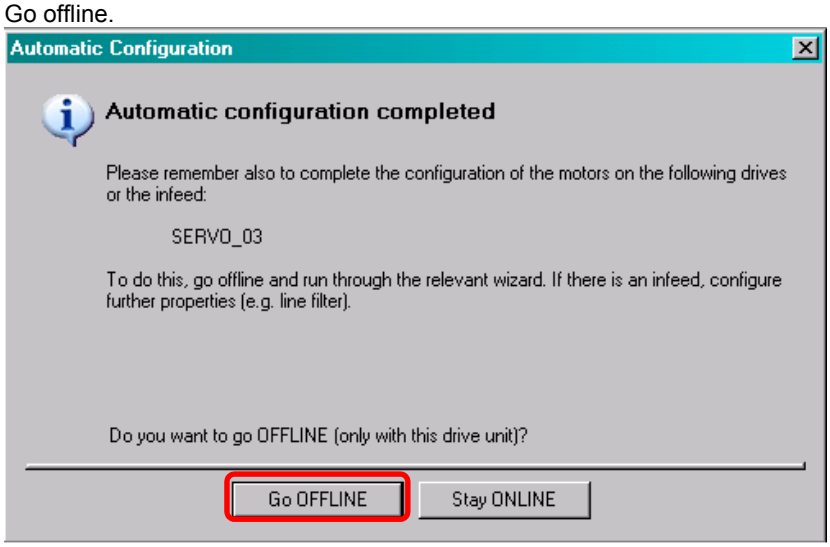
4.4 Configuration of the SINAMICS drive

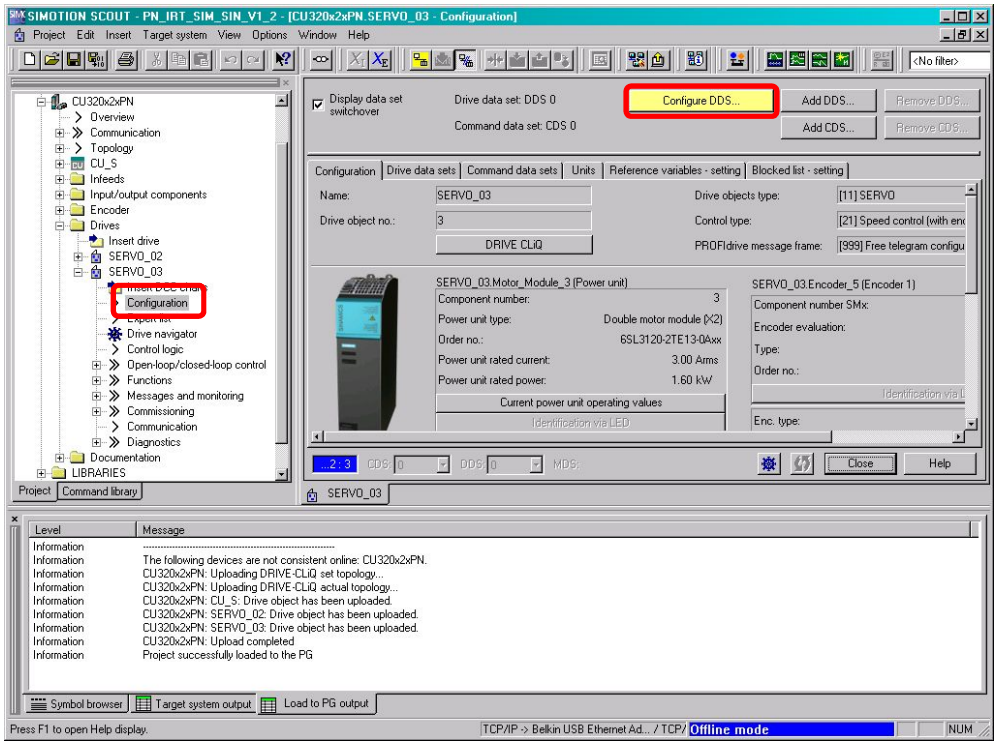
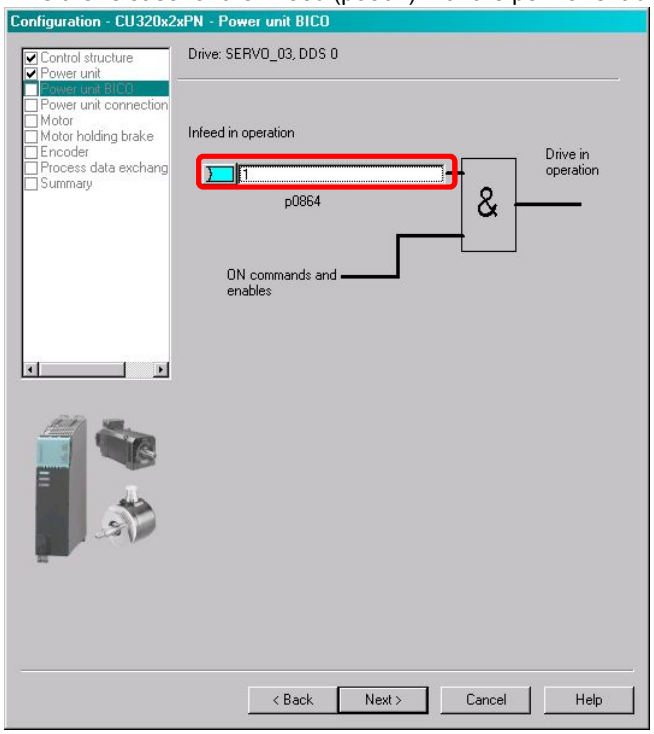
The standard configuration of the SINAMICS drive with the SIMOTION SCOUT engineering system is shown below.

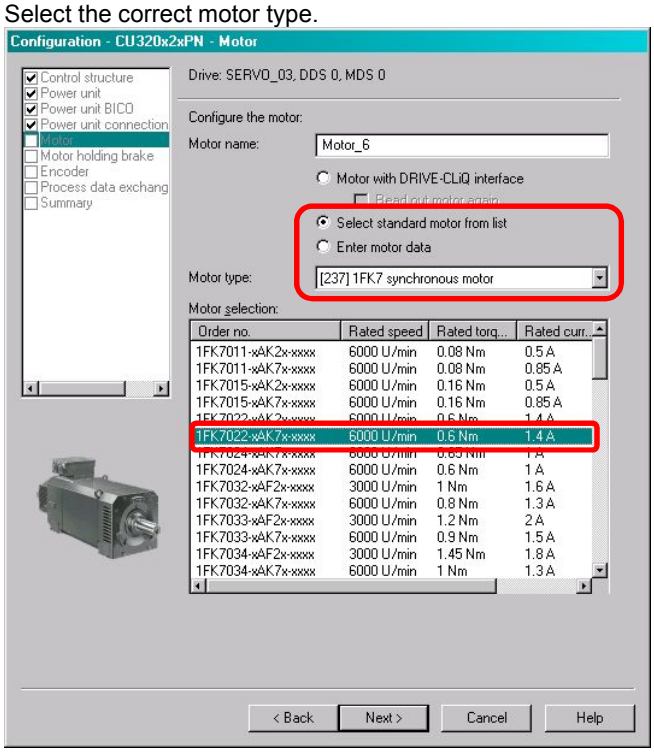
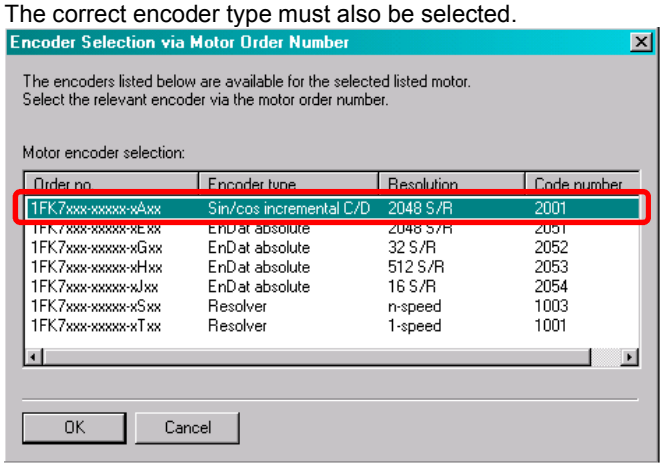
Table 4-4

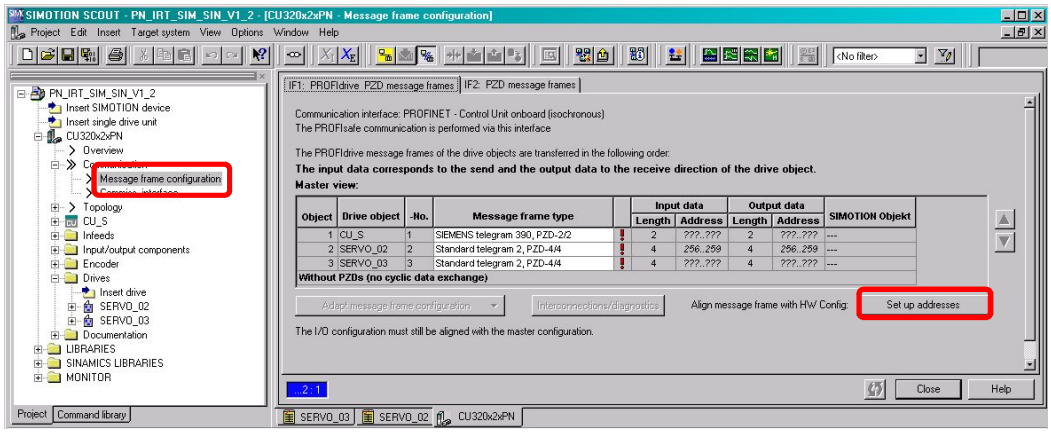
No.	Action
1.	Open the current project in the SIMOTION SCOUT engineering system from the SIMATIC Manager. 
2.	Go online. 
3.	Select the SINAMICS drive in order to establish an online connection. 

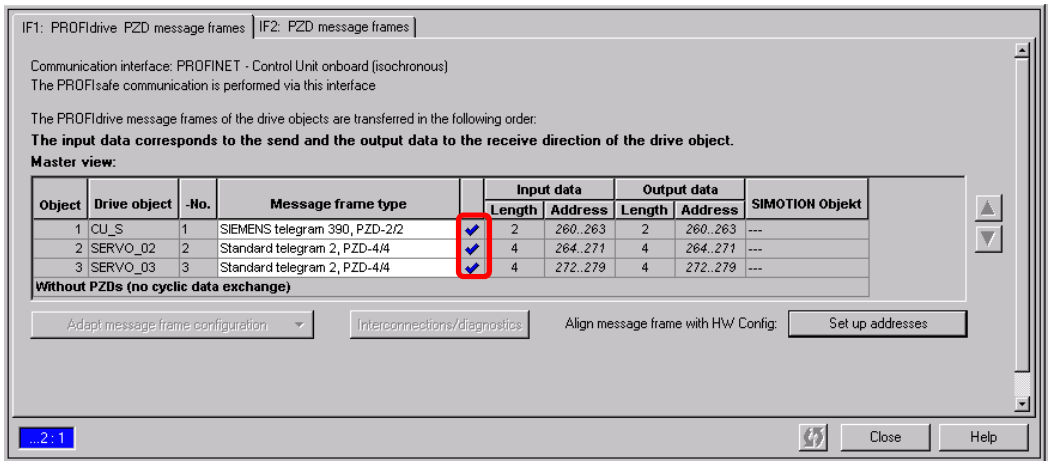
No.	Action
4.	Restore the factory setting on the SINAMICS drive. 
5.	Perform the automatic configuration of the drive. 

No.	Action
6.	The two motors at the SIMOTION training case are created as servo motors. 
7.	After the automatic configuration, the blue drive ("SERVO_03") must be reconfigured at the SIMOTION training case, because this drive does not have any DRIVE-CLiQ interface. a) Go offline. 

No.	Action
8.	b) Open the configuration of the "SERVO_03" drive. For the configuration of the SIMOTION training case, all windows not shown can be bypassed.  c) Wire the release for the infeed (p0864) with the permanent binector "1". 

No.	Action
9.	d) Select the correct motor type.  e) The correct encoder type must also be selected.  f) Close the configuration and save the settings.  g) Go online.  h) Download to the SINAMICS drive.  i) Copy RAM to ROM. 

<table>
<tr><th>No.</th><th>Action</th></tr>
<tr><td>10.</td><td>The following parameters of both drives (“SERVO_02” + “SERVO_03”) must be checked after the automatic configuration. For this purpose open the expert list.
<table>
<tr><th>Parameter</th><th>Description</th><th>Value</th></tr>
<tr><td>p0340</td><td>Automatic calculation</td><td>0</td></tr>
<tr><td>p0210</td><td>Supply voltage</td><td>345 V</td></tr>
<tr><td>p0864</td><td>Infeed in operation</td><td>1</td></tr>
<tr><td>p1244[0]</td><td>Upper voltage limit for the DC link</td><td>401 V</td></tr>
<tr><td>p1248[0]</td><td>Lower voltage limit for the DC link</td><td>240 V</td></tr>
<tr><td>p1460[0]</td><td>P-component for the speed controller (in the sample project)</td><td>0.01 Nms/rad</td></tr>
<tr><td>p1462[0]</td><td>Integrator time for the speed controller (in the sample project)</td><td>20 ms</td></tr>
</table>
These settings apply only when you are working with a SIMOTION training case!</td></tr>
<tr><td>11.</td><td>The correct message frames must be selected for the cyclic communication to the CU and to the two servo motors. Because the “Standard Telegram 1” does not support <u>any</u> IRT communication, at least “Standard Telegram 2” must be selected for “SERVO_02” and “SERVO_03”!


Then align the selection of the message frames with the hardware configuration.</td></tr>
<tr><td>12.</td><td>A blue tick after the message frames indicates the correct alignment with HW Config.

</td></tr>
</table>

No.	Action
13.	Save and compile the HW configuration.  **Note** Assign the input/output addresses of the new added message frames also to the process image partition 1 (“PIP 1”) in order to save and compile the HW Config (see page 29).
14.	Go online. 
15.	Download to the SINAMICS drive. 
16.	Copy RAM to ROM. 

Note Further information about the configuration of the SINAMICS training case can be obtained from the following article:

http://support.automation.siemens.com/WW/view/en/27038754

4.5 Activation of the servo motors

In the application example, the isochronous communication between a SIMATIC controller and a SINAMICS drive is implemented in the OB61 isochronous alarm. The SFC 126 and SFC 127 system functions refresh isochronously the process image partitions of the inputs and outputs. The OB61 contains the user program, which is described below.

Table 4-5

No.	Action
1.	**Network 1**: SFC 126 Comment: CALL "SYNC_PI" SFC126 PART :=B#16#1 RET_VAL:="RetVal_SFC126" MW100 FLADDR :="FlAddr_SFC126" MW102 The SFC 126 system function is called once in each communication cycle when the OB61 starts. The "PART" input parameter must specify which part of the process image of the inputs shall be refreshed isochronously (here: "PIP 1").
2.	**Network 2**: User Programm (speed calculation + move drives + reset failures) Comment: // speed calculation L "N_SOLL_USER" MD300 L 6.000000e+003 /R L 1.073742e+009 → corresponds to W#16#4000_0000 *R TRUNC T "N_SOLL" MD200 U "boMove" M0.0 SPBN S005 The user must specify the speed setpoint used to move the servo motors ("N_SOLL_USER"). The calculation of the speed setpoint is based on the specified definitions of the PROFIdrive profile. 6000 rpm corresponds to "W#16#4000_0000". The calculated speed is then buffered for further accesses ("N_SOLL"). The "boMove" flag is used to move or stop the servo motors with the calculated speed. **Note** The rated speed of the servo motors included in the training case is 6000 rpm. The maximum speed is 10000 rpm.

No.	Action
3.	

```
//blue motor
      L     W#16#47E                    2#0000_0100_0111_1110
      T     MW     1

      L     "N_SOLL"                    MD200
      T     "N_SOLL_Blue_Drive"         AD274

      L     "ZSW1_Blue_Drive"           EW272
      L     W#16#211                    2#0000_0010_0001_0001
      UW
      L     W#16#211
      ==I
      SPBN  S002

      L     W#16#47F                    2#0000_0100_0111_1111
      T     MW     1

S002: L     MW     1
      T     "STW1_Blue_Drive"           AW272


//red motor
      L     W#16#47E
      T     MW     4

      L     "N_SOLL"                    MD200
      T     "N_SOLL_Red_Drive"          AD266

      L     "ZSW1_Red_Drive"            EW264
      L     W#16#211
      UW
      L     W#16#211
      ==I

      SPBN  S003

      L     W#16#47F
      T     MW     4

S003: L     MW     4
      T     "STW1_Red_Drive"            AW264

      SPA   S006
```

If the "boMove" flag is controlled with the value "1", the required releases are set (**W#16#47E**) for the two servo motors in control word 1 ("STW1") in order to move them.

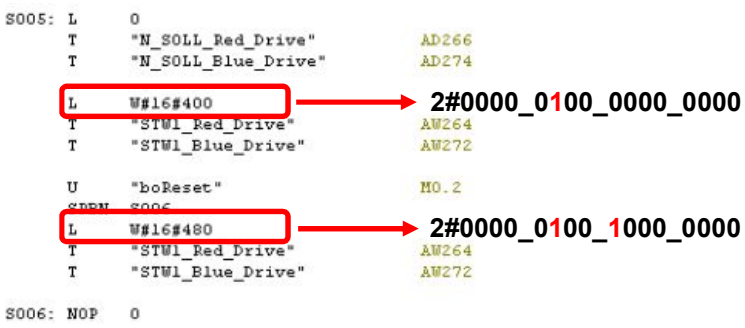
To ensure that the motors can be moved only when all required releases are actually present, their status word 1 ("ZSW1") is compared with a constant word that provides the required releases (**W#16#211**).

Only when the associated status word 1 ("ZSW1") matches with this value, the bit that activates the servo motors (**W#16#47F**) is set in control word 1 ("STW1"). The servo motors are then moved with the speed setpoint specified by the user.

Note

The structure of the particular (standard) message frame (i.e. STW, ZSW, NSOLL_B, etc.) is defined in the PROFIdrive profile. You can find further information using the following link:

List manual SINAMICS S120 / S150 (chapter 2.9)

No.	Action
4.	 The speed setpoints of both servo motors are initialized with 0 rpm while the "boMove" flag is not controlled to the value "1". Only the bit 10 ("Control by PLC") (**W#16#400**) is set in the particular control word 1 ("STW1"). For upcoming errors, the "boReset" flag can be controlled to the value "1". This leads to bit 7 ("Acknowledge faults") is set in control word 1 ("STW1") of the two servo motors that acknowledges the errors (**W#16#480**). Therefor the „boMove" flag must be „0"!

5.	**Network 3**: sign of life
	Comment:
	//life sign counter
	L 15
	L MB 40
	<=I
	SPBN x001
	L 0
	x001: INC 1
	T MB 40
	//red motor
	L "STW2_Red_Drive" AW270
	UW W#16#FFF
	L MB 40
	SLW 12
	OW
	T "STW2_Red_Drive" AW270
	//blue motor
	L "STW2_Blue_Drive" AW278
	UW W#16#FFF
	L MB 40
	SLW 12
	OW
	T "STW2_Blue_Drive" AW278
	NOP 0
	If a SIMATIC CPU is used as IRT IO controller, unlike a SIMOTION controller, the sign-of-life must be formed by the application in order to detect a breakdown of the IO controller or an IO device.
	A flag byte (here: "MB40") will be incremented by 1 until the condition "MB 40 >= 15" is satisfied. The flag byte is then reset to "0" although it will be incremented by "1" in the same cycle. This is important, because the flag byte is not permitted to begin with "0". Otherwise the associated servo motor would not receive any sign-of-life from the controller for the length of one cycle.
	After each increment, the bits of the "MB40" flag byte are written to bits 12-15 of control word 2 ("STW2") of the particular servo motor.
	The controller now continually sends its sign-of-life to the two servo motors.
	They are generating their own sign-of-life and return it to the controller.

No.	Action
6.	Network 4 : SFC 127 Comment: CALL "SYNC_PO" SFC127 PART :=B#16#1 RET_VAL:="RetVal_SFC127" MW106 FLADDR :="FlAddr_SFC127" MW108 The SFC 127 system function is called once in each communication cycle when the OB61 ends. The "PART" input parameter must specify which part of the process image of the outputs shall be refreshed isochronously (here: "PIP 1").

NOTE

The following addresses are used in the example project for controlling the SINAMICS drive:

SERVO_02

- EW 264 → Status word 1 ("ZSW1")
- AW 264 → Control word 1 ("STW1")
- AD 266 → Speed setpoint ("NSOLL_B")
- AW 270 → Control word 2 ("STW2")

SERVO_03

- EW 272 → Status word 1 ("ZSW1")
- AW 272 → Control word 1 ("STW1")
- AD 274 → Speed setpoint ("NSOLL_B")
- AW 278 → Control word 2 ("STW2")

Slot	Module ...	Order number	I address	Q address	Diagnostics address
0	CU320x2xPN	6SL3 040-1MA01-0Axx (CU...			8184*
X15	PN IO				8183*
X15	Port 1				8186*
X15	Port 2				8185*
1	CU_S				8181*
1.1	Program flowchart				8181*
1.2	SIEMENS Telegramm 3		260...263	260...263	
1.3					
2	SERVO_02				8182*
2.1	Program flowchart				8182*
2.2	Standard Telegramm 2		264...271	264...271	
2.3					
3	SERVO_03				8180*
3.1	Program flowchart				8180*
3.2	Standard Telegramm 2		272...279	272...279	
3.3					

4.6 F-CPU: clock-synchronized mode and safety mode

When using a F-CPU only under certain conditions it can be clock-synchronized (standard program in OB6x) and execute a safety program ("F-CALL") at the same time.

It is absolutely necessary to avoid the updating of the process image partition while the safety program is executed!

NOTE If the process image partition is not updated in each OB6x cycle, the S7 application (standard program in OB6x) is not really clock-synchronized!

Table 4-6

Nr.	Aktion

1.	Before the safety program is called ("F-CALL", here "FC1") an auxiliary flag (e.g. "M10.0") is set, as long as the safety program is executed.
	
	Program of OB3x:
	
	`SET;`
	`= M10.0;`
	
	`//call safety program`
	`CALL FC1;`
	
	`CLR;`
	`= M10.0;`

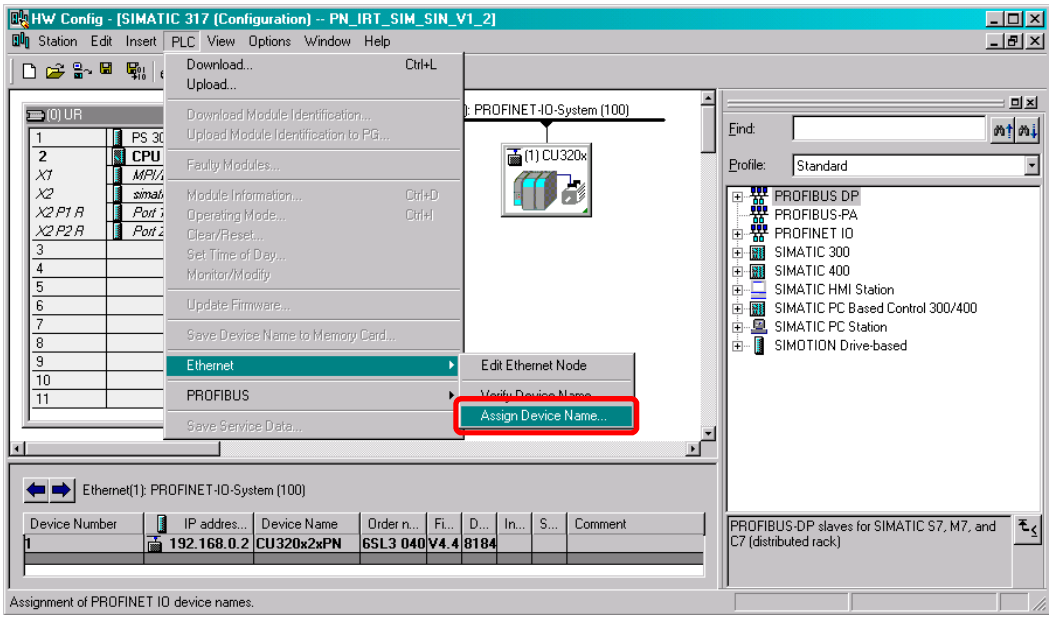
2.	In the clock-synchronized standard program (OB6x) the auxiliary flag (e.g. "M10.0") is the condition to jump to the end of OB6x. It means the update of the process image partition (SFC 126/127) is only done if the safety program is not executed.
	
	Program of OB6x:
	
	`SET;`
	`U M10.0;`
	`SPB end;`
	
	`CALL "SYNC_PI"(      //SFC126`
	`  PART    := B#16#1,`
	`  RET_VAL := MW20,`
	`  FLADDR  := MW22);`
	
	`//here is the user program`
	
	`CALL "SYNC_PO"(      //SFC127`
	`  PART    := B#16#1,`
	`  RET_VAL := MW24,`
	`  FLADDR  := MW26);`
	
	`end: NOP 0;`
	`BEA;`

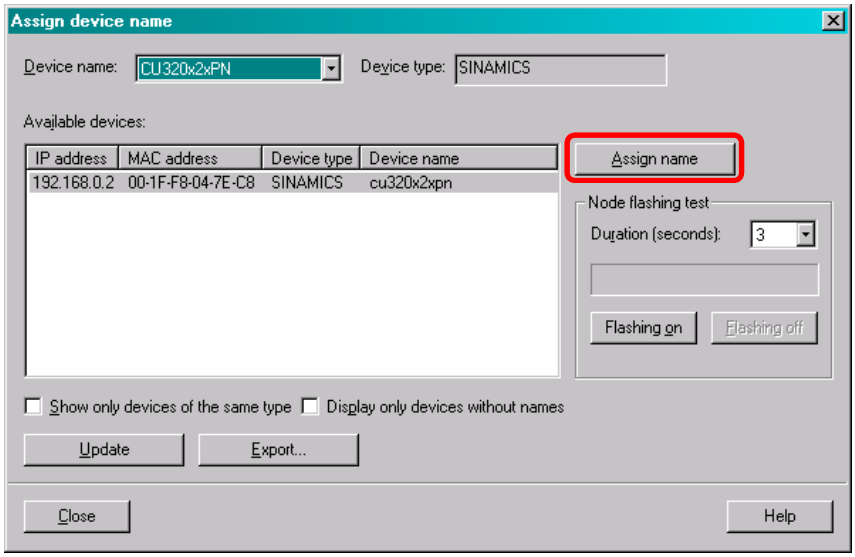
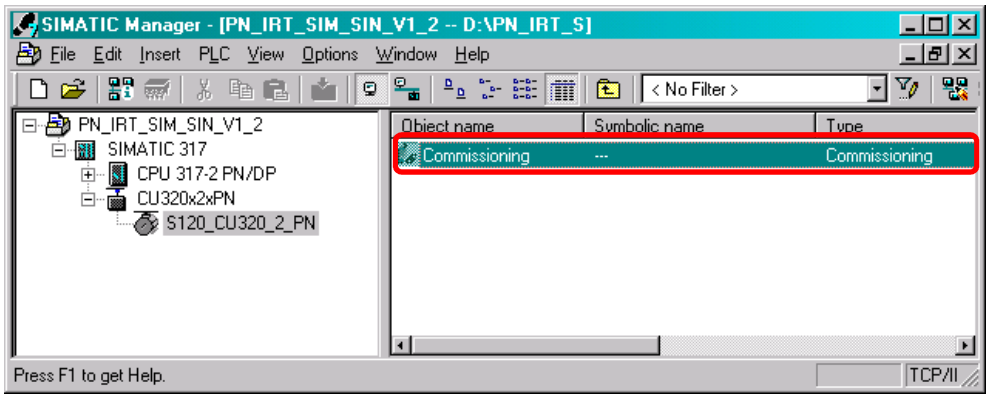
5 Commissioning the sample project

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

5.1 Commissioning

Table 5-1

No.	Action
1.	All hardware components specified in Table 2-1 (page 7) are present and have been upgraded to the required firmware version.
2.	All PROFINET components are interconnected and accessible from the engineering system.
3.	The Ethernet interface of the engineering system is configured correctly. IP address: `192.168. 0 .100` Subnet mask: `255.255.255.0`
4.	Start the STEP 7 SIMATIC Manager engineering system.
5.	Unzip the sample project "`53477498_PN_IRT_SIMATIC_SINAMICS_V1_2.zip`".
6.	Open the HW Config of the SIMATIC CPU.
7.	Download the SIMATIC CPU configuration to the particular controller.
8.	Perform the node initiation afterwards.  Mark the PROFINET network and open the "`Assign Device Name`" window.

No.	Action
9.	You can select the configured device names and assign them to the particular device (IO device).  **Note** Only IO devices are listed here. The IO controllers receive the device name when the HW Config is downloaded.
10.	As an alternative, the Primary Setup Tool (PST) can also be used to perform the node initiation. The PST can be downloaded from the following link. http://support.automation.siemens.com/WW/view/en/19440762
11.	Start the SIMOTION SCOUT engineering system from the project in the SIMATIC Manager. 
12.	Go online. 
13.	Download the configuration of the SINAMICS drive to the particular device. 
14.	Copy RAM to ROM. 
15.	The sample project is now ready for operation.

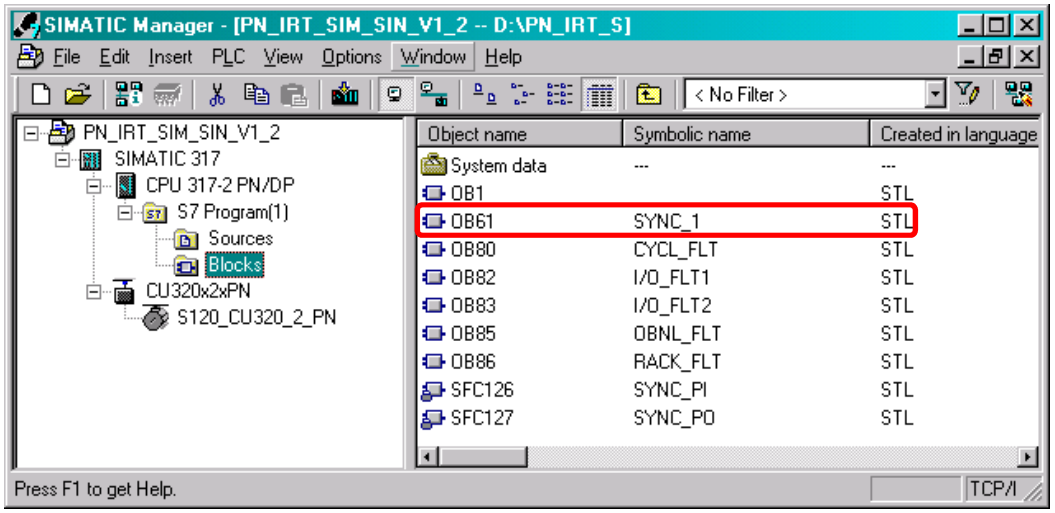
6 Operating the sample project

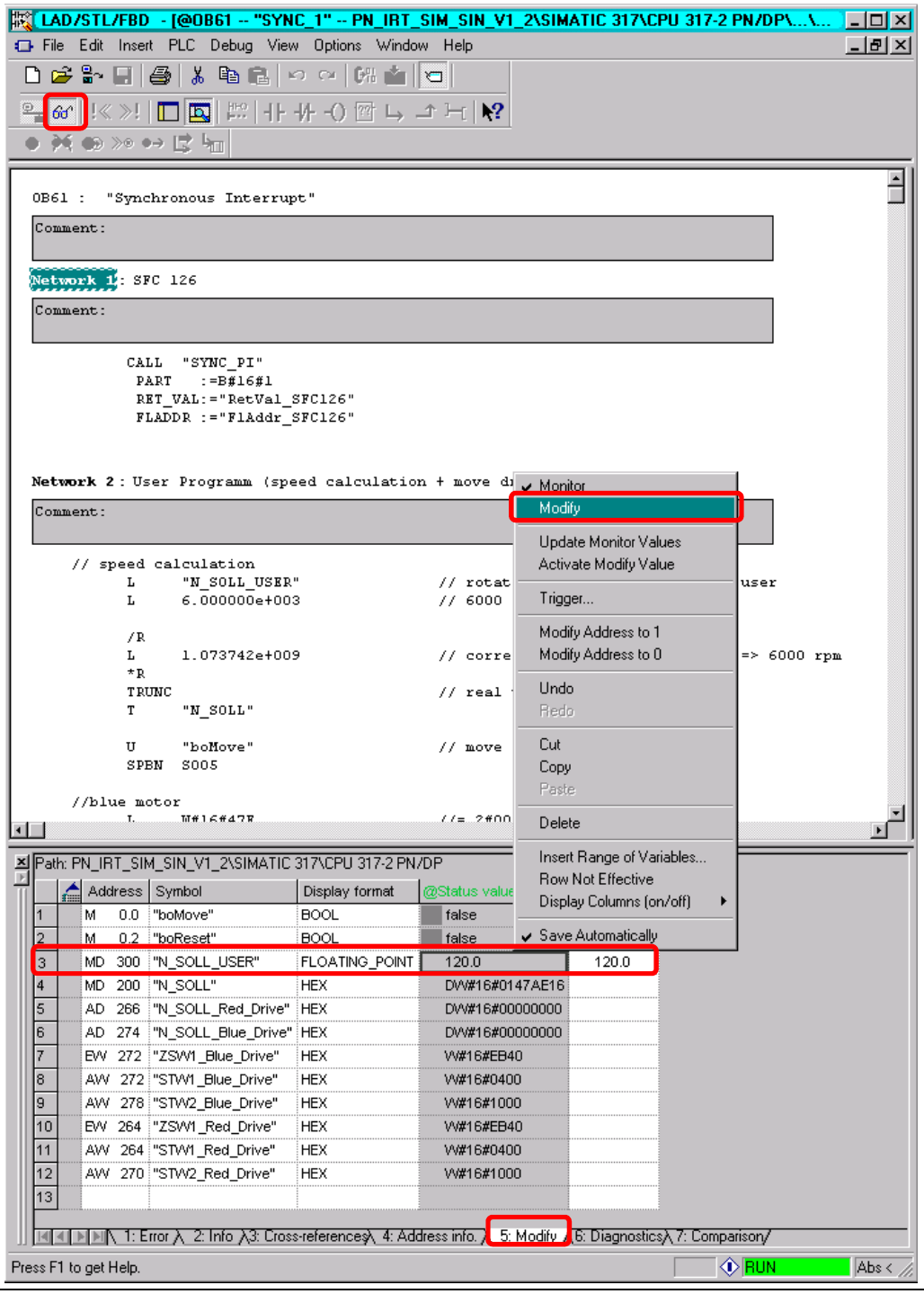
6.1 Overview

The sample project is operated from the SIMATIC Manager by modifying the flags that specify the speed setpoint.

6.2 Distributed SINAMICS drive

Table 6-1

No.	Action
1.	Open the OB61 in the SIMATIC CPU. 

No.	Action
2.	Select the "Modify" tab in the details window and go online. First specify the required speed setpoint in the MD300 doubleword flag ("N_SOLL_USER") (unit: rpm). You can then move both servo motors by controlling the M0.0 flag ("boMove") to the value "1" respectively "TRUE". Both servo motors are now turning with the specified speed setpoint. 

No.	Action
3.	In network 1, calling the SFC 126 system function isochronously refreshes the process image partition of the inputs specified in the "PART" input parameter.
4.	In network 2, the speed setpoint "N_SOLL_USER" specified by the user is converted in accordance with the definitions of the PROFIdrive profile and allowed for both servo motors. The required releases are also set in order to move the servo motors. **Note** The speed setpoint can also be changed while both servo motors are in operation, i.e. the M0.0 flag ("boMove") is set.
5.	By setting the M0.2 flag ("boReset") upcoming errors at the servo motors can be acknowledged. **Note** Upcoming errors can be acknowledged only when no servo motor is in operation, i.e. the M0.0 flag ("boMove") must not be set! In addition, the M0.2 flag ("boReset") is not reset automatically to the value "0" respectively "FALSE". This must be done manually after the acknowledgement of the errors!
6.	In network 3, the application forms the sign-of-life for the SIMATIC CPU and sends it to both servo motors. They are generating their own sign-of-life and return it to the CPU.
7.	In network 4, the call of the SFC 127 system function isochronously refreshes the process image partition of the outputs specified in the "PART" input parameter.

7 Related literature

Table 7-1

	Topic	Title
/1/	Siemens Industry Online Support	http://support.automation.siemens.com
/2/	Download page of this entry	http://support.automation.siemens.com/WW/view/en/53477498
/3/	SINAMICS S120/S150	http://support.automation.siemens.com/WW/view/en/68041075 (List Manual 2013)

8 Contact

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9 History

Table 9-1

Version	Date	Change
1.1	03/2012	First Edition
1.2	04/2012	Revised Edition, Change to CPU 317-2 PN/DP and CU320-2 PN, Chapter 4.6: “F-CPU clock-synchronized mode and safety mode” added
V2.0	01/2014	Revised Edition, New layout, Chapter 1-3 revised