SIEMENS

SINUMERIK

SINUMERIK 840D sl
CNC Commissioning: NCK, PLC, drive

Commissioning Manual

Valid for:

SINUMERIK 840D sl/840DE sl

CNC software Version 4.5

02/2012
6FC5397-2AP40-3BA0

Legal information

Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

⚠ DANGER
indicates that death or severe personal injury **will** result if proper precautions are not taken.

⚠ WARNING
indicates that death or severe personal injury **may** result if proper precautions are not taken.

⚠ CAUTION
with a safety alert symbol, indicates that minor personal injury can result if proper precautions are not taken.

CAUTION
without a safety alert symbol, indicates that property damage can result if proper precautions are not taken.

NOTICE
indicates that an unintended result or situation can occur if the relevant information is not taken into account.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

Proper use of Siemens products

Note the following:

⚠ WARNING
Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed.

Trademarks

All names identified by ® are registered trademarks of Siemens AG. The remaining trademarks in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owner.

Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

Preface

SINUMERIK documentation

The SINUMERIK documentation is organized in the following categories:

- General documentation
- User documentation
- Manufacturer/service documentation

Additional information

You can find information on the following topics under the link (www.siemens.com/motioncontrol/docu):

- Ordering documentation/overview of documentation
- Additional links to download documents
- Using documentation online (find and search in manuals/information)

Please send any questions about the technical documentation (e.g. suggestions for improvement, corrections) to the following address:
(mailto:docu.motioncontrol@siemens.com)

My Documentation Manager (MDM)

Under the following link you will find information to individually compile OEM-specific machine documentation based on the Siemens content: MDM (www.siemens.com/mdm)

Training

For information about the range of training courses, refer under:

- SITRAIN (www.siemens.com/sitrain) - training courses from Siemens for automation products, systems and solutions
- SinuTrain (www.siemens.com/sinutrain) - training software for SINUMERIK

FAQs

You can find Frequently Asked Questions in the Service&Support pages under Product Support (www.siemens.com/automation/service&support).

SINUMERIK

You can find information on SINUMERIK under the following link:
(www.siemens.com/sinumerik)

Target group

This documentation is intended for commissioning personnel.

The plant or system is readily assembled and wired. For the following steps, e.g. configuring the individual components, the Commissioning Manual contains all necessary information or at least references.

Benefits

The intended target group can use the Commissioning Manual to test and commission the system or the plant correctly and safely.

Utilization phase: Setup and commissioning phase

Standard version

This documentation only describes the functionality of the standard version. Extensions or changes made by the machine manufacturer are documented by the machine manufacturer.

Other functions not described in this documentation might be executable in the control. This does not, however, represent an obligation to supply such functions with a new control or when servicing.

Further, for the sake of simplicity, this documentation does not contain all detailed information about all types of the product and cannot cover every conceivable case of installation, operation or maintenance.

Technical Support

Country-specific telephone numbers for technical support are provided in the Internet under "Contact" (www.siemens.com/automation/service&support).

EC Declaration of Conformity

The EC declaration of conformity for the EMC directive can be found in the Internet (www.siemens.com/automation/service&support).

There, as search term, enter the number **15257461** or contact your local Siemens office.

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Introduction

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1.1 Commissioning manuals for SINUMERIK 840D sl

Introduction

The commissioning manuals for SINUMERIK 840D sl are divided into:

- CNC Commissioning: NCK, PLC, Drive
- Base software and operating software

Basic steps for commissioning SINUMERIK 840D sl

Commissioning a SINUMERIK 840D sl is performed in two basic steps:

1. Step 1 (described in "CNC commissioning: NCK, PLC, Drive")
   - PLC commissioning
   - Drive commissioning
   - NCK commissioning
2. Step 2 (described in "Base software and operating software")
   - Commissioning functions in NCK/PLC

Literature

The SINUMERIK Safety Integrated Function Manual describes commissioning for SINUMERIK 840D sl/SINAMICS S120 Safety Integrated.

Commissioning overview

The following figure is a schematic representation of the commissioning steps that are described in the step 1 and in step 2:
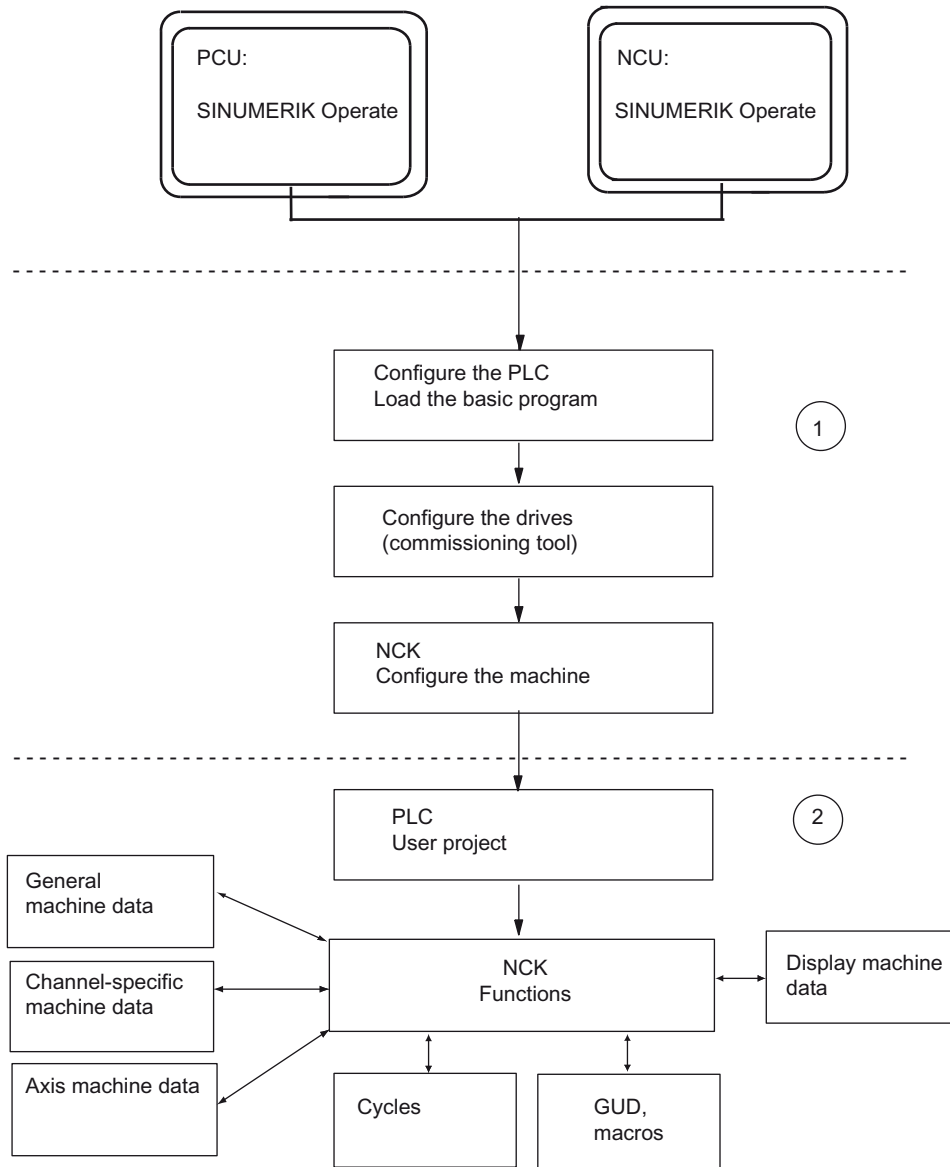
Figure 1-1   Commissioning overview

1.2 Configuration of SINUMERIK 840D sl and components and I/O

Introduction

In principle, an NCU contains the following components:

- NCK
- PLC
- Drive
- HMI
- CP

The following figure is a schematic representation of the NCU:
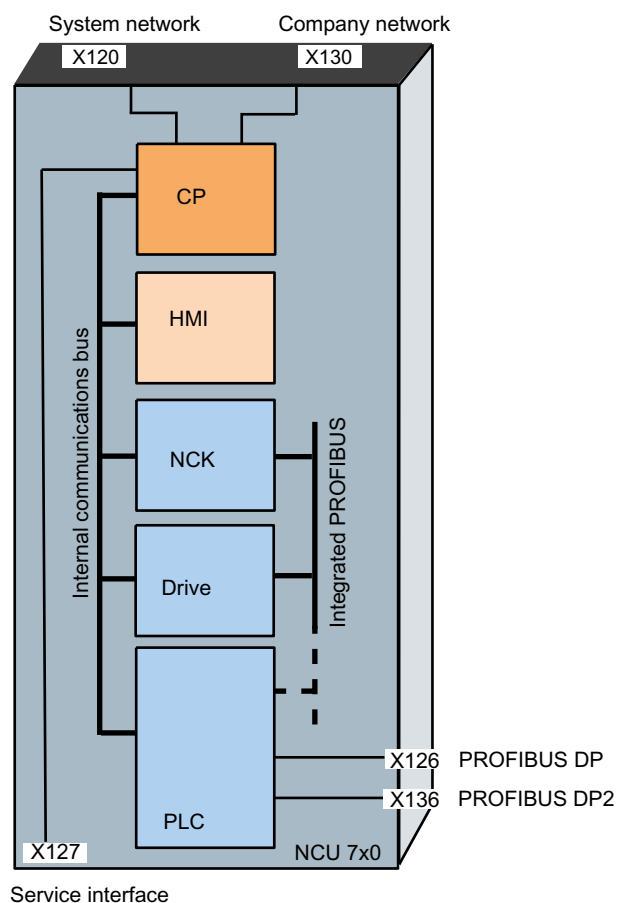
Figure 1-2   Schematic representation of NCU

Commissioning the components

The PG/PC required for commissioning is connected to the X127 service interface or access is made via the company network to X130. The following software tools are also required:

- The commissioning tool on the PG/PC is needed for commissioning the drive.

- For commissioning the PLC, a PG/PC with SIMATIC STEP7 Version 5.5 SP1 is required as well as the toolbox for SINUMERIK 840D sl for the current CNC software version.

- A network switch is required to connect several communication partners to X120.

SINUMERIK Operate on the NCU is running under the Linux operating system. In addition, a PCU can be connected to each NCU on which SINUMERIK Operate is running under Windows XP or Windows 7 with the following general conditions:

- PCU 50.3 with Windows XP
- PCU 50.5 with Windows XP or Windows 7

Note

For the operation of SINUMERIK Operate on the PCU **without** TCU, the "HMI" subsystem must be switched off for SINUMERIK Operate on the NCU.

NCU 7x0.3 PN configuration with SINAMICS S120 Booksize

The following diagram shows an example configuration of an NCU 7x0.3 PN with SINAMICS S120 Booksize:
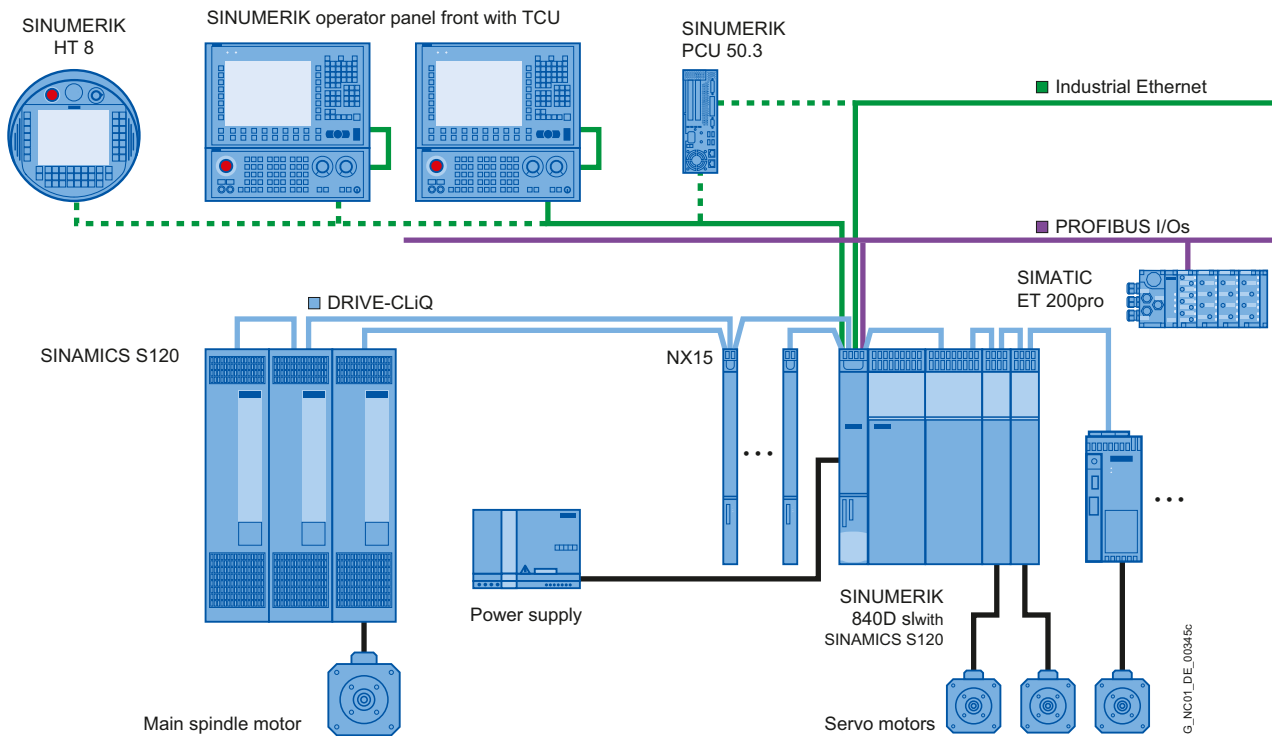
Figure 1-3   Example: SINUMERIK 840D sl configuration with SINAMICS S120 Booksize

NCU 710.3 PN configuration with SINAMICS S120 Combi

The following figure shows a typical configuration of the NCU 710.3 PN with SINAMICS S120 Combi:
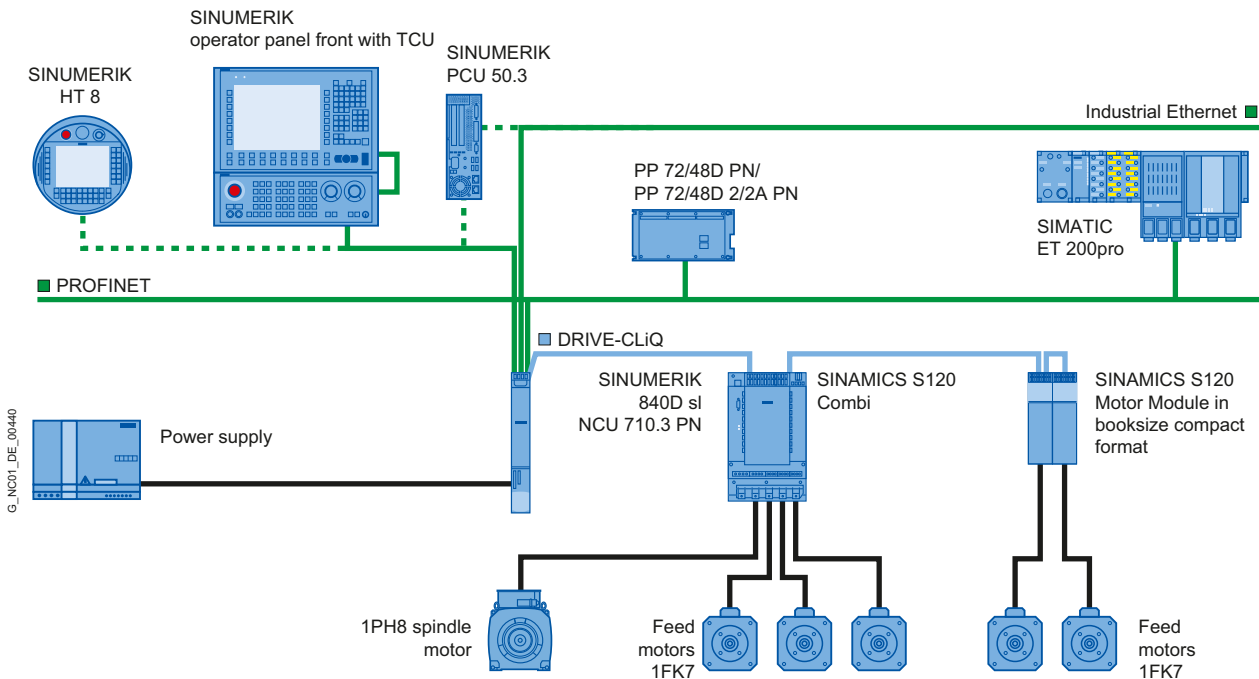
Figure 1-4   Example: SINUMERIK 840D sl configuration with SINAMICS S120 Combi

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Note

SINAMICS S120 Combi

The configuration with SINAMICS S120 Combi is permissible only on an NCU 710.3 PN.

1.3 Initial commissioning procedure

Introduction

The mechanical and electrical installation of the system must be completed.

The following is important when starting commissioning:

● The controller with its components boots error-free.

● The EMC guidelines were carefully maintained when configuring the system.

Commissioning options depending on the CNC software on the CompactFlash card

When commissioning the system for the first time, the following dependencies to the CNC software on the CompactFlash card are considered:

● CompactFlash card with the current CNC software.

● CompactFlash card without CNC software.

● CompactFlash card with older CNC software.

Commissioning steps

The commissioning steps depending on the CNC software on the CompactFlash card are listed in the following table. The order is recommended but not mandatory:

Commissioning steps	With current CNC software (first commissioning)	Without CNC software (reinstallation and initial commissioning)	With older CNC software (upgrade)	See chapter
Install the CNC software on the CompactFlash card using one of the following media: ● Bootable USB-FlashDrive ● WinSCP on PC/PG ● VNC viewer on PC/PG **Note:** Upgrade the controller: New installation/upgrading (Page 327)		1.		Automatic installation of the CNC software using USB-FlashDrive (Page 328) Installation of the CNC software using WinSCP on PC/PG (Page 332) Installation of the CNC software using VNC Viewer on PC/PG (Page 333)
Archive the NCK, PLC, HMI and drive data			1.	Saving data (Page 303)

Commissioning steps	With current CNC software (first commissioning)	Without CNC software (reinstallation and initial commissioning)	With older CNC software (upgrade)	See chapter
Upgrade the CNC software using one of the following media: • Bootable USB-FlashDrive • WinSCP on PC/PG • VNC viewer on PC/PG			2.	Automatic upgrade of the CNC software using USB-FlashDrive (Page 338) Upgrading the CNC software using WinSCP on PC/PG (Page 342) Upgrading the CNC software using VNC Viewer on PC/PG (Page 343)
Load the archived NCK, PLC, HMI and drive data			3.	Saving data (Page 303)
Boot the SINUMERIK 840D sl with NCK/PLC general reset	1.	2.		Power-On and boot-up (Page 26)
Make a communication connection to the PLC	2.	3.		Setting up the communication (Page 35)
PLC commissioning	3.	4.		SIMATIC S7 project overview (Page 37)
Commission the SINAMICS drive system	4.	5.		Commissioning NC-controlled drives (Page 67)
NCK ↔ drive communication	5.	6.		Communication between the NCK and the drive (Page 153)
NCK commissioning • Assign the NCK machine data for communication • Scale the machine data • Parameterize the axis data • Parameterize the spindle data • Parameterize the measuring systems	6.	7.		NCK start-up (Page 163)
Drive Optimization	7.	8.		Optimize the drive. (Page 239)

Safety information 2

2.1 Danger notices

The following notices are intended firstly for your personal safety and secondly to prevent damage occurring to the product described or any connected devices and machines. Non-observance of the warnings can result in severe personal injury or property damage.

> ⚠ **DANGER**
>
> Only appropriately qualified personnel may commission/start-up SINUMERIK equipment.
>
> The personnel must take into account the information provided in the technical customer documentation for the product, and be familiar with and observe the specified danger and warning notices.
>
> When electrical equipment and motors are operated, the electrical circuits automatically conduct a dangerous voltage.
>
> When the system is operating, dangerous axis movements may occur throughout the entire work area.
>
> A potential fire hazard exists due to the energy being transferred in the equipment and the work materials used.
>
> All work on the electrical system must be performed after the system has been switched off and disconnected from the power supply.

> ⚠ **DANGER**
>
> Proper transportation, expert storage, installation and mounting, as well as careful operation and maintenance are essential for this SINUMERIK device to operate correctly and reliably.
>
> The details in the catalogs and proposals also apply to the design of special equipment versions.
>
> In addition to the danger and warning information provided in the technical customer documentation, the applicable national, local, and system-specific regulations and requirements must be taken into account.
>
> Only protective extra-low voltages (PELVs) that comply with EN 61800-5-1 can be connected to all connections and terminals between 0 and 48 V.
>
> Should it be necessary to test or take measurements on live equipment, then the specifications and procedural instructions defined in Accident Prevention Regulation BGV A2 must be adhered to, in particular § 8 "Permissible deviations when working on live components". Suitable electric tools should be used.

> ⚠ **WARNING**
>
> Power cables and signal lines should be installed in such a way that inductive and capacitive interference does not in any way impair the automation and safety functions.

> ⚠ **WARNING**
>
> Repairs to devices that have been supplied by our company may only be carried out by Siemens customer service or by repair centers authorized by Siemens. When replacing parts or components, only use those parts that are included in the spare parts list.
>
> Before opening the device, always disconnect the power supply.
>
> Emergency stop/off devices which comply with EN 60204 / IEC 60204 (VDE 0113-1) must remain effective in all automation equipment operating modes. The act of releasing the emergency stop/off device must not cause an uncontrolled or undefined hot restart.
>
> Additional external measures must be taken, or devices must be created that enforce a safe operational state even when there is a fault (e.g. using independent limit value switches, mechanical locks, etc.) at any location in the automation equipment where faults might cause major material damage or even physical injury, in other words, where faults could be dangerous.

2.2 ESD notices

NOTICE

Handling ESDS modules:
 	
The modules contain electrostatically sensitive devices. Discharge yourself of electrostatic energy before touching the components. The easiest way to do this is to touch a conductive, grounded object immediately beforehand (for example, bare metal parts of the control cabinet or the protective ground contact of a socket outlet).
 	
• When handling electrostatically sensitive devices, make sure that operator, workplace and packing material are properly grounded.
 	
• Generally, electronic modules must not be touched unless work has to be carried out on them. When handling PC boards make absolutely sure that you do not touch component pins or printed conductors.
 	
• Components may only be touched under the following conditions:
  – You are permanently grounded by means of an ESD armband.
  – You are wearing ESD shoes or ESD shoe grounding strips if there is an ESD floor.
 	
• Modules must only be placed on conductive surfaces (table with ESD surface, conductive ESD foam, ESD packaging, ESD transport container).
 	
• Keep modules away from visual display units, monitors or TV sets (minimum distance from screen 10 cm).
 	
• Do not bring electrostatically-sensitive modules into contact with chargeable and highly-insulating materials, such as plastic, insulating table tops or clothing made of synthetic materials.
 	
• Measurements may only be carried out on modules under the following conditions:
  – The measuring device is grounded (via a protective conductor).
  – When floating measuring equipment is used, the probe is briefly discharged before making measurements (e.g. a bare-metal controller housing is touched).

Requirements for commissioning

<div style="text-align: right; font-size: 3em;">3</div>

3.1 General prerequisites

Prerequirements for components involved

The complete system is connected mechanically and electrically, and has been verified in the following points:

- All ESD measures are observed for the design of the components.
- All screws are tightened with their prescribed torque.
- All connectors are plugged correctly and locked/screwed.
- All components are grounded and connected to shields.
- The load capacity of the central power supply is taken into account.

Limit values

All components are dimensioned for defined mechanical, climatic and electrical environmental conditions. No limit value may be exceeded, neither during operation, nor during transportation.

Special attention must be paid to the limit values:

- Power supply conditions
- Pollution burden
- Function-impairing gases
- Ambient environmental conditions
- Storage/transport
- Shock stressing
- Vibration stressing
- Ambient temperature

Literature

You can find further details in the following manuals:

- Installing the SINAMICS S120 drive components: SINAMICS S120 Equipment Manuals
- Connecting the interfaces: NCU Equipment Manual
- Operator Components and Networking Manual, "Networking" chapter

3.2 Requirements for hardware and software

Preconditions

For the commissioning of SINUMERIK 840D sl, the following points are required:

- Hardware requirements
  - NCU 73x0.3 PN
  - CompactFlash card (8 GB, empty, MLFB: 6FC5313-6AG00-0AA0)
  - Dual fan / battery module (MLFB: 6FC5348-0AA02-0AA0) for NCU
  - PCU 50.5 (base software V5XP1.3) or PCU 50.3 (base software V8.6 SP3)

  Note

  Please dispose of used batteries in the specially provided collection points on site. This will ensure they are reused in the correct manner or treated as special waste.

- Connection to NCU
  - Network switch to X120
  - Ethernet connection from PG/PC to X120 or X127 for commissioning the PLC
  - Ethernet machine control panel to socket X120
  - Ethernet connection from the TCU to the Ethernet machine control panel
  - Ethernet connection from the PCU to the Ethernet machine control panel

- Software requirements
  - CNC software with SINUMERIK Operate, NCK, PLC and drive
  - SINUMERIK Operate for operation on the PCU
  - Commissioning tool on PG/PC V7.6 SP3 for commissioning the drive
  - SIMATIC STEP 7 V5.5 SP1 on PG/PC (SIMATIC Manager)
  - STEP 7 package for NCU on PG/PC (Toolbox)
  - GSD file (Toolbox)

  Note

  The order numbers (MLFB) of the SINAMICS drives, motors and encoders should be available for the parameterization.

3.3 Position of the interfaces

Interfaces on the NCU

The NCU has the following interfaces:
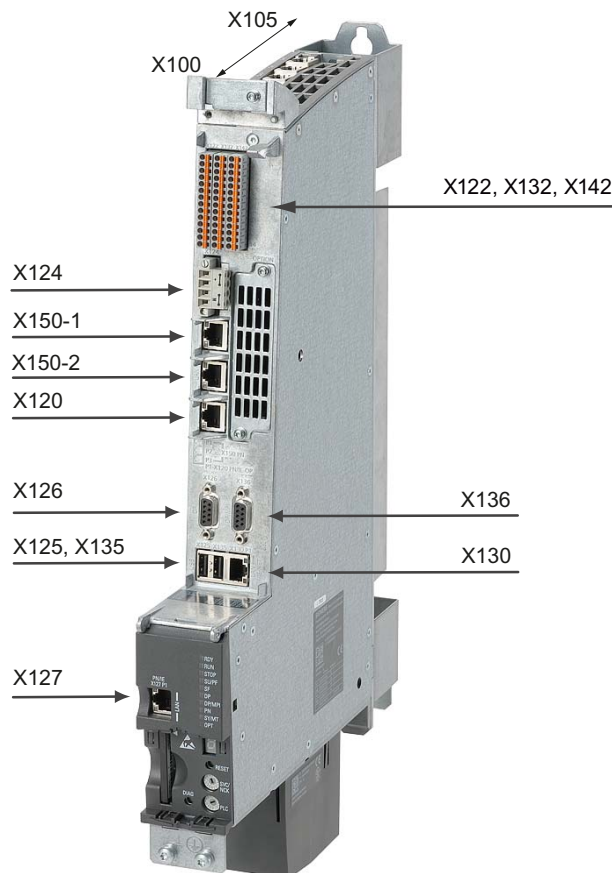
X100 ... X105	DRIVE-CLiQ	for SINAMICS drive components
X124	+24 V DC	external power supply
X125, X135	USB	only for commissioning and servicing
X120	Industrial Ethernet	for connection to a system network (TCU and/or PCU)
X130	Industrial Ethernet	for connection to a company network
X127	Industrial Ethernet	service interface for PG/PC
X136	PROFIBUS DP / MPI	
X126	PROFIBUS DP	PROFIBUS DP (for example for PLC axes)
X150-1, X150-2	PROFINET IO	for PROFINET components
X122, X132, X142	auf Basis PROFINET	Digital inputs/outputs for I/O devices

Figure 3-1   Position of the interfaces

3.4 Power-On and boot-up

SVC/NCK and PLC rotary switches

The NCU has two rotary switches in the lower section of the front panel.

NCK commissioning switch   SVC/ NCK

PLC mode selector   PLC
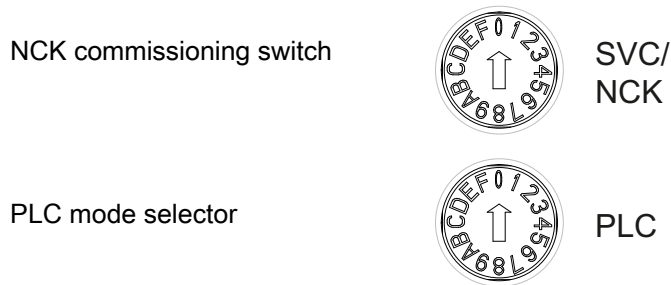
The settings on the SVC/NCK switch have the following meaning:

Switch position	Operating mode of the NCK
0	NCK normal boot-up
1	NCK boot-up with default values (= memory reset)
2	The NCK (and PLC) boots up with the data that was saved at the last shutdown
7	Debug mode (NCK is not started)
8	IP address of the NCU is displayed on the seven-segment display
All others	Not relevant

The settings on the PLC switch have the same meaning as for a SIMATIC S7-CPU:

Switch position	Operating mode of the PLC
0	RUN
1	RUN (protected mode)
2	STOP
3	Memory reset (MRES)
All others	Not relevant

Initial commissioning

In order to achieve a defined initial state of the complete system, for the initial commissioning of the NCU, a NCK reset and a general reset of the PLC must be performed.

Note

In the following cases, a general PLC reset must always be performed:

- Initial commissioning
- Module replacement
- Battery failure
- General reset request via the PLC
- Upgrading the PLC

Procedure:

1. Set the rotary switch of the NCU to the following settings:

   – NCK commissioning switch: Switch position "1"

   – PLC commissioning switch: Switch position "3"

2. Initiate a power on reset by switching-off the control and switching-on again – or by pressing the Reset button on the front of the NCU. The NCU is terminated and with the request for a general reset is restarted.

   Effect:

   – "STOP" LED flashes

   – "SF" LED is lit

3. Turn the PLC mode selector switch to position "2" and back again to position "3".

   Effect:

   – "STOP" LED first flashes with about 2 Hz and then changes to a steady light

   – "RUN" LED is lit

4. After the "STOP" LED again has a steady light condition, turn the PLC mode selector back to position "0".

   Effect:

   – "STOP" LED goes dark

5. Turn the NCK mode selector switch back to the "0" position.

Result

The NCU has now been generally reset and is in the following state:

- NCK
    - The user data has been deleted
    - The system data is initialized
    - The standard machine data is loaded
- PLC
    - The user data has been deleted (data and program blocks)
    - The system data blocks (SDB) have been deleted
    - The buffered data has been written back to the RAM area
    - The time of day and the operating hours counter have not been reset
    - The diagnostics buffer and the MPI parameters are reset
    - General reset puts the PLC in a defined initial state by deleting and initializing all system and user data

Then initiate a power on reset again by switching-off the controller and switching-on again - or by pressing the Reset button on the front of the NCU.

After an error-free boot, the number "6" and a flashing point are output on the status display on the front of the NCU. The "RUN" LED lights up. NCK and PLC are in cyclic operation.

Note

PLC general reset

If a general PLC reset is performed using a power on reset, then the user data must again be transferred to the PLC, e.g. via a programming device (PG).

If position "3" is selected for less than three seconds, no general reset is requested. Furthermore, the "STOP" LED remains unlit if the sequence "2" → "3" → "2" is not completed within three seconds after requesting a general reset.

After the PLC general reset, no PLC start is performed and the following alarms are displayed:

- Alarm: "120201 Communication failed"
- Alarm: "380040 PROFIBUS DP: Configuring error 3, parameter"
- Alarm: "2001 PLC not booted"

These alarms have no influence on the next steps.

3.4.1 Separate NCK and PLC general reset

NCK general reset

Carry out the following actions to perform an NCK general reset:

1. Turn the NCK commissioning switch on the front of the NCU to position "1".

2. Initiate a power on reset by switching-off the controller and switching-on again - or by pressing the Reset button on the front of the NCU (labeled "RESET").
   The NCU is terminated and with the request for a general NCK reset is restarted.

3. After the NCU has booted, turn the NCK commissioning switch back to position "0".

   Effect:

   – The number "6" and a flashing point are output on the status display (7-segment display) on the front of the NCU

   – "RUN" LED is lit

The NCU is in the following state after an error-free boot-up:

- The static memory of the NCU is deleted.

- The machine data is preassigned standard values.

- The NCK is in cyclic operation.

PLC general reset without power on reset

A PLC general reset can be performed with or without power on reset. Depending on this - and depending on the PLC - different states are obtained for the basic PLC and user program.

Perform the following operator actions for a PLC general reset without power-on reset:

1. Turn the PLC mode selector switch on the front of the NCU to position "2" (STOP).
   Effect:

   – The PLC goes into the "STOP" state

   – "STOP" LED is lit

2. Turn the PLC mode selector switch to position "3" (MRES)

   Effect:

   – "STOP" LED goes dark and after approximately three seconds is lit again

3. Within approx. three seconds, turn the PLC mode selector to the positions
   "2" → "3" → "2"

   Effect:

   – "STOP" LED first flashes with about 2 Hz and then changes to a steady light

4. After the "STOP" LED again has a steady light condition, turn the PLC mode selector
   back to position "0".

   Effect:

   – "STOP" LED goes dark

   – "RUN" LED is lit

A general reset has now been performed for the PLC and is now in cyclic operation with the
following properties:

● The user data has been deleted (data and program blocks)
  PLC319-3PN/DP: see the following note

● The system data blocks (SDB) have been deleted.

● The buffered data has been written back to the RAM area

● The time of day and the operating hours counter have not been reset.

● The **diagnostics buffer** and the MPI parameters **are** not reset.

Note

PLC319-3PN/DP

For a PLC319-3PN/DP, in the case of a PLC general reset without power on reset, the
user data is first backed up on the CompactFlash card and is then loaded into the PLC.
Therefore, after a PLC general reset, user data is not deleted.

PLC general reset with power on reset

Perform the following operator actions for a PLC general reset with power on reset:

1. Turn the PLC mode selector on the front of the NCU to position "3" (MRES).

2. Initiate a power on reset by switching-off the controller and switching-on again - or by
   pressing the Reset button on the front of the NCU (labeled "RESET").
   The NCU is shut down and with the request for a general PLC reset is restarted.

   Effect:

   – "STOP" LED flashes

   – "SF" LED is lit

3. Turn the PLC mode selector switch to position "2" and back again to position "3".

   Effect:

   – The "STOP" LED flashes approx. 20 seconds with approx. 2 Hz,
     then:

   – "STOP" LED is lit

   – "RUN" LED is lit

4. After the "STOP" LED again has a steady light condition, turn the PLC mode selector
   back to position "0".

   Effect:

   – "STOP" LED goes dark

A general reset has now been performed for the PLC and is now in cyclic operation with the following properties:

● The user data has been deleted (data and program blocks)

● The system data blocks (SDB) have been deleted.

● The buffered data has been written back to the RAM area

● The time of day and the operating hours counter have not been reset.

● The **diagnostics buffer** and the MPI parameters **are** reset.

Boot completed without error

After an error-free boot of the NCU, it displays the following:

● Number "6" and a flashing point

● RUN LED illuminates GREEN continuously

● RDY LED illuminates GREEN continuously

In the following step, commissioning of the PLC is done with the SIMATIC Manager.

3.5 Access levels

Access to functions and machine data

The access concept controls access to functions and data areas. Access levels 0 to 7 are available, where 0 represents the highest level and 7 the lowest level. Access levels 0 to 3 are locked using a password and 4 to 7 using the appropriate key-operated switch settings.

Access level	Locked by	Area	Data class
0	---	(reserved)	---
1	Password: SUNRISE	Manufacturer	Manufacturer (M)
2	Password: EVENING	Service	Individual (I)
3	Password: CUSTOMER	User	User (U)
4	Key-operated switch setting 3	Programmer, machine setter	User (U)
5	Key-operated switch setting 2	Qualified operator	User (U)
6	Key-operated switch setting 1	Trained operator	User (U)
7	Key-operated switch setting 0	Semi-skilled operator	User (U)

The password remains valid until it is reset with the "Delete Password" softkey. The passwords can be changed after activation.

If, for example, the passwords are no longer known, reinitialization (boot-up with "NCK default data") must be carried out. This resets all passwords to the default (see table). POWER ON does not reset the password.

Key-operated switch

Access levels 4 to 7 require a corresponding key-operated switch setting on the machine control panel. Three keys of different colors are provided for this purpose. Each of these keys provides access only to certain areas.

Meaning of the key-operated switch settings:
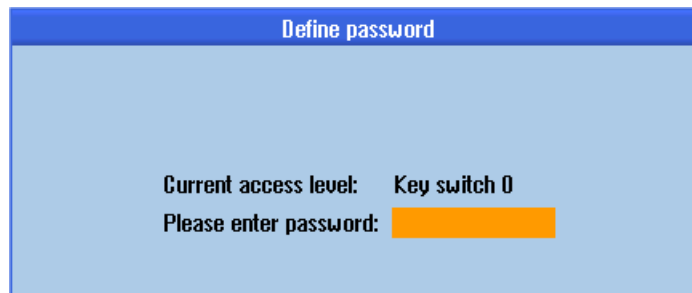
Access level	Switch position	Key color
4-7	0 to 3	red
5-7	0 to 2	green
6-7	0 and 1	black
7	0 = Key removal position	No key inserted

The key-operated switch setting must always be edited from the PLC user program and applied to the interface accordingly.

Set password

To change the access level, select the "Start-up" operating area:

1. Press the "Password" softkey.

2. Press the "Set password" softkey to open the following dialog:

Figure 3-2   Set password
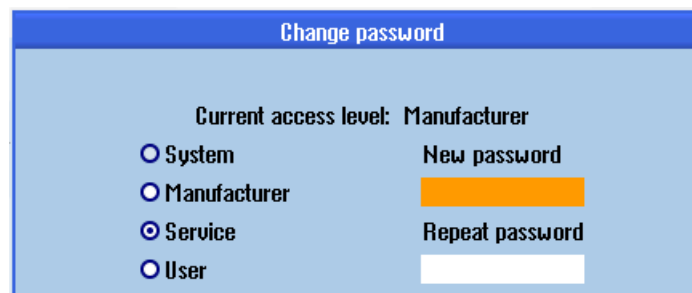
3. Enter a password and confirm this with "OK" or with the <Input> key.

   A valid password is acknowledged as set and the currently applicable access level is displayed. Invalid passwords will be rejected.

4. You must delete the old password before activating a password for a lower access level than the one activated.

   The last valid password is deleted by pressing the "Delete password" softkey. Then the current key-operated switch setting is valid.

Change password

To change the password:

1. Press the "Change password" softkey to open the following dialog:

Figure 3-3   Change password

2. Enter the new password in both fields and then confirm with the "OK" softkey. If both passwords match, the new password becomes valid and is adopted by the system.

PLC commissioning

4

4.1 Connect PG/PC with the PLC

4.1.1 Setting up the communication

Introduction

SIMATIC Manager is a GUI for online/offline editing of S7 objects (projects, user programs, blocks, hardware stations and tools).

You can perform the following actions with the SIMATIC Manager:

- Manage projects and libraries
- Call STEP 7 tools
- Establish an online connection to the PLC

A corresponding editing tool is started up when you open the relevant objects. The program editor starts by double-clicking a program block. The block can be processed.

Starting SIMATIC Manager

After installation, the SIMATIC Manager icon appears on the Windows desktop, and in the Start menu a "SIMATIC Manager" program item appears under "SIMATIC".

- Start the SIMATIC Manager by double-clicking the link on the Windows desktop or from the Start menu.
- The online help for the active window is always called by pressing the <F1> function key.

Establishing a communications connection to the PLC

To load the configuration into the PLC, the communications connection (Ethernet) from the PG/PC to the PLC required for the loading must be secured.

Procedure:

1. Select menu command: "Extras" > "Set PG/PC interface..."

2. Under the "Access mode" tab, look for the interface used in the "Interface parameterization used" selection field, for instance: "TCP/IP → Realtek RTL8139/810x F…"

3. Confirm the parameterization with "OK".

Note

Parameterization of the PG/PC interface can be performed or changed from the SIMATIC Manager at any time.

4.2 Creating a SIMATIC S7 project

4.2.1 SIMATIC S7 project overview

Steps to be taken

It is necessary to create a SIMATIC S7 project for the basic commissioning of the PLC, the Ethernet and PROFIBUS communication as well as the input/output data areas of the NCK. To do this, perform the following steps:

● Create a project

● Insert a SIMATIC station 300

● Insert an NCU to the hardware configuration

● Configure the network interfaces

● Insert the machine control panel and hand wheel

What do you need to be aware of?

Loading the PLC via network interface X130 is also possible if the IP address of the Ethernet interface is known. Loading an archive may always be carried out if the communication HMI↔NCK is available.

Note

Loading the PLC (CP840) is essential for the configuration of the data path for saving/restoring the drive data.

Literature

The PLC interface signals are described in the "Lists 2" parameters manual.

Operating sequence

You have started the SIMATIC Manager.

1. To create a new project, select the "File" → "New" menu command in the SIMATIC Manager.

2. Enter the project data:
   – Name (for example: SINU_840Dsl)
   – Storage location (path)
   – Type

3. Confirm the dialog with "OK".

   The project window is displayed showing an empty S7 project structure.

4.2.2 Inserting SINUMERIK NCU to the HW Config

Overview

Insert the necessary hardware in the following order in the S7 project:

- Insert a SIMATIC station 300
- Start the hardware configuration
- Insert a SINUMERIK NCU

Operating sequence

Procedure:

1. Select via the context menu (right-click) "Insert new object" > "SIMATIC 300 station".
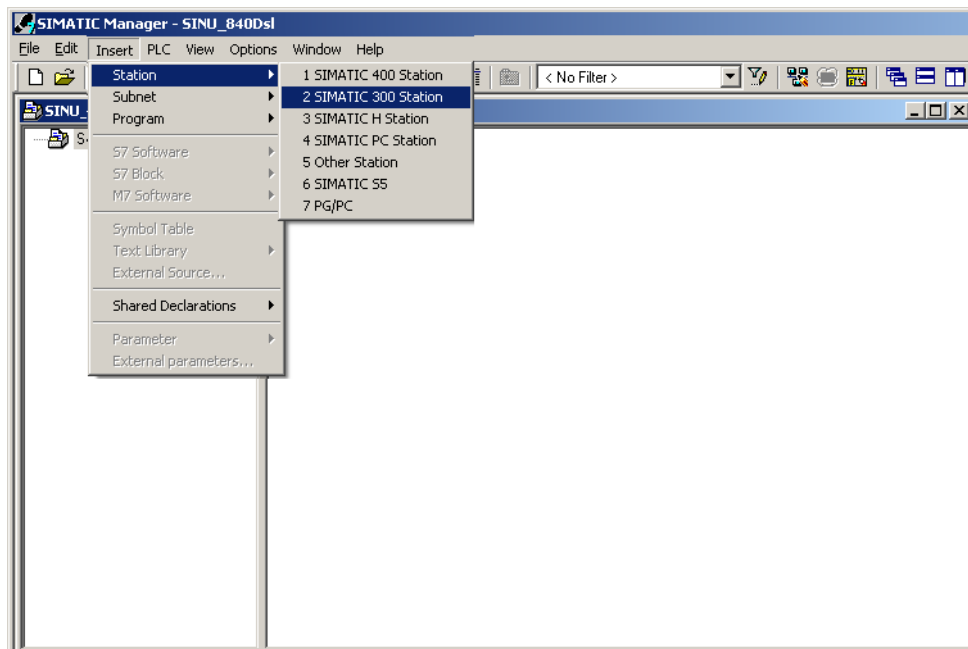
2. Double-click the <SIMATIC 300> symbol.

3. Double-click the <Hardware> symbol.

   The HW Config for introducing required hardware is started.

4. In the menu, select "View" > "Catalog". The catalog with the modules is displayed.
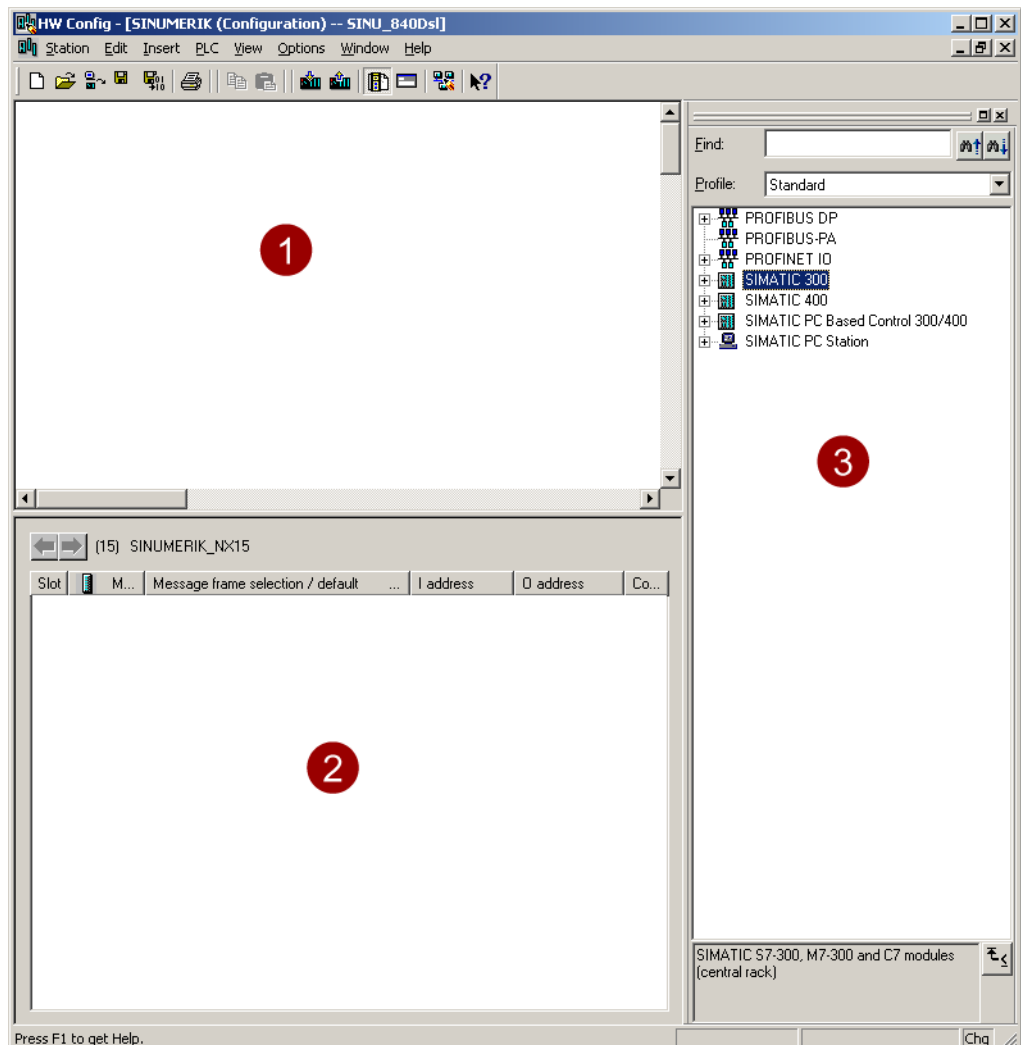
① Station window:
② Details
③ Hardware catalog

The user interface of the "HW Config" hardware configuration shows the following details:

– Station window:

The station window is split. The upper part displays the structure of the station graphically, and the lower part provides a detailed view of the selected module.

– Hardware catalog

This catalog also contains the SINUMERIK NCU that you need for configuring the hardware.

Inserting a SINUMERIK NCU

With the operating sequence described below, you insert the NCU 720.3 PN as example:

1. Select "View" > "Catalog".

2. Search for the module in the catalog under "SIMATIC 300" → "SINUMERIK" → "840D sl" > "NCU 720.3 PN".
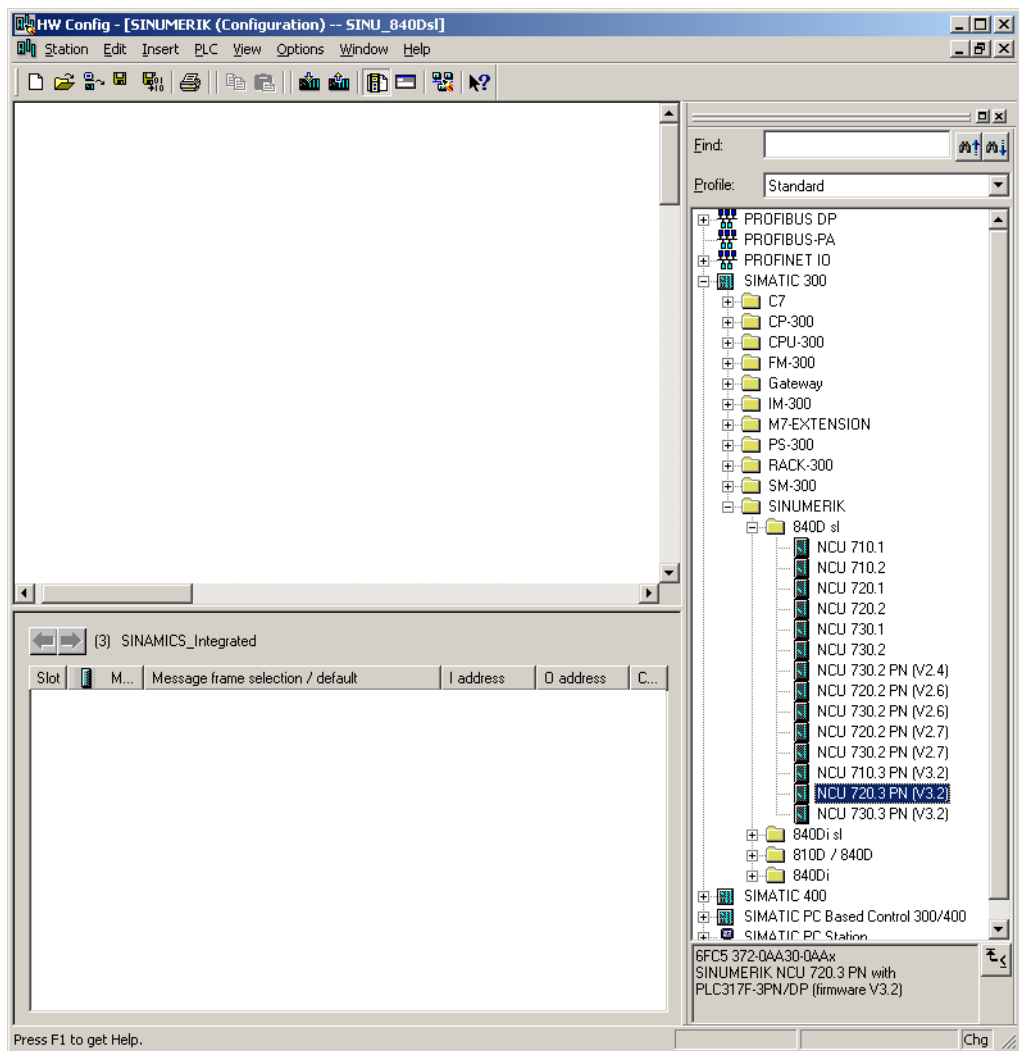
3. Select "NCU 720.3 PN" with the left mouse button and drag it to the "Station design" station window while keeping the mouse button pressed.

After you release the mouse button, configure in the dialog the properties of the interfaces of the CP 840D sl processor present on the NCU 720.3 PN.

4.2.3 Configure the network interfaces

Introduction

Configure the following network interfaces in the STEP 7 project over which you want to reach the NCU:

● Ethernet

● Integrated PROFIBUS

● PROFIBUS DP, only with machine control panel for PROFIBUS (see Configure PROFIBUS components (Page 382))

When creating a new project using the catalog, the configuration of the PROFIBUS interface is called automatically.

PROFIBUS DP operating sequence

1. You used the left mouse button to select an NCU and while holding down the mouse button you dragged it to the "Station design" station window.

2. After you release the mouse button, configure the properties of the PROFIBUS DP interface for socket X126 (machine control panel) in the dialog.
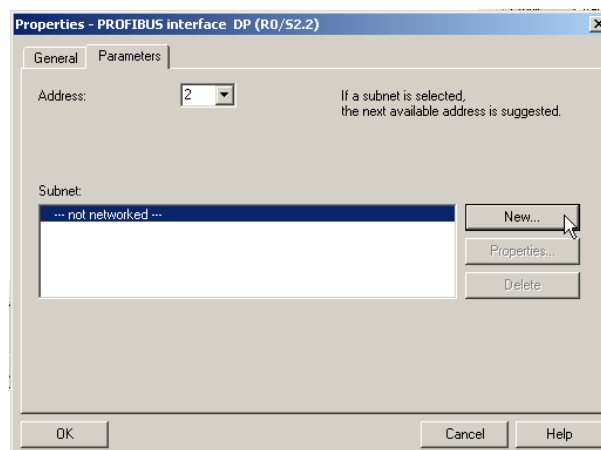
3. This is an Ethernet machine control panel that does not require configuration. Select "Cancel".

4. The NCU module with SINAMICS S120 is inserted into the HW Config.

Note

With the <F4> key and confirmation of the prompt regarding "Reorganize", you can reorganize the display in the station window.
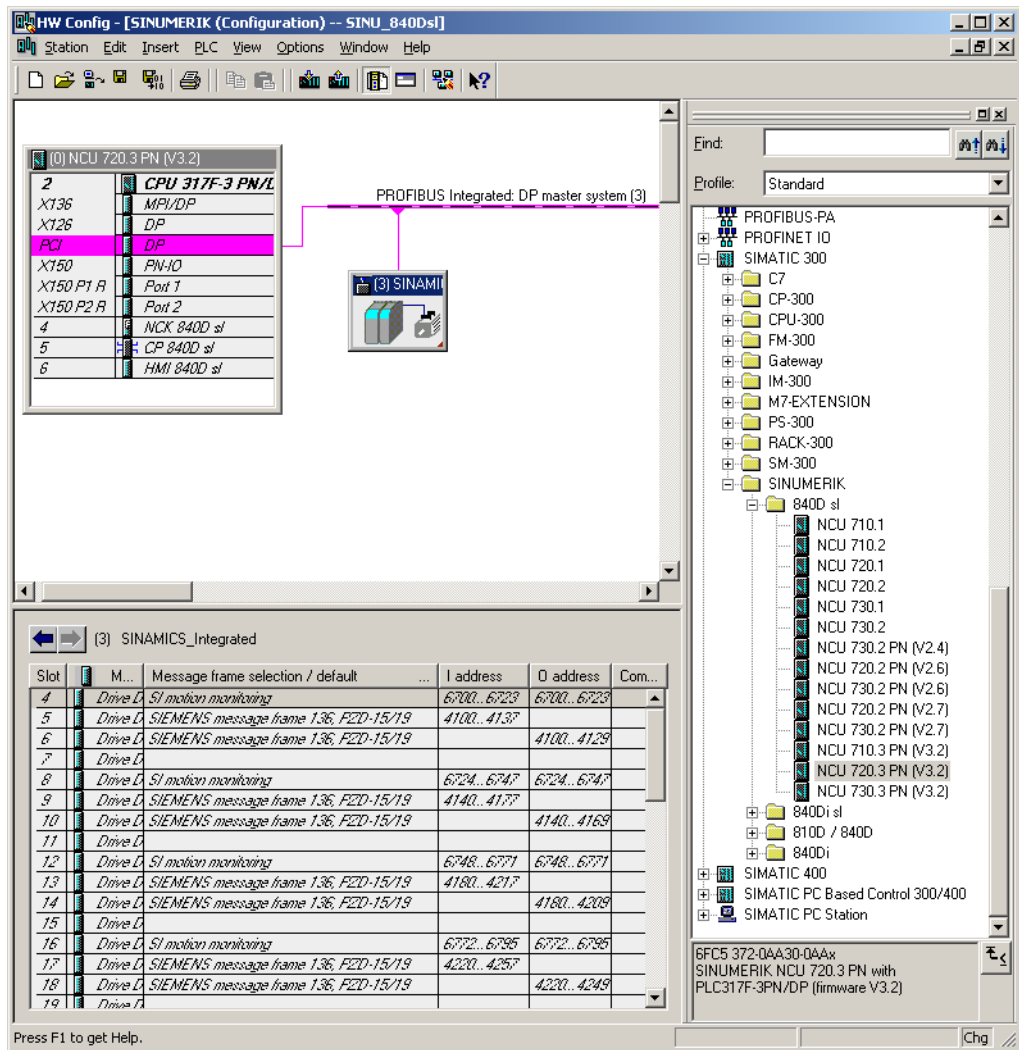
Next, specify the properties for the Ethernet interface.

Operating sequence for Ethernet interface

Note

Use the X127 service interface for commissioning the PLC. No configuration of the Ethernet interface is required for this. This interface is already initialized with the IP address 192.168.215.1

For the initial commissioning with a PG/PC, it is necessary to configure an Ethernet interface. In our example, this involves the interface to socket X120.

1. Double-click "CP 840D sl" in the basic rack of the NCU. The "Properties - CP 840D sl" dialog opens.
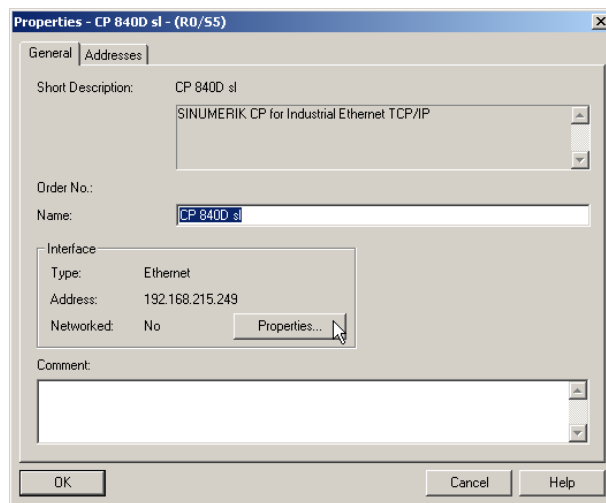
2. After clicking the "Properties" button, a new Ethernet interface can be created.
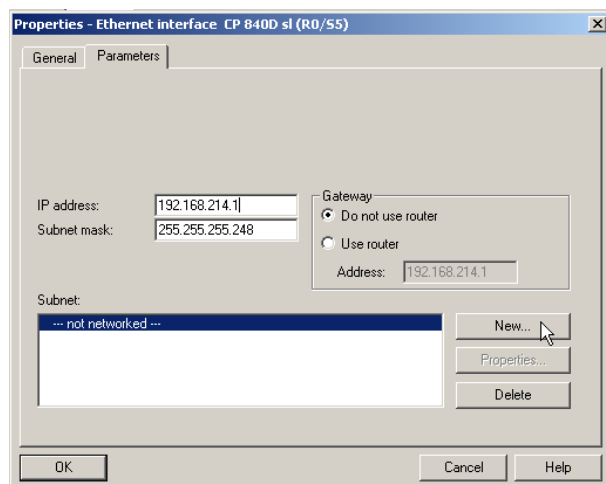
3. For socket X120, enter the IP address "192.168.214.1" and the Subnet screen form "255.255.255.0".

4. Create the Ethernet interface using "New" and then "OK".

5. Click "OK" twice.

As the next step, configure the Web browser of the PLC.

See also

Configuring the communication to the drive (Page 155)

4.2.4 Configuring the Web browser

Operating sequence

1. Click the SINUMERIK module in the hardware configuration.

   The following dialog opens:
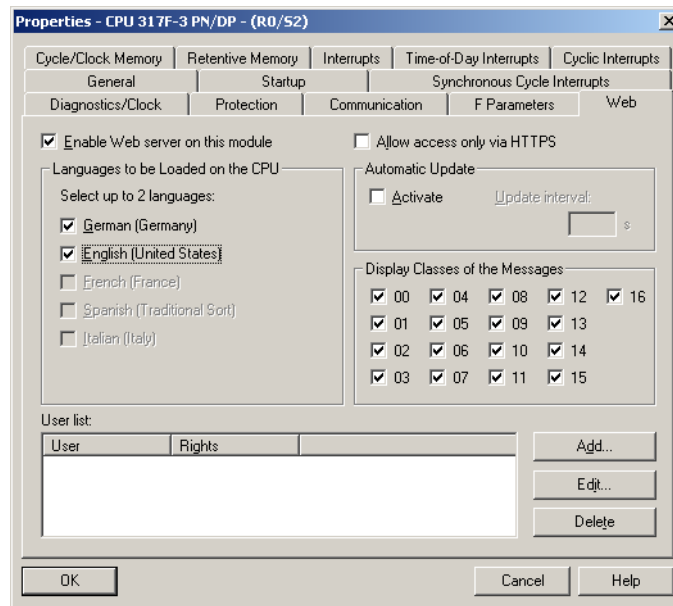
2. Select the "Web" tab.

3. Select the option: "Enable the Web server on this module".

   If the checkbox is selected, after loading the configuration data, the Web server of the CPU is started and information can be read from the PLC via a Web browser.

4. Select the language for language-dependent texts to be loaded into the CPU.

   The number of available languages is CPU-dependent. Examples of language-dependent texts are diagnostics buffer entries or messages.

   Note

   Available languages

   The languages you select here must be installed in the S7 project. You can install the languages for the project in the SIMATIC Manager from "Extras" → "Language for display devices ... "

   If the languages you select in the SIMATIC Manager have not be installed previously, the Web server can only display texts in the set default language.

5. Activate the "Automatic update" if you want the Web pages to be updated automatically. The "Identification" Web page is excluded from the automatic update.

Telegram lengths and I/O addresses

The telegram lengths and I/O addresses for communication between the PLC and the drive (can be viewed via the object properties of the integrated SINAMICS) have already been pre-assigned correctly and do not need to be configured.

As the next step insert an NX component.

4.2.5 Inserting an NX to the hardware configuration

Introduction

The NX must be wired to the NCU via the DRIVE-CLiQ. A fixed DRIVE-CLiQ socket is provided for the relevant address. The following table contains the wiring:

Address on the integrated PROFIBUS	DRIVE-CLiQ interfaces NCU 720.3 PN / 730.3 PN	DRIVE-CLiQ interfaces NCU 710.3 PN
10	X100	X100
11	X101	X101
12	X102	X102
13	X103	X103
14	X104	--
15	X105	--

Operating sequence

An NX component is contained in the example configuration, for the axis to control the spindle. This component must be integrated in the hardware configuration also when creating the STEP 7 project:

1. Search for the NX module NX15.3 in the hardware catalog under "PROFIBUS DP" > "SINAMICS" > "SINUMERIK NX…".

2. Left-click to select the "SINUMERIK NX ..." module and drag it to the "PROFIBUS Integrated DP master system" bus in the "Station design" station window.

3. The "DP Slave Properties" dialog box opens.
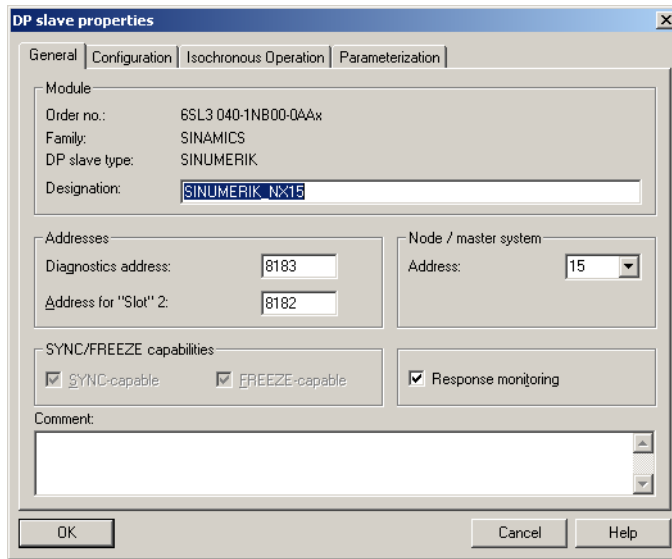
Enter the address for the integrated PROFIBUS in this dialog. "15" is proposed for the first NX in a configuration.

4. Enter the address and click "OK".
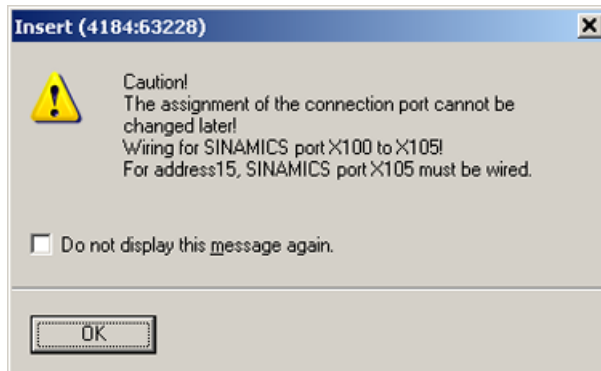
5. Confirm the wiring notification with "OK".

6. After releasing the mouse key, you have inserted the NX module:
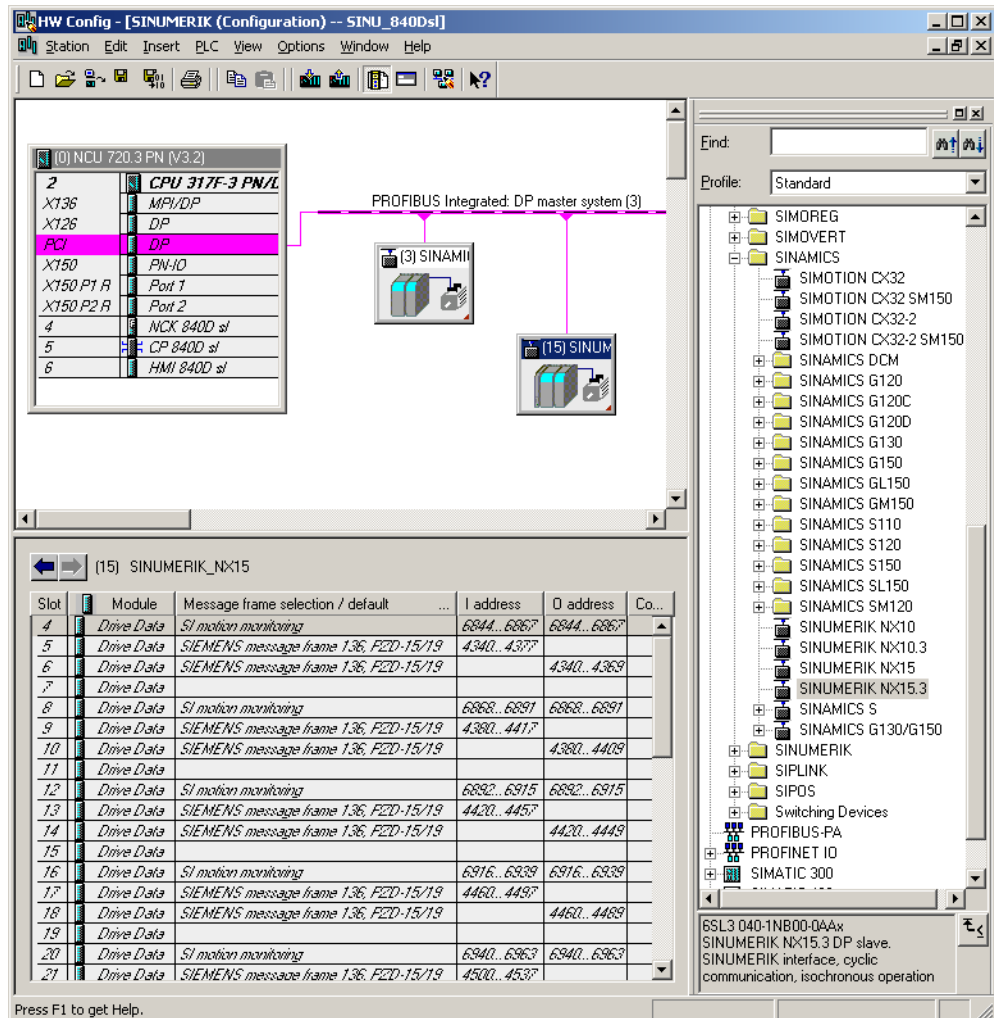
When deleting and re-inserting NX modules in the hardware configuration, new slot addresses are assigned during the address assignment. In order to create a clear and transparent configuration that is always the same, we recommend that addresses are allocated as shown in the following table:

Address on the integrated PROFIBUS	DRIVE-CLiQ interface, e.g. NCU 720.3 PN	Start address of first controller slot	Start address of last controller slot
10	X100	5540	5740
11	X101	5300	5500
12	X102	5060	5260
13	X103	4820	5020
14	X104	4580	4780
15	X105	4340	4540

4.2.6 End the hardware configuration and load it to the PLC

End the hardware configuration and load the to the PLC

To end the overall configuration and generate the system data for the PLC, the project must be saved and compiled.

1. Select the "Station" > "Save and compile" menu.

2. Click the "Load in module" button to load the configuration to the PLC.

   The "Select target module" dialog automatically displays both configured communication partners.
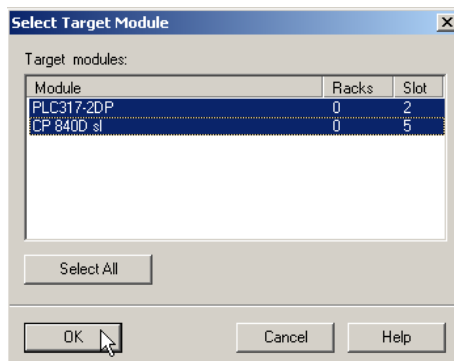
3. Confirm with OK to load into these two modules.

4. Confirm the dialog boxes displayed subsequently with "OK" or "No" for the query "…Should the module be started now (restart)?".

Note

You can test the communication interface at "Target system > Diagnosis > Operating mode".

---

5. Close the "HW Config" window.

The next step is to create the PLC program.

4.3 Creating a PLC program

Introduction

The PLC program is constructed modularly. It comprises the two parts:

- PLC basic program

  The PLC basic program organizes the exchange of signals and data between the PLC user program and the NCK, HMI, and machine control panel components. The PLC basic program is a part of the Toolbox delivered with the SINUMERIK 840D sl.

- PLC user program

  The PLC user program is the user-specific part of the PLC program by which the PLC basic program has been added to or extended.

FB 1 (start-up block of the PLC program) must be assigned variables. A precise description of the variables and options for modifying their parameterization can be found in:

Literature

Function Manual, Basic Functions, PLC Basic Program (P3)

Cyclical mode (OB 1)

From a chronological viewpoint, the basic program runs ahead of the PLC user program. The complete processing of the NCKPLC interface is carried out in cyclic mode. A cyclic monitoring function is activated between PLC and NCK once boot-up and the first OB1 cycle have been completed. A PLC failure produces alarm "2000 Sign-of-life monitoring PLC".

PLC user program

The following organization blocks of the basic program contain the entry points for the appropriate parts of the PLC user program:

- OB100 (cold restart)
- OB1 (cyclic processing)
- OB40 (process alarm)

The following figure illustrates the structure of the PLC program:
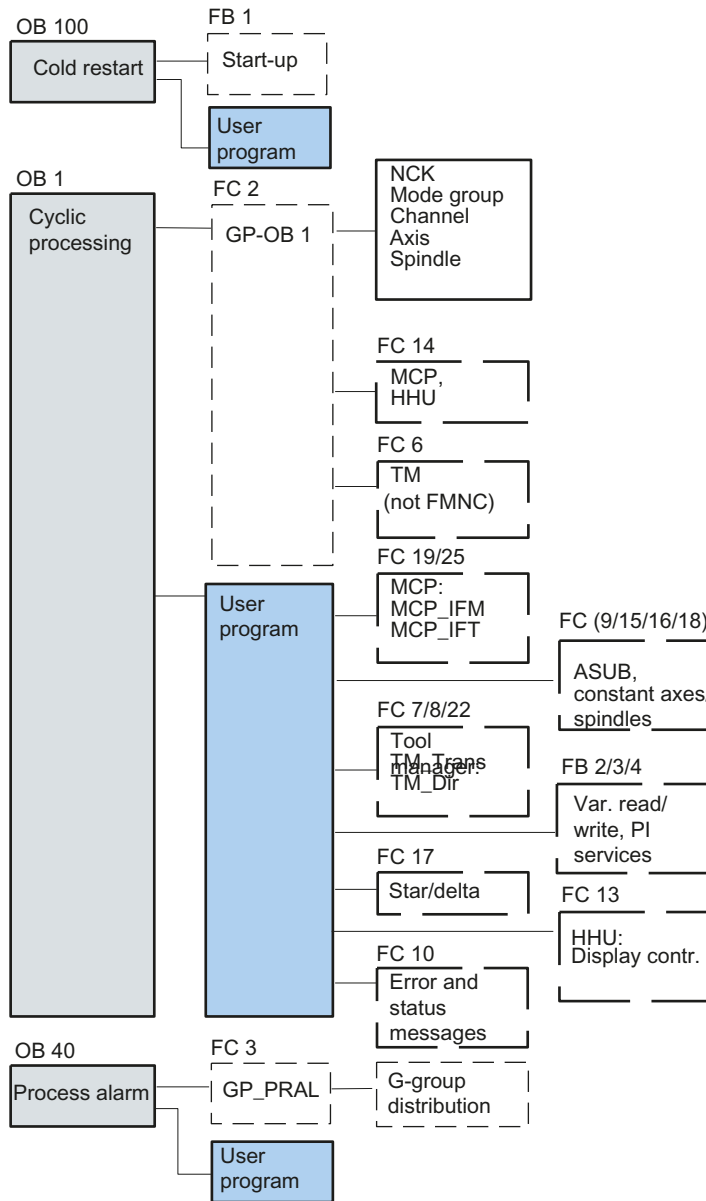
Figure 4-1   Structure of the PLC program

PLC status

The PLC always starts up in RESTART mode, i.e. the PLC operating system runs OB100 after initialization and starts cyclic operation at the beginning of OB1. No return is made to the interruption point (for example, in the event of a power failure).

Start-up behavior of the PLC

There are both remanent and non-remanent areas for the markers, timers and counters. The areas are continuous and are divided by a parameterizable limit, where the area with the higher-value address range is defined as the non-remanent area. Data blocks are always remanent.

Start-up mode COLD RESTART (OB 100)

If the remanent area has no battery backup (backup battery is empty) start-up is prevented. The following operations are performed during a cold restart:

- UStack, BStack and non-retentive flags, timers and counters are deleted
- The process output image (POI) is deleted
- Process and diagnostics alarms are canceled
- The system status list is updated
- Parameterization objects of modules (from SD100 onwards) are evaluated or default parameters are output to all modules in single-processor mode
- Execute cold restart (OB100)
- Read in process input image (PII)
- Cancel command ouptput inhibit (BASP)

4.3.1 Preconditions for creating the PLC user program

Software and hardware preconditions

The following conditions must be met for creating a PLC user program:

- SIMATIC STEP 7 V5.5 SP1
- SIMATIC STEP 7 is installed on the PG/PC
- Installing the toolbox (PLC basic program, slave OEM, GSD files)
- Editing the blocks in the PLC basic program
- Installing the PLC basic program library

    To be able to use the blocks of the PLC basic program (OBs, FBs, DBs) in a SIMATIC S7 project, the library must first be installed in the SIMATIC Manager.

Editing the blocks in the PLC basic program

The operating sequence for the creation of a PLC program describe how to create a basic program. The SIMATIC STEP 7 documentation describes how to modify and extend a user program.

The individual blocks in the PLC basic program can be processed as follows in the SIMATIC Manager:

- Select the appropriate block, e.g. OB 100, in the folder blocks of the corresponding module

- Use the "Edit" > "Open object" menu command to open the block or double-click the block with the left mouse button

- Edit the block using the LAD/STL/CSF editor. Switch over to the block display using the "View" > "LAD" or STL or CSF menu command

4.3.2   Insert PLC basic program

Introduction

You have performed the hardware configuration, have saved and compiled the project and have created the system data for the PLC. You have installed the Toolbox software that also contains the libraries for the PLC basic program of an NCU.

Operating sequence to open the library and copy sources, symbols and blocks

You are on the main screen of the SIMATIC Manager:

1. Select the "File" → "Open" menu and then click the "Libraries" tab.
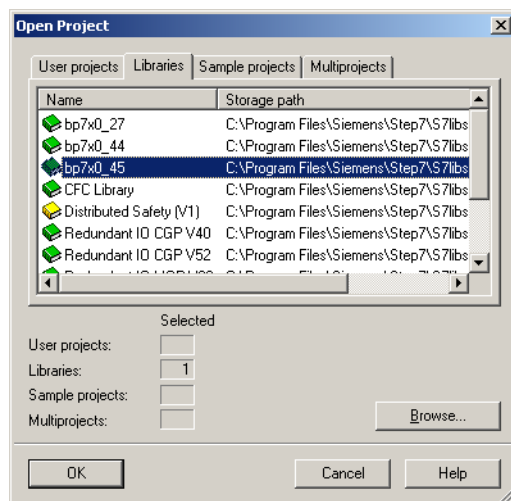
2. Select the library of the PLC basic program, e.g. "bp7x0_45" and confirm the dialog with "OK".

   You have inserted the library and selected the PLC program from "SINU_840Dsl" > "SINUMERIK" → "PLC 317 2DP" → "S7 program".
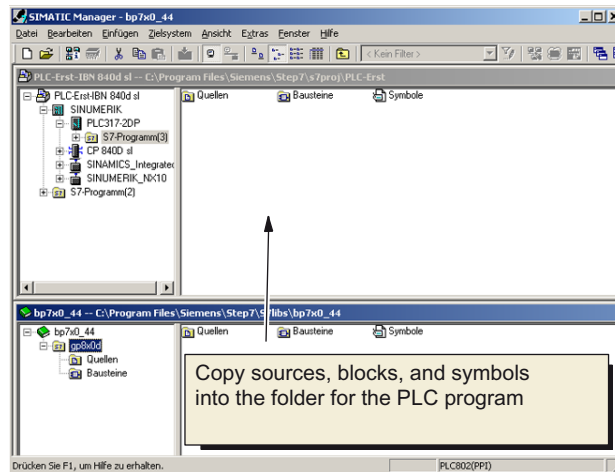
3. Copy the sources, modules and symbols to the PLC program.

Overwrite OB1

Inserting blocks overwrites the existing organization block OB1. Confirm the query as to whether you want to overwrite the block with "Yes".

You have now created the PLC basic program.

In the next section you will modify some of the data for the machine control panel in OB100.

4.3.3 Modifying Ethernet machine control panel in OB100

Operating sequence

The PLC basic program automatically transfers the machine control panel signals (MCP signals) and the addresses of the MCP in the HW Config if the configuration is set up as laid out below.

Under "Blocks", double-click "OB100" to open it. The following parameters must be pre-assigned as follows:

```
MCPNum := 1

MCP1IN := P#E 0.0

MCP1OUT := P#E 0.0

MCP1StatSend := P#E 8.0

MCP1StatREc := P#E 12.0
```

MCPBusAddress := 192

MCPBusType = B#16#55

You have completed the configuration of the PLC basic program.

In the next step, you will load the project to the PLC.

4.4 Download the project to the PLC

Introduction

For loading the configured PLC project, the following prerequisites must be fulfilled:

Precondition

- An Ethernet network connection exists between STEP7 and the PLC.
- The configuration to be loaded corresponds to the actual station configuration.
- The NCU is active:
  - NCK is in cyclic mode.
  - PLC in RUN or STOP mode.

Supplementary condition

The following supplementary conditions regarding the system data blocks must be observed when the configuration is loaded:

- HW Config

  When loading the configuration via HW Config, only the system modules and their associated system data blocks selected in HW Config are loaded into the module. However, global data defined in SDB 210 is not loaded from the HW Config, for example.

  You have loaded the HW Config to the module in the previous "End the hardware configuration and load to the PLC" chapter.

- SIMATIC Manager

  When loading the configuration via the SIMATIC Manager all the system data blocks are loaded into the module.

  #### Note

  When the PLC program is loaded in the "RUN" mode, each block loaded becomes active immediately. This can result in inconsistencies when executing the active PLC program. It is therefore advised to place the PLC in the "STOP" mode before loading the configuration, if this has not already been done.

Operating sequence for loading system blocks into the module

1. To load the configuration of the system blocks change to the SIMATIC Manager.

2. In the SIMATIC Manager in the PLC directory, select the directory "Blocks" > right mouse button > "Target system" > "Load" (see figure below), or the "Load" symbol.
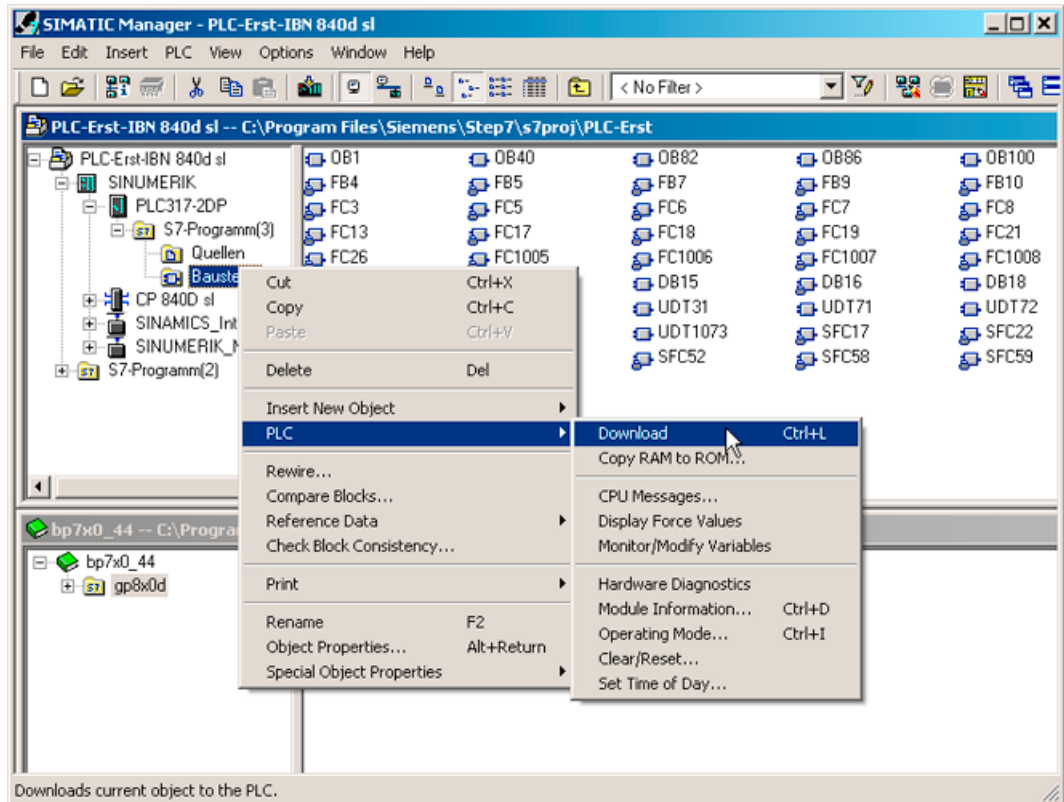
Figure 4-2   Loading system blocks

3. If there is no connection to the target system, you must confirm in sequence the following dialog requests with:

   – "OK" for "Check the required sequence of blocks for correct functioning"

   – "Yes" for "Do you want to load system data?"

   – "Yes" for "Must system data be deleted on the module and replaced by off-line system data?"

   – "No" for "The module is in STOP mode. Do you want to start the module (cold restart)?"

   You have loaded the PLC program to the PLC; the PLC is in "STOP" mode.

Note

If the PLC is stopped via the SIMATIC Manager, then it also has to be started via the SIMATIC Manager. Starting via the PLC mode selector is also possible.

4.5 Loading PLC symbols to the controller

Precondition

You require the SIMATIC STEP 7 software and the "PLC Symbols Generator" program that is provided in the toolbox.

Generating PLC symbols

To edit PLC blocks via symbolic names, you can generate the symbols of the STEP 7 project for SINUMERIK Operate and store them on the CompactFlash card on the controller.

Procedure:

1. Open the "PLC Symbols Generator" program and navigate to the corresponding PLC project.

2. To start the generation, first select the required language.

3. Save the "PlcSym.snh" and "PlcSym_xx.snt" files. xx is the language code specified when creating the file. The generation is then started.

4. Create the following directory on the CompactFlash card and store the generated files (PlcSym_xx.snt, PlcSym.snh) under the following path: **/oem**/sinumerik/plc/symbols

5. After restarting SINUMERIK Operate, the symbol tables are loaded when booting. Select the "Insert variables" softkey to display the imported symbols in the table of the "NC/PLC variables".

NOTICE
Notation
The notation (upper/lower case) of the file name that the program created is mandatory and must not be changed.

4.6 Configuring an Ethernet machine control panel

Note

If you have an Ethernet machine control panel with Ethernet hand wheel, a "7" for "Ethernet" must be entered for the hand wheel in the general machine data MD11350[0] $MN_HANDWHEEL_SEGMENT.

4.7 First commissioning of the PLC completed

Initial commissioning of the PLC completed

NOTICE
A reset (warm restart) of the NCK is required for the PLC-NCK synchronization. See also: Triggering a reset (warm restart) for NCK and drive system (Page 76)

The PLC and NCK are in the following state after a reset (warm restart):

- RUN LED illuminates GREEN continuously.
- Status display shows a "6" with a flashing point.

  ⇒ PLC and NCK are in cyclic operation.

You have completed the initial commissioning of the PLC.

Continue with the steps for "Guided commissioning" of SINAMICS drives.

You start with Reset (warm restart) for the NCK and drive system.

NOTICE
PROFIBUS outputs
For a stop of the NCK, the PLC normally continues to run and the type of stop response is the user's responsibility depending on the machine situation. In this special case, the NCK can no longer switch the outputs to zero and the current status is retained because the PLC is still running. In order to switch off the outputs or to force a PLC stop, for example, the "NC READY" signal is evaluated in the PLC user program.

4.8 Configuring a network (NetPro) for PG/PC

4.8.1 Integrating PG/PC into NetPro

Preconditions

The following preconditions for integrating a PG/PC must be met:

- The is NCU inserted in the S7 project with the HW Config Inserting SINUMERIK NCU to the HW Config (Page 38).

- The properties of the network interfaces are configured Configure the network interfaces (Page 41).

- The PLC communication to the drive is configured.

- The machine control panel is inserted Modifying Ethernet machine control panel in OB100 (Page 54).

- The configuration is saved and compiled End the hardware configuration and load it to the PLC (Page 48).

- A PLC program has been created.

Operating sequence for integrating the PG/PC in the S7 project

To carry out routing functions, it is necessary to integrate a PG/PC in the SIMATIC Manager under NetPro and to configure the interfaces.

To enable the communication between PG/PC ↔ HMI via Ethernet, the PG/PC should be included in the network configuration.

Procedure:

1. To integrate a PG/PC, open the S7 project in the SIMATIC Manager.

2. Select "Extras" → "Configure the network" in the menu or click the following button to start "NetPro":

3. Insert the PG/PC with drag&drop under "Stations" from the catalog into the network configuration.
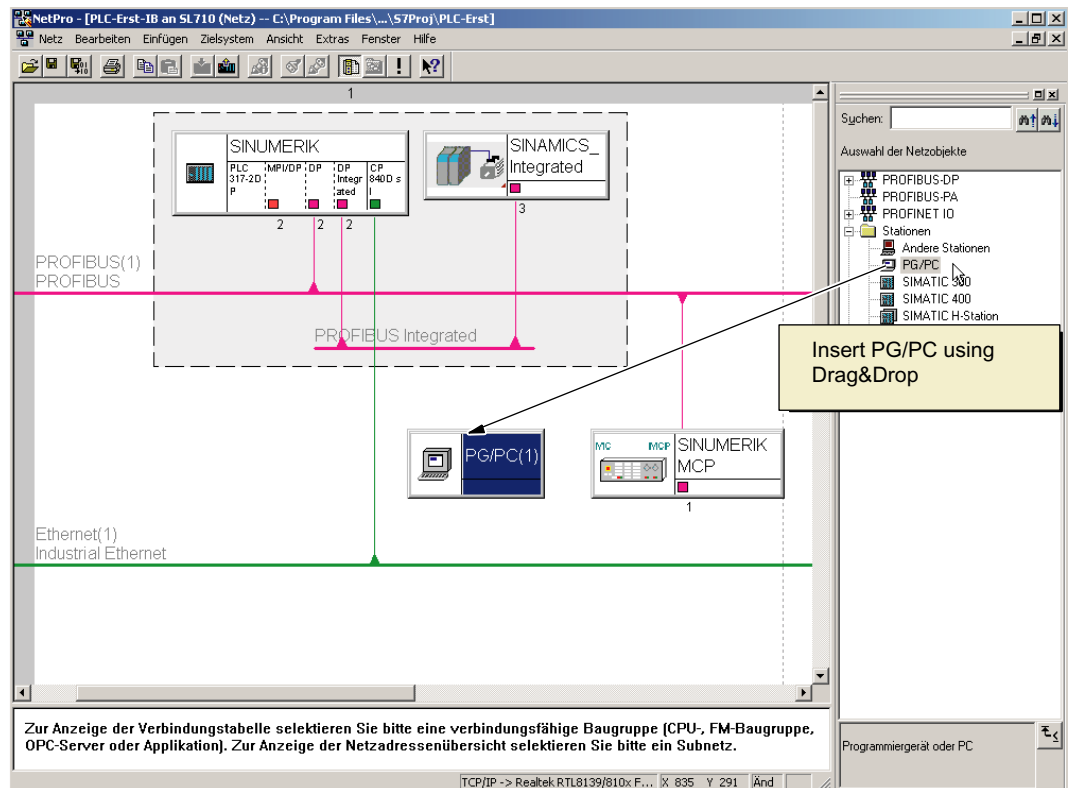
The inserted "PG/PC" station does not yet contain any interfaces. These are configured in the next step.

4.8.2 PG/PC interface configuration

Introduction

Under NetPro, configure the interfaces required for commissioning at the PG/PC. These may include the following interfaces:

- Industrial Ethernet for communication via the service interface X127 on the NCU.

- PROFIBUS

Operating sequence for configuring interfaces

1. Highlight the symbol "PG/PC" under NetPro.

2. Select "Object properties" <right-click>.

3. In the displayed "Properties - PG/PC" dialog, select the "Interfaces" tab to configure the required interfaces.
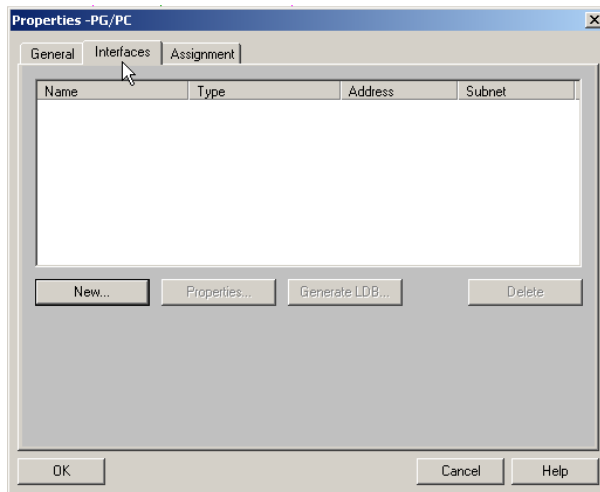
Operating sequence for configuring interfaces at the PG/PC

1. Click "New…" to configure the Ethernet interface first.

2. In the selection field, select "Industrial Ethernet".
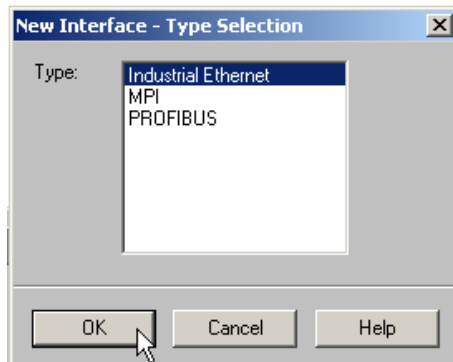
3. Click "OK".

4. Select the subnet "Ethernet(1)" and enter the following IP address and subnet mask for the PG/PC:

   – IP address 192.168.215.2

   – Subnet mask 255.255.255.224
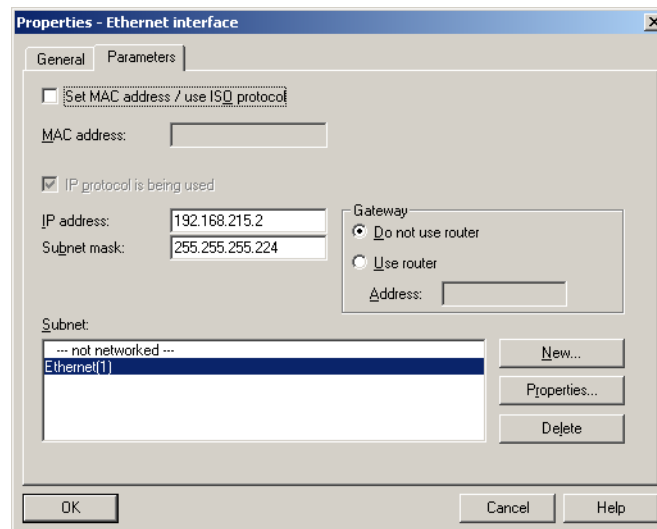
5. Deactivate the option "Set MAC address/Use ISO protocol" and confirm with "OK".

6. You can configure additional interfaces via "New".

7. If you have configured the interfaces, all the configured interfaces are visible under the "Interface" tab:
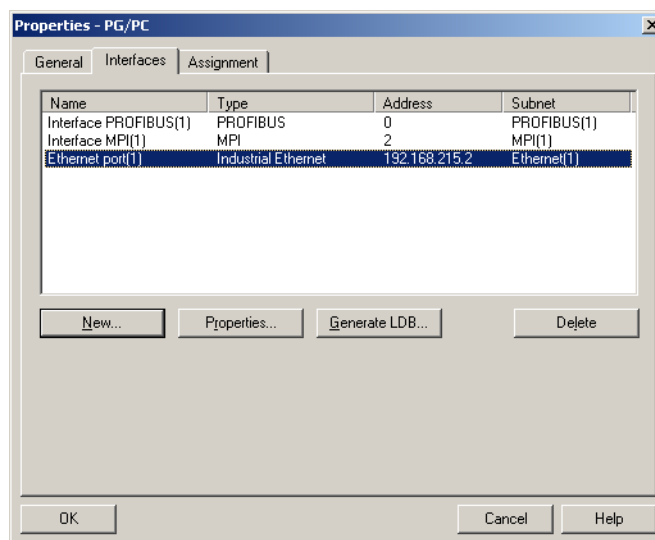
The configured interfaces must be assigned in a device-specific manner to the available hardware interfaces on the PG/PC. The sequence steps are laid out in the following section.

4.8.3   Assigning interfaces

Introduction

The interfaces configured in the previous chapter must now be assigned in a device-specific manner to the available hardware interfaces on the PG/PC.

Operating sequence for assigning an Ethernet interface

1. Select the "Assign" tab.

2. Select "Ethernet interface(1)" in the selection field "Configured interfaces".

3. Select in the "Interface parameter assignments in the PG/PC" selection field, the "TCP/IP -> Realtek RTL8139/810xF…" network card installed on the PG/PC.
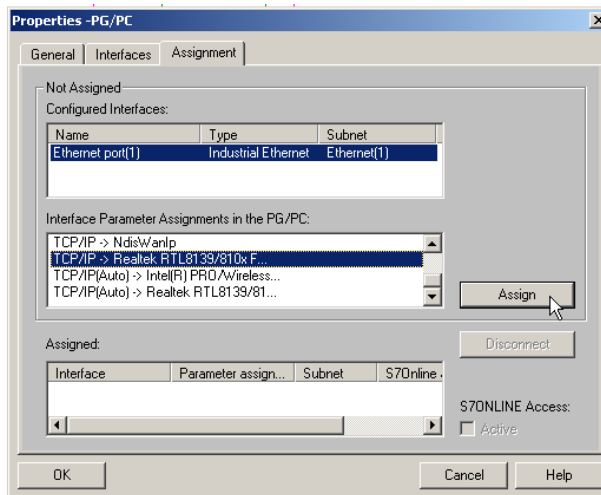
4. Click "Assign" and confirm the subsequent message on processing object properties with "OK". The assigned interfaces are deleted from the "Configured interfaces" field and these assigned interfaces are displayed in the "Assigned" field.
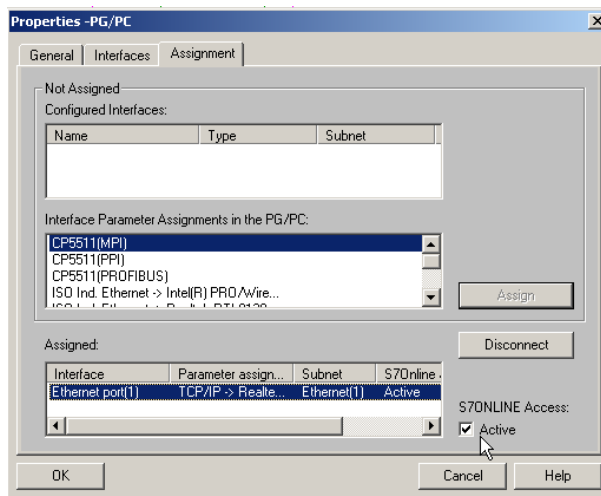
5. Now assign the remaining configured interfaces (PROFIBUS).

   From those interfaces assigned, one must be marked as "active".

6. Select "Ethernet interface" in the "Assigned" field and mark the field next to it as "active".

7. Click "OK" to end the dialog "Properties - PG/PC".

   In NetPro, the PG/PC interface declared as "active" has a yellow background.
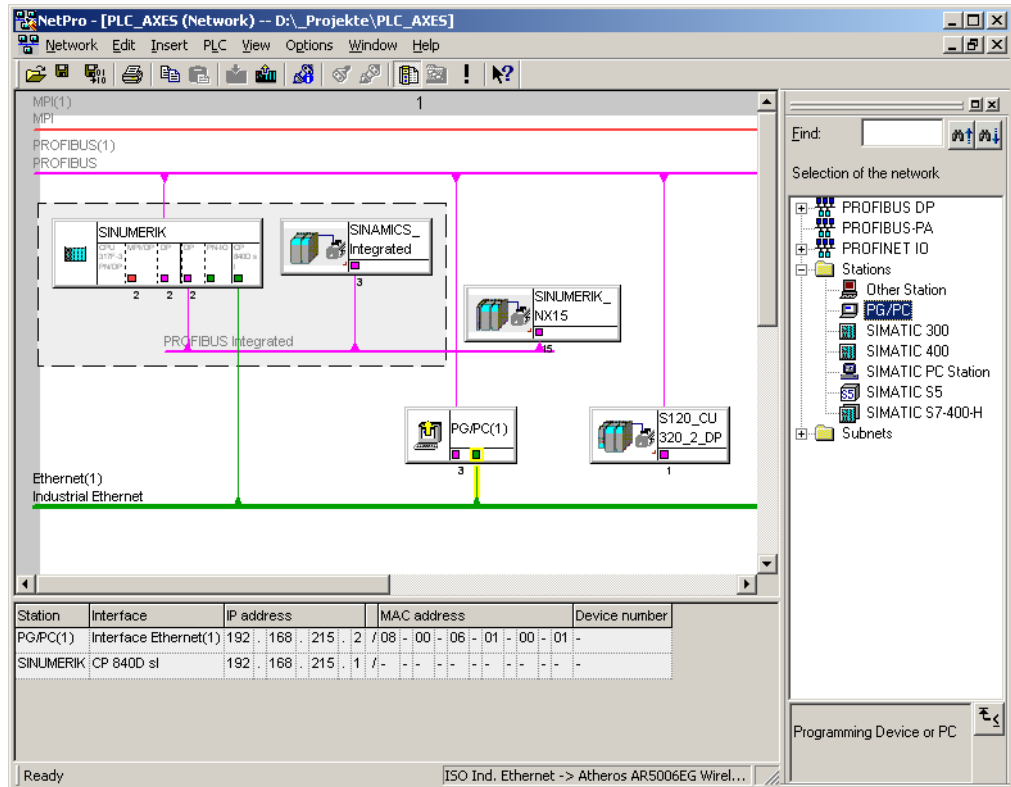
8. Select "Save and compile → Save and check all" and confirm the process with "OK".

The next described operating sequence explains how to load this hardware configuration to the NCU.

4.8.4 Loading the HW config to NCU

Introduction

The newly created network configuration PG/PC must be introduced to the NCU.

You have established a connection to the Ethernet interface (X120 or X127) and you now load this configuration from the PG/PC to the NCU.

Operating sequence for loading HW config to the NCU

1. Change from "NetPro" to "HW Config".

2. Click the "Download to module" button.

   The target module interactive screen form automatically displays both configured communication peers.

3. Confirm the load into the module with "OK".

4. Confirm the dialog boxes displayed subsequently with "OK" or "No" for the query "…Should the module be started now (restart)?".

Note

Loading the HW config to the NCU is only possible via the Ethernet interface.

Commissioning NC-controlled drives

5

Overview

You have the following options when commissioning NC-controlled SINAMICS drives:

- Guided commissioning

  For "Guided commissioning", you are guided through the configuration / parameterization of the units, infeed(s) and drives (SERVO).

  ### Note

  We recommend that "Guided commissioning" is used when commissioning a drive system for the first time.

- Manual commissioning

  For "Manual commissioning", you can select the steps of "Guided commissioning" in any sequence. You perform additional optional functions that are not part of "Guided commissioning" (e.g. PROFIBUS connection).

  ### Note

  "Manually commissioning" is recommended for experienced commissioning engineers.

The closed-loop drive control for SINAMICS S120 is integrated in the NCU. The drives connected to the internal virtual PROFIBUS can only be assigned to NC axes.

The assignment is realized using the axis machine data:

- MD30110 $MA_CTRLOUT_MODULE_NR (setpoint channel)
- MD30220 $MA_ENC_MODUL_NR (actual value channel)
- MD30130 $MA_CTRLOUT_TYPE (type of output setpoint)
- MD30240 $MA_ENC_TYPE (acquisition of actual value)
- MD13050 $MN_DRIVE_LOGIC_ADDRESS (axis address)

  The logical I/O addresses ≥ 4100 are determined in this machine data.

  The NC axis assignment is also made using the above-mentioned machine data with the modified logical I/O address ≤ 4095.

  ### Note

  A drive that can be assigned to an NC axis must be a standard slave according to the PROFIdrive profile version 4.1.

5.1 Configuration examples

5.1.1 Example: Configuration of the drive components

Configuration overview

The commissioning described in this manual is orientated on the following example configuration of the SINAMICS drive line-up.

- NCU 720.3 PN with:
    - A Single Motor Module for a motor with SMI (Sensor Module Integrated)
    - A Double Motor Module for two motors each with an SMC20 (Sensor Module Cabinet).
- NX 15.3 with:
    - A Single Motor Module for a motor with two SMC20 units for the encoders.
- Infeed (Active Line Module)
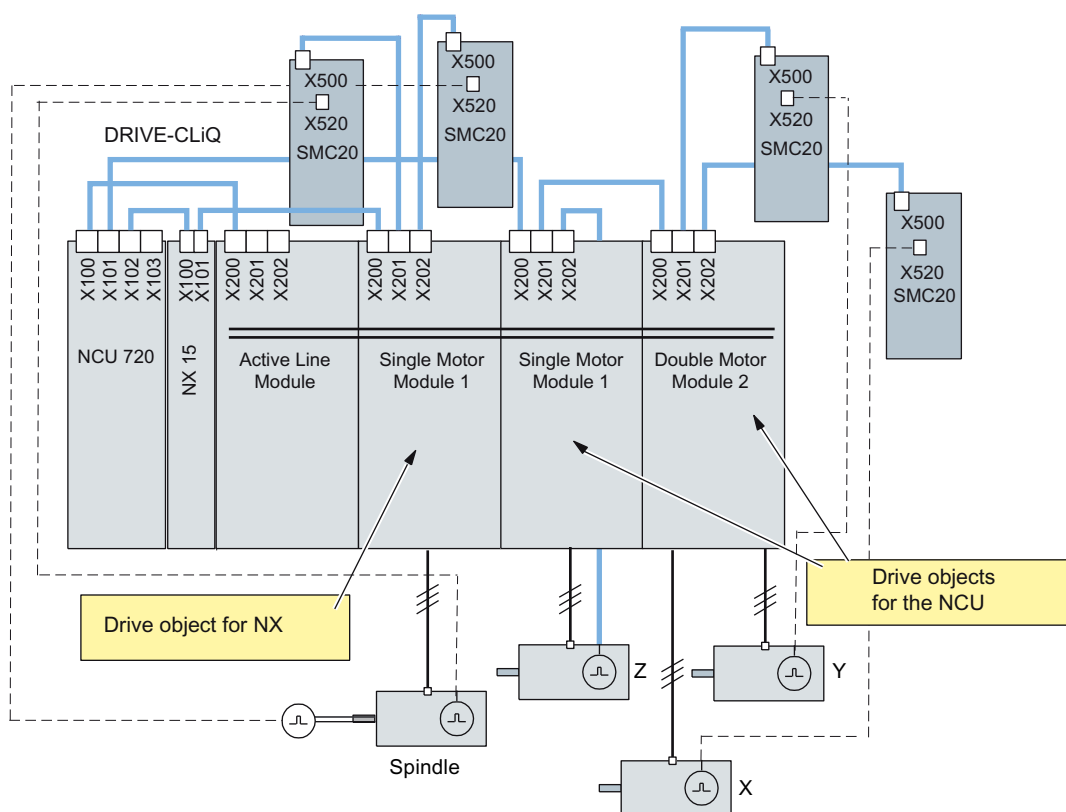
Figure 5-1   SINAMICS S120 example configuration

Literature

Additional DRIVE-CLiQ components of the SINAMICS drive line-up can be found in:
SINAMICS S120 Equipment Manual for "Control Units and Additional System Components"
/GH1/

5.1.2 Example: Parallel connection with TM120

Application: Four motors connected in parallel

Sample topology:

4 x temperature input
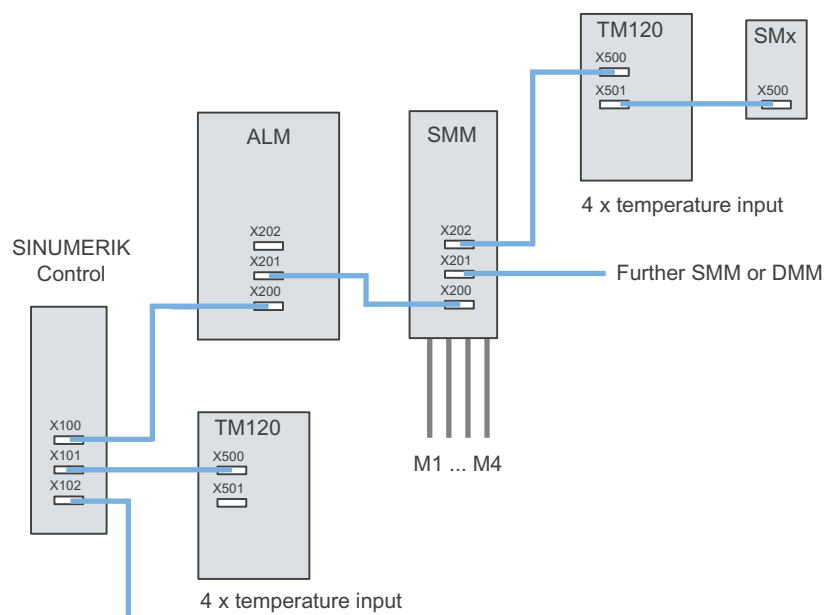
M1 ... M4	Motor 1 ... motor 4
	One KTY and three PTC in series are connected for each motor.
SMx	Sensor Module (motor encoder)
ALM	Active Line Module
DMM	Double Motor Module
SMM	Single Motor Module
TM120	Terminal Module

The shown topology requires four KTY sensors and four PTC sensors:

- Each primary section has one KTY sensor (Temp-F) and three series-connected PTC sensors (Temp-S).

Two TM120s are required:

- A TM120 is interconnected automatically in series between the Motor Module and the SMx sensor module.

- A TM120 is directly inserted into a Line Module: This requires a manual interconnection by the commissioning engineer.

Measures for the TM120:

1. **TM120 between the Motor Module and the SMx Sensor Module**

   This TM120 evaluates four KTYs => sensor types must be selected by Servo-p4610/TM-p4100. The associated temperature is output by servo-r4620/TM120-r4105.

2. **TM120 directly on the Line Module**

   This TM120 evaluates four PTCs => sensor types must be selected by TM-p4100. The associated temperature is output by servo-r4105.

   Setting the threshold values in the PTC context:

   – TM120-p4102[x]=251 => evaluation Off

   – TM120-p4102[x]=120 => evaluation On

   Assignment of the TM120 response using fault propagation on the drive => setting of the propagation by servo-p0609=BICO:<object number>TM120:4105.0

Assignment of the alarms to the motor

The occurring error messages are assigned to the motors as follows:

- Temperature channel on the TM120 in series connection with motor modules and encoders:

  Alarm 207015 <location>drive: Motor temperature sensor warning

  Alarm 207016 <location>drive: Motor temperature sensor fault

  Alarm 235920 <location>TM: Temperature sensor channel 0 error

  In this case, the output message with reference to the motor and to the temperature component shows the relevant motor.

- Temperature channel on the TM120 directly to the line module:

  Alarm 235207 <location>TM: Temperature fault/alarm threshold channel 0 exceeded

  Special feature with PTC:

  TM120-r4105 = -50 temperature is below the nominal response temperature

  TM120-r4105 = 250 temperature is above the nominal response temperature

  In this case, a message is output only with reference to the temperature component.

  The affected motor can be determined from the information concerning the TM120.

5.2 Terminal assignment

5.2.1 NCU 7x0.3 PN terminal assignment

The SINAMICS device configuration (Page 79) occupies the following terminals on an NCU 7x0.3 PN:

- X122
- X132
- X142

The following table lists the terminal assignments for the X122, X132 and X142 terminal blocks of the NCU.

5.2.2 X122 terminal assignment

Terminal	Signal name	Function	Pre-assignment
X122.1	DI 0	Input ON/OFF1 infeed (if **one** infeed with a DRIVE-CLiQ connection is operated at the NCU)	x
X122.2	DI 1	Input 2. Operating condition OFF3 drives "OFF3 rapid stop" Braking with a configurable OFF3 ramp (p1135, p1136, p1137); thereafter, pulse suppression and switching on inhibited. The drive stops controlled. The braking response can be set separately for each SERVO.	x
X122.3	DI 2	Selection safe standstill group 1 SH/SBC - Group 1 SINAMICS Safety Integrated (SH = p9601 release)	---
X122.4	DI 3	Selection safe standstill group 2 SH/SBC - Group 2 SINAMICS Safety Integrated (SH = p9601 release)	---
X122.5	DI16	Freely available	---
X122.6	DI17	Freely available	---
X122.7	Ground for terminals 1...6		
X122.8	Ground for terminals 9, 10, 12, 13		
X122.9	DI/DO 8	Status safe standstill group 1 SH/SBC - Group 1 SINAMICS Safety Integrated	---
X122.10	DI/DO 9	Status safe standstill group 2 SH/SBC - Group 2 SINAMICS Safety Integrated	---

Terminal	Signal name	Function	Pre-assignment
X122.11	Ground for terminals 9, 10, 12, 13		---
X122.12	DI/DO 10	Input, external zero mark Bero 1 – "equivalent zero mark"	---
X122.13	DI/DO 11	Input probe 1 - central measurement (Check that MD13210 = 0)	x
		Input probe 1 - distributed measurement (Check that MD13210 = 1)	---
X122.14	Ground for terminals 9, 10, 12, 13		

In the "pre-assignment" column, the signals for which the associated SINAMICS parameters are set when configuring a SINAMICS device are marked with "x".

5.2.3   X132 terminal assignment

Terminal	Signal name	Function	Pre-assignment
X132.1	DI 4	Freely available	---
X132.2	DI 5	Freely available	---
X132.3	DI 6	Freely available	---
X132.4	DI 7	Infeed line contactor feedback signal (if **one** infeed is operated with a DRIVE-CLiQ connection at the NCU)	---
X132.5	DI20	Freely available	---
X132.6	DI21	Freely available	---
X132.7	Ground for terminals 1...6		
X132.8	Ground for terminals 9, 10, 12, 13		
X132.9	DI/DO 12	Output: Infeed operation (if **one** infeed is operated with a DRIVE-CLiQ connection at the NCU)	x
		Input 2. Operating condition OFF2 drives	---
X132.10	DI/DO 13	Output: Status, infeed ready to start (if **one** infeed is operated at the NCU with a DRIVE-CLiQ connection)	x
		Input 2. Operating condition OFF2 drives	---
		Input, external zero mark 2	---
		Input probe 2 - central measurement	---
		Input probe 2 - distributed measurement	---
X132.11	Ground for terminals 9, 10, 12, 13		
X132.12	DI/DO 14	Input 2. Operating condition OFF2 drives	---
		Input, external zero mark 3	---
		Input probe 2 - central measurement	---
		Input probe 2 - distributed measurement	---
		Infeed, control line contactor	---

Terminal	Signal name	Function	Pre-assignment
X132.13	DI/DO 15	Input 2. Operating condition OFF2 drives	---
		Input, external zero mark 4	---
		Input probe 2 - central measurement	---
		Input probe 2 - distributed measurement	---
X132.14	Ground for terminals 9, 10, 12, 13		

In the "pre-assigned" column, the signals for which the associated SINAMICS parameters are set when configuring a SINAMICS device are marked with "x".

5.2.4 X142 terminal assignment

Terminal	Signal name	Function		Pre-assignment
X142.1	---	reserved		---
X142.2	---	reserved		---
X142.3	DI0	NCK input	$A_IN[1]	fixed
X142.4	DI1	NCK input	$A_IN[2]	fixed
X142.5	Ground for terminals X142.3, 4, 6, 7, 9, 10, 12, 13			---
X142.6	DI2	NCK input	$A_IN[3]	fixed
X142.7	DI3	NCK input	$A_IN[4]	fixed
X142.8	Power supply			---
X142.9	DO4	NCK output	$A_OUT[1]	fixed
X142.10	DO5	NCK output	$A_OUT[2]	fixed
X142.11	Ground for terminals X142.3, 4, 6, 7, 9, 10, 12, 13			---
X142.12	DO6	NCK output	$A_OUT[3]	fixed
X142.13	DO7	NCK output	$A_OUT[4]	fixed
X142.14	Ground for terminals X142.3, 4, 6, 7, 9, 10, 12, 13			---

5.2.5 NX 1x.3 terminal assignment

The table lists the assignments of the terminals on an NX 1x.3 for the X122 terminal strip.

The SINAMICS device configuration sets the following preassignment:

Number	Function	Signal	Pre-assignment
X122.1	DI 0	Input ON/OFF1 infeed (if **one** infeed with a DRIVE-CLiQ connection is operated at the NX)	x
		Input infeed operation - "infeed ready signal" (if **no** infeed with DRIVE-CLiQ connection is operated at the NX)	x
X122.2	DI 1	Input 2. Operating condition OFF3 drives	x
		Freely available	--
X122.3	DI 2	Selection safe standstill group 1	--
		SH/SBC - Group 1 SINAMICS Safety Integrated (SH = p9601 release)	
X122.4	DI 3	Selection safe standstill group 2	--
		SH/SBC - Group 2 SINAMICS Safety Integrated (SH = p9601 release)	
X122.5	DI 16	Freely available	--
X122.6	DI 17	Freely available	--
X122.7	Reference potential for terminals 1…6		
X122.8	Mass		
X122.9	DI/DO 8	Status safe standstill group 1	-
		SH/SBC - Group 1 SINAMICS Safety Integrated	
X122.10	DI/DO 9	Status safe standstill group 2	--
		SH/SBC - Group 2 SINAMICS Safety Integrated	
X122.11	Mass		
X122.12	DI/DO 10	Input, external zero mark	--
		BERO 1 – "equivalent zero mark"	
X122.13	DI/DO 11	Input, external zero mark 2/1	--
		Input 2. Operating condition OFF2 drives	--
X122.14	Mass		

Those signals for which the associated SINAMICS parameters are set for the SINAMICS device configuration are marked with "x" in the "Pre-assigned" column.

See also

Automatic device configuration (Page 79)

5.2.6 Support for terminal assignment

Support for terminal assignment

The following overview shows the terminal assignment of those drive units (NCU, NX) involved on the SINAMICS drive line-up, in the commissioning tool V7.7.

"Commissioning" > "Drive system" > "Drive units" > "Inputs/outputs" menu:

Figure 5-2   Interconnection of the digital inputs/outputs

5.3 Guided commissioning of SINAMICS drives

5.3.1 Triggering a reset (warm restart) for NCK and drive system

Introduction

After booting the system you will find yourself in the "Machine" operating area:
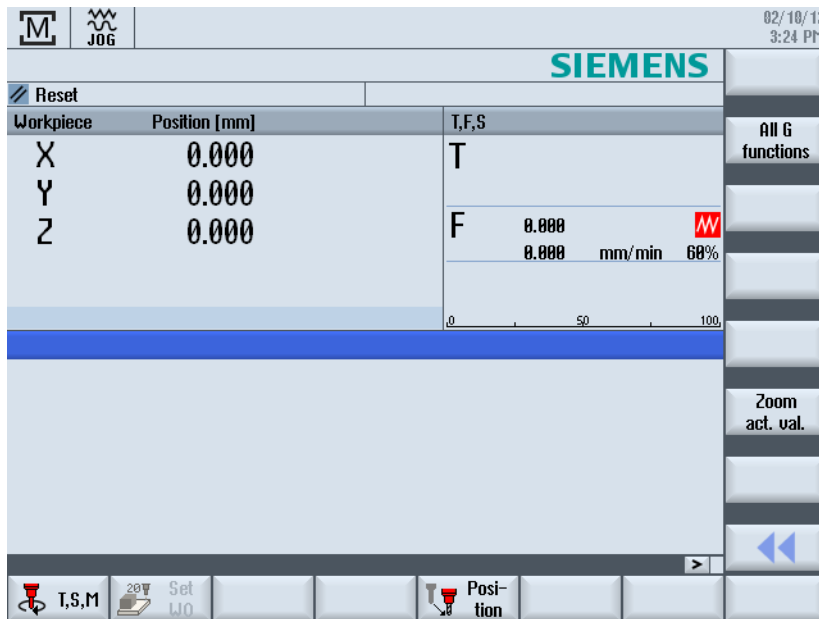
In the previous step before loading the project to the PLC (Page 55), this was brought into the STOP state. The NCK interprets this STOP state, with a corresponding alarm response, as failure of the PLC.

Alarm response

A "Reset (po)" (warm restart) is required for the PLC-NCK synchronization. This can cause alarm responses. The output of all alarms in form list can be found in the "Diagnostics" → "Alarms" operating area. Additional support for the diagnosis of the drive system is described in Section Drive system diagnostics (Page 124).

Operating sequence for initiating an NCK reset

1. Press the <MENU SELECT> key and select the "Commissioning" operating area.

The commissioning operating area is displayed without password:
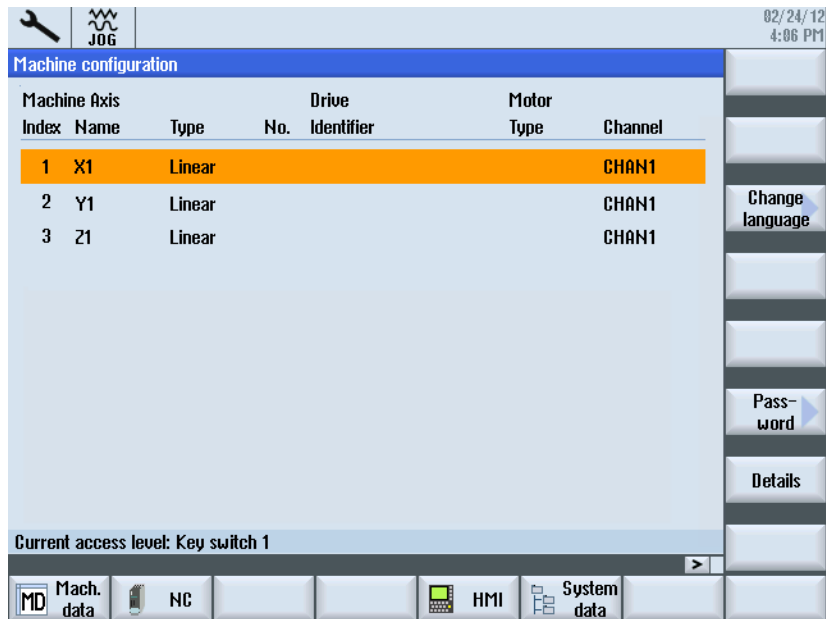
2. Press "Password...".

3. Press "Set password".

4. Enter the password for the "Manufacturer" access level.

5. Confirm with "OK".
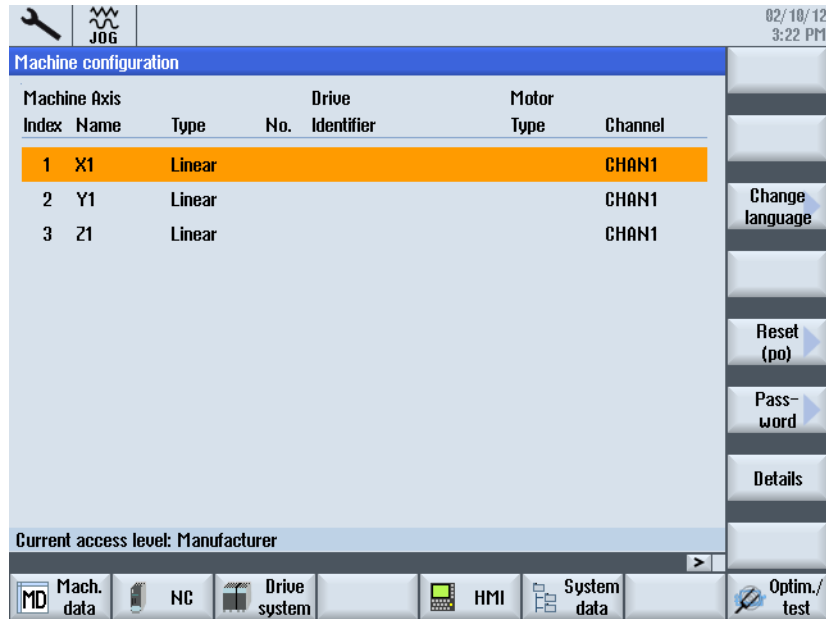
6. Press the "Reset (po)" softkey.

7. Acknowledge the "Do you want to trigger a reset (warm restart) for the NCK and the entire drive system (all drive units)?" prompt with the "Yes" softkey.

The PLC goes to RUN mode. Guided commissioning of the SINAMICS drives is then started. Continue with the steps described in the following chapter.

5.3.2 Automatic device configuration

Automatic device configuration

Procedure:

You have set the password for manufacturer and initiated a reset (warm restart). The following alarm is initiated:

"120402 ... SINAMICS initial commissioning required! ".

1. Once the complete drive system has powered-up, the following dialog for the automatic device configuration is displayed:
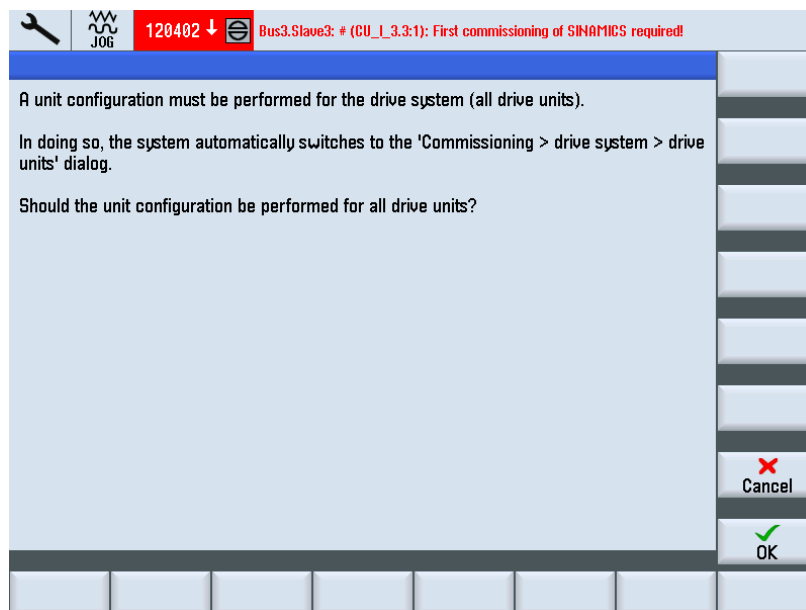
2. Press "OK".

   If you press "Cancel", then you can manually perform the commissioning (see Chapter Manual commissioning of SINAMICS drives (Page 102)).

3. The individual steps for automatic device configuration are displayed one after the other in the following dialog box:
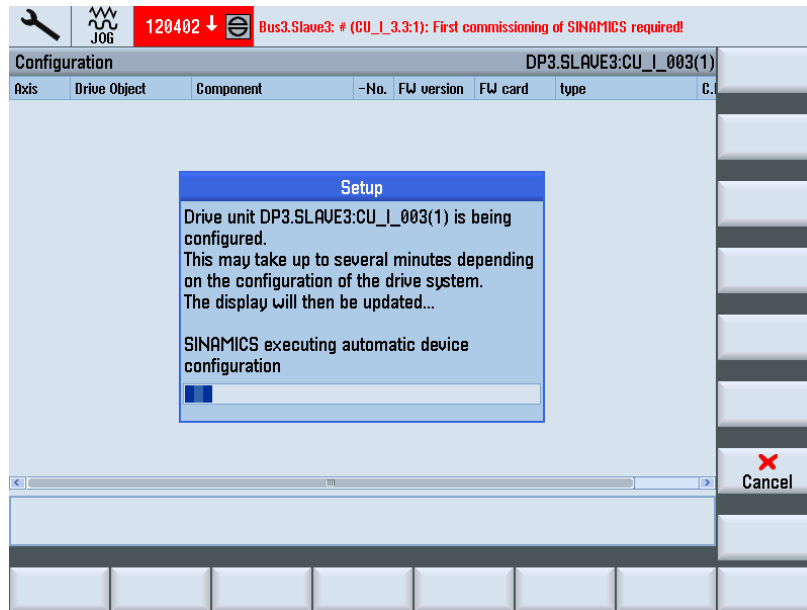
4. The following dialog box is displayed after the device has been configured:
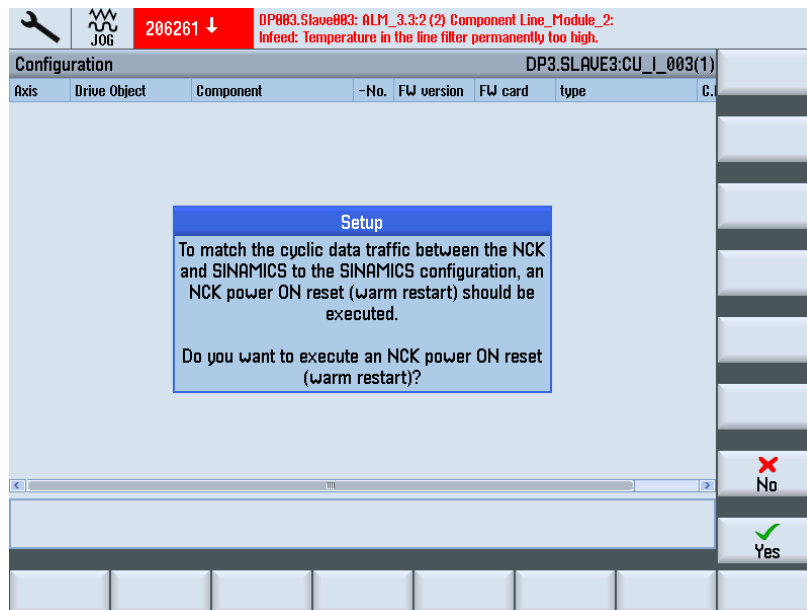
5. Press "Yes".

   The following notes are displayed during the NCK power on reset:

   – "Wait for communication with the NC"

   – "Wait for communication to the drive"

   – "Wait until communication is restored"

   After the automatic device configuration, an automatic check is made which infeeds and drives (SERVO) still need to be parameterized/commissioned. Commissioning guides you using the following dialog box to the individual drive objects that have still not been commissioned.
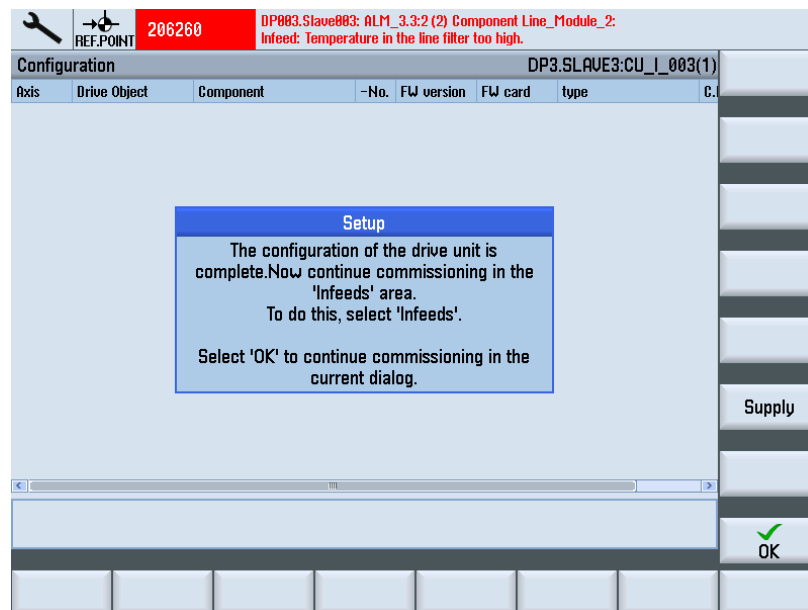
6. Press the "Infeeds" softkey to continue with the parameterization of the infeed in the following section.

5.3.3 Parameterization of infeed

Operating sequence

The system detects that the infeed has not been commissioned and that a commissioning is required:

1. Select the "Commissioning" > "Drive system" > "Infeeds" menu.
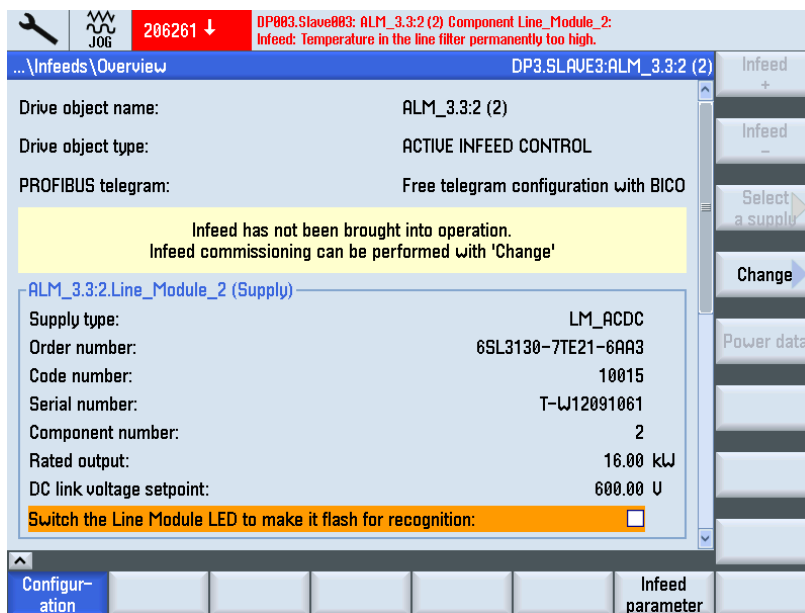
2. The commissioning is performed with the "Change" vertical softkey.

   The wizard guides you step-by-step through the commissioning when you press the "Next step" softkey.
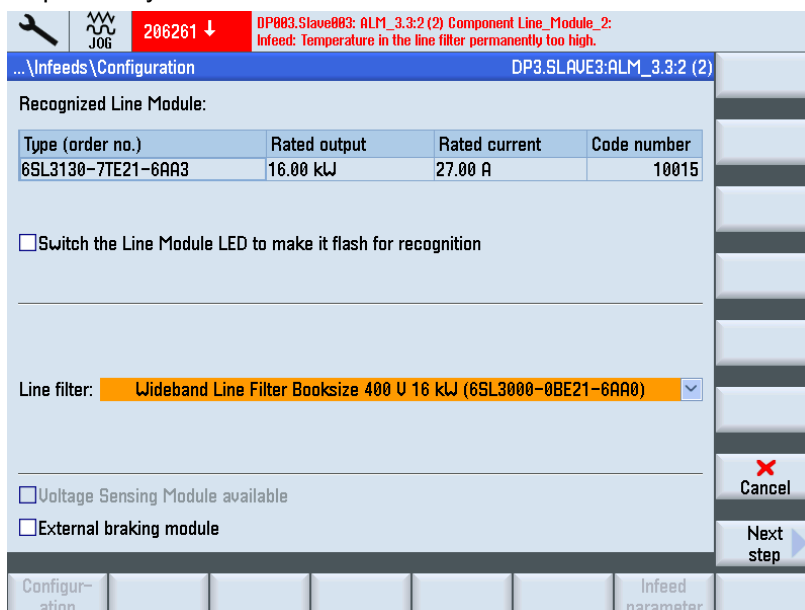
3. Select the net filter: In this example, a Broadband Line Filter (16 kW) is available.

4. Accept the default setting (see also: Check the power system data of the infeed (Page 150)).

5. Select the terminal wiring.
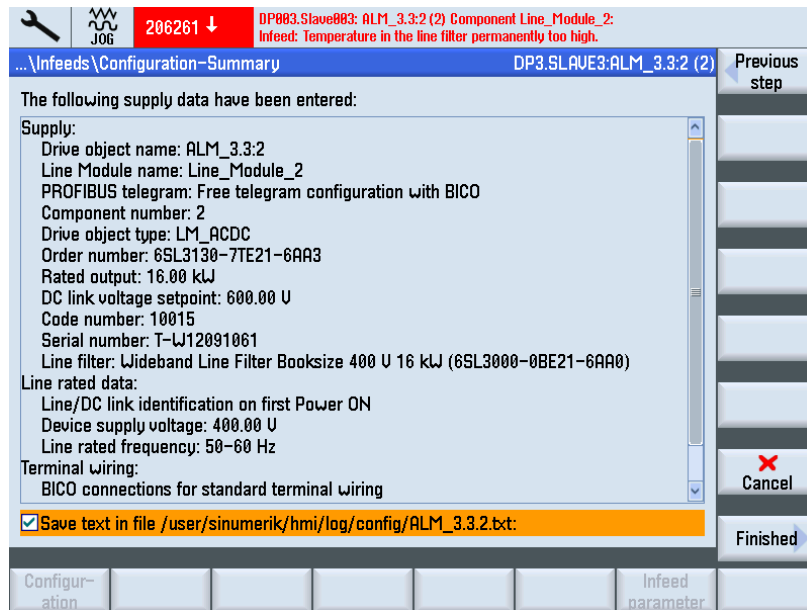
Check the configuration in the summary. You have now completed configuring the infeed. Optionally, you can save the configuration data in a text file.

6. Press the "Finish >" softkey.
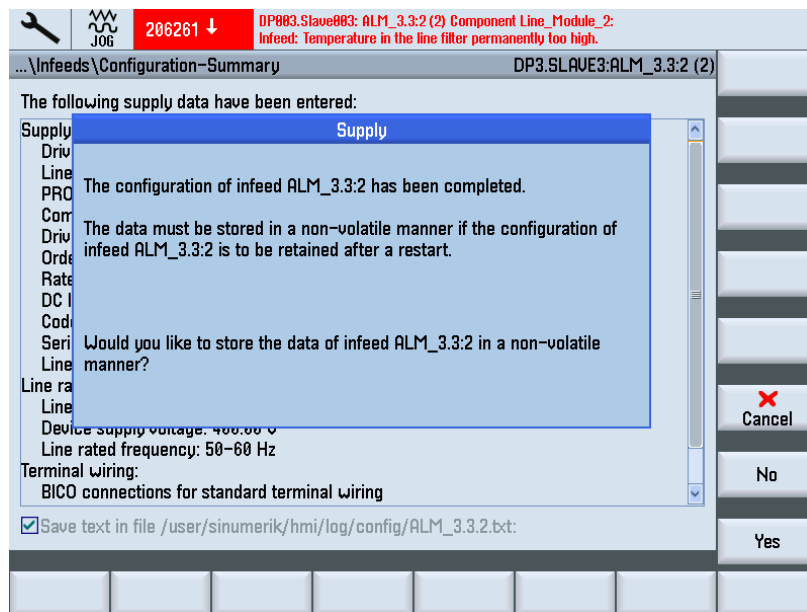
7. Press "Yes" to save the data to the non-volatile memory.

8. After commissioning the infeed, an automatic check is made for which drives (SERVO) still need to be commissioned. The following dialog appears:
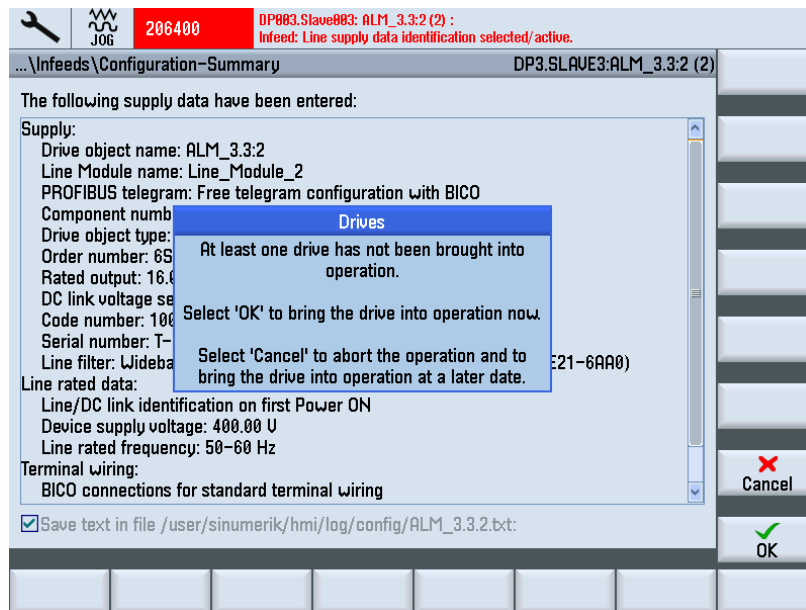
9. Press the "OK" softkey to continue with the steps to commission the drives (see also: Parameterization of the drives (Page 87)).

The overview screen of the infeed is displayed if "Cancel" was pressed:
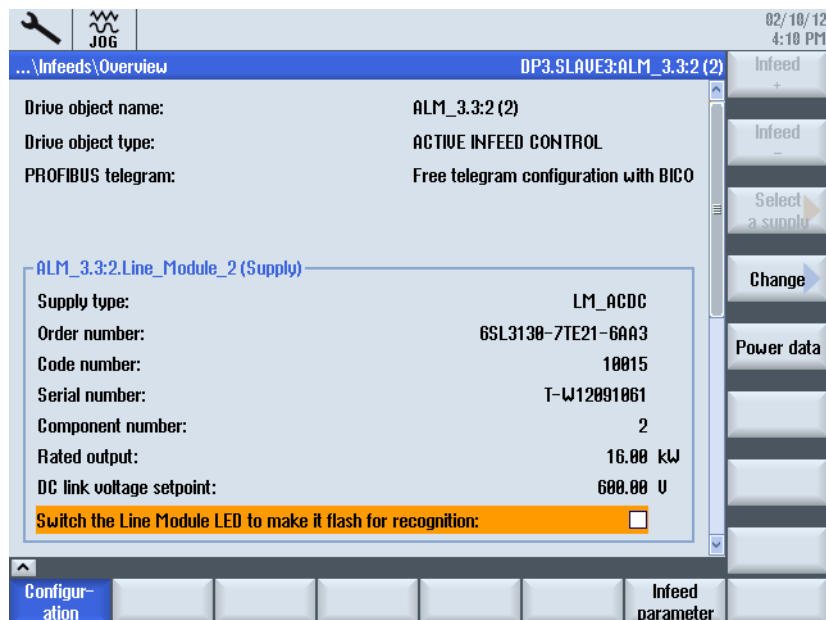
Figure 5-3   Infeeds\overview (page 1)
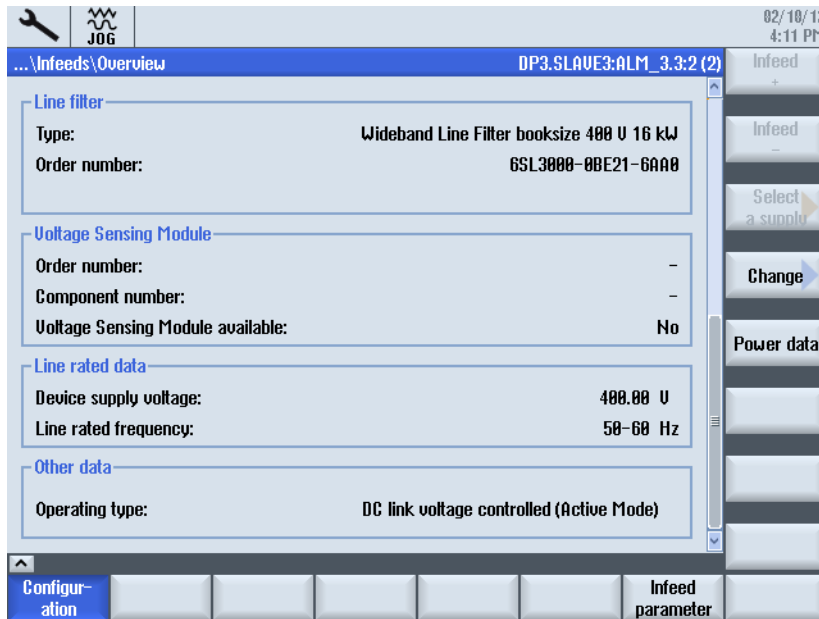
Figure 5-4   Infeeds\overview (page 2)

Note

The "Guided commissioning" ends here. Using " Manual commissioning (Page 102) " you can now perform additional commissioning steps.

5.3.4 Parameterization of the drives

Introduction

The following components are parameterize/configured with the drive wizard:

- Motor
- encoder
- Interface signals

Parameterizing/configuring

Guided commissioning navigates you through the commissioning of SINAMICS drives with motors without SMI (Sensor Module Integrated).

For motors without SMI, when parameterizing/configuring, a distinction is made between the following motor types:

- Catalog motors (standard motors, listed with associated motor data) (Page 88)
- Third-party motors (Page 94)

Note

Motors with SMI (DRIVE-CLiQ) are automatically configured by the drive unit during the device configuration with a drive data set (DDS), but only with the motor measuring system; i.e. motors with SMI only have to be configured with the drive wizard when more than one drive/motor data set (DDS/MDS) or a second (direct) measuring system is required.

5.3.4.1 Commissioning of listed motor and encoder via SMC

Operating sequence

In our example a power section is to be configured with a listed motor and encoder. You are in the "Commissioning" → "Drive system" → "Drives" menu:

1. The system detects that the drive object has not been commissioned and that an initial commissioning is required:
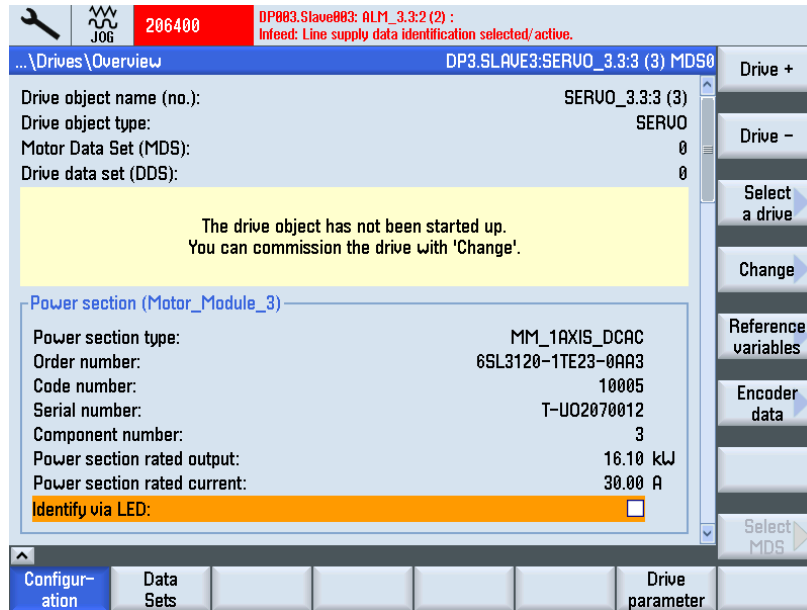
2. Press the "Change" vertical softkey.
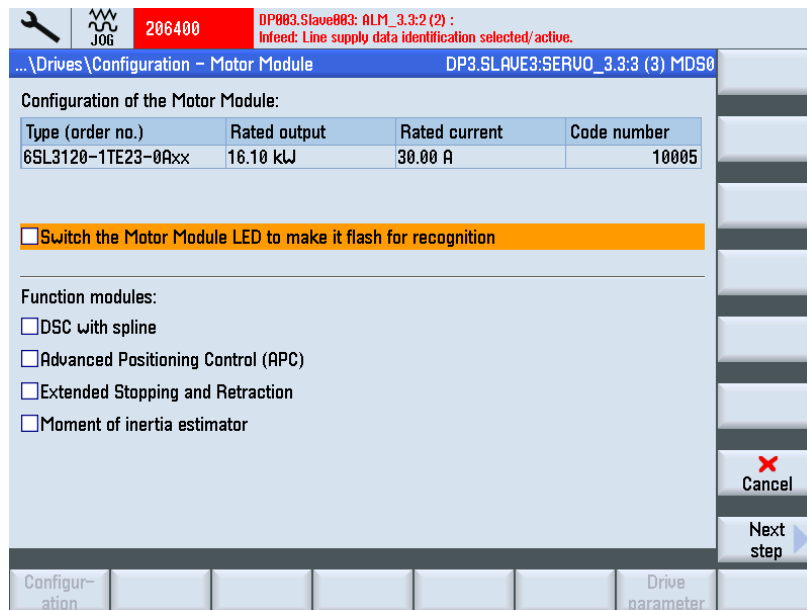
3. The motor module type is detected and output. Activate the available function modules.
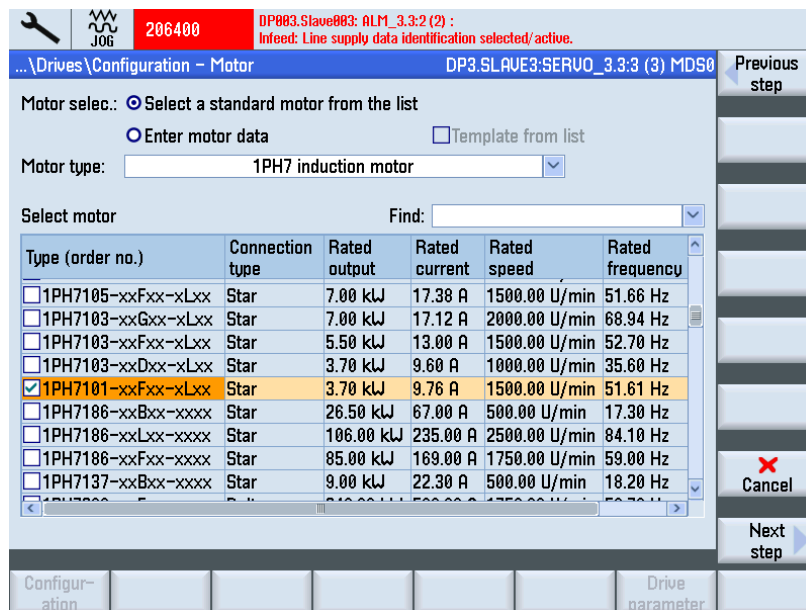
4. Select the "Select standard motor from list" option.

5. Select the motor with the "Cursor up / Cursor down" keys.

6. Press "Next step >".

7. You can select brake control in the "Configuration - motor holding brake" dialog. If a connected brake is detected during the unit configuration, the system will automatically activate the brake control and will by default display "Brake control according to procedural control" here.

8. Press "Next step >".
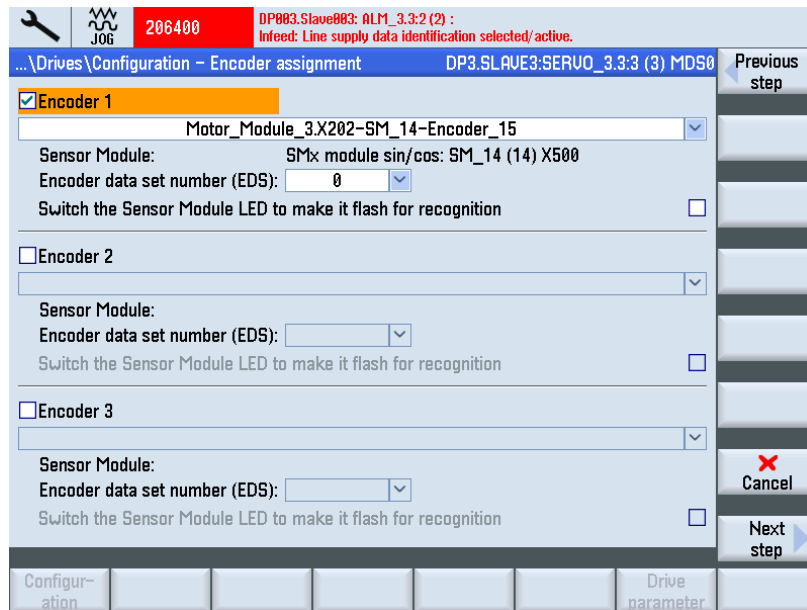
An identification of the selected encoders is triggered (Encoder 1).

The drive unit can identify encoders with EnDat protocol. These encoders are selected in the encoder list in the follow-up dialog boxes ("Configuration - Encoder 1" menu).
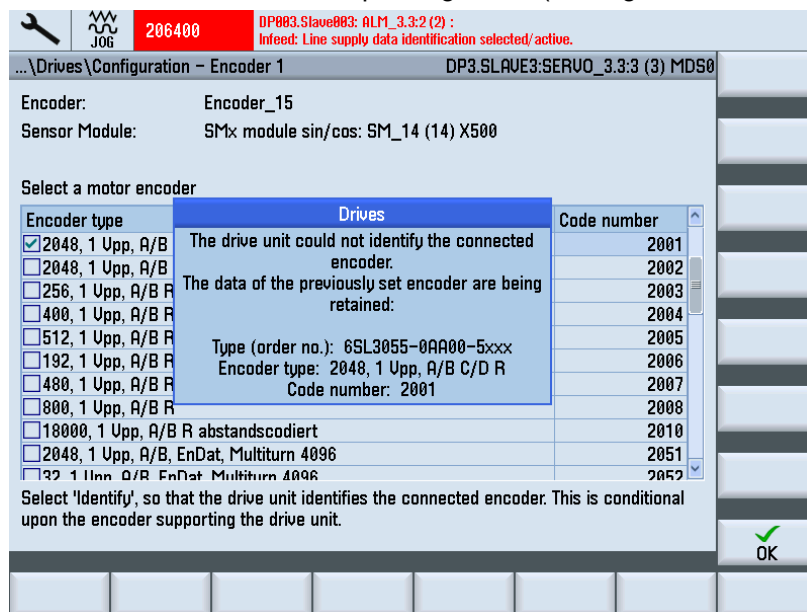
The entry "No encoder" is selected in the encoder list for encoders that the drive unit cannot identify. The connected encoder must be configured.
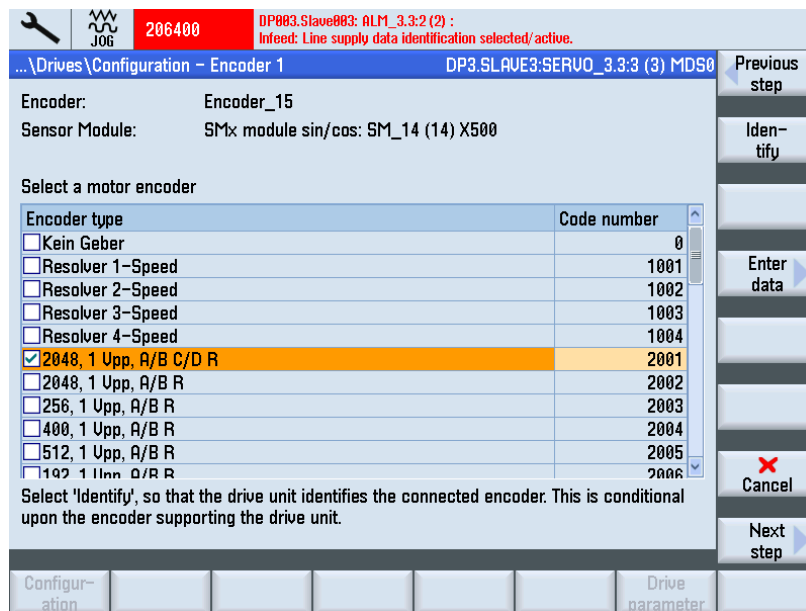
9. Select the motor encoder from the list: Select the encoder with the "Cursor up / Cursor down" keys. Alternatively, the encoder system can be parameterized manually using the "Enter data" softkey.

10. Press "Enter data".
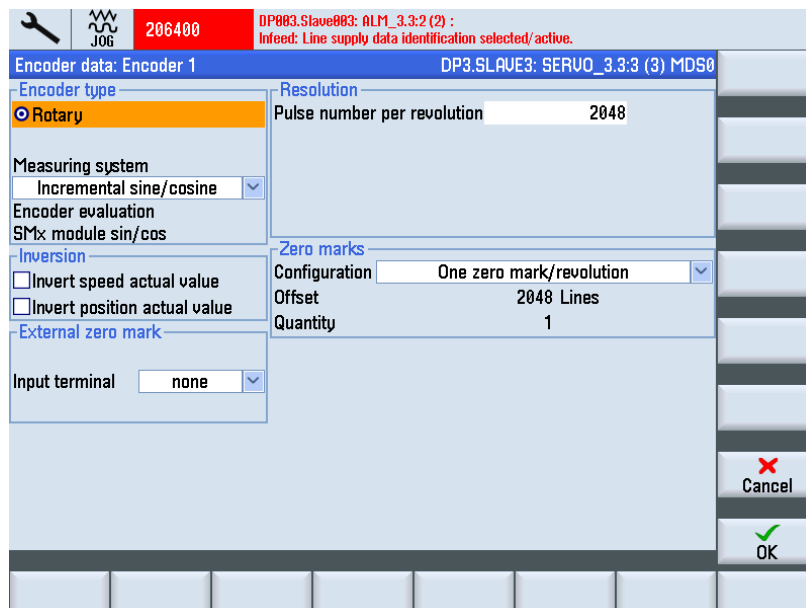
Check the encoder data of the connected encoder and confirm with "OK".

– Encoder type

– Incremental tracks

– Zero marks

– Synchronization

11. Press "Next step >".
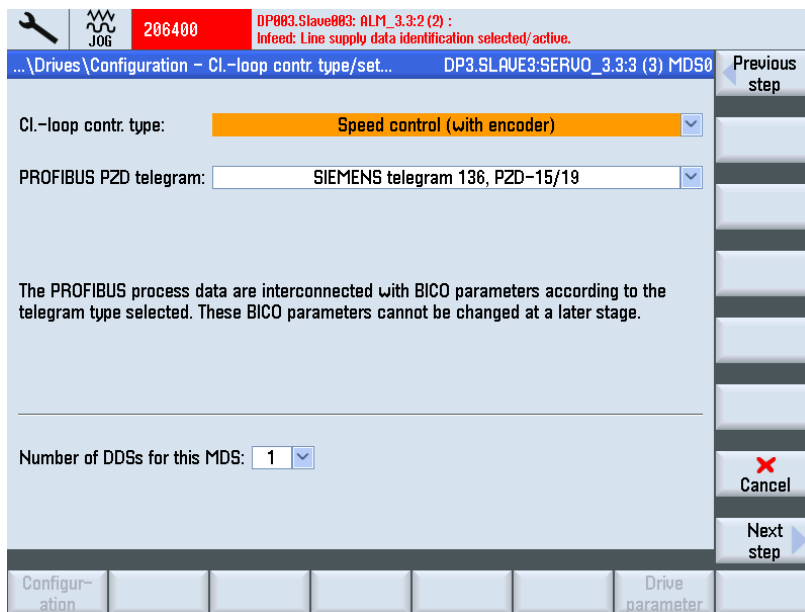
12. Set the number of required drive data sets (DDS). The default setting is one drive data set.

13. You can change the settings for the control mode and the PROFIBUS telegram type.

    The control mode and the PROFIBUS telegram are generally correctly pre-assigned by the drive wizards.

14. Press "Next step >".
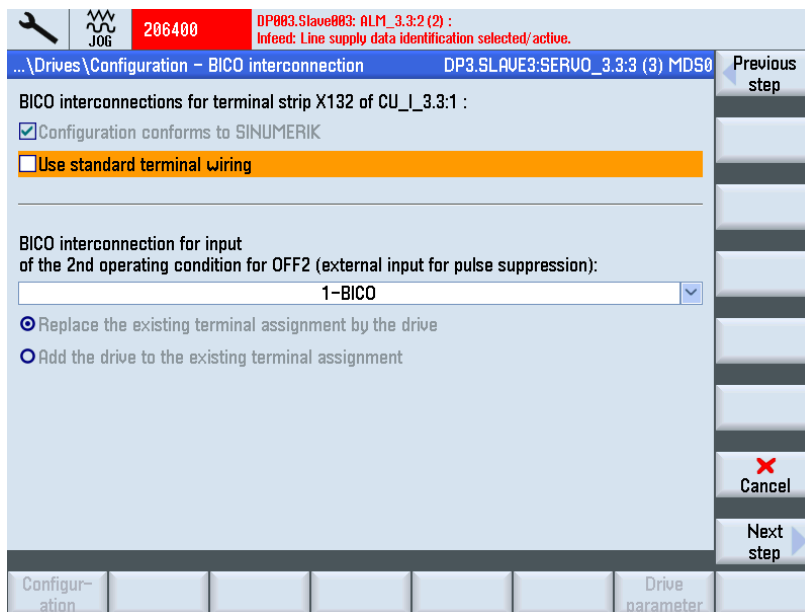
15. You can select the 2nd operating condition Input 2nd OFF2 (Page 71) (external input for pulse cancellation)

16. Press "Next step >".
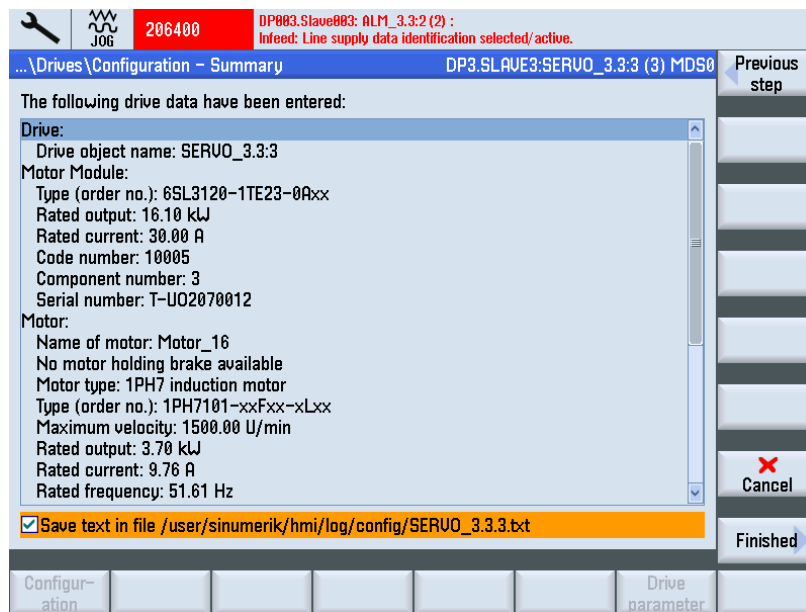
17. The configuration of a drive with listed motor has completed. You can check the configuration in the summary.

18. Press the "Finish >" softkey.
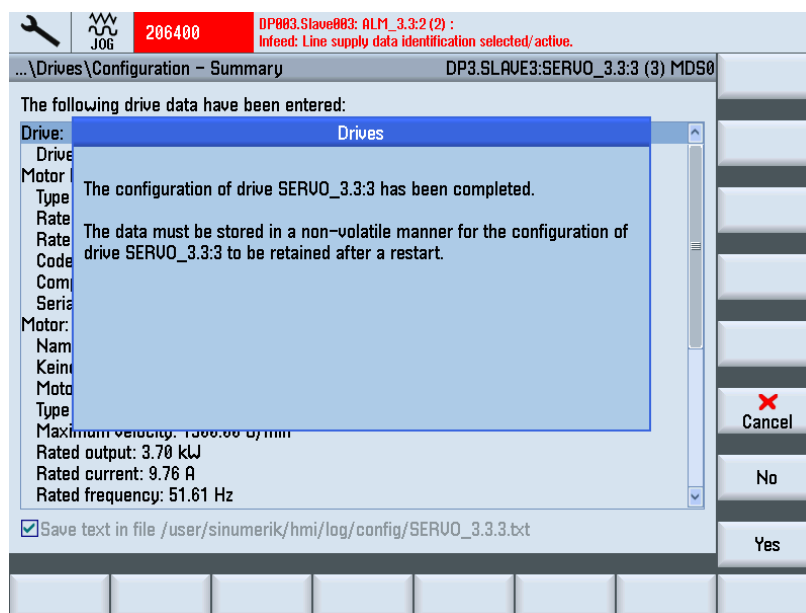
19. Confirm the query with "Yes".

20. The next section describes how you can configure a drive with a third-party motor and a second encoder.

5.3.4.2 Commissioning a third-party motor with encoder via SMC

Operating sequence

In our example a power section is to be configured with third-party motor and encoder. You are in the "Commissioning" → "Drive system" → "Drives" menu:

1. The system detects that the drive object has not been commissioned and that an initial commissioning is required:
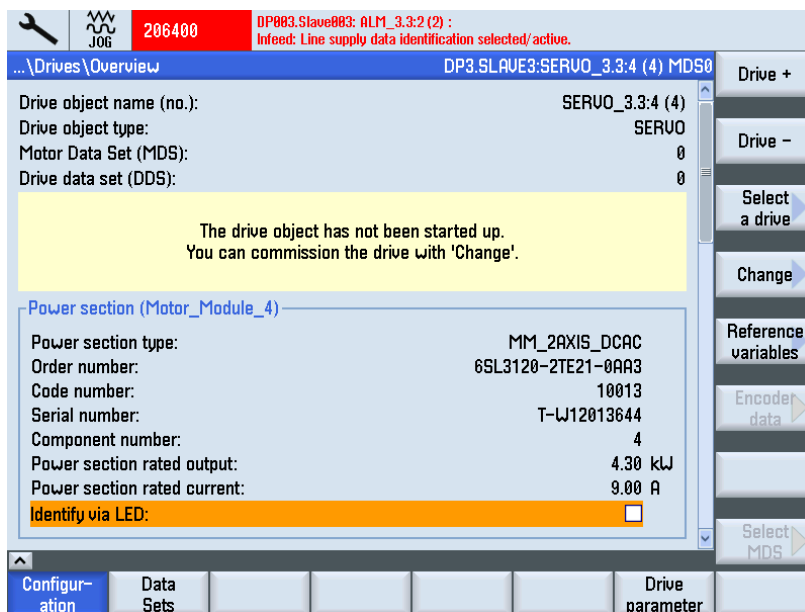
2. Press the "Change" vertical softkey.

   The power section (motor module) will be identified:
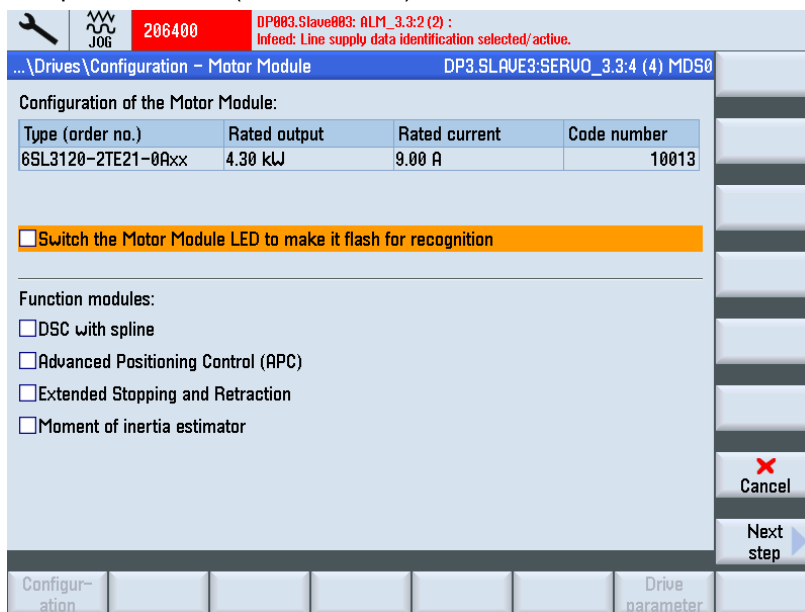
3. Press "Next step >".
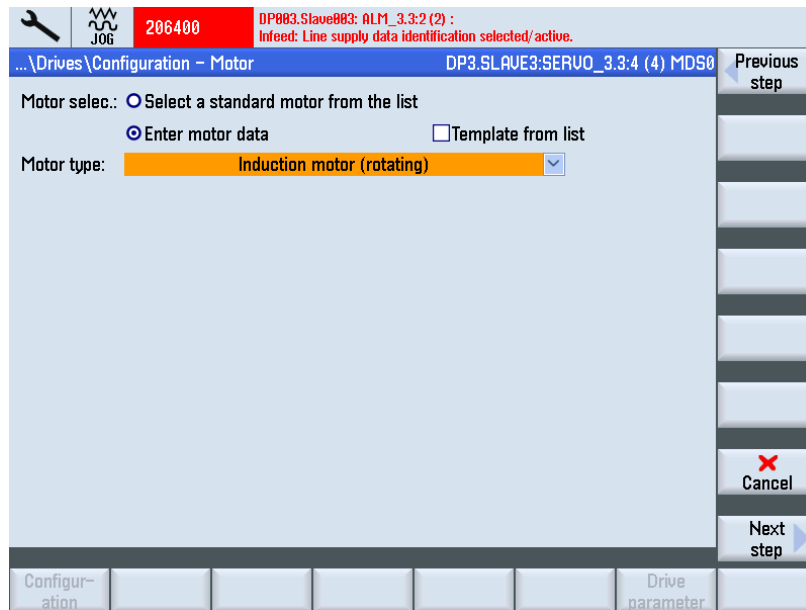
4. Select the "Enter motor data" option to select the motor type.

5. Press "Next step >" to select the type of the brake control in the next dialog.
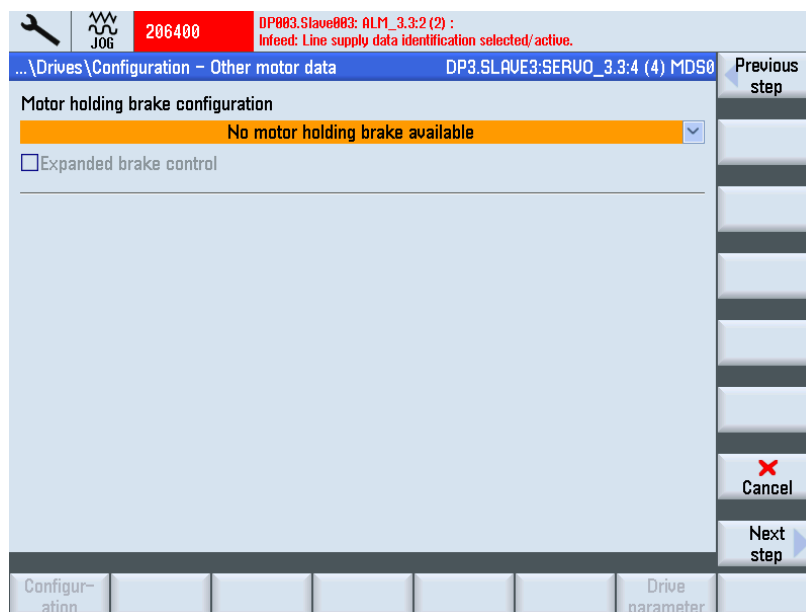
If a connected brake is detected during the unit configuration, the system will automatically activate the brake control and displays "Brake control according to procedural control".

6. Press "Next step >".

7. Enter the data for the connected motor.

8. If you have activated the "Replacement circuit diagram data" option, press "Next step >" to open the following dialog:

9. You can enter additional motor data here.

10. Press "Next step >".

11. Press "Next step >".

If more than one encoder has been selected, press "Next step >" successively to parameterize each individual encoder:

12. Press "Next step >".

   An identification of the selected encoders is triggered (Encoder 1).

   The drive unit can identify encoders with EnDat protocol. Select other encoders in the encoder list:
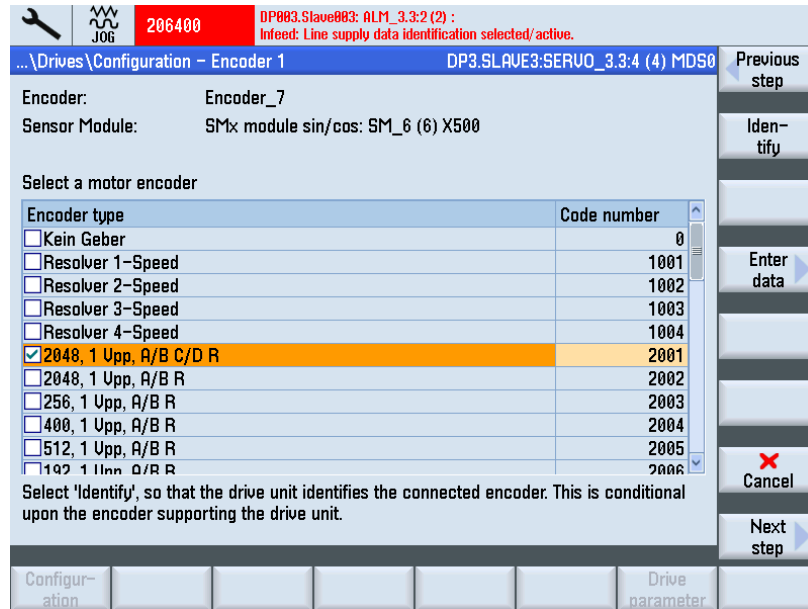
13. Press the "Input data" softkey to check or modify the encoder data.
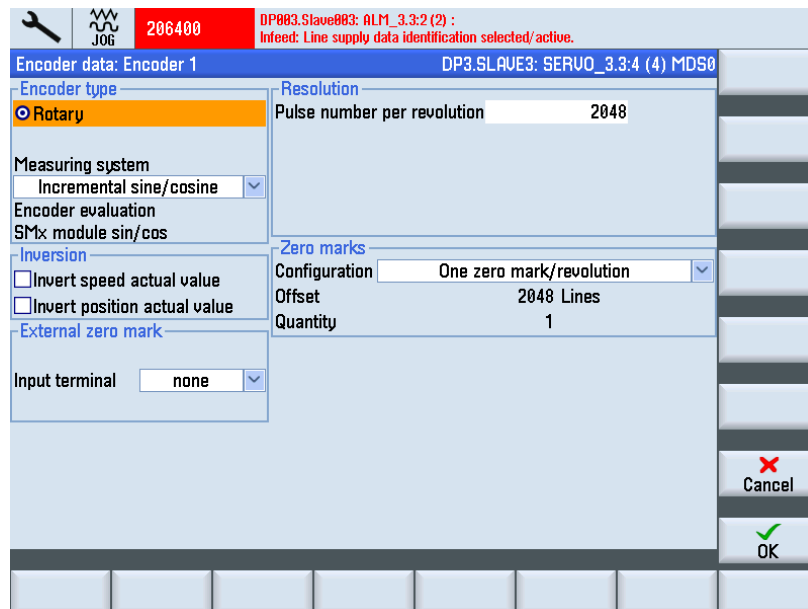
14.Confirm with "OK" and press "Next step >" to continue the commissioning.
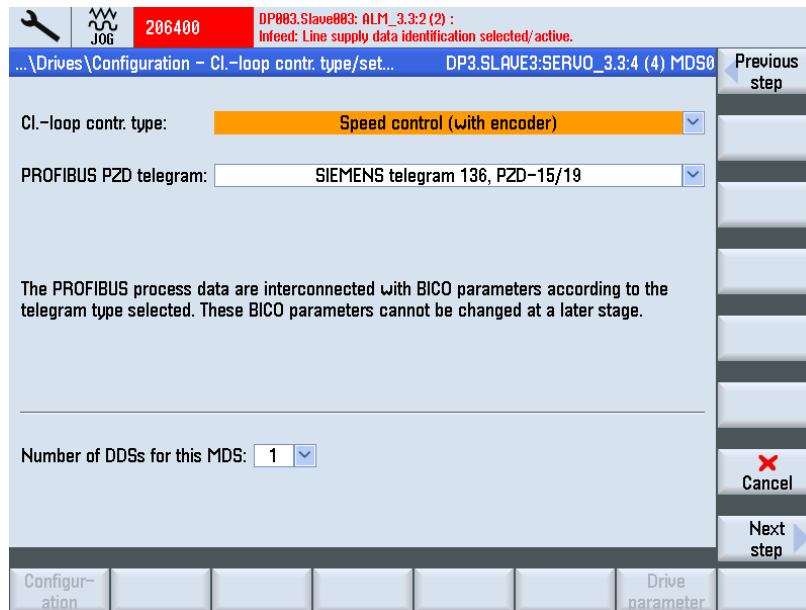
The control mode and the PROFIBUS telegram are generally correctly pre-assigned by the drive wizards.

15.Set the number of required drive data sets (DDS). The default setting: 1 DDS can be accepted in most cases.

16.Press "Next step >".
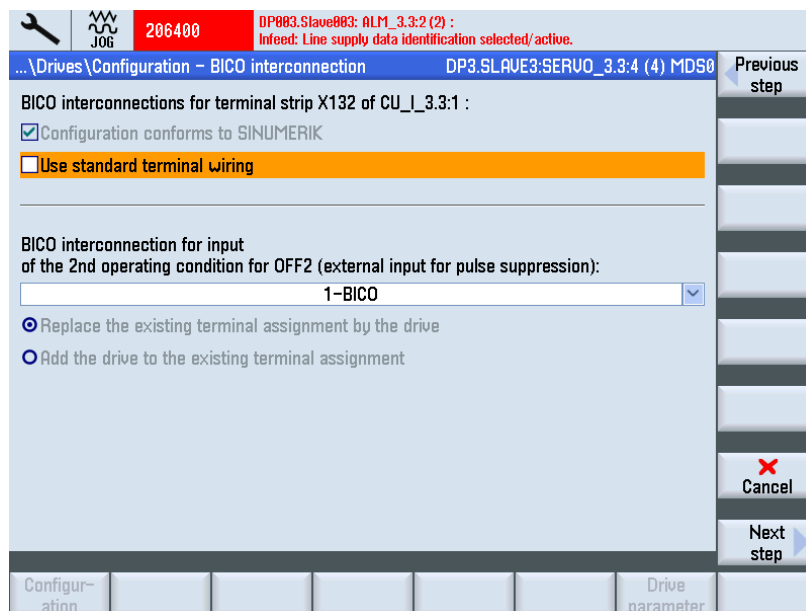
You can select the 2nd operating condition Input 2nd OFF2 (Page 71) (external input for pulse cancellation)

17. Press "Next step >".
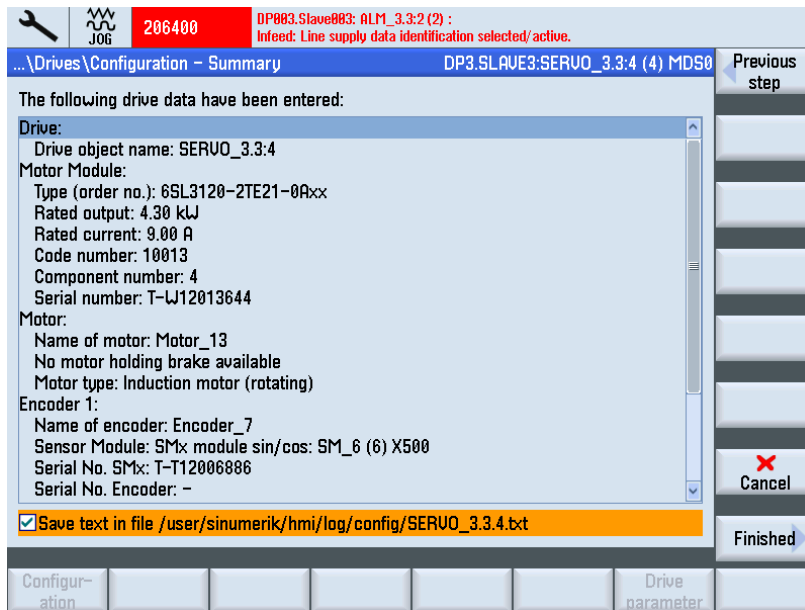
The configuration of the drive (SERVO) with third-party motor is completed. You can check the configuration in the summary.

18. Press the "Finish >" softkey.
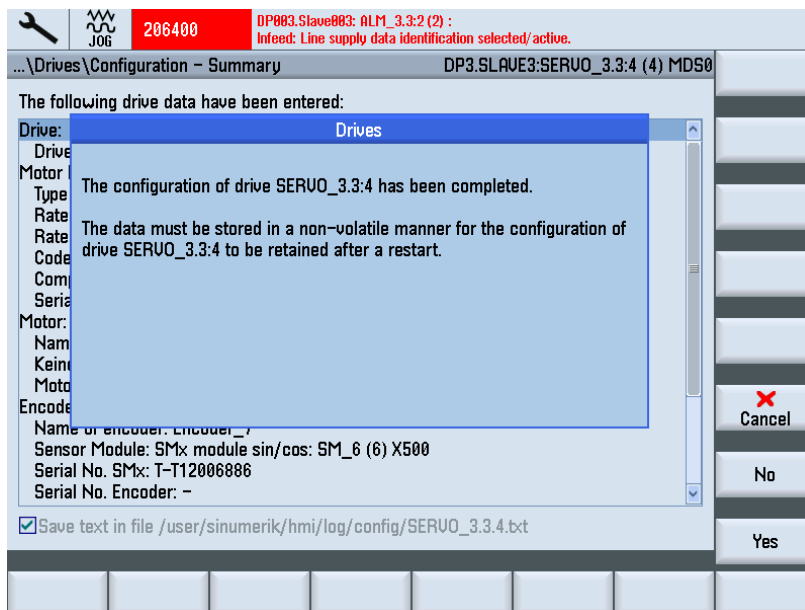
19. Confirm the query with "Yes".

If the system detects additional drive objects that have not yet been commissioned, you will be prompted to commission the next SERVO. Otherwise, the initial commissioning is complete.

5.3.5 First commissioning of SINAMICS drive ended

First commissioning of SINAMICS drive completed

You have completed the first commissioning of the SINAMICS drives.

The unit configuration and parameterization has been completed successfully:

- All upper LEDs of the drives (SERVOs) are GREEN.
- The lower LEDs of the drives (SERVOs) are always YELLOW.

Continue with the steps for commissioning the NCK (see chapter Communication between the NCK and the drive (Page 153)).

5.4 Manual commissioning of SINAMICS drives

5.4.1 Introduction to commissioning of SINAMICS drives

Machine configuration

Note

"Manually commissioning" is recommended for experienced commissioning engineers.

Procedure:

1. Press the <MENU SELECT> key.

2. Select the "Commissioning" operating area.

3. Press the "Drive system" softkey.

See also

The following functions for commissioning the SINAMICS drives can be performed manually:

- Restore the factory settings (Page 103)
- Update the component firmware (Page 105)
- Configure the infeed and drives
- Check and configure the PROFIBUS connection (Page 107)

5.4.2 Activate the factory settings

Introduction

After the commissioning, the "Factory setting >" function can be used reset the drive system to the factory settings.

NOTICE
Before restoring the factory settings, ensure that the EP terminal (Enable Pulses) of the infeed (booksize: X21, chassis: X41) is de-energized.

Loading the factory settings

Procedure:

1. You are in the "Commissioning" > "Drive system" operating area.
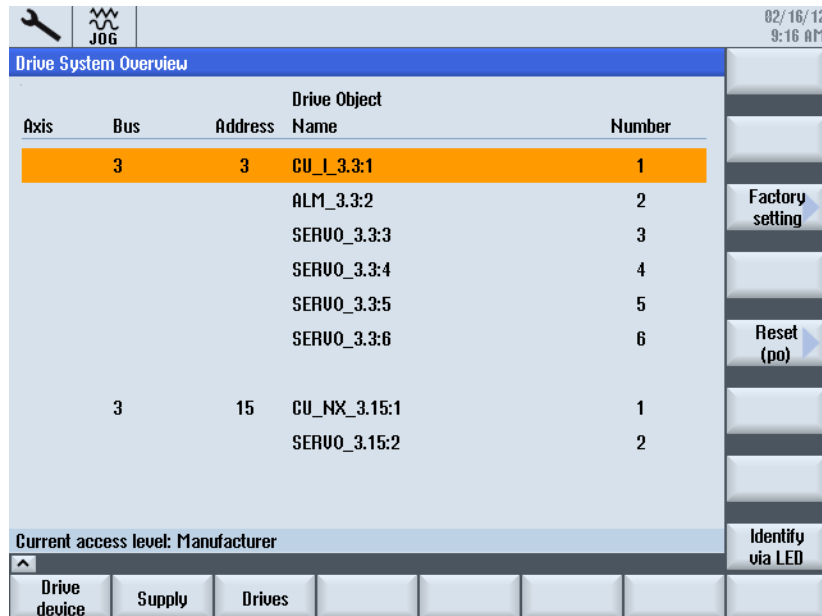
2. Press the "Factory settings >" softkey.
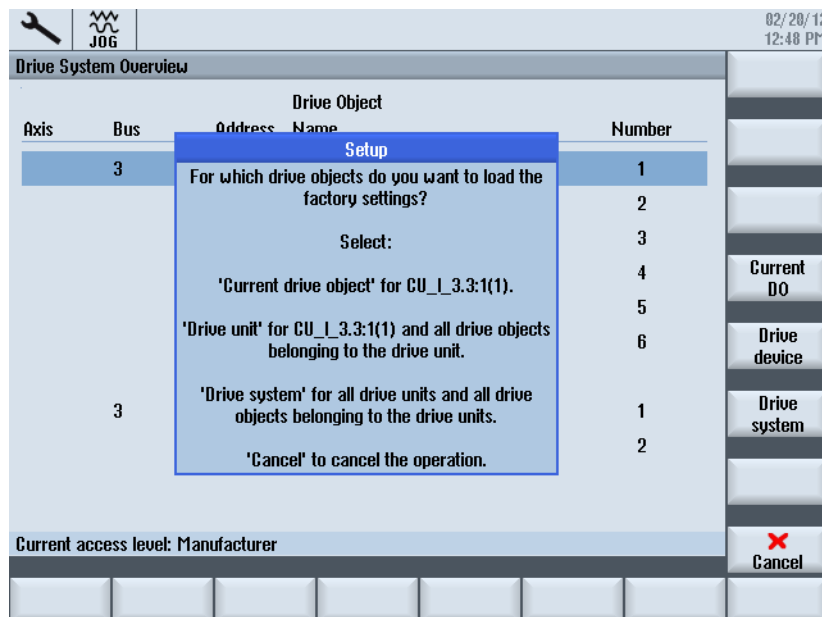
3. Press the "Drive system" softkey for this example to load the factory settings for all drive units used in the system (the NCU and NX module).

You must explicitly confirm another prompt with "OK" or "Cancel".

4. Switch the system (de-energized drive system) off and on again. Wait until communication has been established again with the NC.
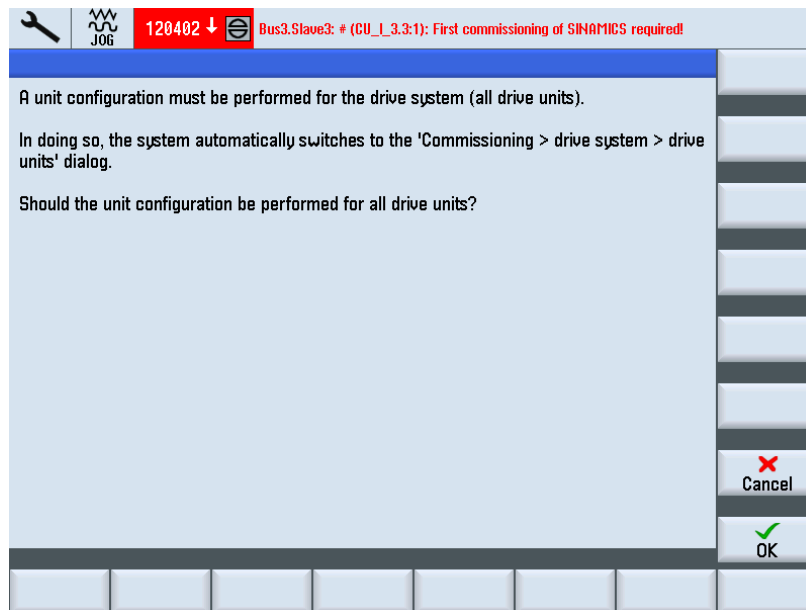
5. A message appears that an initial commissioning is required (Alarm 120402).

   You have the following options in this dialog:

   – If you press "OK", the "Guided commissioning" (Page 76) of the SINAMICS drives starts.

   – Press "Cancel" to continue the "Manual commissioning".

5.4.3 Firmware update of the drive components

Firmware update as of SINAMICS V2.5

As of SINAMICS V2.5, an automatic firmware update is undertaken when powering up the drive system if required.

Precondition

All NCU/NX components are connected via DRIVE-CLiQ.

NOTICE
The correct firmware update of the SINAMICS components is performed ONLY if ALL were inserted in the switched-off state. The subsequent insertion of components may ONLY be performed in the switched-off state.

Loading firmware for the entire drive system

Procedure:

1. Switch on the system.

   During run-up, it will be detected that an older firmware version is present. This causes the update to start automatically and the firmware is loaded from the CompactFlash card to all DRIVE-CLiQ components of the drive system (NCU and NX).

   Note

   Depending on the configuration of the SINAMICS drive line-up, a complete update of the component firmware takes approximately 10 minutes. The firmware component currently being updated is indicated with a flashing LED.

   ---

2. While the firmware update is running, a progress bar informs you about the current process. In this case, the following messages are output:

   Notice !

   The process should not be interrupted! Please wait until the automatic firmware update completes!

   A firmware update is performed for the following drive units of the DRIVE-CLiQ components:

   CU_I_3.3:1   ... 39%

   CU_NX_3.15:1   ... 50%

3. The following messages are output when the firmware update completes:

   Firmware update of the DRIVE-CLiQ components completed.

   Notice !

   Switch the control system and the entire drive system (all hardware components) off and then on again to activate the firmware.

   Then commissioning can be continued.

   CU_I_3.3:1   ... 100%

   CU_NX_3.15:1   ... 100%

4. Follow this prompt. You can then continue the commissioning of the drive components (infeed, motor modules, encoders).

   Note

   Loading firmware for individual components

   If only certain components of the drive system have an older firmware version, the update also starts automatically and needs correspondingly less time.

5.4.4 Automatic device configuration

Introduction

The following unit configuration is performed during the initial commissioning of the drive units:

- Transfer of the DRIVE-CLiQ topology to the drive unit.

  With the transfer of the topology, all components connected on the DRIVE-CLiQ are detected and the drive-internal data traffic is initialized.

- Drive-object assignment for PROFIBUS connection.

  The PROFIBUS connection via the relevant telegrams has been specified with the configuration in the HW Config.

Operating sequence

The drive unit is in the initial commissioning state.

1. Press the "Drive units" softkey in the "Commissioning" > "Drive system" menu.
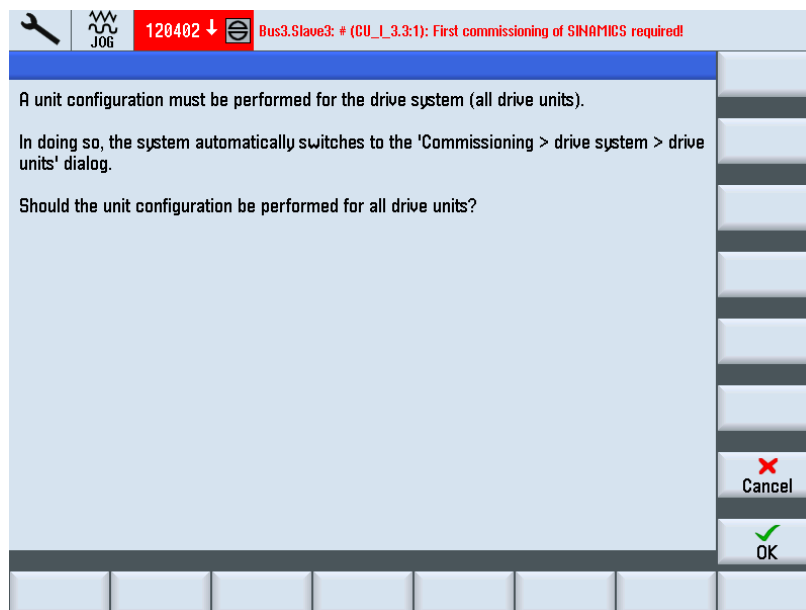
You are reminded that the drive unit is in the initial commissioning state and that a unit configuration must be performed for the drive system.

2. Confirm with "OK".

   During the unit configuration, a succession of messages containing information on the respective configuration of the individual drive components are displayed.

   Depending on the size of the drive system, this can take several minutes.

   Before the configuration is completed, you must confirm the following prompt:
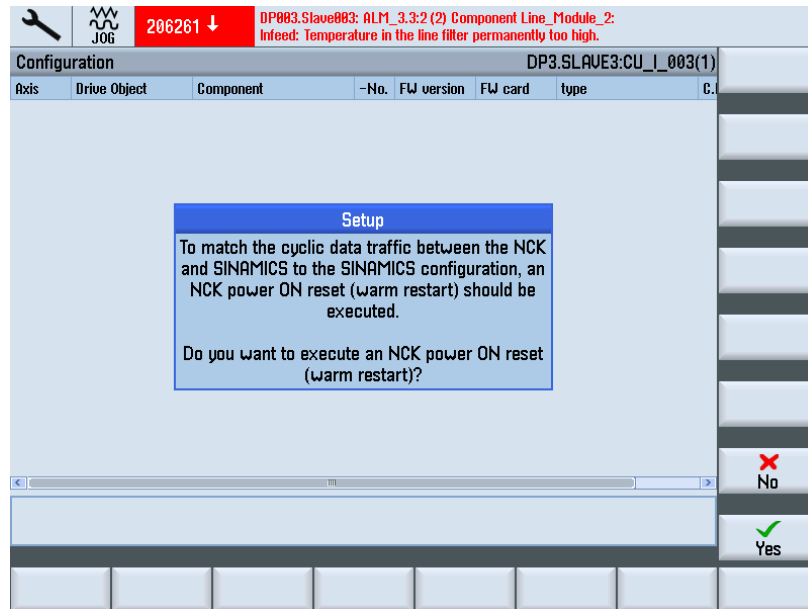
3. Press "Yes" to perform an NCK power on reset (warm restart).
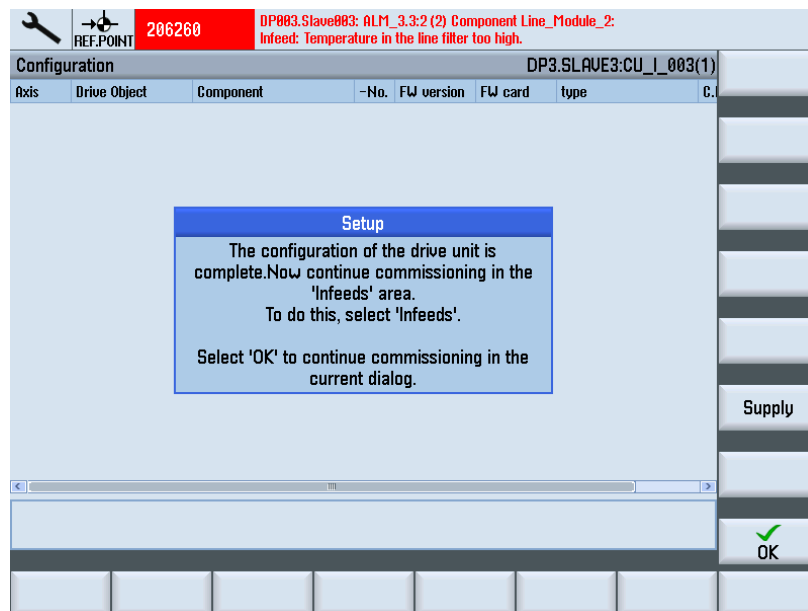
   The unit configuration for the drive units and drive components of the NCU has been completed.

4. Press "OK".

   This means that you continue commissioning in the actual dialog box "Drive system" → "Drive units" → "Configuration". The associated components of the selected drive unit are displayed:

5. If necessary, check and correct the settings in the "PROFIBUS" dialog.

6. Press "Drive unit +".

   If you have selected the NX, then the components belonging to the NX are displayed.

Axis	Drive Object	Component	–No.	FW version	type
	CU_NX_3.15:1	CU_LINK_1	1	4503000	NX15.3
	SERVO_3.15:2	Motor_Module_2	2	4503000	MM_1AXIS_DCAC
	SERVO_3.15:2	DRIVE-CLiQ-Encoder_3	3	4503000	DQEncoder
	SERVO_3.15:2	Encoder_4	4	---	Analog Sensor
	SERVO_3.15:2	SMI20_5	5	4503000	SMI20/DQI
	SERVO_3.15:2	Encoder_6	6	---	Analog Sensor
	SERVO_3.15:2	Motor_SMI_7	7	---	SMI-Motor

CU_NX_3.15:1.CU_LINK_1(1)

Configuration | Topology | PROFIBUS

If necessary, you can correct or change the settings in the "PROFIBUS" dialog.

7. Press "PROFIBUS" → "Change>".

...\Drive devices\PROFIBUS — DP3.SLAVE15:CU_NX_3.15:1(1)

NC-axis	NC Telegram type	I-/O-addr.	Slot	SINAMICS-drive object	SINAMICS-telegram type
AX7:U1	SIEMENS 136	6844	4	SERVO_3.15:2(2)	SIEMENS 136
		6844	4		
		4340	5		
		4340	6		
AX8:U1	--	6868	8	(255)	--
		6868	8		
		4380	9		
		4380	10		
AX9:AX9	--	6892	12	(255)	--
		6892	12		
		4420	13		
		4420	14		
AX10:AX10	--	6916	16	(255)	--
		6916	16		
		4460	17		
		4460	18		
AX11:AX11	--	6940	20	(255)	--
		6940	20		

Configuration | Topology
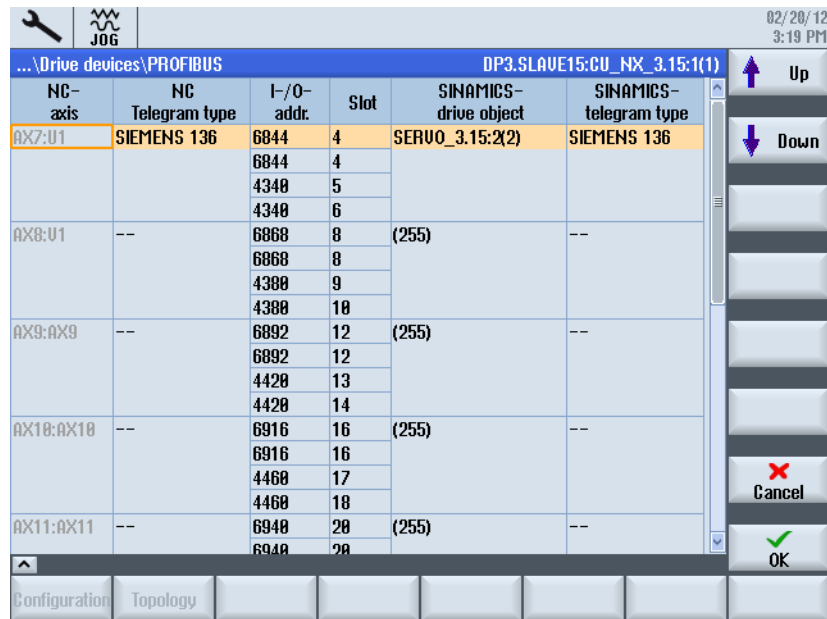
8. Press "Cancel" to exit the dialog.

9. Press the menu back key.

Axis	Bus	Address	Drive Object Name	Number
	3	3	CU_I_3.3:1	1
			ALM_3.3:2	2
			SERVO_3.3:3	3
			SERVO_3.3:4	4
			SERVO_3.3:5	5
			SERVO_3.3:6	6
	3	15	CU_NX_3.15:1	1
			SERVO_3.15:2	2

Current access level: Manufacturer

Drive device | Supply | Drives

Factory setting

Reset (po)

Identify via LED

5.4.5 Commissioning using a drive wizard

Introduction

Perform the drive configuration with a drive wizard. The following drive components are to be configured:

- Active Line Module (infeed)
- Motor Module, motor and encoders (drives)

Operating sequence for drive configuration

To start the drive configuration, select the "Commission" → "Drive system" operating area:

Axis	Bus	Address	Drive Object Name	Number
	3	3	CU_I_3.3:1	1
			ALM_3.3:2	2
			SERVO_3.3:3	3
			SERVO_3.3:4	4
			SERVO_3.3:5	5
			SERVO_3.3:6	6
	3	15	CU_NX_3.15:1	1
			SERVO_3.15:2	2
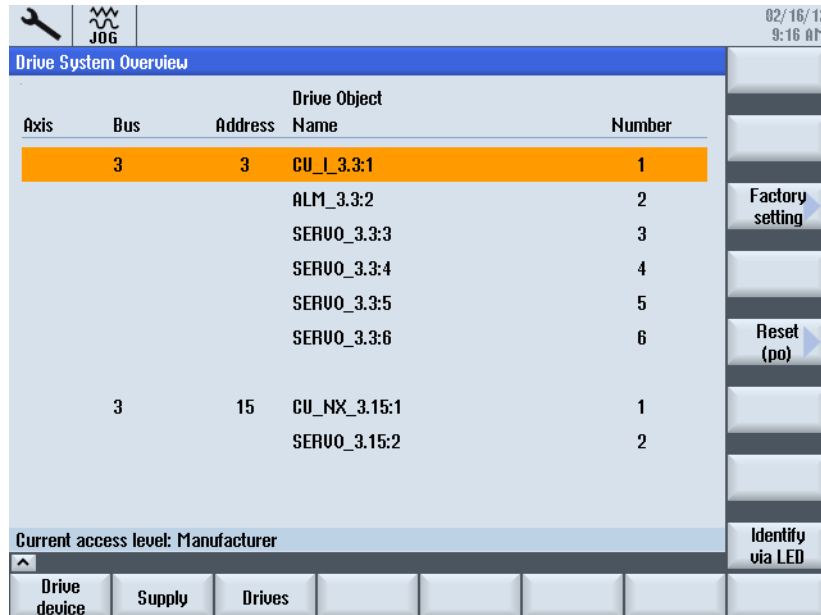
Procedure:

1. Press the corresponding softkey for the drive object to be configured.

   – "Infeeds"

   – "Drives" for the corresponding drive object (SERVO)

   Configuration is performed in the following sequence:

2. Select the component with the "Infeed+/Infeed-" or "Drive+/Drive-" vertical softkey.

3. Press the "Change" vertical softkey and follow the drive wizard with the "Next step >" horizontal softkey.

4. Parameterize the appropriate configuration in the following dialogs.

5. Check the network data of the infeed with the "Network data (Page 150)" softkey.

See also

The individual dialogs are described at:

- "Parameterization of infeed (Page 82)"

- "Parameterization of the drives (Page 87)"

5.5 Configuring data sets

Precondition

Note

The particular drives must have been already commissioned.

Data sets

The data sets are configured in the "Commissioning" → Drive system" → "Drives" → "Data sets" operating area. The following prompts lead you through the sequences:

- "Add data set"
- "Remove data set" if an additional data set has already been created
- "Modify data set"

Number of configurable data sets:

- Motor data set → MDS0...3 (max. 4)
- Drive data set → DDS0...31 (max. 8 per MDS)
- Encoder data sets → EDS0...2 (max. 3)

5.5.1 Adding a data set

Adding a data set operating sequence

The default factory setting specifies an MDS0 motor data set with a DDS0 drive data set and an EDS0 encoder data set:
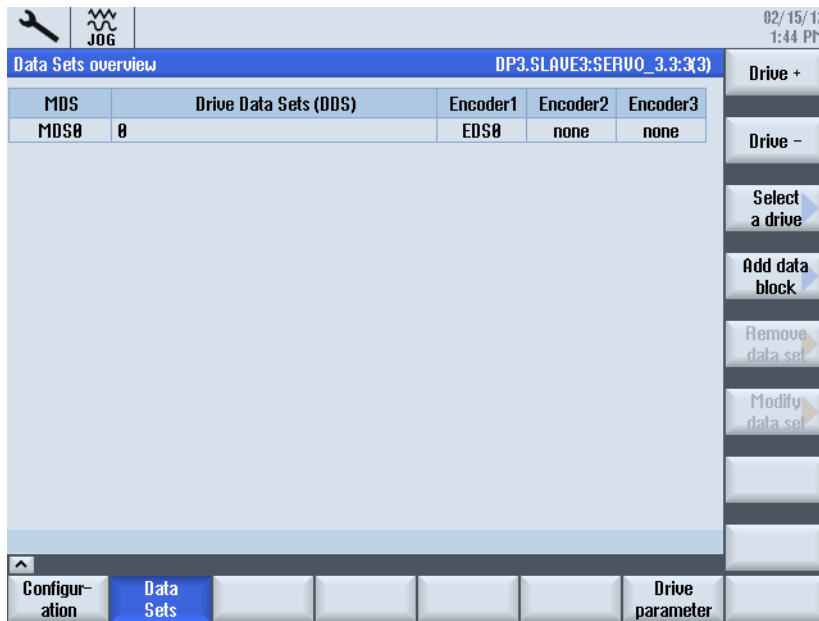
1. Press "Add data set". In the example, the maximum number of four MDSes are created.
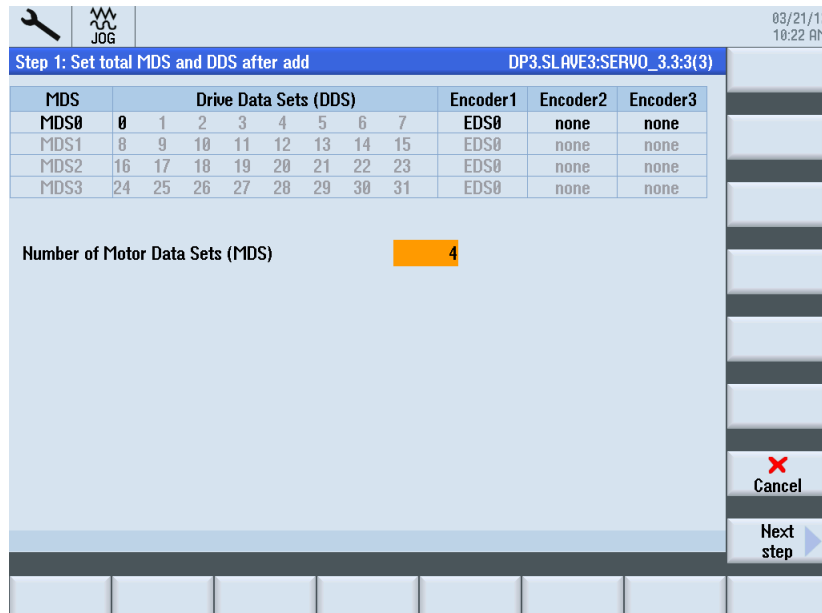
2. Press "Next step >".

   In the first step, the DDS1 to DDS7 drive data sets are created in the MDS0.

3. Press "Next step >". The MDS1 motor data set is created.

4. Press "Next step >". The MDS2 motor data set is created.
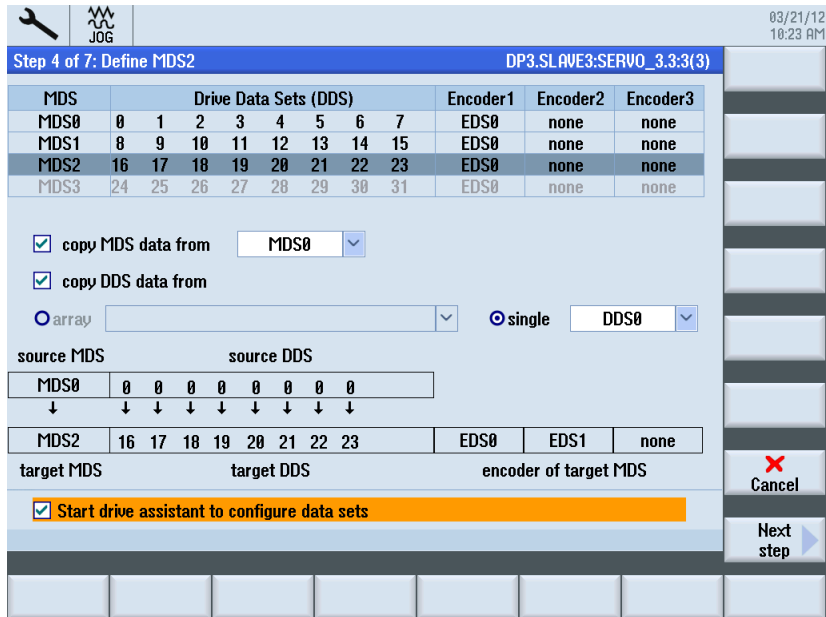
5. Press "Next step >". The MDS3 motor data set is created.
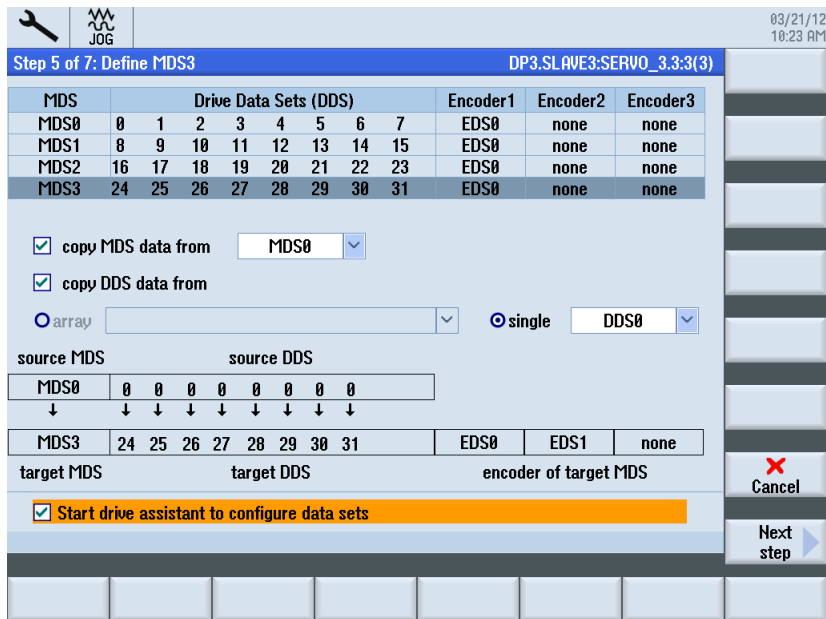
6. Press "Next step >". You need to create a complete MDS as shown in the following diagram, or as an option, enter the number of DDS for the MDSx:

MDS	Drive Data Sets (DDS)								Encoder1	Encoder2	Encoder3
MDS0	0	1	2	3	4	5	6	7	EDS0	none	none
MDS1	8	9	10	11	12	13	14	15	EDS0	none	none
MDS2	16	17	18	19	20	21	22	23	EDS0	none	none
MDS3	24	25	26	27	28	29	30	31	EDS0	none	none

Step 6 of 7: Adjust DDS on MDS3 (optional)   DP3.SLAVE3:SERVO_3.3:3(3)

03/21/12 10:24 AM

Number of DDS on MDS3   8

Cancel

Next step

7. Press "Next step >" to check in the summary the changes to be performed.

Step 7 of 7: Summary of proposed changes   DP3.SLAVE3:SERVO_3.3:3(3)

03/21/12 10:24 AM

Press "Finish" to make the following changes

The number of MDS will be increased from 1 to 4.
For existing MDS0, the number of DDS per MDS will be increased from 1 to 8.
The number of DDS for MDS3 will be set to 8.

The new configuration will contain 4 MDS (MDS0...MDS3).
Every MDS will contain 8 DDS.

Cancel

Finished

8. Press "Finish >" to accept the changes.
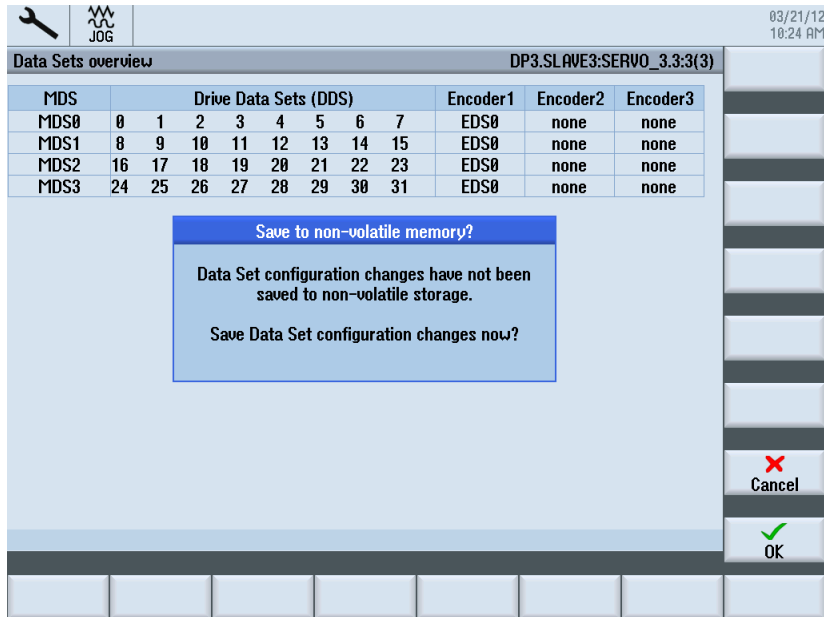
9. Confirm with "OK" to save the data in non-volatile memory.

   The saving/writing of the parameters can take several minutes.

10. The "Drives" → "Overview" dialog of the drive object is displayed. The "Select MDS >" softkey is now available. Press "Select MDS...".
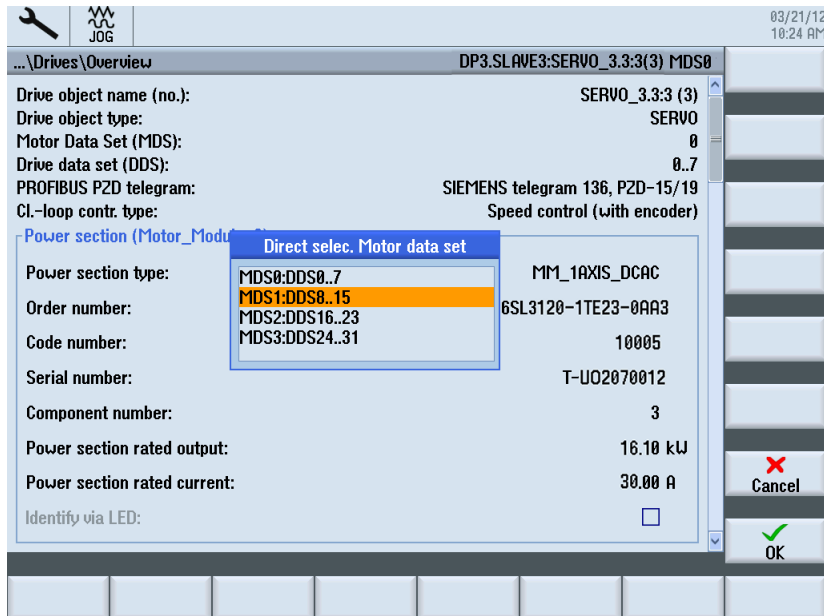
In the direct selection, select the motor data set, e.g. in this case MDS1.

11. Press "OK" to transfer the new motor data set for the drive object.
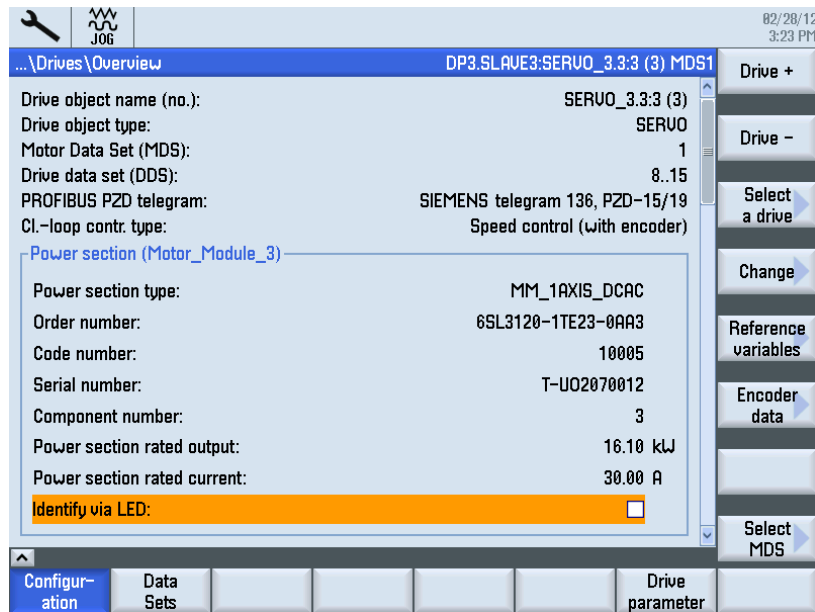
The drive is now operational.

5.5.2 Modify data set

Precondition

If more than one encoder is assigned to the drive object (SERVO), additional encoder data sets (EDS0 ... 2) will be created.

Modify data set

To change the assignment of these encoder data sets for the associated encoder, select the "Modify data sets" softkey:

This activates the edit function in order to subsequently modify the assignment of EDSes to the encoders:
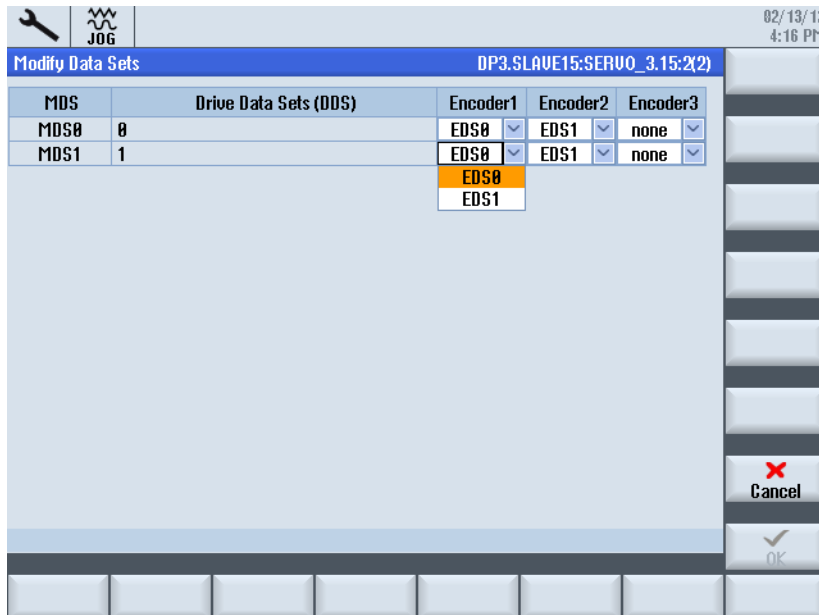
5.5.3 Remove data set

Precondition

To remove data sets, the following conditions must be met:

- Number of DDS > 1 in the MDS ⇒ DDSes can be removed.
- Number of MDS > 1 ⇒ MDSes can be removed.

Operating sequence to remove a data set

1. Select "Remove data set":

In the first column, select the MDS to be removed by marking the row with a check mark. Several data sets can also be selected.

2. Press "Next step >".
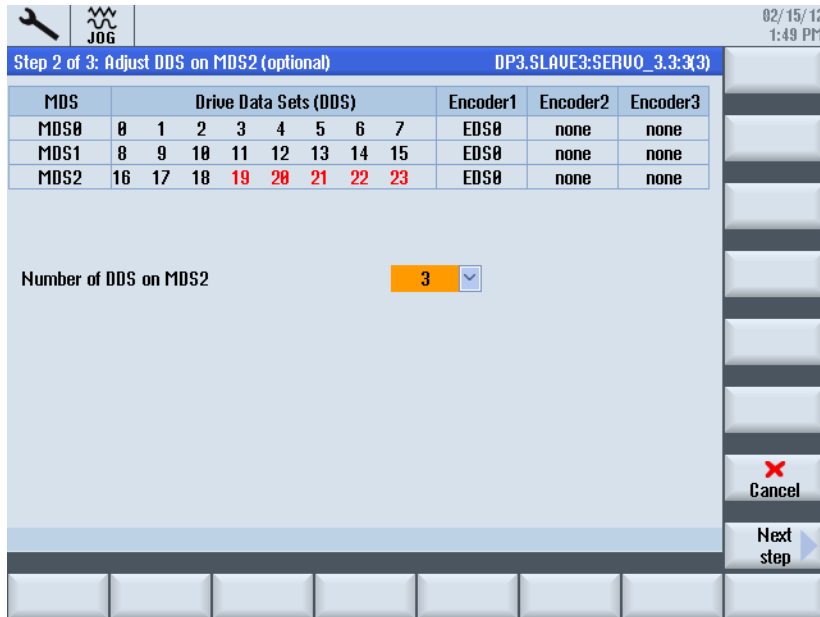
As an option, you can remove the remaining DDSes from MDS2 by entering the number of DDS drive data sets that should remain in the MDS: By entering 3 DDS in MDS, five DDSes are removed.

3. Press "Next step >".
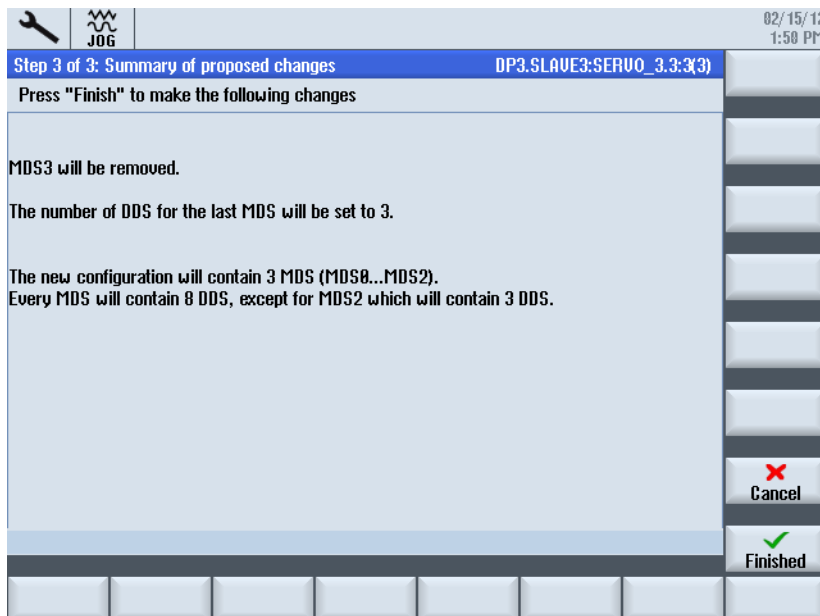
"Cancel" terminates this process and the data set overview with MDS0 ... MDS3 is displayed.

4. Press "Finish >" to accept the changes.

The data is written to the parameters. The results are then displayed:

MDS	Drive Data Sets (DDS)								Encoder1	Encoder2	Encoder3
MDS0	0	1	2	3	4	5	6	7	EDS0	none	none
MDS1	8	9	10	11	12	13	14	15	EDS0	none	none
MDS2	16	17	18						EDS0	none	none

Data Sets overview — DP3.SLAVE3:SERVO_3.3:3(3) — 02/15/12 1:58 PM

Drive +
Drive –
Select a drive
Add data block
Remove data set
Modify data set

Configuration | Data Sets | | | | | Drive parameter |

When you exit this dialog, press "Yes" to confirm the prompt to save the data to the non-volatile memory.

5.6 Drive system diagnostics

Operating sequence

1. To check warnings and faults of the drive, select the "Diagnostics" → "Drive system" operating area:
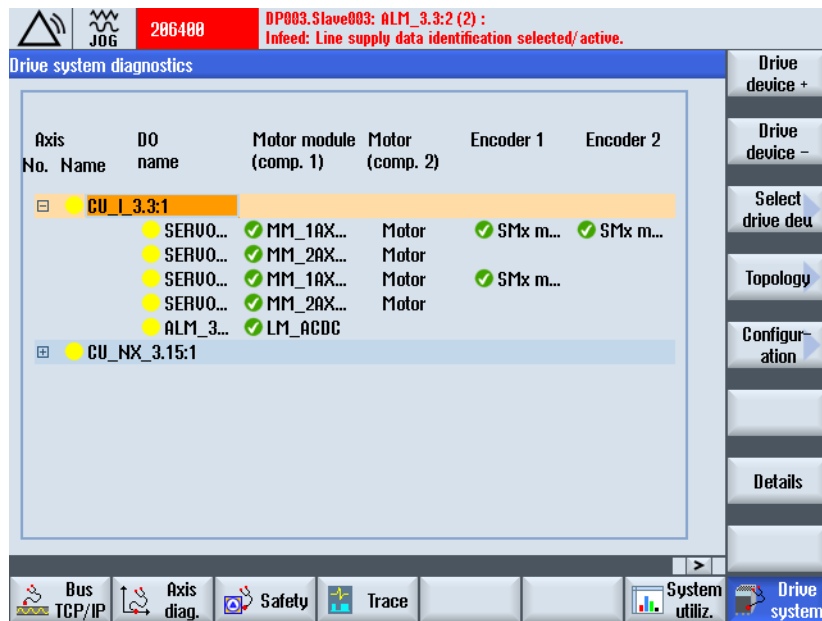
2. Select the relevant drive component with the cursor in the overview of the drive states.

3. Press the "Details" softkey:
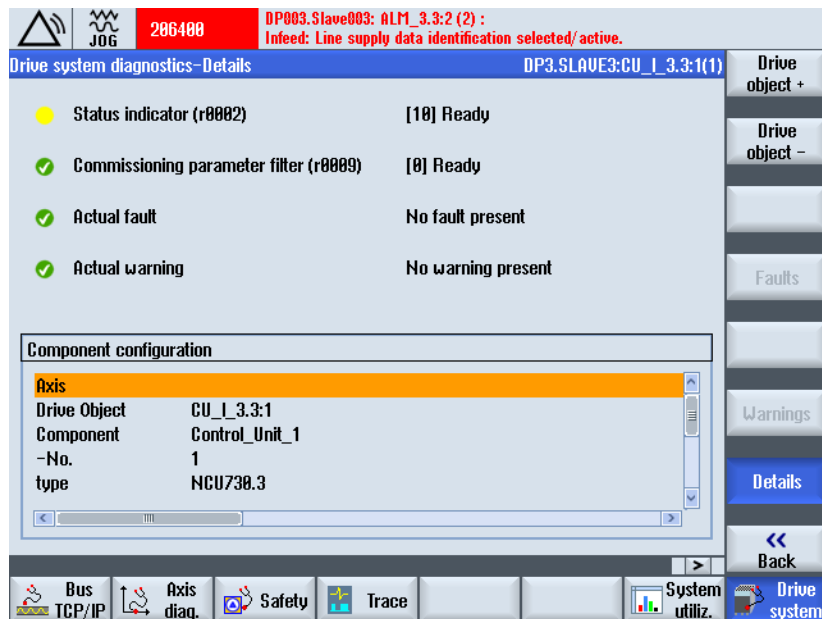
4. Press "Warnings". The warnings for this drive component are listed.

5. Press "Faults": No faults are present for this drive component.

See also

Adding components (Page 141)

Check topology (Page 133)

Warnings/faults

SINAMICS alarms can be the warning (A) or fault (F) type.

- Pending **warnings** are indicated by parameter r2122 of the relevant drive components.

- The number of warnings that have occurred after the last reset is available in parameter p2111 of the drive components.

  p2111 = 0 This results in the deletion of all existing warnings of this component and updates the current warnings still pending. This parameter is reset to zero at POWER ON.

- The parameter r0945 shows the numbers of **faults** that have occurred.

- To activate the fault and warning buffer output for SINAMICS, set MD13150 $MN_SINAMICS_ALARM_MASK to the hexadecimal value "D0D". This automatically outputs the pending warnings/faults of the SINAMICS S120 in the message line.

5.7 Modular machine

5.7.1 What does "modular machine" mean?

Modular machine

The modular machine concept is based on a maximum reference topology created offline. The maximum design of a particular machine type is referred to as the maximum configuration in which all the machine components that may be used are pre-configured in the reference topology. By deactivating/deleting drive objects (p0105 = 2), sections of the maximum configuration can be removed.

If a component fails, the sub-topology can also be used to allow a machine to continue running until the spare part is available. In this case, however, no BICO source must be interconnected from this drive object to other drive objects.

NOTICE

Data backup

Before you make any changes, save the drive data in a commissioning archive (Page 303)!

Drive unit - Configuration

The "Commissioning" → "Drive system" → "Drive unit" operating area provides the following functions under "Configuration":

- "Configuration" > "Change >" (Page 131)

  – Change the name of the drive object

  – Change the name of the component

  – Change the comparison level

- "Configuration" > "Sort >": (Page 131)

- "Configuration" → "Display options >":

Drive unit - topology
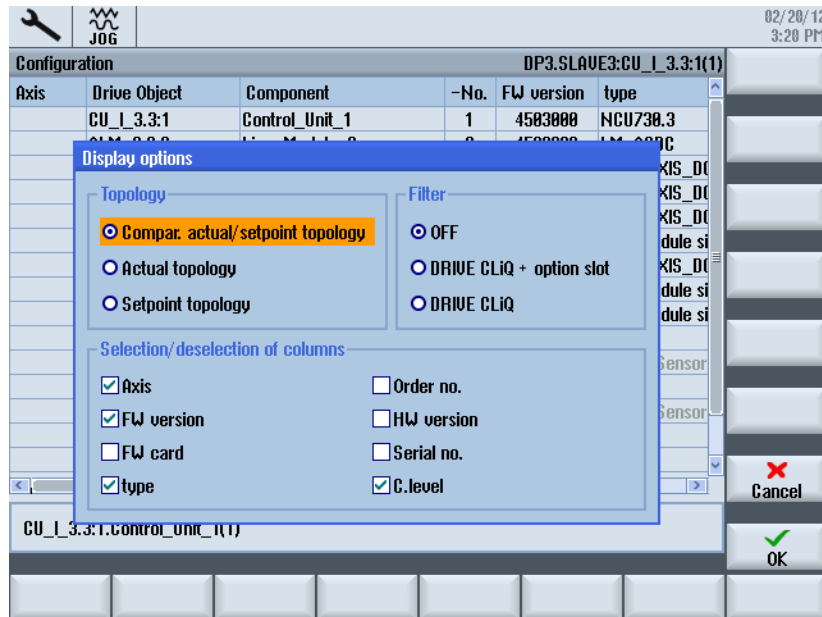
Topology								DP3.SLAVE3:CU_I_3.3:1(1)
from						to		
Drive object	-No	Component	-No	Socket		Socket	-No	Component
CU_I_3.3:1	1	Control_Unit_1	1	X100	---	X201	2	Line_Module_2
				X101				
				X102				
				X103				
				X104				
				X105	---	X100		CU_NX_3.15:1
ALM_3.3:2	2	Line_Module_2	2	X200	---	X201	3	Motor_Module...
				X201	---	X100	1	Control_Unit_1
				X202				
SERVO_3.3:3	3	Motor_Module...	3	X200	---	X202	4	Motor_Module...
				X201	---	X200	2	Line_Module_2
				X202	---	X500	14	SM_14
SERVO_3.3:4/	4/	Motor_Module...	4	X200	---	X201	5	Motor_Module...

from: CU_I_3.3:1.Control_Unit_1(1)

to: ALM_3.3:2.Line_Module_2(2)

Configuration	Topology	PROFIBUS					

Drive device+
Drive device-
Select drive dev
Change
Configure drive unit
Add component
Display options

The "Commissioning" → "Drive system" → "Drive unit" operating area provides the following functions under "Topology":

- "Topology" → "Change >"

  – Delete a drive object

  – Delete the component

  – Enable/disable drive objects

  – Drive object: Change name/number

  – Component: Change name/number

- "Topology" > "Add component >" (Page 141)

- "Topology" → "Display options >":
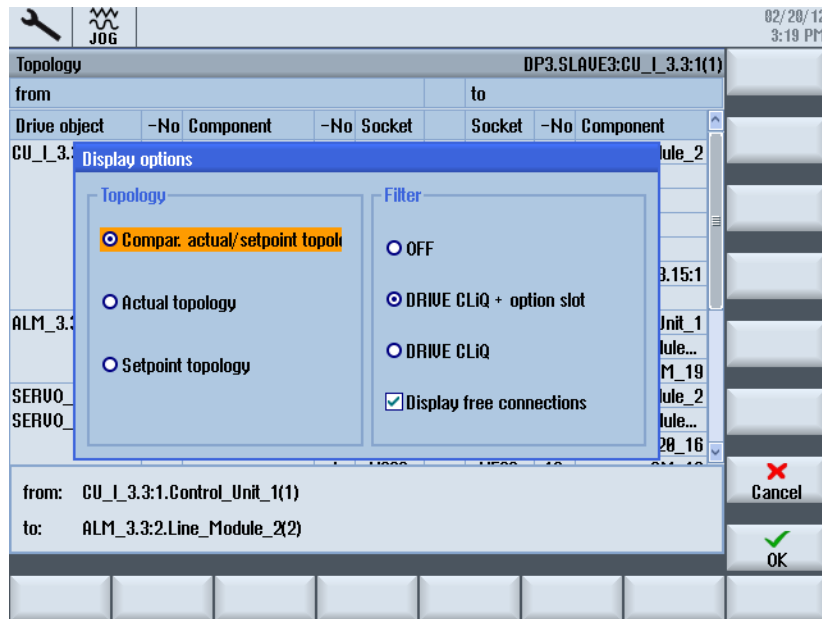
Example: Select filter "off" to also display the components that are not connected via DRIVE-CLiQ:

Note

No initial commissioning is required after changing the topology.

5.7.2 Modify configuration

Drive unit - Configuration "Change >"

Procedure:

1. Press the "Change > " softkey to change the configuration.

   "Cancel" can be used backup the drive data if it does not yet exist.
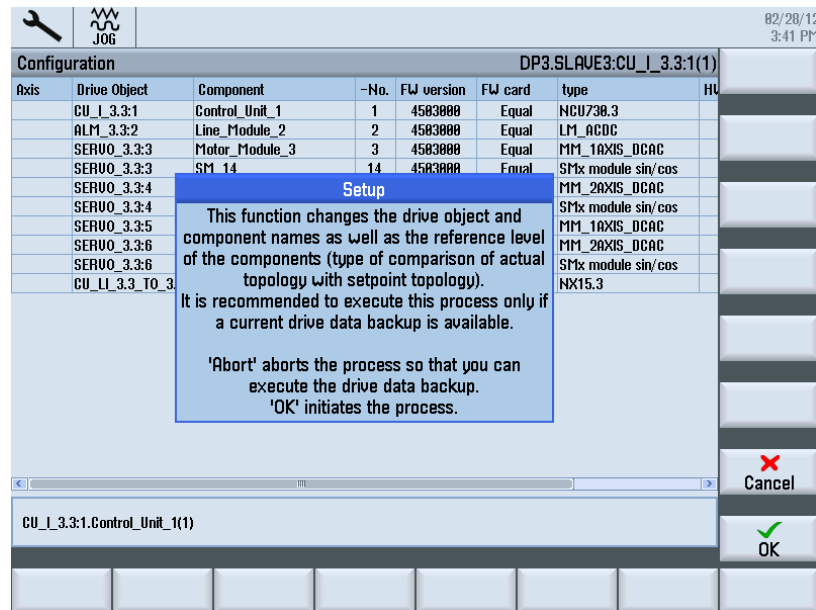
2. If a data backup is available, confirm with "OK".

3. Navigate with the arrow keys to the drive object / component that is to be changed.

4. Press the "INSERT" key to enter the new designation.
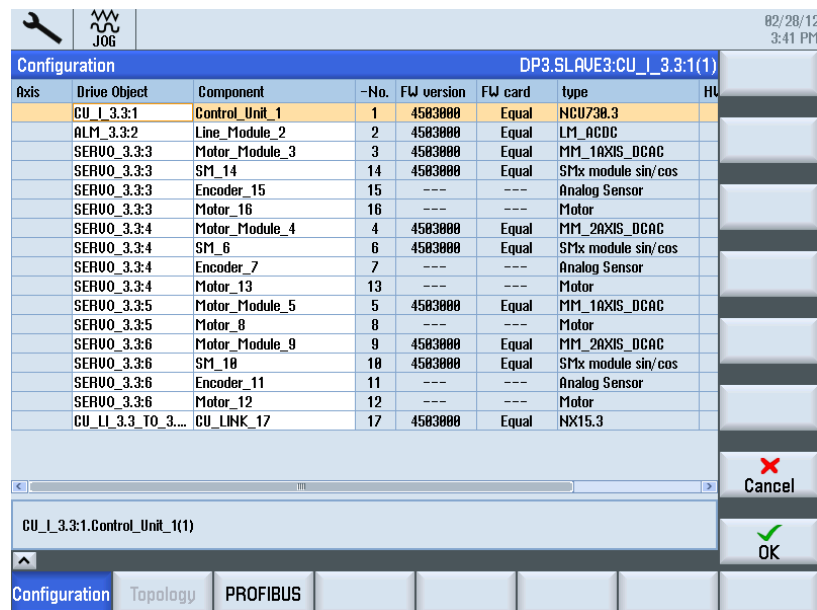
Drive unit - Configuration "Sort >"

Procedure:

1. Press the "Sort >" softkey to open the display of the sort criteria.
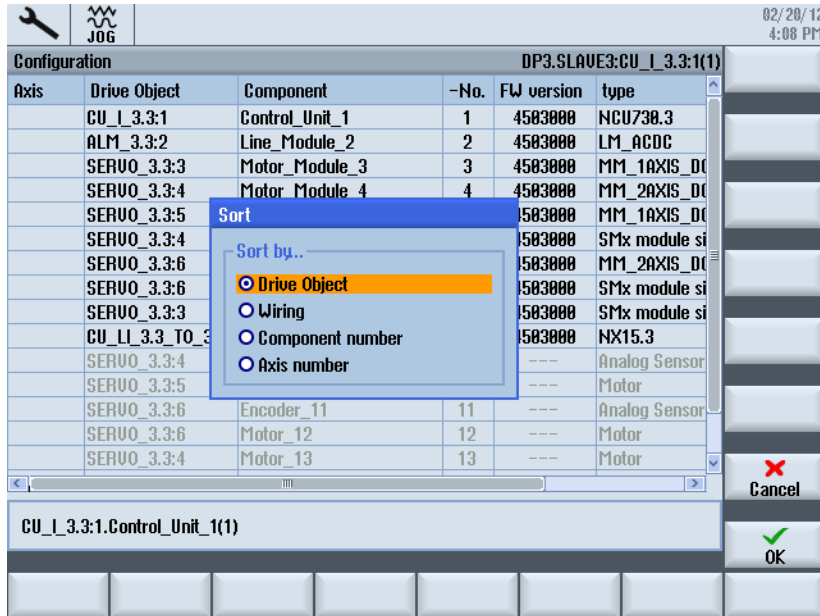
2. Select one of the following sort criteria for the display from:
   – Drive object: The display is sorted according to the drive object number.
   – Wiring: The display is sorted according to wiring of the drive components in the drive system.
   – Component number: The display is sorted according to the component number.
   – Axis number: The display is sorted according to the axis number.

5.7.3 Check topology

Comparing topologies

Once you have parameterized the drive components, you can check the topology:

1. Select "Commissioning" → "Drive system" → "Drive unit" → "Topology" in the operating area.

2. Set the actual/reference topology comparison for "Display options".

   The topology of individual drive components is displayed:

3. This means you are supported during the check whether the displayed reference topology matches the actual topology of the system.

Note

You will need the component numbers in order to configure direct measuring systems manually.

See also

Drive system diagnostics (Page 124)

5.7.4 Changing topology

Drive unit - Topology "Change >"

Procedure:

1. Press the "Change > " softkey to change the topology.

   "Cancel" can be used backup the drive data if it does not yet exist.
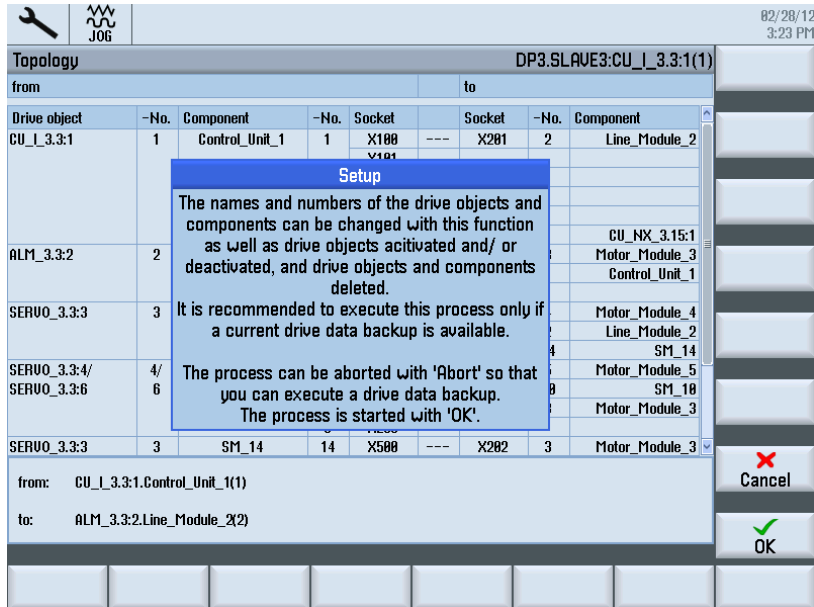
2. If a data backup is available, confirm with "OK".

3. Navigate with the arrow keys to the drive object / component that is to be changed.

4. Press the "INSERT" key to enter the new designation.

   In the example, the drive object is changed from "number "3" to number "30".

Note

Effect

The change of the name and number is applied to the data in the reference and actual topologies of the drive software. Changing the comparison level affects the topology comparison in the drive software.

5.7.5 Activating or deactivating a drive object

Activating/deactivating drive objects

Operating sequence:

1. Select with the arrow keys a drive object.

2. Press the "Activate/deactivate drive object" softkey
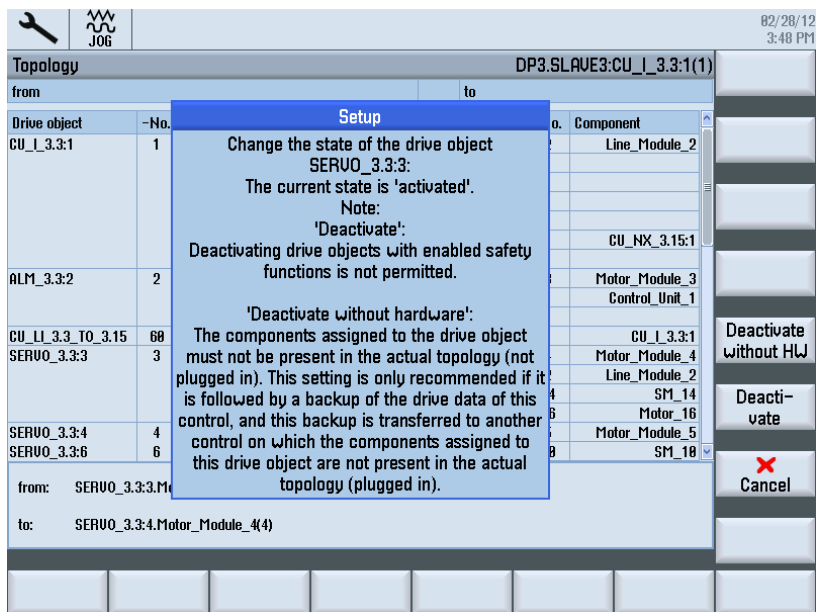
3. Follow the instructions in the information text.

4. Once successfully deactivated, the drive object and the associated components are grayed out.
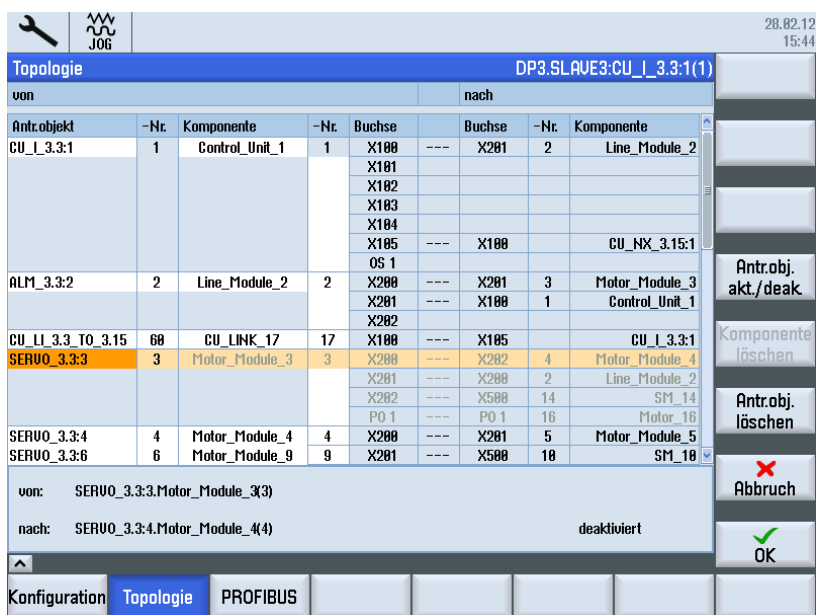
5. If you want to reactivate the drive object, press the "Activate/deactivate drive object" softkey and follow the instructions in the information text.

Example series commissioning

When commissioning several machines (series) of the same type, a drive object that is not present is marked with p0105 = 0. This creates a commissioning archive that is transferred to the next machine.

To avoid triggering the alarm 201416, the serial number of this component must be deleted and the p0105 = 2 parameter of this component must be set to "Deactivate drive object and not present".

Note

General conditions for deactivating:

- If a component is deactivated, only the component with the correct serial number or none may be inserted.

- If a component with a different serial number is inserted, this is by definition a different component. If no other component remains, it must certainly be an excess component. This component is marked as an additional component and alarm 201416 triggered.

5.7.6   Deleting a drive object

Deleting a drive object

Procedure:

1. Navigate with the arrow keys to the drive object that is to be deleted.

2. Press the "Delete drive" softkey.

   A security prompt follows to delete the drive object.

3. If a data backup is available, confirm with "OK".

   The drive object is deleted from the reference topology.

4. The see the change in the topology, the "Actual/reference topology comparison" display options must be set:

Result: The module can now be removed.

5.7.7 Delete the component

Delete the component

Procedure:

1. You are in the "Topology" dialog and have selected the "Change" mode:
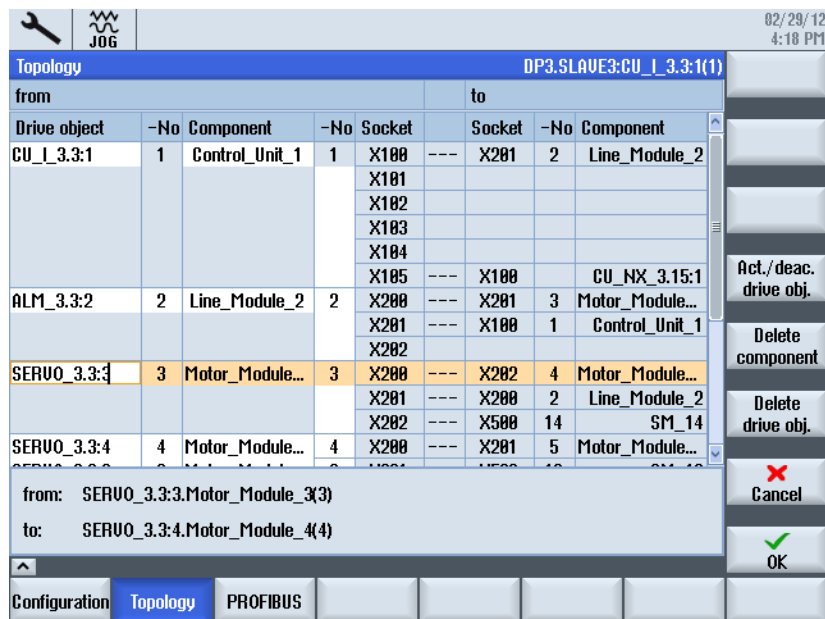
2. Navigate with the arrow keys to the component to be deleted.
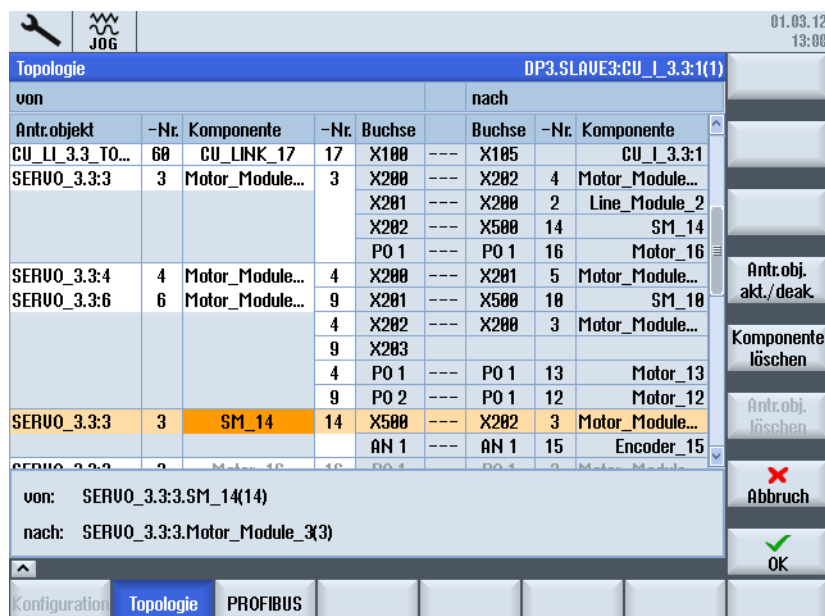
If you select a component, the "Delete component" softkey is active.

3. Press the "Delete component" softkey, in this example: Sensor SM_14 (sin/cos).

   A security prompt follows to delete the component.

4. If you are sure, confirm with "OK". The component is deleted from the reference topology.

   If the component is not yet available in the actual topology, i.e. still connected, an alarm is output and the component highlighted in red. To see the change in the topology, the "Actual/reference topology comparison" display options must be set.

5. Remove the module.

5.7.8 Adding components

Adding components

If you connect a new component (e.g. SMC20) via DRIVE-CLiQ to the drive system, SINAMICS detects the change in the actual topology and displays the actual/reference topology difference. The new component must then be configured and assigned to a drive object (Motor Module) using the drive wizard.

Operating sequence:

1. Select "Commissioning" → "Drive system" → "Drive unit" → "Topology" in the operating area. In the "Topology" dialog, start at an actual state.

   The component has not been connected yet. Connect a new DRIVE-CLiQ component (e.g. SMC20) to a Motor Module.

   Note

   Only plug in (connect) components when the drive unit is switched off.

SINAMICS recognizes the change in the actual topology and displays the actual/reference topology difference:

– GRAY: Desired state, drive object/component not plugged in and/or deactivated in the drive system. Use the cursor keys to select the required line. The state is indicated in the bottom part of the window.

– RED: Actual state, drive object/component present in the actual topology.

  New components that have not yet been commissioned have a component number > "200"; in this example, the number "210".

2. Navigate with the arrow keys to the component to be deleted. Press "Add component >".
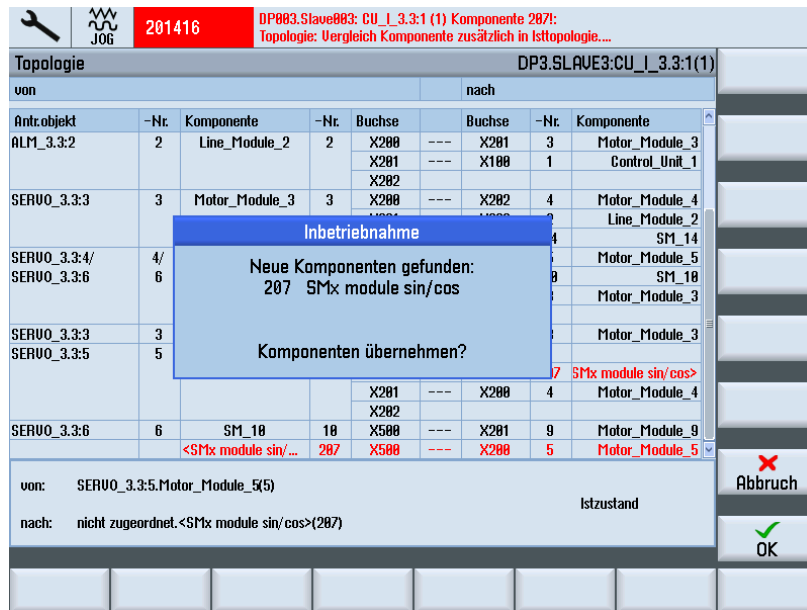
The system recognizes the new component and outputs a message.

3. Press "OK" as confirmation to configure and accept this component.

   Determining the device configuration may take several minutes. Depending on the device configuration, you will be prompted to perform further actions or to cancel:

   To match the cyclic data traffic between the NCK and SINAMICS to the configuration of the SINAMICS, an NCK and drive reset should be performed.

   Should an NCK and drive system reset be performed?

4. Press "OK" to confirm that an NCK and drive system reset should be performed. The following message will then appear:
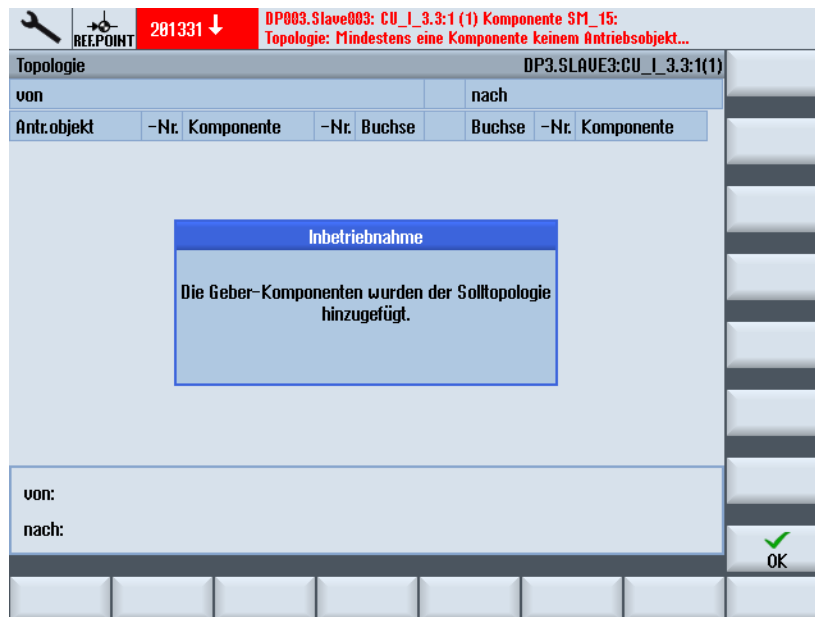
The unit configuration is finished. The component has been accepted.

5. Press "OK" to include the component in the topology again although it is not yet assigned to any drive:

   – Select "Drive unit" to open the drive wizard. Select the drive and assign the new encoder in the encoder configuration (Page 87) to the drive.

   – Press "OK" to assign this component to the drive later.

5.7.9 Replacing SINAMICS S120 components

Preconditions

There are two procedures for replacing components:

1. Replacing an existing Motor Module with a more powerful Motor Module.

2. Replacing SMI or SMx motor components.

The following preconditions are satisfied:

● The motor modules are of the same type.

● The serial number is different: ⇒ No further configuration is needed.

● The order number (MLFB) differs, for example, 9 A instead of 5 A.

Replacing an existing Motor Module with a more powerful Motor Module

Operating sequence:

Note

Do not make a permanent change in the drive system.

Before you replace the DRIVE-CLiQ component, change the comparison level.

---

1. Select the "Commissioning" → "Machine data" → "Control unit MD" dialog.

2. Change parameters p9907 (component number) and p9908 (comparison level of a component).

3. Save the changed drive data before switching off (power OFF).

4. Switch off the drive system: Power OFF.

5. Replace the component with a more powerful Motor Module.

6. Switch on the drive system: Power ON.

7. No further configuration is required because the Motor Module has been replaced in the switched-off status of the system. The new configuration and topology data is exported and the display refreshed.

Permanently replacing a Motor Module

Operating sequence:

1. Select the "Commissioning" → "Machine data" → "Control unit MD" dialog.

2. Set the "Device configuration" parameter to control unit: p0009 = 1

3. Transfer the new component: Control Unit: p9905 = 2

4. Wait until p9905 = 0 is automatically set again.

5. Set the "Device configuration" parameter to control unit: p0009 = 0

6. Save "All": set p977 = 1.

7. Ensure that you wait until p977 is automatically set to "0" again. This can take as long as 40 seconds.

The replacement of a single SINAMICS component is automatically acknowledged by the system.

Replacing SMI or SMx motor components

> **Note**
>
> The new SMI/SMx motor component must not yet be inserted!

Operating sequence:

1. You have removed the previous SMI or SMx motor component.

   This motor component is missing in the actual topology. SINAMICS indicates this in the form of a topology error alarm.

   The "Commissioning" → "Drive system" → "Drive units" → "Topology" dialog shows the previous motor component to be replaced "**gray**", i.e. present only in the reference topology.

2. In the "Commissioning" → "Drive system" → "Drive units" → "Topology" → "Change..." dialog, remove the SMI/SMx motor component awaiting replacement from the reference topology using the "Delete component" (Page 139) dialog.

> **Note**
>
> Save the changed drive data before switching off (power OFF).

3. Switch the drive system off and on (power OFF→ON).

4. In the "Commissioning" → "Drive system" → "Drive units" → "Topology" dialog, check whether the SMI/SMx motor component has been removed from the reference topology:

   – The alarm topology error is no longer pending.

   – The "Commissioning" → "Drive system" → "Drive units" → "Topology" dialog no longer shows any differences.

5. Switch off the drive system.

6. Plug in the new SMI/SMx motor component.

7. Switch on the drive system.

8. Add the new SMI/SMx motor component using the "Commissioning" → "Drive system" → "Drive units" → "Topology" → "Add component" (Page 141) dialog to the reference topology.

9. Assign the added SMI/SMx motor component via the "Commissioning" → "Drive system" → "Drives" (Page 87) drive wizard.

5.8 Tips for commissioning the SINAMICS drives

5.8.1 Drive (SERVO) parameter RESET, individual

Operating sequence

Note

Not just the motor and encoder data are reset. All the configured BICO logic operations (enable signals, probe signals) and message frame type are also deleted.

The factory setting (parameter RESET) may be set for each drive (SERVO) individually:

1. Set the factory settings on the selected drive: p0010 = 30

2. Activate the factory settings on this drive: p0970 = 1

3. Device automatically carries out RESET of all parameters on this drive.

4. Save drive-specific: Set p0971 = 1

    OR:

    Save "All": Set p0977 = 1.

5. Wait until p0977/p0971 is automatically set to " 0" again; this can take up to 40 seconds.

5.8.2 Drive-object assignment for PROFIBUS connection

Introduction

PROFIBUS telegrams (internal PROFIBUS, HW Config) are used to specify the process data to be exchanged between the NCK and the drives. The sequence of the drive objects (configurable/configured using HW Config) involved in PROFIBUS process-data exchange is defined via a drive-object list.

List of drive objects

You usually configure eight drive objects. The drive objects have drive-object (DO) numbers and are entered in p0978[0…9] as a list of drive objects.

You configure the following from parameter p0978 in the index:

- **0…5** -> Motor Module (e.g. DO no. 3…8)

- **6** -> Control Unit (e.g. DO no. 1)

- **7** -> Active Line Module (e.g. DO no. 2),

PROFIBUS telegram 370 is not currently available for the Active Line Module (infeed). However, according to the SINAMICS rule, all DO from parameter p0101 have to be assigned in parameter p0978. The resulting infeed DO number then has to be entered in index **9** (see table below).

Note

The list of DO involved in process-data exchange is completed by entering the value "0". Components that are available, but do not communicate on PROFIBUS, must be preset to "255".

The list of drive objects is already pre-assigned in the following order by the system upon initializing the drive (acceptance of topology):

- ALM, 1st Motor Module …n., CU; e.g. 2-3-4-5-1.

- The assignment allocated by the drive when the DRIVE-CLiQ topology is accepted must be reviewed and adapted.

Drive-object numbers

The drive-object numbers (DO numbers) can be viewed under "Commissioning > Machine data > Control Unit MD/Infeed MD/Drive MD" in the component name line. For example, the name for a Control Unit could be: "DP3.Slave3:CU_003 (1)". The DO number appears inside the brackets "(…)".

Assigning drive objects

Using an example of an SINAMICS S120 component structure, the following table illustrates the drive object assignment for the drive parameters:

- One Control Unit (CU)

- One Active Line Module (ALM)

- Three Motor Modules

Assignment p0978[0…9] for supply **with** DRIVE-CLiQ connection:

Component	Index p0978	List of drive objects
1. Motor Module	0	3
2. Motor Module	1	4
3. Motor Module	2	5
not found	3	255[1]
not found	4	255[1]
not found	5	255[1]
CU	6	1
ALM, only if protocol 370 is available	7	255[1]
not found	8	0[2]
ALM (Standard for SINUMERIK)	9	2

1) Not active

2) End of exchange of PZD

Note

The following table describes the assignment of the drive objects in the p0978[0…9] for an infeed without DRIVE-CLiQ connection. This assignment is also done for a drive group with NX module.

Assignment of p0978[0…9] for infeed **without** DRIVE-CLiQ connection:

Component	Index p0978	List of drive objects
1. Motor Module	0	2
2. Motor Module	1	3
3. Motor Module	2	4
not found	3	255[1]
not found	4	255[1]
not found	5	255[1]
CU	6	1
ALM, only if protocol 370 is available	7	255[1]
not found	8	0[2]
not found	9	0

1) Not active

2) End of exchange of PZD

Procedure for assigning the drive objects in parameter p0978

You are now in the "Commissioning > Machine data > Control Unit MD" menu.

p0978 can be written using the following sequence:

1. Set p0009= 1.

2. Set p0978[0…9] to the values listed in the table below (column …List of drive objects…), e.g. 3-4-5-255-255-255-1-255-0-2

   – Motor Module drive objects, ascending order (connected as per DRIVE-CLiQ)

   – Control Unit

   – ALM

3. Set p0009= 0.

4. Save "All": Set p0977= 1.

   Wait until p0977 is automatically written back to "0".

5.8.3   Firmware version display of drive components

Firmware version of the drive components

The versions of the drive components are output from "Commissioning" → "Drive system" → "Drive units" → Configuration" in the "FW version" column.

Example: 4503000 ⇒ Firmware version: 04.50.30.00

Figure 5-5   "Drive units" - "Configuration"

Using certain parameters from individual drive components, it is also possible to view the relevant firmware version for:

- SINAMICS S120 system software in parameter r0018
- Firmware version of the drive components in parameter r0975[2,10]
- Firmware version of the Sensor Module in parameter r0148[0...2]

System software SINAMICS S120

The version of the SINAMICS S120 software available in the system can be found in the parameter r0018 for the Control Unit machine data:

Example: r0018 = 45030000 ⇒ System software: 04.50.30.00

Firmware version of the drive components

The firmware version of all individual components can be individually fetched from the parameters r975[2] and r975[10] for each drive component (NCU, ALM, power section).

Example:

r0975[2] = 450, r0975[10] = 3000 -⇒ Firmware version: 04.50.30.00

Firmware version of all Sensor Modules

The firmware version of all Sensor Modules can be fetched from the parameter r0148[0...2] on the associated Motor Module.

Example: r0148[0] = 45030000 ⇒ Firmware version: 04.50.30.00 of the connected Sensor Module.

5.8.4   Check the power system data of the infeed

Introduction

The power supply data settings must be checked and possibly set in SINAMICS during commissioning.

Checking and setting the power supply data

The "Power supply data" softkey is active in the "Commissioning" → "Drive units" → "Infeed" operating area if the infeed has already been commissioned and the data has been saved in non-volatile memory:
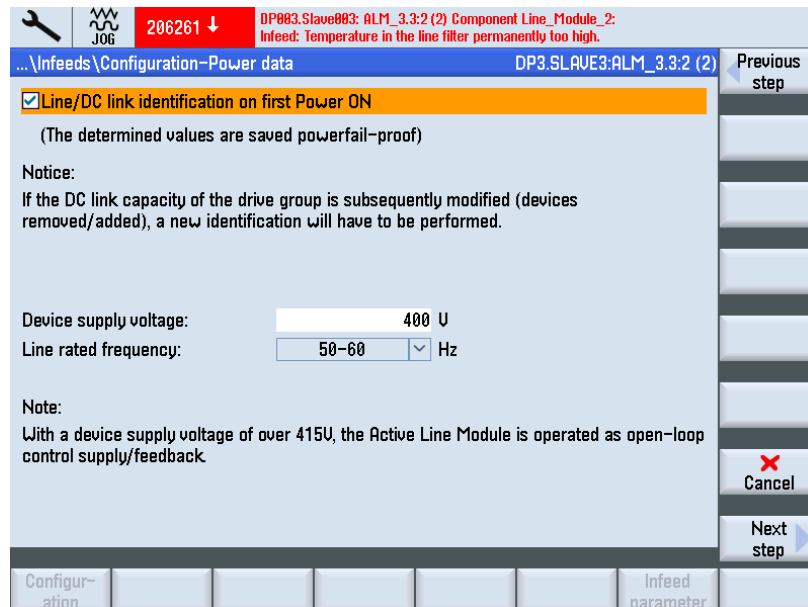
The following supply system data is configured:

- When the checkbox is selected, the supply system / DC-link identification is activated once the infeed pulse has been enabled (p3410). The infeed then switches to operational mode.

Note

DC-link identification

If the line supply environment changes or the components on the intermediate circuit change (e.g. after setting up the equipment at the customer site or after expanding the drive group), the checkbox must be set again: Hence the "Supply system data" softkey in the overview in order to restart the supply system / DC-link circuit identification.

If P3410 = 5 is saved in the commissioning archive then the supply system / DC-link identification starts automatically once the drive data is input into the archive.

Only then can it be guaranteed that the infeed operates with the optimum controller settings.

- Enter the device connection voltage: This is the basis for monitoring the supply voltage (p0281 - p0283), whereby an alarm is triggered in the case of an overshoot or undershoot. (Alarm threshold and shutdown threshold). The actual supply voltage is determined automatically and the adjustment is made based on this value.

- The actual network frequency for the infeed is determined automatically.

  Set in parameter p0284, p0285 a threshold from which an alarm is triggered (default setting of the monitoring: 45 Hz to 65 Hz).

5.8.5 Infeed optimization with DC-link identification

Introduction

The control optimization in the ALM is also performed with the identification of the ALM. Here, the inductance and capacity of the DC link are determined and the optimum control data determined for the set-up converter.

Identification can only be performed after the controller and the drive have been put into operation.

Procedure for the automatic identification of the ALM

The identification of the ALM is performed automatically by the system in the current SINAMICS versions as soon as the first drive has been commissioned and the X122.1 enable terminal activated. This automatically starts an internal optimization sequence that takes approx. 20 seconds to complete.

During this optimization sequence, enable terminal X122.1 should not be deactivated; otherwise the optimization would be aborted. If optimization is aborted, identification may be carried out manually at a later stage by the user.

Procedure for the manual identification of the ALM

The identification of the ALM is performed as follows:

1. Disconnect release (AUS1) ALM (X122.1) by the commissioning engineer.

2. Select machine data for the infeed (ALM) in the "Commissioning" > "Machine data" > "Infeed MD" menu.

3. Initiate identification on the ALM: p3410 = 5.

4. Connect ALM enable (the enable must remain pending during the execution of the first step of the identification).

5. The ALM controller data is reset automatically and power supply identification starts.

6. After a successful identification, p3410 is automatically set to 0 and the values for the controller data of the ALM are saved automatically. Check: p3402 = 9 (Release has to remain during the execution of this step of the identification!).

7. Disconnect ALM enable (X122.1) by the commissioning engineer.

8. The optimized infeed data is saved automatically. The data does not need to be saved manually (p0977 = 1).

Communication between the NCK and the drive 6

6.1 Overview of the NCK and drive communication

What will be configured next?

The initial commissioning of the PLC and SINAMICS drives is completed.

The NCK machine data that communicates with the drive is:

- General machine data

  General machine data required for communication with the drive via PROFIBUS that has been preset with default values. These values can be taken over during the initial commissioning:

  – The telegram type for transfer

  – The logical addresses for the PLC

- Axis-specific machine data

  The axis component for transfer of the setpoints and actual values for the relevant axis, is set in the axis machine data.

Assigning general and axis-specific machine data

The following table illustrates using the example of an SINAMICS S120 module structure (one NCU, one ALM, three motor modules (MM)) the assignment of the machine data for input/output address / telegram / setpoint / actual value:

SINAMICS S120	STEP 7 (HW Config) DP slave properties		NCK: General machine data			NCK: Axis machine data[2]	
Component	Telegram type length[1]	I/O address[1]	MD13120[0] I/O address[1]	MD13050 [0-5] I/O address[1]	MD13060 [0-5] telegram type [1]	MD30110/ MD30220 setpoint / actual value assignment	MD30130 Type of output Setpoint
MM1	136. PZD-11/19	4100		4100	136	1	1
MM2	136. PZD-11/19	4140		4140	136	2	1
MM3	136. PZD-11/19	4180		4180	136	3	1
not found	136. PZD-11/19	4220		4220	136	--	0
not found	136. PZD-11/19	4260		4260	136	--	0
not found	136. PZD-11/19	4300		4300	136	--	0
CU	391. PZD-3/7	6500	6500				
ALM	370. PZD-1/1	6514					

[1] Preassignment: do not change.

[2] The axis-specific machine data for the configuration of the setpoints and actual values is pre-assigned using the "Assign axis" function.

6.2 Configuring the communication to the drive

Default settings

The telegram length in the hardware configuration is preassigned with the associated I/O addresses. This pre-assignment for SINAMICS corresponds to the following telegrams with the maximum possible telegram length:

- Telegram 136: for the axes

- Telegram 391: for the NCU

- Telegram 370: for the ALM

This ensures that all telegrams can be supplied without change.

Operating sequence for telegram length and I/O addresses

Procedure:

1. To view this configuration, click in the HW Config on the module "SINAMICS Integrated" and select "Object properties", using the <right mouse button>.

2. Select the "Configuration" tab and select the "Overview" tab to display the lengths of the preassigned telegrams.

The figure shows the default setting of the telegrams for six axes:
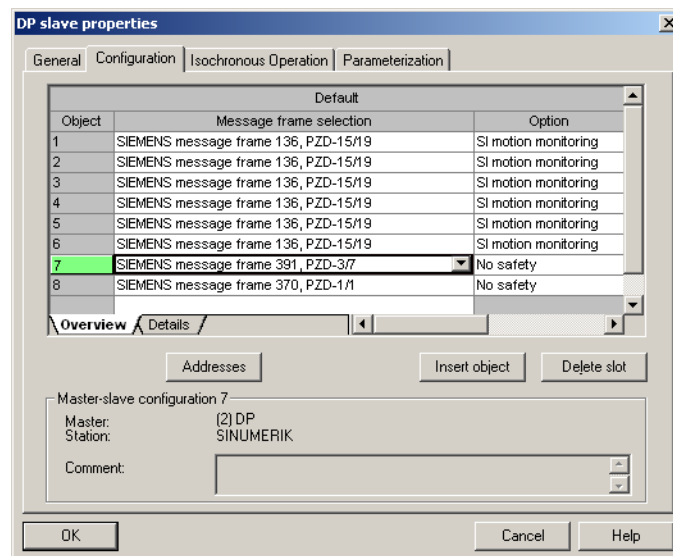
3. Click "OK" to close the dialog.

Example

You can view the address areas in the station window in the detail view by clicking "SINAMICS Integrated". Here, for example, address 4100 corresponds to the address entered in MD13050 $MN_DRIVE-LOGIC_ADRESS[0]. The addresses have a gap of 40 bytes. The following example shows the assignment of the pre-assignment of the I/O addresses of the PLC configuration to MD13050 $MN_DRIVE-LOGIC_ADRESS[0 … 5]:
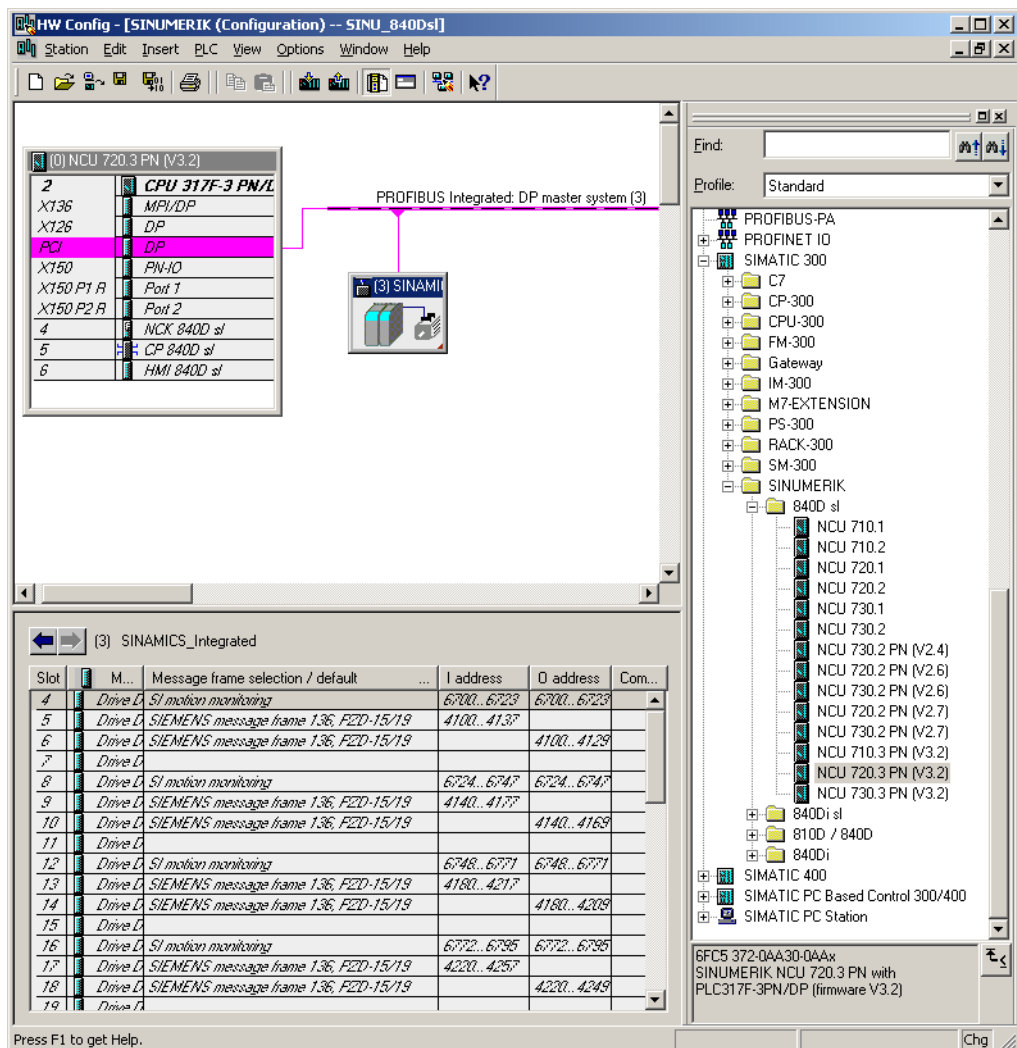
Default setting in the NCK:

MD13050 $MN_DRIVE_LOGIC_ADRESS[0] = 4100	For the 1st axis
MD13050 $MN_DRIVE_LOGIC_ADRESS[1] = 4140	For the 2nd axis
MD13050 $MN_DRIVE_LOGIC_ADRESS[2] = 4180	For the 3rd axis
MD13050 $MN_DRIVE_LOGIC_ADRESS[3] = 4220	For the 4th axis ... etc.

Figure 6-1   Telegram lengths and I/O addresses

6.3 Configuring the I/O address and telegram

PROFIBUS connection

The following general machine data is also set by default for the PROFIBUS connection of the axes to the drive:

- MD13050 $MN_DRIVE_LOGIC_ADDRESS (axis address)

- MD13060 $MN_DRIVE_TELEGRAM_TYPE (telegram type)

- MD13120 $MN_CONTROL_UNIT_LOGIC_ADDRESS (CU address)

The connection of the relevant axes to the drive via PROFIBUS is displayed in the "Commissioning" → "Drive system" → "Drive units" → "PROFIBUS" operating area.

Example for the connection of relevant axis to the drive:

Figure 6-2   Drive units - PROFIBUS

To do this, press the "Change" softkey. You can then change the assignment using the arrow keys:
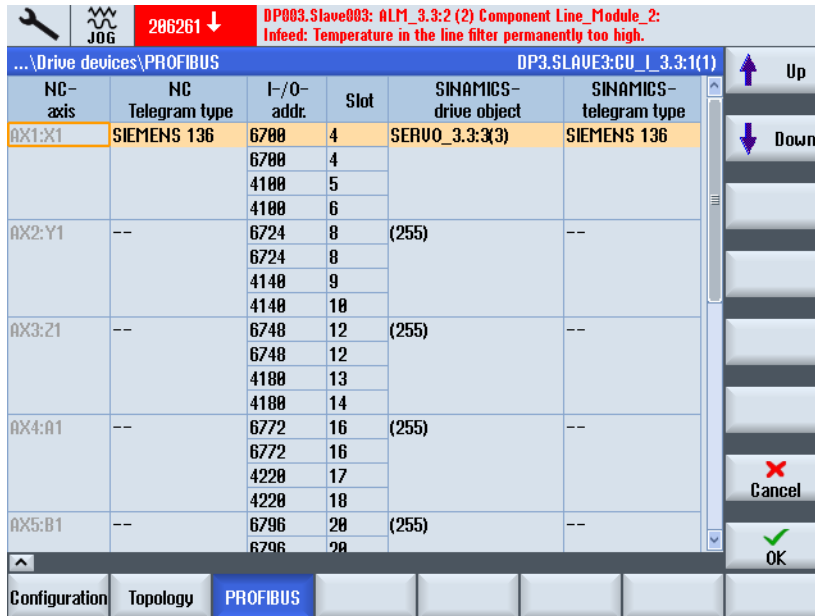
Figure 6-3   Change assignment

NOTICE

To ensure the communication to the drive, the I/O addresses and telegram types set here must match the settings in the STEP 7 hardware configuration.

6.4 Configuring the setpoint / actual value

Introduction

The axis component for transfer of the setpoints and actual values for the relevant axis, is set in the axis machine data. The following axis machine data must be adapted for each axis:

- MD30110 $MA_CTRLOUT_MODULE_NR (setpoint channel)
- MD30220 $MA_ENC_MODUL_NR (actual value channel)
- MD30130 $MA_CTRLOUT_TYPE (type of output setpoint)
- MD30240 $MA_ENC_TYPE (acquisition of actual value)

The axis/machine data can be automatically adapted using the "Assign axis" function or directly using the "Axis MD" function.

Assigning setpoints and actual values

Procedure:

1. Select the "Axis MD" softkey in the "Commissioning > Machine data" in the operating area.
2. Select the corresponding axis using "Axis+".
3. For the setpoint channel, search for MD30110 $MA_CTRLOUT_MODULE_NR.
4. Enter the drive number.
5. For the actual value channel, search for MD30220 $MA_ENC_MODUL_NR.
6. Enter the drive number.
7. For the output setpoint, search for MD30130 $MA_CTRLOUT_TYPE.
8. Enter "1".
9. For the actual-value acquisition, search for MD30240 $MA_ENC_TYPE.
10. Enter "1" for incremental encoder or "4" for absolute value encoder.
11. Select the next axis in each case with **Axis+** and continue with Step 3 for the next drive.

6.5   Assigning axes

Operating sequence in the "Assign axis" menu

Procedure:

1. Select the "Commissioning" > "Drive system" > "Drives" menu.
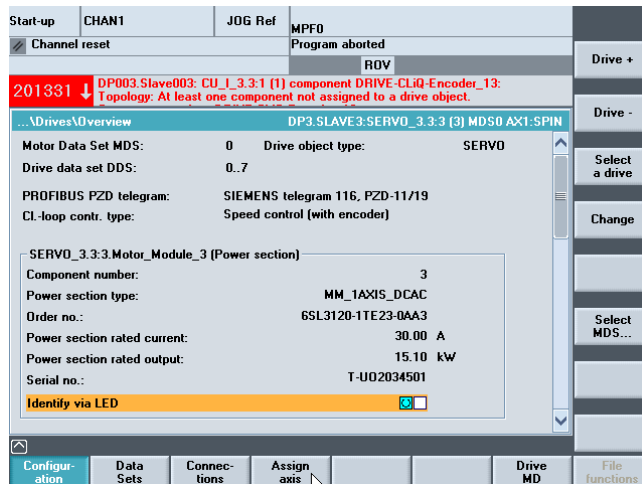
Figure 6-4   "Commissioning" > "Drive system" > "Drives" menu

---

Note

The "Assign axis" function can also be activated in the "Commissioning > Drive system" function using the vertical softkey bar. You must have selected a servo drive before doing this.

---

2. Press the "Assign axis" horizontal softkey
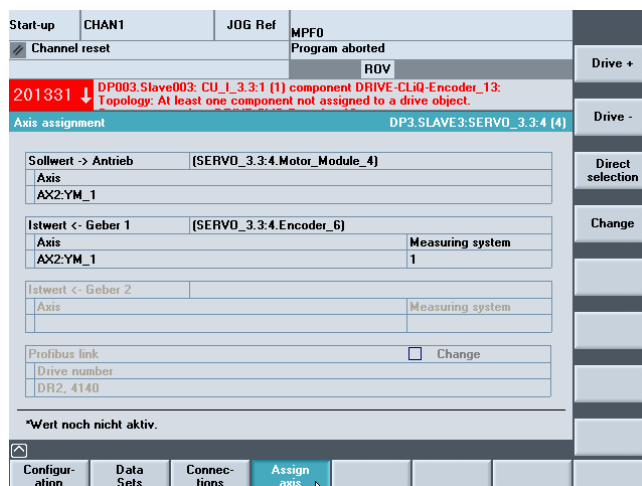
Figure 6-5   Assignment of setpoints and actual values for axes to drive

3. Use "Drive +"/"Drive -"/"Direct selection" to select the corresponding servo.

4. Press "Change".
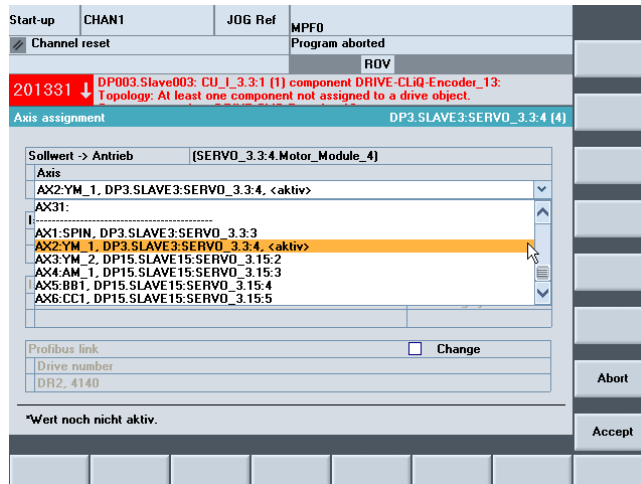
Figure 6-6   "Assign axis" > "Change" menu

5. Use the cursor keys to select the selection boxes for the setpoint or actual value.

6. Use the <INPUT> key to open the selection box.

7. Use the cursor keys to select the component.

8. Press "Transfer".

6.6 Ending the communications commissioning

Commissioning communication NCK<->PLC completed

You have commissioned the following in operation:

- PLC
- SINAMICS drives
- Communication NCK-PLC

The basic commissioning is completed. Now you can move the axes.

The next chapter, "Commissioning NCK", describes the parameterization of NCK regarding the connected machine by setting system variables.

NCK start-up

<div style="text-align: right; font-size: 3em;">7</div>

7.1 Machine and setting data

Parameterizing the NCK

Adaptation of the controller at the machine is performed using the machine and setting data.

- The machine data (MD) is divided into the following areas:
  - General machine data
  - Channel-specific machine data
  - Axis-specific machine data
  - Machine data for control unit
  - Machine data for infeed
  - Machine data for drives
- The setting data (SD) is divided into the following areas:
  - General setting data
  - Channel-specific setting data
  - Axis-specific setting data

The following table provides an overview of the machine data and setting data areas:

Range	Name
from 9000 to 9999	Display machine data
from 10000 to 18999	General NC machine data
from 19000 to 19999	Reserved
from 20000 to 28999	Channel-specific machine data
from 29000 to 29999	Reserved
from 30000 to 38999	Axis-specific machine data
from 39000 to 39999	Reserved
from 41000 to 41999	General setting data
from 42000 to 42999	Channel-specific setting data
from 43000 to 43999	Axis-specific setting data
from 51000 to 51299	General configuration machine data
from 51300 to 51999	General cycle machine data
from 52000 to 52299	Channel-specific configuration machine data
from 52300 to 52999	Channel-specific cycle machine data
from 53000 to 53299	Axis-specific configuration machine data
from 53300 to 53999	Axis-specific cycle machine data

Effectiveness

The effectiveness with regard to a machine data item specifies when a change of the machine data becomes active. The levels of effectiveness have been listed below in order of priority.

- POWER ON (po) NCK RESET
- NEWCONF (cf)
  - "Set MD to active" softkey
  - <RESET> key on the MSTT
  - It is possible to modify block limits during program operation
- RESET (re)
  - At end of program M2/M30 or
  - <RESET> key on the MSTT
- IMMEDIATE (so)
  - After the input of a value

Note

Unlike machine data, changes to setting data always take effect **immediately**.

Literature

The description of the machine data and setting data can be found in the online help on the controller and in the following manuals:

- The "Lists1" Parameters Manual /LIS1/.
- The "Detailed description of the machine data" Parameters Manual /AMD/

7.2 Parameter sets of axis/spindle

Introduction

Six parameter sets are available for each machine axis:

● For an axis, the parameter sets are used to adapt the own dynamic response to another machine axis, e.g. when tapping or thread cutting on the relevant spindle.

● For a spindle, the parameter sets are used to adapt the position control to the modified properties of the machine during operation, e.g. when switching the gearbox.

Tapping, thread cutting

The following applies to axes:

● For machine axes that are not involved in tapping or thread cutting, the first set of parameters (index=0) is active in all cases. The further parameter sets need not be considered.

● For machine axes involved in tapping or thread cutting: the parameter set is activated in accordance with the current gear stage. All parameter sets must be parameterized in accordance with the gear stages of the spindle.

The following applies to spindles:

● With spindles, each gear stage is assigned a parameter set of its own.

For example, gear stage 1 - parameter set 2 (index 1). Spindles in axis operation (DB31, ... DBX60.0 = 0) use Parameter set 1 (Index 0). The active gearbox step can be read in the PLC via the signals DB31, ... DBX82.0-2 (gearbox step setpoint). The parameter set is selected from the PLC using the interface signal DB31, ... DBX16.0 - 16.2 (actual gear stage). All parameter sets must be parameterized in accordance with the gear stages of the spindle.

Validity of parameter sets for axis and spindle modes

The active parameter set of a machine axis is displayed under "Service axis" in the "Diagnostics" operating area. The active parameter set can be read in the PLC via the signals DB31, ... DBX69.0-2 (Controller parameter set)."

Parameter set number	Axis	Spindle	Spindle gear stage
0	**Standard**	Axis mode	Depending on the manufacturer's specification
1	Axis interpolates with spindle (G33)	Spindle mode	1.
2	Axis interpolates with spindle (G33)	Spindle mode	2.
3	Axis interpolates with spindle (G33)	Spindle mode	3.
4	Axis interpolates with spindle (G33)	Spindle mode	4.
5	Axis interpolates with spindle (G33)	Spindle mode	5.

Remarks on the "Axis" column: The switchover applies to G33 as well as for G34, G35, G331 and G332.

Parameter-set-dependent machine data

The following machine data of an axis depends on the parameter set:

MD	Name	Meaning
31050	$MA_DRIVE_AX_RATIO_DENOM[n]	Denominator load gearbox
31060	$MA_DRIVE_AX_RATIO_NUMERA[n]	Numerator load gearbox
32200	$MA_POSCTRL_GAIN[n]	K_V factor
32810	$MA_EQUIV_SPEEDCTRL_TIME[n]	Equivalent time constant speed control loop for feedforward control
32910	$MA_DYN_MATCH_TIME[n]	Time constant for dynamic matching
35110	$MA_GEAR_STEP_MAX_VELO[n]	Maximum speed for gear stage change
35120	$MA_GEAR_STEP_MIN_VELO[n]	Minimum speed for gear stage change
35130	$MA_GEAR_STEP_MAX_VELO_LIMIT[n]	Maximum speed of gear stage
35140	$MA_GEAR_STEP_MIN_VELO_LIMIT[n]	Minimum speed of gear stage
35200	$MA_GEAR_STEP_SPEEDCTRL_ACCEL[n]	Acceleration in speed control mode
35210	$MA_GEAR_STEP_POSCTRL_ACCEL[n]	Acceleration in position-control mode
36200	$MA_AX_VELO_LIMIT[n]	Threshold value for velocity monitoring

n = parameter set number (0 ... 5)

7.3 Parameterize axis data

7.3.1 Parameterizing the incremental-rotary measuring system

Rotary measuring system

The diagrams below show the general possibilities for arranging a rotary incremental measuring system with regard to motor and load, as well as the resulting values for the appropriate machine data.

The figures equally apply to rotary axes, modulo axis and spindles:

● Linear axis with encoder on the machine
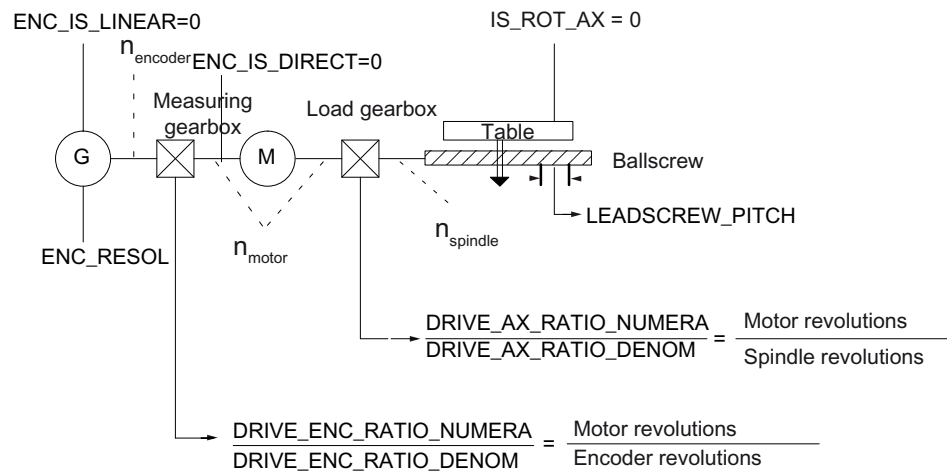
Figure 7-1   Linear axis with encoder on motor

● Linear axis with encoder on load
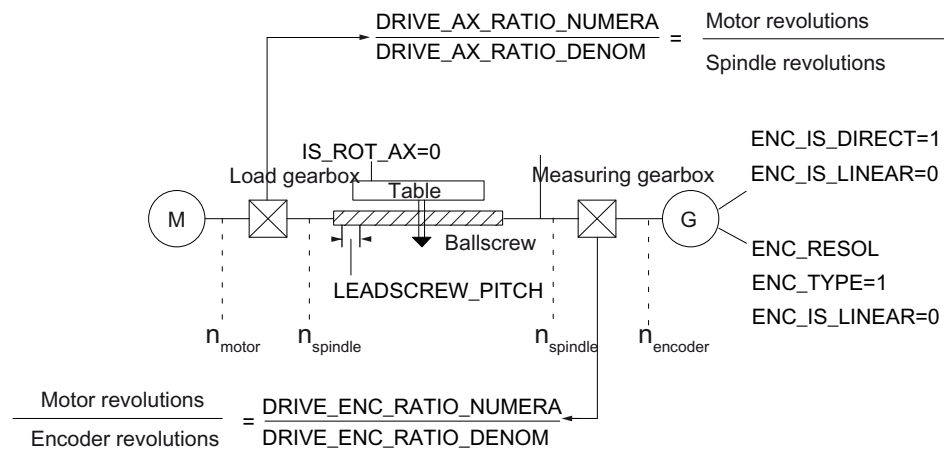
Figure 7-2   Linear axis with encoder on load

● Rotary axis with encoder on motor

$$\frac{DRIVE\_AX\_RATIO\_NUMERA}{DRIVE\_AX\_RATIO\_DENOM} = \frac{Motor\ revolutions}{Load\ revolutions}$$

$$\frac{DRIVE\_ENC\_RATIO\_NUMERA}{DRIVE\_ENC\_RATIO\_DENOM} = \frac{Motor\ revolutions}{Encoder\ revolutions}$$
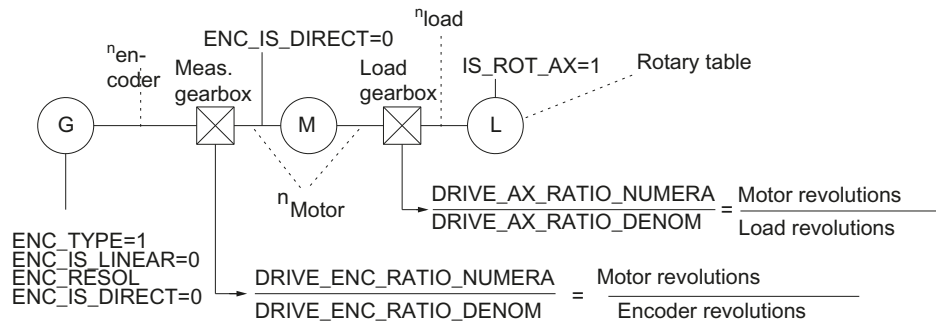
Figure 7-3   Rotary axis with encoder on motor

● Linear axis with encoder on the machine

$$\frac{DRIVE\_ENC\_RATIO\_NUMERA}{DRIVE\_ENC\_RATIO\_DENOM} = \frac{Encoder\ revolutions}{Load\ revolutions}$$

$$\frac{DRIVE\_AX\_RATIO\_NUMERA}{DRIVE\_AX\_RATIO\_DENOM} = \frac{Motor\ revolutions}{Load\ revolutions}$$
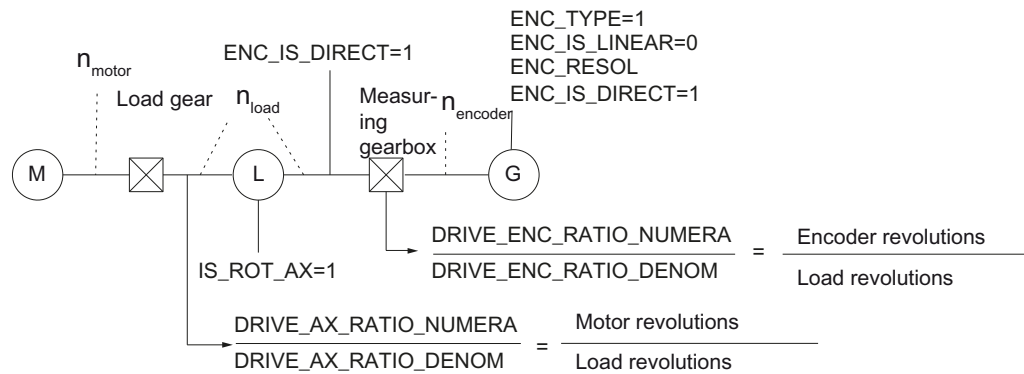
Figure 7-4   Linear axis with encoder on the machine

Machine data for incremental measuring systems

MD	Identifier	Comment
30240	$MA_ENC_TYPE[n]	Actual-value acquisition modes: 1 = incremental raw signal generator
30242	$MA_ENC_IS_INDEPENDENT[n]	Encoder is independent
30300	$MA_IS_ROT_AX	Rotary axis
31000	$MA_ENC_IS_LINEAR[n]	Direct measuring system (linear scale)
31020	$MA_ENC_RESOL[n]	Encoder pulses per revolution
31030	$MA_LEADSCREW_PITCH	Leadscrew pitch
31040	$MA_ENC_IS_DIRECT[n]	Encoder is connected directly to the machine
31050	$MA_DRIVE_AX_RATIO_DENOM[n]	Denominator load gearbox
31060	$MA_DRIVE_AX_RATIO_NUMERA[n]	Numerator load gearbox
31070	$MA_DRIVE_ENC_RATIO_DENOM[n]	Denominator of resolver gearbox
31080	$MA_DRIVE_ENC_RATIO_NUMERA[n]	Numerator of resolver gearbox

7.3.2 Parameterizing the incremental-linear measuring system

Linear measuring system

The diagram below shows the general possibilities for arranging a linear incremental measuring system with regard to motor and load, as well as the resulting values for the respective machine data.

The representation applies equally to rotary axes, modulo axis and spindles:
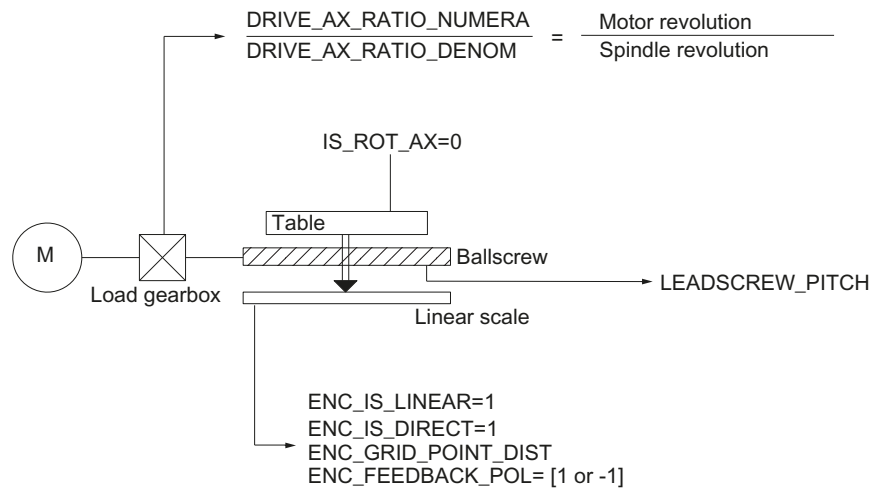
Figure 7-5   Linear axis with linear scale

Machine data for linear measuring systems

MD	Identifier	Comment
30240	$MA_ENC_TYPE[n]	Actual-value acquisition modes
		1 = incremental raw signal generator
30242	$MA_ENC_IS_INDEPENDENT[n]	Encoder is independent
30300	$MA_IS_ROT_AX	Rotary axis
31000	$MA_ENC_IS_LINEAR[n]	Direct measuring system (linear scale)
31010	$MA_ENC_GRID_POINT_DIST[n]	Distance between reference marks on linear scales
31030	$MA_LEADSCREW_PITCH	Leadscrew pitch
31040	$MA_ENC_IS_DIRECT[n]	Encoder is connected directly to the machine
31050	$MA_DRIVE_AX_RATIO_DENOM[n]	Denominator load gearbox
31060	$MA_DRIVE_AX_RATIO_NUMERA[n]	Numerator load gearbox
32110	$MA_ENC_FEEDBACK_POL[n]	Sign actual value (feedback polarity)

7.3.3 Parameterizing the absolute measuring system

Encoder types

The following encoder types with EnDat protocol and incremental sinusoidal encoder signals A and B are currently supported:

- Single-turn absolute value encoder
- Multi-turn absolute value encoder

The absolute value encoder EQN 1325 from Heidenhain has the following properties:

- EnDat protocol
- PPR count: 2048 = 2^{11} (encoder fine resolution)
- Positions/revolution: 8192 (13 bits)
- Differentiable revolutions: 4096 (12 bits)
- Encoder signals A/B: 1Vpp sin/cos

Calibration

Convergence of the measuring system with the machine positions is performed by calibration of the absolute value encoder in absolute measuring systems.

- Linear axis with absolute value encoder on motor

$$\frac{\text{DRIVE\_ENC\_RATIO\_NUMERA}}{\text{DRIVE\_ENC\_RATIO\_DENOM}} = \frac{\text{Motor revolutions}}{\text{Encoder revolutions}}$$

ENC_IS_LINEAR=0
ENC_IS_DIRECT=0
$n_{encoder}$

IS_ROT_AX=0

load gearbox

G — Measuring gearbox — M — n_{motor} — $n_{spindle}$ — Table — Ballscrew — LEADSCREW_PITCH

ENC_TYPE=4
ENC_ABS_TURNS_MODULO=4096
ENC_REFP_MODE=2

$$\frac{\text{DRIVE\_AX\_RATIO\_NUMERA}}{\text{DRIVE\_AX\_RATIO\_DENOM}} = \frac{\text{Motor revolutions}}{\text{Spindle revolutions}}$$
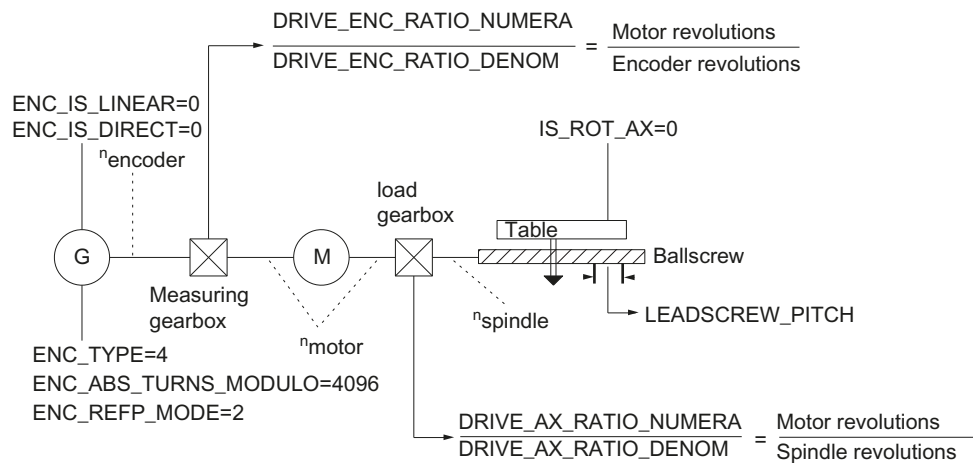
Figure 7-6   Linear axis with absolute value encoder on motor

- Rotary axis, modulo axis and spindle with absolute value encoder on motor
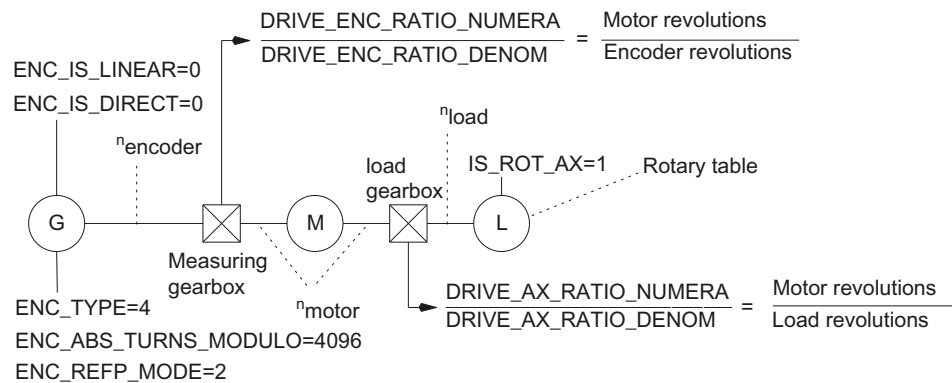
Figure 7-7   Rotary axis, modulo axis and spindle with absolute value encoder on motor

Machine data for absolute measuring systems

MD	Identifier	Comment
30240	$MA_ENC_TYPE[n]	Actual-value acquisition modes
30242	$MA_ENC_IS_INDEPENDENT[n]	Encoder is independent
30260	$MA_ABS_INC_RATION[n]	Encoder fine resolution (absolute value encoder)
30300	$MA_IS_ROT_AX[n]	Rotary axis
31000	$MA_ENC_IS_LINEAR[n]	Direct measuring system (linear scale)
31030	$MA_LEADSCREW_PITCH[n]	Leadscrew pitch
31040	$MA_ENC_IS_DIRECT[n]	Encoder is connected directly to the machine
31050	$MA_DRIVE_AX_RATIO_DENOM[n]	Denominator load gearbox
31060	$MA_DRIVE_AX_RATIO_NUMERA[n]	Numerator load gearbox
31070	$MA_DRIVE_ENC_RATIO_DENOM[n]	Measuring gearbox denominator
31080	$MA_DRIVE_ENC_RATIO_NUMERA[n]	Measuring gearbox numerator
34200	$MA_ENC_REFP_MODE[n]	Referencing mode
34210	$MA_ENC_REFP_STATE[n]	Status of absolute value encoder
34220	$MA_ENC_ABS_TURNS_MODULO[n]	Absolute value encoder range for rotary encoders (multi-turn resolution)

See also

For calibration of the absolute value encoder, see Chapter "Axis Homing" (Page 195).

7.3.4 Setpoint/actual value channels

Introduction

The following points must be observed for setpoint / actual value channels:

Note

In order to guarantee that the controller runs up reliably, all machine axes are declared as simulation axes (without hardware).

- MD30130 $MA_CTRLOUT_TYPE (output type of setpoint value) = 0
- MD30240 $MA_ENC_TYPE (actual-value acquisition mode) = 0

Traversing of the axes in SERVO mode is simulated without speed setpoint output, and no hardware-specific alarms are output.

The following machine data can be used to select whether the interface signals of a simulation axis are output at the NC/PLC interface (e.g. during program test, if there is no drive hardware, used in FC18 in PLC).

- MD30350 $MA_SIMU_AX_VDI_OUTPUT (output of axis signals with simulation axes)

Assignment of the setpoint / actual value channels

For each machine axis to which a drive is assigned, the following must be parameterized:

- A setpoint channel and
- At least one actual-value channel

A second actual-value channel can be set up as an option.

NOTICE

The motor measuring system is always used for the speed control function. Motor and motor measuring system must therefore always be connected to the same drive (SERVO).

In the following two axis-specific machine data, the logical drive number m of the drive is entered, which represents the machine axis:

- MD30110 $MA_CTRLOUT_MODULE_NR[0] (setpoint assignment: Logical drive number)
- MD30220 $MA_ENC_MODUL_NR[n] (actual value assignment: Logical drive number)

With the logical drive number m, that drive is addressed whose I/O address is entered under the index n = (m - 1) in MD13050 $MN_DRIVE_LOGIC_ADDRESS[<n>] (see Chapter "Axis assignment (Page 369)").

NCK Reset

Once the drive configuration and setpoint / actual value assignment have been parameterized, an NCK reset must be executed to initiate a warm restart of the NC. After the NC has powered up, the set configuration is effective.

Measuring system switchover

The following interface signals can be used to switch between the two position measuring systems of a machine axis from the PLC.

- DB31, ... DBX1.5 (position measuring system 1 selected)
- DB31, ... DBX1.6 (position measuring system 2 selected)

Machine data

MD	Identifier	Comment
30110	$MA_CTRLOUT_MODULE_NR	Setpoint assignment: Logical drive number
30130	$MA_CTRLOUT_TYPE	Output of setpoint value 0 = Simulation 1 = Output of speed setpoint
30200	$MA_NUM_ENCS	Number of measuring channels 1 = One position measuring system present 2 = Two position measuring systems present
30220	$MA_ENC_MODULE_NR[0]	Actual value assignment: Logical drive number for position measuring system 1
30220	$MA_ENC_MODULE_NR[1]	Actual value assignment: Logical drive number for position measuring system **2**
30230	$MA_ENC_INPUT_NR[0]	Actual value assignment: Position measuring system 1 1 = G1_XIST encoder 1 position actual value 1 2 = G2_XIST encoder 1 position actual value 2
30230	$MA_ENC_INPUT_NR[1]	Actual value assignment: Position measuring system **2** 1 = G1_XIST encoder 2 position actual value 1 2 = G2_XIST encoder 2 position actual value 2
30240	$MA_ENC_TYPE[0]	Type of actual value recording 0 = Simulation 1 = Incremental encoder 4 = Absolute encoder with EnDat interface

References

Basic Functions Function Manual; Various Interface Signals (A2)

7.3.5 Dynamic Servo Control (DSC)

Overview

The DSC function eliminates the deadtime that necessarily exists at the speed-setpoint interface normally used between the NCK and drive due to relocation of the position controller into the drive.

This results in the following advantages for an axis operated with DSC:

- Considerably improved fault response/stability of the position control loop

- Improved command behavior (contour precision) if the loop gain (K_V factor) that can be set higher in conjunction with DSC is used.

- A reduction of the cyclic communication load on the PROFIBUS, if the position controller cycle/PROFIBUS cycle is reduced by adjusting the above parameters, even if the control loop performance is the same.

Note

The speed feedforward control can be used in conjunction with DSC.

Preconditions

Before you can activate DSC mode, the following preconditions must be fulfilled:

- DSC-capable drive

- A DSC-capable telegram type has been parameterized in the S7 project for the drive.

Switch ON/OFF

The DSC function is switched on via the following axis-specific NCK machine data:

- MD32640 $MA_STIFFNESS_CONTROL_ENABLE (dynamic stiffness control)

If the DSC operation is switched ON or OFF, it might be necessary to adjust the following machine data:

- MD32200 $MA_POSCRTL_GAIN ($K_V$ factor)

- MD32610 $MA_VELO_FFW_WEIGHT (Feedforward control factor)

- MD32810 $MA_EQUIV_SPEEDCTRL_TIME (Equivalent time constant of the closed speed control loop)

NOTICE
Before you can switch off DSC operation you might have to adapt (reduce) the K_V factor of the axis. Otherwise, instability of the position control loop might result.

Actual value inversion during DSC operation

> **Note**
>
> Actual value inversion during DSC operation (MD32640=1) is undertaken as follows:
> - Set the p0410 parameter (encoder inversion actual value) in the drive.
> - In the NC in the machine data, set MD32110 $MA_ENC_FEEDBACK_POL = 0 or 1 (no inversion!).
>
>   Actual value inversion via MD32110=-1 is not possible during activated DSC operation.
>
>   If MD32110=-1 is to be set, the "26017 axis%1 machine data 32110 value not permitted" alarm is output when DSC operation is activated.

Speed setpoint filter

If you use DSC, a speed setpoint filter for rounding the speed setpoint steps is no longer necessary. The speed setpoint filter is then only of any use with differential connection to support the position controller, for example, to suppress resonance.

Machine data

MD	Identifier	Name
32640	$MA_STIFFNESS_CONTROL_ENABLE	Dyn. stiffness control
32200	$MA_POSCRTL_GAIN	K_V factor
32642	$MA_STIFFNESS_CONTROL_CONFIG	The dynamic stiffness control is configured:
		0: DSC in the drive operates with an indirect measuring system (default setting)
		1: DSC in drive operating with direct measuring system

7.3.6 Rotary axes

Rotary axes

A machine axis is parameterized as a rotary axis in

- MD30300 $MA_IS_ROT_AX (rotary axis) = 1

The machine data is a scaling machine data. A change results in a conversion of all machine data of the machine axis with length-related units.

For the recommended procedure with respect to scaling machine data, please refer to Section "Modifying Scaling Machine Data".

Modulo display

The display of the rotary axis position modulo 360 degrees is displayed via the following machine data:

- MD30320 $MA_DISPLAY_IS_MODULO (modulo 360 degrees display for rotary axes)

Endlessly rotating rotary axis / modulo axis

The traversing of the rotary axis modulo 360 degrees is displayed via the following machine data:

- MD30310 $MA_ROT_IS_MODULO (modulo conversion for rotary axis)

  The limit switches are not monitored during this process. The rotary axis can thus rotate endlessly.

  The limit switch monitoring can be activated by the PLC interface.

Machine data

MD	Identifier	Name
10210	$MN_INT_INCR_PER_DEG	Computational resolution for angular positions
30300	$MA_IS_ROT_AX	Axis is rotary axis
30310	$MA_ROT_IS_MODULO	Modulo conversion for rotary axis
30320	$MA_DISPLAY_IS_MODULO	Actual value display modulo
36100	$MA_POS_LIMIT_MINUS	Minus software limit switch
36110	$MA_POS_LIMIT_PLUS	Plus software limit switch

Literature

Function Manual, Extended Functions; Rotary Axes (R2)

7.3.7   Positioning axes

Positioning axes

Positioning axes are channel axes traversing parallel to the path axes without interpolating with them. Positioning axes can be traversed either from the part program or from the PLC.

A channel axis is defined as neutral with the following machine data. As a result no REORG takes place if the axis/spindle is traversed by the PLC (FC18) or by synchronous actions.

- MD30450 $MA_IS_CONCURRENT_POS_AX (neutral axis / channel axis) = 1

Positioning axis feedrate

If a positioning axis is programmed in the part program without specifying an axis-specific feedrate, the feedrate entered in the following machine data is automatically applicable to this axis:

- MD32060 $MA_POS_AX_VELO (initial setting for positioning axis velocity)

This feedrate applies until an axis-specific feedrate is programmed in the part program for this axis.

Machine data

MD	Identifier	Name
22240	$MC_AUXFU_F_SYNC_TYPE	Output timing of F functions
30450	$MA_IS_CONCURRENT_POS_AX	Neutral axis or channel axis
32060	$MA_POS_AX_VELO	Initial setting for positioning-axis velocity

Literature

Function Manual, Extended Functions; Positioning Axes (P2)

7.3.8   Indexed axes/"Hirth" axes

Indexing axis

Indexing axes are rotary or linear axes, which can be traversed to indexing positions by part program instructions. These indexing positions are approached in JOG mode. In "normal" positioning, every position can be approached.

Note

Traversing to indexing positions using the part program or manually is only effective if the corresponding machine axis has been successfully referenced.

Hirth axes are indexing axes with Hirth tooth system. These axes are rotary or linear axes, which may only be traversed to defined positions, the indexing positions, within the traversing range (MD30505 $MA_HIRTH_IS_ACTIVE). The indexing positions are stored in tables.

The following machine data assigns the machine axis the relevant table of indexing positions and also defines the machine axis as an indexing axis:

- MD30500 $MA_INDEX_AX_ASSIGN_POS_TAB[n] (axis is an indexing axis)

Indexing position tables

The indexing positions are stored in one of the two tables.

- MD10900 $MN_INDEX_AX_LENGTH_POS_TAB_1 (number of positions of indexing axis table 1)

- MD10910 $MN_INDEX_AX_POS_TAB_1 [n] (indexing position table 1)

- MD10920 $MN_INDEX_AX_LENGTH_POS_TAB_2 (number of positions of indexing axis table 2)

- MD10930 $MN_INDEX_AX_POS_TAB_2 [n] (indexing position table 2)

Machine data

MD	Identifier	Comment
10260	$MN_CONVERT_SCALING_SYSTEM	Basic system switchover active
10270	$MN_POS_TAB_SCALING_SYSTEM	Measuring system of position tables
10900	$MN_INDEX_AX_LENGTH_POS_TAB_1	Number of indexing positions used in table 1
10910	$MN_INDEX_AX_POS_TAB_1[n]	Indexing position table 1
10920	$MN_INDEX_AX_LENGTH_POS_TAB_2	Number of indexing positions used in table 2
10930	$MN_INDEX_AX_POS_TAB_2[n]	Indexing position table 2
30300	$MA_IS_ROT_AX	Rotary axis
30310	$MA_ROT_IS_MODULO	Modulo conversion for rotary axis
30320	$MA_DISPLAY_IS_MODULO	Position display is modulo 360 degrees
30500	$MA_INDEX_AX_ASSIGN_POS_TAB	Axis is indexing axis
30501	$MA_INDEX_AX_NUMERATOR	Numerator for indexing axes with equidistant positions
30505	$MA_HIRTH_IS_ACTIVE	Axis is an indexing axis with Hirth toothing

Literature

Function Manual Expanded Functions; Indexing Axes (T1)

7.3.9 Position controller

Control loops

The closed-loop control of a machine axis consists of the cascaded closed-loop control circuits of current controller, speed controller and position controller.
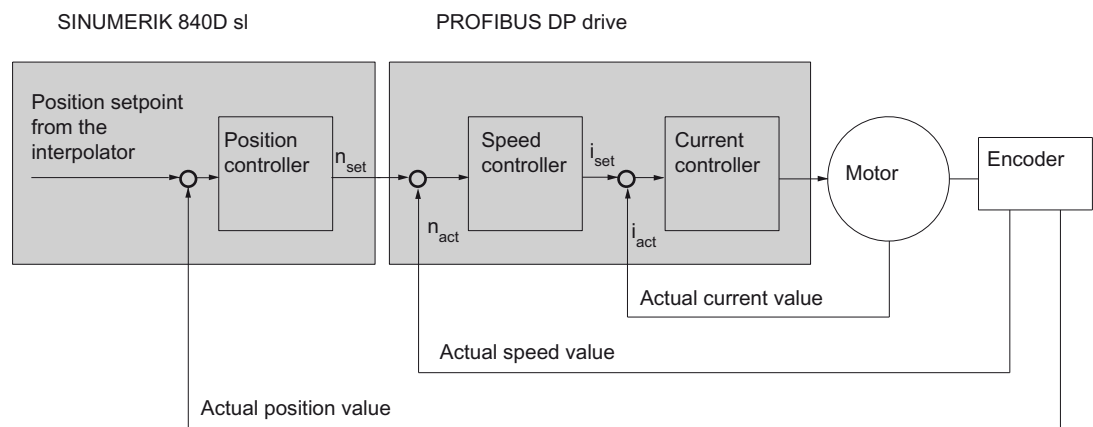
Figure 7-8   Control loops

Travel direction

If the axis does not traverse into the desired direction, the appropriate adaptation is made in the following machine data:

● MD32100 $MA_AX_MOTION_DIR (travel direction)

The value "-1" reverses the direction of motion.

Control direction

If the control direction of the position measuring system is incorrect, it can be adjusted with the following machine data:

● MD32110 $MA_ENC_FEEDBACK_POL (sign of actual value)

Note

When DSC is activated on the incorrect position measuring system, the control direction must also be adjusted in SINAMICS parameter p410.

Servo gain

To obtain high contour accuracy, a high loop gain (K_V factor) of the position controller is required. However, an excessively high K_V factor causes overshoot, instability and impermissibly high machine loads.

The maximum permissible K_V factor is dependent on the dynamic response and the use of the feedforward control or DSC, of the drive and the mechanical system of the machine.

Note

The initial commissioning is performed without feedforward control.

A K_V factor of "0" leads to the position controller being cut.

Definition of K_V factor

The K_V factor is defined as the ratio of velocity in m/min and the resulting following error in mm

$$KV = \frac{\text{Velocity}}{\text{Following error}} \quad \left[\frac{\text{[m/min]}}{\text{[mm]}} \right]$$

This means for a K_V factor of 1 that at a velocity of 1m/min, a following error of 1mm results.

The K_V factor of the machine axis is entered via the following machine data:

- MD32200 $MA_POSCTRL_GAIN (servo $_{gain}$ factor)

Note

To adapt the input/output unit of the K_V factor selected by default to the internal unit [1/s], the following machine data is pre-assigned:

- MD10230 $MN_SCALING_FACTORS_USER_DEF[9] = 16.666667
- MD10220 $MN_SCALING_USER_DEF_MASK = 'H200'; (bit 9 as hex value)

When entering the K_V factor it is important to note that the gain factor of the whole position control loop is still dependent on other parameters of the controlled system (speed setpoint alignment).

These factors include, among others:

- MD32260 $MA_RATED_VELO
- MD32250 $MA_RATED_OUTVAL
- Automatic interface alignment (SINAMICS parameter "Reference speed" p2000)

For drive optimization, see also: Further optimization options (Page 264)

NOTICE

Machine axes that interpolate one with another must have the same dynamic response at the same velocities.

This can be achieved by setting the same K_V factor or dynamic response adaptation in the following machine data:

- MD32900 $MA_DYN_MATCH_ENABLE
- MD32910 $MA_DYN_MATCH_TIME

The real K_V factor can be checked with the following error in the service display.
"Diagnostics" operating area → Menu forward key → "Axis diagnostics" → "Service axis".

Checking the loop gain

If a K_V factor is already known for a machine type in question, this can be set and checked. To ensure that the drive does not reach its current limit during acceleration and deceleration, the acceleration is reduced for checking via the following machine data:

- MD32300 $MA_MAX_AX_ACCEL (axis acceleration)

The K_V factor must also be checked for high speeds of the rotary axis and spindle (e.g. for spindle positioning, tapping).

The approach behavior at various speeds can be checked by means of the HMI-Advanced servo trace software. The speed setpoint is recorded for this purpose.
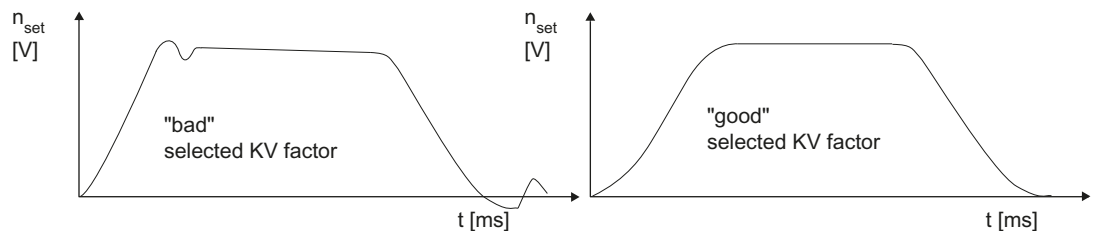
Figure 7-9   Speed setpoint characteristic

No overshoots may occur while the drive is approaching the static states; this applies to all speed ranges.

Overshoot in the position control loop

The reasons for an overshoot in the control loop can be:

- Acceleration too high (current limit is reached)
- Rise time too long (re-optimization necessary)
- Mechanical backlash
- Mechanical components canted

For safety reasons, set the K_V factor for each axis to a little less than the maximum possible value.

- MD32900 $MA_DYN_MATCH_ENABLE[n]
- MD32910 $MA_DYN_MATCH_TIME[n]

For axes interpolating with each other, the same K_V-factor should be set. Normally it is the K_V-factor of the weakest interpolating axis.

Contour monitoring must be set subsequently (MD36400 $MA_CONTROL_TOL).

Acceleration

In the following machine data machine axes are accelerated and decelerated with the values entered.

- MD32300 $MA_MAX_AX_ACCEL (axis acceleration)

This value should allow the axes to be accelerated and positioned fast and accurately, while ensuring that the machine is not loaded unduly.

Checking the acceleration

The sign of a properly adjusted acceleration of a machine axis is acceleration and positioning free from overshoot at rapid traverse rate and maximum load (max. external moment of inertia).

After the acceleration has been entered, the axis is traversed rapidly and the actual current values and current setpoint are recorded.

This recording shows whether the drive reaches the current limit. Here, the current limit can be reached for a short time.

The current must be well below the current limit, however, before the rapid traverse velocity or the final position is reached.

Load changes during the machining should not result in the current limit being reached, as they may result in contour errors. For this reason, the acceleration value should be a little bit less than the maximum acceleration value.

Machine axes can have different acceleration values, even if they interpolate with each other.

Jerk

For jerk, the following should be noted:

- For indexing program instructions (SOFT), the maximum jerk must be set in the following machine data:
  - MD32431 $MA_MAX_AX_JERK (maximum jerk)
- For JOG and positioning axes the following machine data should be supplemented:
  - MD32420 $MA_JOG_AND_POS_JERK_ENABLE
  - MD32430 $MA_JOG_AND_POS_MAX_JERK

Machine data for the closed-loop position control

MD	Identifier	Comment
32100	$MA_AX_MOTION_DIR[n]	Travel direction
32110	$MA_ENC_FEEDBACK_POL[n]	Actual value sign
32200	$MA_POSCTRL_GAIN[n]	KV factor
32300	$MA_MAX_AX_ACCEL[n]	Axis acceleration
32420	$MA_JOG_AND_POS_JERK_ENABLE	Enabling jerk limitation
32430	$MA_JOG_AND_POS_MAX_JERK	Axial jerk
32431	$MA_MAX_AX_JERK	Maximum axial jerk when traversing along the path
32900	$MA_DYN_MATCH_ENABLE[n]	Dynamic response adaptation
32910	$MA_DYN_MATCH_TIME[n]	Time constant for dynamic matching
36400	$MA_CONTROL_TOL	Contour monitoring

Literature

- Function Manual, Basic Functions; Velocities, Setpoint-Actual Value Systems, Closed-Loop Control (G2)

- Extended Functions Function Manual; Compensation (K3)

7.3.10   Speed setpoint matching

Overview

In the case of speed setpoint comparison, the NC is informed which speed setpoint corresponds to which motor speed in the drive, for parameterizing the axial control and monitoring. Speed setpoint matching can be performed automatically or manually.

Automatic adjustment

It is possible to perform automatic speed setpoint adjustment if the drive supports acyclic services on the PROFIBUS DP (standard for SINAMICS).

Acyclic services on the PROFIBUS DP are supported if the value "0" is entered in the following machine data:

- MD32250 $MA_RATED_OUTVAL (rated output voltage) [%]

During start-up of the NCK, speed setpoint matching between the NCK and the drive is then performed automatically.

> ⚠ WARNING
>
> The "Reference speed" p2000 parameter may not be changed during operation of the controller with the drive.

If automatic speed setpoint matching fails for one axis, the following message is output on a traverse request for this axis: "Wait, axis enable missing". This axis and any axes that interpolate with it are not traversed.

Manual comparison

The speed setpoint alignment (interface normalization) is specified in the following machine data:

- MD32250 $MA_RATED_OUTVAL (rated output voltage) [%]

- MD32260 $MA_RATED_VELO (rated motor speed)

If a value not equal to 0 is entered in the following machine data, a manual speed setpoint matching is performed:

- MD32250 $MA_RATED_OUTVAL (rated output voltage) [%]

Note

The maximum upper limit for the speed setpoint is predefined in the following machine data:
- MD36210 $MA_CTRLOUT_LIMIT (maximum speed setpoint) [%]

Calculation of the motor speed

If the motor speed required for speed setpoint matching is not known directly, it can be calculated as follows with reference to the required axis velocity (linear axis) or load speed (rotary axis/spindle):

- Motor speed for linear axis:

$$n_{motor} = \frac{v_{axis} * \dfrac{\text{MD31060 }\$MA\_DRIVE\_RATIO\_NUMERA}{\text{MD31050 }\$MA\_DRIVE\_RATIO\_DENOM}}{\text{MD31030 }\$MA\_LEADSCREW\_PITCH}}$$

- Motor speed for rotary axis/spindle:

$$n_{motor} = n_{load} * \frac{\text{MD31060 }\$MA\_DRIVE\_RATIO\_NUMERA}{\text{MD31050 }\$MA\_DRIVE\_RATIO\_DENOM}}$$

v_{Axis} [mm/min]	
n_{Motor} [rpm]	Motor speed
n_{Load} [rpm]	Load speed
MD31060 $MA_DRIVE_RATIO_NUMERA	Numerator load gearbox
MD31050 $MA_DRIVE_RATIO_DENOM	Denominator load gearbox
MD31030 $MA_LEADSCREW_PITCH	Pitch of the ball screw [mm/rev]

Checking the trim

Incorrect speed setpoint matching has a negative impact on the real loop gain of the axis. To check speed setpoint matching it is necessary for a defined traverse velocity to compare the actual following error with the desired following error that should be set if speed setpoint matching is correct.

$$\text{Desired following error} = \frac{\text{Traverse rate}}{\text{MD32200 \$MA\_POSCTRL\_GAIN}}$$

[mm]	Desired following error
[m/min]	Traverse rate
MD32200 $MA_POSCTRL_GAIN	K $_\text{v}$factor in [(m/min)/mm]

The actual following error is displayed in the "Diagnosis" operating area → Menu forward key → "Axis diagnostics" → "Service axis".

Machine data

MD	Identifier	Comment
32250	$MA_RATED_OUTVAL	Rated output voltage [%]
32260	$MA_RATED_VELO	Rated motor speed

Literature

Function Manual, Basic Functions; Velocities, Setpoint-Actual Value Systems, Closed-Loop Control (G2)

7.3.11   Velocity matching (axis)

Maximum axis velocity

The value entered in the following machine data is the limit velocity up to which a machine axis can accelerate (rapid traverse limiting). It depends on the machine and drive dynamics and the limit frequency of actual-value acquisition.

- MD32000 $MA_MAX_AX_VELO[n] (max. axis velocity)

The max. axis velocity is used for traversing in the part program when rapid traverse (G00) is programmed. The maximum linear or rotary axis velocity should be entered in the machine data in accordance with MD30300 $MA_IS_ROT_AX[n].

Rapid traverse in jog mode

The value entered in the following machine data is the velocity at which the machine axis traverses in JOG mode with the rapid traverse override key actuated and with an axial feed override of 100%.

- MD32010 $MA_JOG_VELO_RAPID[n] (rapid traverse in JOG mode) or
- MD32040 $MA_JOG_REV_VELO_RAPID[n] (revolutional feedrate in JOG mode with rapid traverse override)

The entered value may not exceed the max. permissible axis velocity.

This machine data will not be used for the programmed rapid traverse G00.

JOG axis velocity

The value entered in this machine data is the velocity at which the machine axis traverses in JOG mode with an axial feed override of 100%:

- MD32020 $MA_JOG_VELO[n] (axis velocity in JOG mode) or
- MD32050 $MA_JOG_REV_VELO[n] (revolutional feedrate in JOG mode)

The velocity from MD32020 JOG_VELO[n] or MD32050 JOG_REV_VELO[n] is used only in the following cases:

- For linear axes: SD41110 $SN_JOG_SET_VELO = 0
- For rotary axes: SD41130 $SN_JOG_ROT_AX_SET_VELO = 0
- For reverse feed: SD41120 $SN_JOG_REV_SET_VELO = 0

If the above-mentioned setting data is not equal 0, this produces the following JOG velocity:

1. SD41100 $SN_JOG_REV_IS_ACTIVE (revolutional feedrate in JOG mode) = 0

   => Linear feedrate (G94)

   – Linear axes:

   JOG velocity = SD41110 $SN_JOG_SET_VELO (JOG velocity for G94)

   – Rotary axes:

   JOG velocity = SD41130 $SN_JOG_ROT_AX_SET_VELO (JOG velocity for rotary axes)

2. SD41100 $SN_JOG_REV_IS_ACTIVE (revolutional feedrate in JOG mode) = 1

   – JOG velocity = SD41120 $SN_JOG_REV_SET_VELO (JOG velocity for G95)

The entered values may not exceed the maximum permissible axis velocity.

Note

Depending on MD30300 $MA_IS_ROT_AX[n] , the speeds must be entered in mm/min, inch/min or rpm.

If the velocities are changed, MD36200 $MA_AX_VELO_LIMIT[n] (threshold value for velocity monitoring) must be adapted accordingly.

Machine data

MD	Identifier	Comment
30300	$MA_IS_ROT_AX[n]	Rotary axis
32000	$MA_MAX_AX_VELO[n]	Maximum axis velocity
32010	$MA_JOG_VELO_RAPID[n]	Rapid traverse in jog mode
32020	$MA_JOG_VELO[n]	JOG axis velocity
32040	$MA_JOG_REV_VELO_RAPID[n]	Revolutional feedrate in JOG mode with rapid traverse override
32050	$MA_JOG_REV_VELO[n]	Revolutional feedrate in JOG mode
32060	$MA_POS_AX_VELO[n]	Initial setting for positioning-axis velocity
32250	$MA_RATED_OUTVAL	Rated output voltage
32260	$MA_RATED_VELO[n]	Rated motor speed

Literature

- Function Manual, Basic Functions; Velocities, Setpoint-Actual Value Systems, Closed-Loop Control (G2)

- Extended Functions Function Manual; Manual and Handwheel Travel (H1)

7.3.12 Axis monitoring functions (static)

Static monitoring functions

The static monitoring functions with reference to a machine axis are:

Exact stop coarse

Window around the setpoint position within which exact stop coarse is detected.

- MD36000 $MA_STOP_LIMIT_COARSE (exact stop coarse)
- IS: DB31,... DBX60.6 (position reached with exact stop coarse)

Exact stop fine

Window around the setpoint position within which exact stop fine is detected.

- MD36010 $MA_STOP_LIMIT_FINE (exact stop fine)
- IS: DB31,... DBX60.7 (position reached with exact stop coarse)

Delay time exact stop fine

Delay time after which the actual value must have reached the tolerance window "Exact stop fine" when the setpoint position is reached.

- MD36020 $MA_POSITIONING_TIME (delay time exact stop fine)
- Alarm: "25080 Positioning monitoring" and follow-up mode

Zero speed tolerance

Position tolerance which a standing machine axis may not leave.

- MD36030 $MA_STANDSTILL_POS_TOL (standstill tolerance)
- Alarm: "25040 Zero speed control" and follow-up mode

Delay time zero speed monitoring

Delay time after which the actual value must have reached the tolerance window "zero speed tolerance" when the setpoint position is reached.

- MD36040 $MA_STANDSTILL_DELAY_TIME (Zero-speed monitoring delay time)
- Alarm: "25040 Zero speed control" and follow-up mode

Clamping tolerance

Tolerance window for a standing machine axis while the signal "Clamping active" is present at the PLC interface.

- MD36050 $MA_CLAMP_POS_TOL (clamping tolerance)
- IS: DB31,... DBX2.3 (clamping active)
- Alarm: "26000 Clamping monitoring"
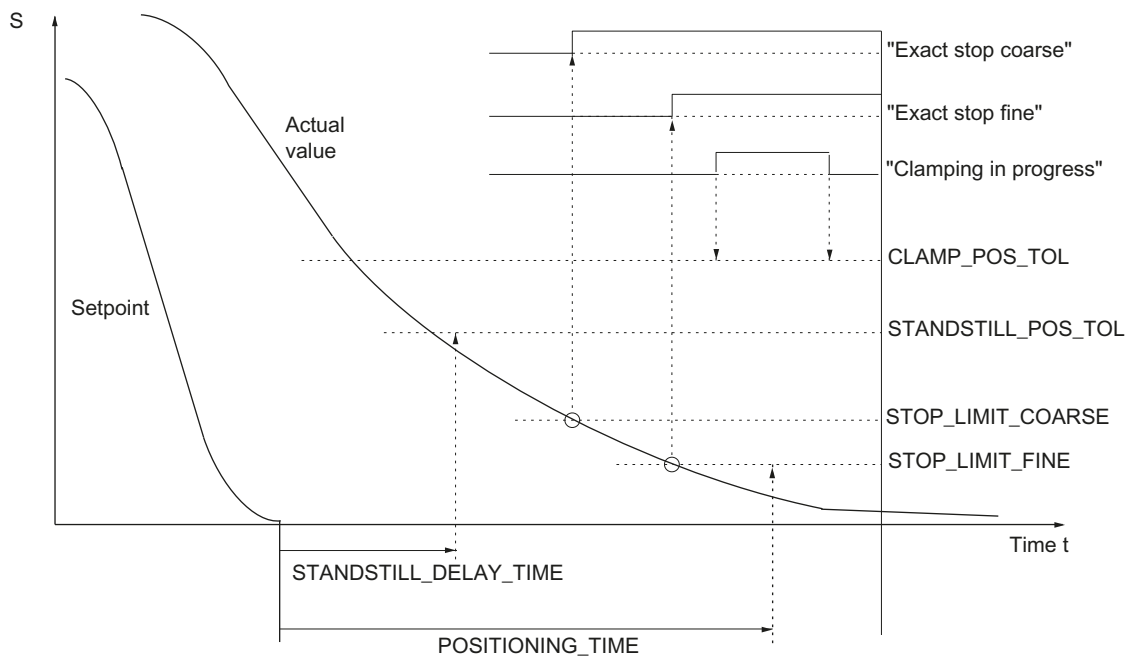
Figure 7-10   Static monitoring functions

Working area limitation

The permissible working area of the machine axes can be adapted to the particular machining situation using the "dynamic" working area limitation.

- SD43400 $SA_WORKAREA_PLUS_ENABLE (working area limitation active in the positive direction)

- SD43410 $SA_WORKAREA_MINUS_ENABLE (working area limitation active in the negative direction)

- SD43420 $SA_WORKAREA_LIMIT_PLUS (working area limitation plus)

- SD43430 $SA_WORKAREA_LIMIT_MINUS (working area limitation minus)

- Alarm: "10630 Axis reaching operating range limit +/-"

- Alarm: "10631 Axis is at operating range limit +/- (JOG)"

- Alarm: "10730 Progr. end point is behind working area limitation +/-"

Software limit switch

Two software limit switch pairs are provided per machine axis. The active software limit switch pair is selected in the PLC.

- MD36100 $MA_POS_LIMIT_MINUS (1st software limit switch minus)

- MD36110 $MA_POS_LIMIT_PLUS (1st software limit switch plus)

- MD36120 $MA_POS_LIMIT_MINUS2 (2nd software limit switch minus)

- MD36130 $MA_POS_LIMIT_PLUS2 (2nd software limit switch plus)

- IS: DB31,... DBX12.2 (2nd software limit switch minus)

- IS: DB31,... DBX12.3 (2nd software limit switch plus)

- Alarm: "10620 Axis reaching software limit switch +/-"

- Alarm: "10621 Axis is at software limit switch +/- (JOG)"

- Alarm: "10720 Progr. end point is behind software limit switch +/-"

Note

All position monitoring functions are only active with valid reference point of the corresponding reference point of the machine axis.

Hardware limit switch

If the PLC signals that a hardware limit switch has been reached, the machine axis is stopped with the parameterized brake response.

- IS: DB31, ... DBX12.1 (hardware limit switch plus)

- IS: DB31, ... DBX12.0 (hardware limit switch minus)

- MD36600 $MA_BRAKE_MODE_CHOICE (braking behavior on hardware limit switch)

    0 = Brake characteristic is complied with

    1 = Rapid deceleration with setpoint "0"

- Alarm: "21614 Hardware limit switch [+/-]"
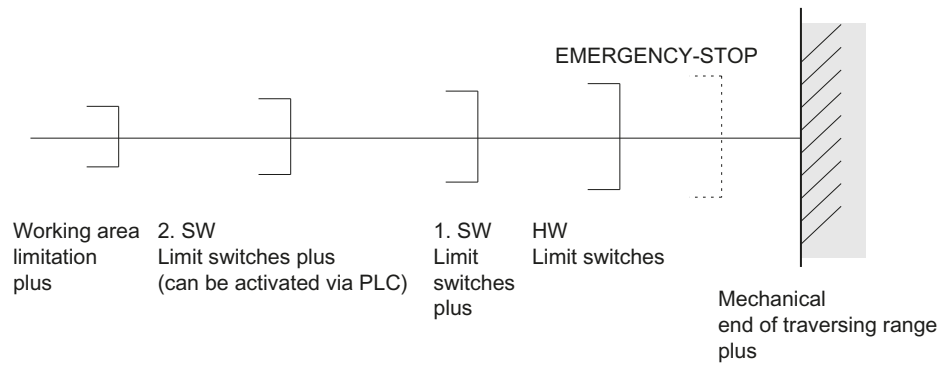
Figure 7-11   Overview of end limitations

Literature

Function Manual Basic Functions; Axis monitoring: Protection zones (A3)

7.3.13   Axis monitoring functions (dynamic)

Dynamic monitoring functions

The dynamic monitoring functions with reference to a machine axis are:

Speed-setpoint monitoring

The speed-setpoint monitoring prevents that the max. admissible motor speed is exceeded.

It must be set such that the max. velocity (rapid traverse) can be reached and, in addition, a certain control margin remains.

- MD36210 $MA_CTRLOUT_LIMIT[n] (maximum speed setpoint as %)
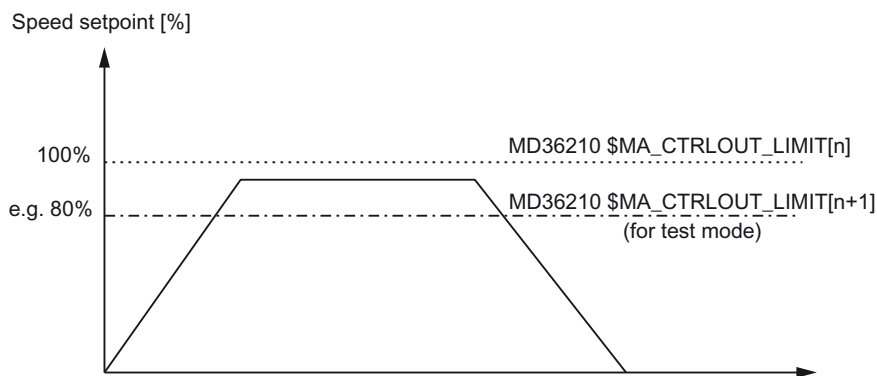
Figure 7-12   Speed setpoint limitation

The following machine data is used to define how long the speed setpoint may remain within the limits before the speed-setpoint monitoring responds.

- MD36220 $MA_CTRLOUT_LIMIT_TIME[n] (delay time for speed-setpoint monitoring)

Error response

● Alarm: "25060 Speed-setpoint limiting"

and stopping the machine axis using a speed-setpoint ramp whose characteristic is set in

● MD36610 $MA_AX_EMERGENCY_STOP_TIME (braking ramp time when errors occur)

Cause of errors / error handling

● A measuring circuit error or drive error is present.

● Setpoints are too high (accelerations, velocities, reducing factors).

● Obstacle in the machining space (e.g. tool hits working table) => remove obstacle.

The speed setpoint consists of the speed setpoint of the position controller and the feedforward control parameter (if feedforward control is active).
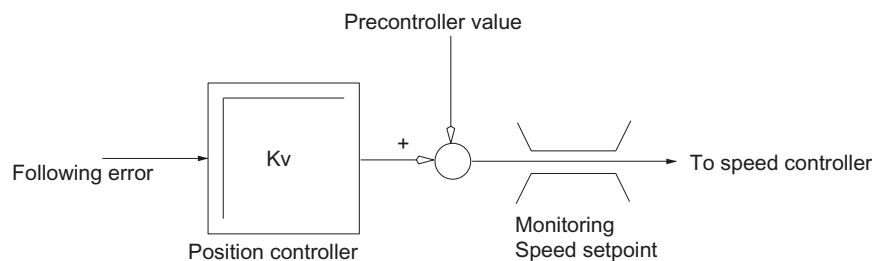
Figure 7-13   Speed setpoint calculation

NOTICE

The limitation of the speed setpoint will turn the control loop into a non-linear control loop.

Generally, this will result in deviations from the contour and longer dwelling of the machine axis within the speed-setpoint limitation.

Actual velocity monitoring

Monitoring due to the actual velocity of the machine axis determined based on the encoder values

● MD36020 $MA_AX_VELO_LIMIT (velocity-monitoring threshold)

Error response

● Alarm: "25030 Alarm limit of actual velocity"

and stopping the machine axis using a speed-setpoint ramp whose characteristic is set in

● MD36610 $MA_AX_EMERGENCY_STOP_TIME (braking ramp time when errors occur)

Error correction

- Check actual values

- Check position control direction (control sense)

- Threshold value for velocity monitoring is possibly too low.

Contour monitoring

Monitoring of the difference between the following error measured and the following error calculated from the position setpoint.

- MD36400 CONTOUR_TOL (contour monitoring tolerance range)

Error response

- Alarm: "25050 Contour monitoring"

and stopping the machine axis using a speed-setpoint ramp whose characteristic is set in

- MD36610 $MA_AX_EMERGENCY_STOP_TIME (braking ramp time when errors occur)

Error correction

Contour errors are caused by signal distortions in the position control loop.

- Increase the tolerance band

- Check the K_V factor:

  The real K_V factor must correspond to the desired K_V factor, set via
  MD32200 $MA_POSCTRL_GAIN[n] ($K_V$ factor).

  "Diagnostics" operating area → Menu forward key → "Axis diagnostics" → "Service axis"

- Check optimization of the speed controller

- Check smooth running of the axes

- Check machine data for traversing motions

  (feed override, acceleration, max. velocities, ...)

- For operation with feedforward control:

  MD32810 $MA_EQUIV_SPEEDCTRL_TIME (equivalent time constant of speed control loop for feedforward control) or if the machine data is imprecisely set, the MD36400 $MA_CONTOUR_TOL must be enlarged.

Encoder limit frequency monitoring

Monitoring of the limit frequency of the encoder of a machine axis.

- MD36300 $MA_ENC_FREQ_LIMIT (encoder limit frequency)

Error response

- Alarm: "21610 Encoder frequency exceeded"

- IS: DB31, ... DBX60.2 "Encoder limit frequency exceeded 1"

- IS: DB31, ... DBX60.3 "Encoder limit frequency exceeded 2"

and stopping the machine axis using a speed-setpoint ramp whose characteristic is set in

- MD36610 $MA_AX_EMERGENCY_STOP_TIME (braking ramp time when errors occur)

Error correction

After the axes have come to a stop, the position control is resumed after the alarm (RESET at the machine control panel) is acknowledged.

NOTICE
The axis affected must be re-referenced.

Encoder zero-mark monitoring

The zero-mark monitoring of the encoder of a machine axis checks whether pulses were lost between two zero mark passes.

● MD36310 $MA_ENC_ZERO_MONITORING (zero-mark monitoring)

is used to enter the number of detected zero-mark errors at which the monitoring is to respond.

Special feature: A value of 100 will additionally disable the hardware monitoring of the encoder.

Error response

● Alarm: "25020 Zero-mark monitoring"

and stopping the machine axes using a speed setpoint ramp whose characteristic is set in

● MD36610 $MA_AX_EMERGENCY_STOP_TIME (braking ramp time when errors occur) is set

Error causes

● MD36300 $MA_ENC_FREQ_LIMIT [n] (encoder limit frequency) set too high

● Encoder cable damaged

● Encoder or encoder electronics defective

Position tolerance when switching over the encoder

It is possible to switch between the two encoders or position measuring systems of a machine axis at any time. The permissible position difference between the two position measuring systems when switching over is monitored.

● MD36500 $MA_ENC_CHANGE_TOL (max. tolerance on actual position value switchover)

Error response

● Alarm: "25100 Measuring system cannot be switched over"

The requested switchover to another encoder is not carried out.

Error causes

● The specified permissible tolerance is too small.

● The position measuring system to which you want to switch over to is not referenced.

Cyclical monitoring of the encoder position tolerance

The position difference between the two encoders or position measuring systems of a machine axis is monitored with:

- MD36510 $MA_ENC_DIFF_TOL (measuring system synchronism tolerance)

Error response

- Alarm: "25105 Measuring systems are not synchronous"

and stopping the machine axes using a speed setpoint ramp whose characteristic is set in the following machine data:

- MD36610 $MA_AX_EMERGENCY_STOP_TIME (braking ramp time when errors occur)
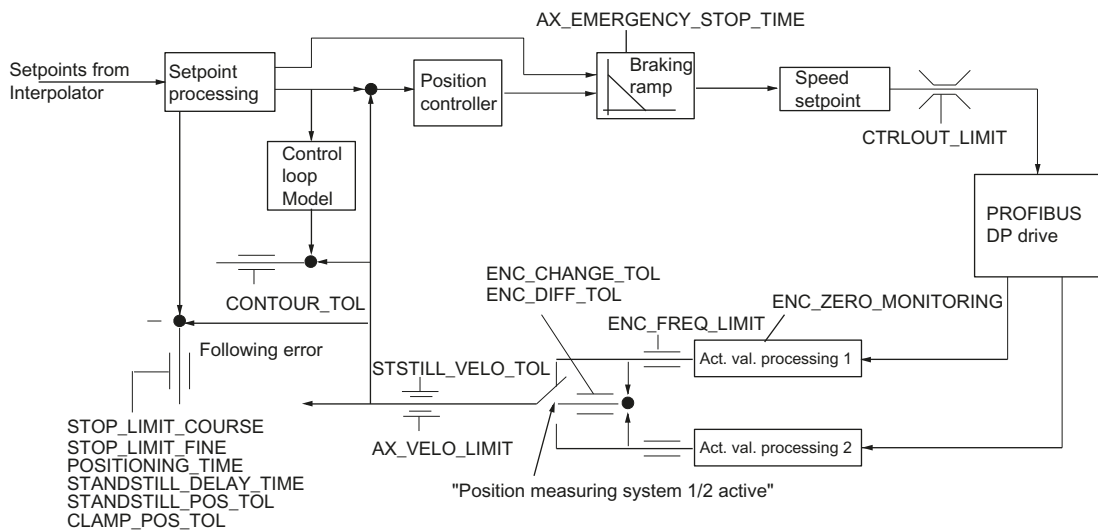
Figure 7-14   Monitoring for SINUMERIK 840D sl:

Note

MD36620 $MA_SERVO_DISABLE_DELAY_TIME (switch-off delay controller enable) must always be selected greater than MD36610 $MA_AX_EMERGENCY_STOP_TIME (duration of the braking ramp for error states).

If this is not the case, the braking ramp cannot be kept.

Literature

Function Manual Basic Functions; Axis monitoring: Protection zones (A3)

7.4 Axis homing

referencing

When referencing a machine axis, the actual position value system of the machine axis is synchronized with the machine geometry. Depending on the encoder type used, the machine axis is referenced with or without traversing movements.

Reference point approach

For all machine axes which are not equipped with an encoder providing an absolute actual position value, referencing is carried out by traversing the machine axis to a reference point; this is called the reference point approach.

The reference point approach can be carried out either manually in JOG mode, submode REF, or using a parts program.

With the operating mode JOG and submode REF, reference point approach is started using traverse direction keys PLUS or MINUS (depending on the parameterized reference point approach direction).

7.4.1 Incremental measuring system

Incremental measuring systems

With incremental measuring systems, referencing is carried out using a reference point approach divided into three phases:

1. Traversing to the reference cam

2. Synchronizing to the encoder zero mark

3. Approach reference point
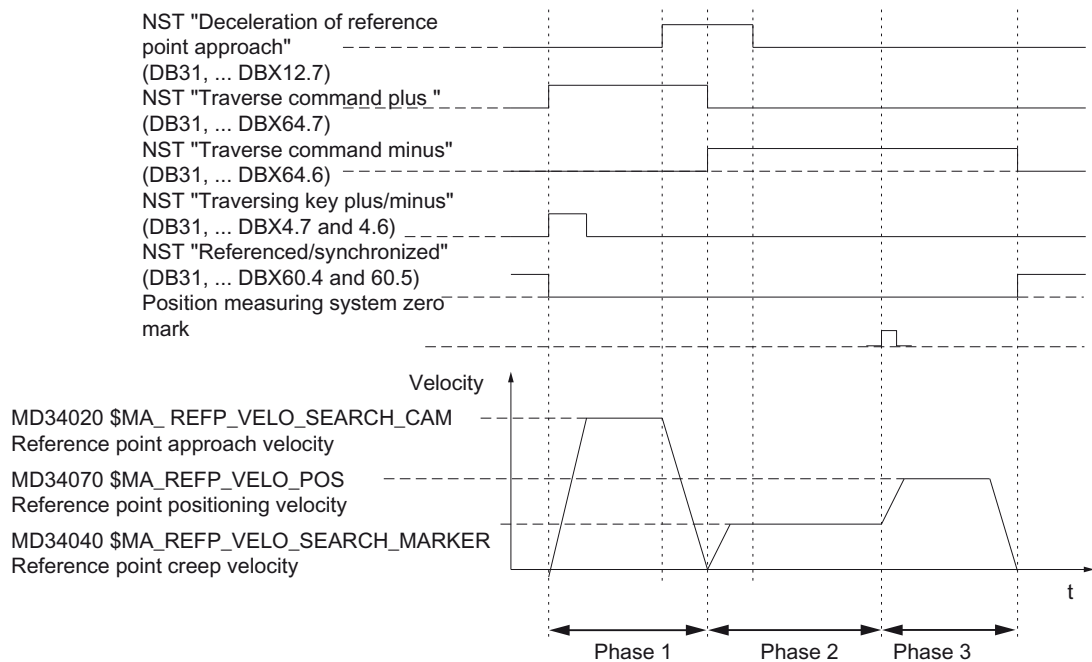
Figure 7-15   Signal chart: Referencing with an incremental measuring system (principle)

Phase-independent data

The following **machine data** and **interface signals** are relevant in each of the individual phases of the reference point approach:

- MD11300 $MN_JOG_INC_MODE_LEVELTRIGGRD (INC/REF in jog mode)

- MD34000 $MA_REFP_CAM_IS_ACTIVE (axis with reference cam)

- MD34110 $MA_REFP_CYCLE_NR (axis sequence for channel-specific reference point approach)

- MD30240 $MA_ENC_TYPE (encoder type)

- MD34200 $MA_ENC_REFP_MODE (referencing mode)

- IS: DB21, ... DBX1.0 ("Activate referencing")

- IS: DB21, ... DBX33.0 ("Referencing active")

Phase 1: Traversing to the reference cam

The following **machine data** and **interface signals** are relevant:

- MD34010 $MA_REFP_CAM_DIR_IS_MINUS (approach reference cam in minus direction)

- MD34020 $MA_REFP_VELO_SEARCH_CAM (reference cam approach velocity)

- MD34030 $MA_REFP_MAX_CAM_DIST (maximum distance to the reference cam)

- MD34092 $MA_REFP_CAM_SHIFT (electr. cam offset, incremental measuring systems with equidistant zero marks)

- IS: DB21, ... DBX36.2 ("All axes with obligatory reference point are referenced")

- IS: DB31, ... DBX4.7/DBX4.6 ("Traversing keys plus/minus")

- IS: DB31, ... DBX12.7 ("Reference point approach delay")

- IS: DB31, ... DBX60.4, DBX60.5 ("Referenced/synchronized 1, 2")

Properties of phase 1:

- The feed override (feedrate switch) is active.

- The feed stop (channelspecific and axisspecific) is active.

- The machine axis can be stopped and restarted with NC-stop/NC-start.

- The machine axis traverses a distance specified in the following machine data from the starting position in the direction of the reference cam, without reaching the reference cam.

  – MD34030 $MA_REFP_MAX_CAM_DIST (max. distance to reference cam)

- The following interface signal is set to "0". The axis stops, and alarm 20000 "Reference cam not reached" is output.

  – IS: DB31, ... DBX12.7 ("Reference point approach delay") = 0

> ⚠ **WARNING**
>
> If the reference cam is not calibrated exactly, it is possible that a wrong zero mark is evaluated after the reference cam has been left. As a result, the control system will take a wrong machine zero.
>
> Software limit switches, protection areas and work area limits will thus also be active for the wrong positions. The difference is equivalent to one encoder revolution in each case.
>
> Danger for man and machine exists.

Phase 2: Synchronizing to the encoder zero mark

The following **machine data** and **interface signals** are relevant:

- MD34040 $MA_REFP_VELO_SEARCH_MARKER (creep velocity)

- MD34050 $MA_REFP_SEARCH_MARKER_REVERSE (direction reversal on reference cam)

- MD34060 $MA_REFP_MAX_MARKER_DIST (maximum distance from cam to reference mark)

Properties of phase 2:

- Feed override (the feed override switch) is not active.

  If a feed override of 0% is selected via the feed override switch, the traverse motion is stopped.

- Feed stop (channel-specific and axis-specific) is active.

  On a feed stop, the traverse motion is stopped and the alarm displayed: 20005 "Reference point approach canceled"

- NC-Stop/NC-Start is inactive.

- With IS: DB31, ... DBX12.7 ("Reference point approach delay") = 0, the machine axis traverses a distance parameterized in the following machine data after leaving the reference cam:

  MD34060 $MA_REFP_MAX_MARKER_DIST (max. distance to the reference mark)

  Without the zero mark being detected, the machine axis stops and the following alarm is displayed: 20002 "Zero mark missing"

Phase 3: Approach reference point

The following **machine data** and **interface signals** are relevant:

- MD34070 $MA_REFP_VELO_POS (reference point positioning velocity)
- MD34080 $MA_REFP_MOVE_DIST (reference point distance to zero mark)
- MD34090 $MA_REFP_MOVE_DIST_CORR (reference point offset, additive)
- MD34100 $MA_REFP_SET_POS (reference point value)
- IS: DB31, ... DBX2.4, 2.5, 2.6, 2.7 ("Reference point value 1...4")
- IS: DB31, ... DBX60.4, DBX60.5 ("Referenced/synchronized 1, 2")

Properties of phase 3:

- Feed override (the feed override switch) is active.
- Feed stop (channel-specific and axis-specific) is active.
- NC-Stop/NC-Start is active.

Literature

Basic Functions Function Manual; Reference Point Travel (R1)

7.4.2 Distancecoded reference marks

Distancecoded reference marks

When dictance-coded reference marks are used, referencing is divided into two phases:

1. Synchronize by overriding two reference marks

2. Traverse to target point

"Deceleration of reference point approach"
(DB31, ... DBX12.7)
"Travel command minus"
(DB31, ... DBX64.6)

"Traversing key plus/minus" (DB31, ... DBX4.7 and 4.6)
"Referenced/synchronized" (DB31, ... DBX60.4 and 60.5)
Length measuring system reference marks

Velocity

MD34070 $MA_REFP_VELO_POS
Reference point positioning velocity

MD34040 $MA_REFP_VELO_SEARCH_MARKER
Reference point creep velocity
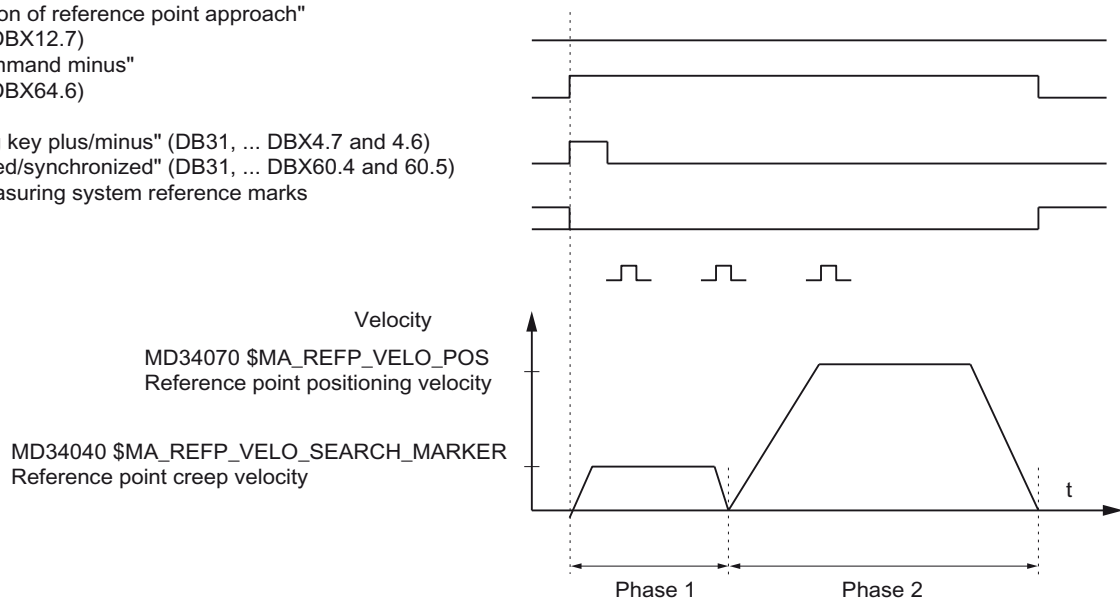
Figure 7-16   Signal chart: Distance-coded reference marks (principle)

Phase-independent data

The following **machine data** and **interface signals** are independent with respect to the individual phases of reference point approach:

- MD11300 $MN_JOG_INC_MODE_LEVELTRIGGRD (INC/REF in jog mode)

- MD34000 $MA_REFP_CAM_IS_ACTIVE (axis with reference cam)

- MD34110 $MA REFP_CYCLE_NR (axis sequence for channel-specific reference point approach)

- MD30240 $MA ENC_TYPE (encoder type)

- MD34200 $MA ENC_REFP_MODE (referencing mode)

- MD34310 $MA ENC_MARKER_INC (interval between two reference marks)

- MD34320 $MA ENC_INVERS (inverse measuring system)

- IS: DB21, ... DBX1.0 ("Activate referencing")

- IS: DB21, ... DBX33.0 ("Referencing active")

Phase 1: Synchronize by overriding two reference marks

The following **machine data** and **interface signals** are relevant:

- MD34010 $MA REFP_CAM_DIR_IS_MINUS (approach reference cam in negative direction)
- MD34040 $MA REFP_VELO_SEARCH_MARKER (referencing velocity)
- MD34060 $MA REFP_MAX_MARKER_DIST (maximum distance between two reference marks)
- MD34300 $MA ENC_REFP_MARKER_DIST (reference mark distance)
- IS: DB21 .. 30, DBX36.2 ("All axes to be referenced are referenced")
- IS: DB31, ... DBX4.7/DBX4.6 ("Traversing keys plus/minus")
- IS: DB31, ... DBX12.7 ("Reference point approach delay")
- IS: DB31, ... DBX60.4, DBX60.5 ("Referenced/synchronized 1, 2")

Properties of phase 1:

- If the machine axis travels from the initial position a distance defined in

  MD34300 $MA REFP_MARKER_DIST (max. distance to the reference mark) without two reference marks being overridden, then the machine axis stops and

  the system issues alarm 20004 "Reference mark missing".

Phase 2: Traversing to the target point

The following **machine data** and **interface signals** are relevant:

- MD34070 $MA REFP_VELO_POS (target point positioning velocity)
- MD34090 $MA REFP_MOVE_DIST_CORR (absolute offset)
- MD34100 $MA REFP_SET_POS (target point)
- MD34330 $MA REFP_STOP_AT_ABS_MARKER (with/without target point)
- IS: DB31, ... DBX60.4, DBX60.5 ("Referenced/synchronized 1, 2")

Properties of phase 2:

- The feed override (feedrate switch) is active.
- The feed stop (channelspecific and axisspecific) is active.
- The machine axis can be stopped and restarted with NC-stop/NC-start.

Determining the absolute offset

To determine the absolute offset between the measuring system zero point and the machine zero, the following procedure is recommended:

1. Determine the actual position of the measuring system

   After two reference marks following one after the other (synchronized) have been overtraveled, the actual position of the length measuring system can be read on the user interface at "Actual position".

   The absolute offset must be zero at this time:

- MD34090 $MA REFP_MOVE_DIST_CORR = 0

1. Determine the absolute machine actual position

   Determining the absolute machine actual position, e.g. can be performed by traversing the machine axis to a known position (fixed stop). Alternatively, it can be measured at any position (laser interferometer).

2. Calculate the absolute offset

   Linear measurement system non-inverse to machine system:

   Absolute offset = actual machine position + actual position of the measuring system

   Linear measuring system inverse to machine system:

   Absolute offset = actual machine position - actual position of the measuring system

- MD34090 $MA REFP_MOVE_DIST_CORR (reference point / absolute offset)

⚠ **WARNING**

After you have determined the absolute offset and made an entry in

- MD34090 $MA REFP_MOVE_DIST_CORR (absolute offset)

the position measuring system must be re-referenced.

Literature

Basic Functions Function Manual; Reference Point Travel (R1)

7.4.3 Absolute encoder homing

Absolute encoder calibration

In order to reference the measuring system of a machine axis with an absolute encoder for the first time, calibrate the encoder. To calibrate the absolute encoder, the actual value of the encoder is matched with the machine zero once and then enabled.

The SINUMERIK supports the following types of calibration:

● Operator-assisted calibration

● Automatic calibration with a measuring input

● Calibration with the BERO

Operator-assisted calibration

During operator-assisted calibration, the machine axis of the absolute encoder is moved to the known machine position (reference position). The position value of the reference position is taken over by the NC as the reference point value.

Recommended procedure:

1. Parameterize the referencing mode

    –   MD34200 $MA_ENC_REFP_MODE[n] = 0

2. Approach the referencing position

    Traverse the machine axis to the referencing position in JOG mode. Approach direction according to machine data:

    –   MD34010 $MA_REFP_CAM_DIR_IS_MINUS (reference point approach in the minus direction)

    0 = positive approach direction

    1 = negative approach direction

NOTICE
To avoid the actual position of the machine axis being falsified by backlash in the drive train, reference point approach must be performed at low velocity and always from the same direction.

3. Assume the reference position in the NC

    The reference position is entered in the machine data:

    –   MD34100 $MA_REFP_SET_POS[n] (reference point value)

4. Enable the encoder calibration

    The enable of the encoder calibration is set in the following machine data:

    –   MD34210 $MA_ENC_REFP_STATE[n] = **1**

5. Activate the changed machine data by NCK reset.

6. Complete the encoder calibration

   To complete the encoder calibration, the same direction key must be pressed again after the booting of the NC in the JOG mode → REF for the machine axis:

   – Select JOG > REF mode

   – Select the machine axis

   – Press the traverse direction key

   Note

   Pressing the traverse direction key does not move the machine axis!

The NC then calculates the reference point offset and enters it in the machine data:

● MD34090 $MA_REFP_MOVE_DIST_CORR[n] (reference point offset)

   To indicate that the calibration has been completed, the value in the machine data changes from 1 = enable encoder calibration to 2 = encoder calibrated:

● MD34210 $MA_ENC_REFP_STATE[n] = **2**

   The value from the following machine data is shown as the actual position of the machine axis for the current machine position on the user interface:

● MD34100 $MA_REFP_SET_POS[n] (reference point value)

Calibrating several absolute encoders

For time-optimized calibration of the absolute encoders of several machine axes, the following procedure is recommended:

1. Depending on the machine design, move all or several machine axes to their reference position. See above: Points 1 to 4.

2. Perform an NCK reset. See above: Point 5.

3. Complete encoder calibration for all machine axes. See above: Point 6.

Recalibration

A new calibration of the absolute encoder is required under the following conditions:

● Gear change between load and absolute encoder

● Removal/installation of the absolute encoder (encoder replacement)

● Removal/installation of the motor with the absolute encoder (motor replacement)

● SRAM data loss of the NC or battery power failure: For this purpose, a start-up archive must be imported.

● PRESET

- Change of the drive parameters:

  If the p0418 and p0419 drive parameters are changed during the commissioning phase, the absolute encoder in the NC via MD34210 $MA_ENC_REFP_STATE[n] must also be recalibrated: The change of drive parameters takes effect only after a warm restart / power ON on the NCK side.

NOTICE

The status of the absolute encoder is only automatically reset to 1 = "encoder not calibrated" by the NCK on gear change:

- MD34210 $MA_ENC_REFP_STATE[n] = **1**

In all other cases, it is the sole responsibility of the NCK user to indicate the uncalibrated state of the absolute encoder by manually resetting the status to "encoder not calibrated" and to perform calibration again.

A new calibration of the absolute encoder is also required when MD34210 $MA_ENC_REFP_STATE[n] = 0 is set and one of the following conditions is met:

- Alarm 25020 "Zero-mark monitoring of the active encoder" has been issued.

- The controller has been switched off during the consistency check.

- The encoder number has changed.

Subsequent referencing procedures

The subsequent referencing of a machine axis is performed automatically without axis motion in the NC start-up.

The following conditions must be fulfilled:

- The measuring system of the machine axis active after the booting of the NC works with the absolute encoder

- The absolute encoder is calibrated: MD34210 $MA_ENC_REFP_STATE[n] = **2**

Literature

Basic Functions Function Manual; Reference Point Travel (R1)

- Automatic adjustment with measuring probe, adjustment with BERO

- Referencing with absolute encoders

7.5 Parameterization of spindle data

7.5.1 Setpoint/actual value channels of spindle

Parameterization of the setpoint/actual value channels of a spindle is identical to parameterization of the setpoint and actual value channels of an axis. For this, see Section "Setpoint / actual value channels" (Page 172).

7.5.2 Gear stages

Enable

The gear stage change is generally carried out in the following machine data:

- MD35010 $MA_GEAR_STEP_CHANGE_ENABLE (gear stage change possible, spindle has several gear stages)

If this machine data is not set, the system assumes that the spindle has no gear stages.

Multiple gearbox steps

If more than one gearbox step exists, the number of gearbox steps is entered into MD35090 $MA_NUM_GEAR_STEPS.

Parameter sets

In **spindle mode** of a spindle, the NC will select the parameter set that suits the current gear stage best.

Gear stage x => parameter set (x+1) => index [x]

In **axis mode** of a spindle, the NC always selects the 1st parameter set (index [0], independent of the current gear stage

The machine data listed in the following are gear stage-dependent machine data of a spindle:

- MD35110 $MA_GEAR_STEP_MAX_VELO[n] (n_{max} for gear stage change)
- MD35120 $MA_GEAR_STEP_MIN_VELO[n] (n_{min} for gear stage change)
- MD35130 $MA_GEAR_STEP_MAX_VELO_LIMIT[n] (n_{max} for gear stage)
- MD35135 $MA_GEAR_STEP_PC_MAX_VELO_LIMIT (n_{max} for gearbox step with position-control)
- MD35140 $MA_GEAR_STEP_MIN_VELO_LIMIT[n] (n_{min} for gear stage)

- MD35200 $MA_GEAR_STEP_SPEEDCTRL_ACCEL[n] (acceleration in speed-control mode)

- MD35210 $MA_GEAR_STEP_POSCTRL_ACCEL[n] (acceleration in position control mode)

For further information on parameter sets, see Section "Axis/spindle parameter sets" (Page 165).

Literature

Function Manual Basic Functions; Spindles: Gear stage change (S1)

7.5.3 Spindle measuring systems

Encoder matching

When parameterizing the measuring systems of spindles, the same conditions apply as for parameterization of the measuring systems of rotary axes. This multiple is 2048.

For incremental measuring systems see Section "Parameterization of incremental measuring systems" (Page 169).

For absolute measuring systems see Section "Parameterization of absolute measuring systems" (Page 170).

NOTICE
If the motor encoder is used for actual-value sensing, the encoder matching data must be entered in the machine data for each individual gear stage if several gear stages are present.

Pulse multiplication factor

The maximum multiplication of the appropriate drive is always used as the multiplication of the increments.

Examples of encoder adaptation

Example A: encoder on the spindle

Suppose the following conditions are provided:

- The incremental encoder is mounted on the spindle.

- Encoder pulses = 500 [pulses/rev.]

- Pulse multiplication = 128

- Internal precision = 1000 [increment/degree]

- Sensor ratio = 1:1
- Load ratio = 1:1

The machine data are set acc. to the values above:

- MD10210 $MN_INT_INC_PER_DEG (computational resolution) = 1,000 [incr./degree]
- MD31020 $MA_ENC_RESOL (encoder resolution) = 500 [pulses/revolution]
- MD31050 $MA_DRIVE_AX_RATION_DENOM (load rev. denominator) = 1
- MD31060 $MA_DRIVE_AX_RATION_NUMERA (load rev. numerator) = 1
- MD31070 $MA_DRIVE_ENC_RATION_DENOM (sensor speed denominator) = 1
- MD31080 $MA_DRIVE_ENC_RATION_NUMERA (sensor speed numerator) = 1

$$\frac{\text{Internal}}{\text{Resolution}} = \frac{360 \text{ degree}}{\text{MD31020} * \text{pulse rev.}} * \frac{\text{MD31080}}{\text{MD31070}} * \frac{\text{MD31050}}{\text{MD31060}} * \text{MD10210}$$

$$\frac{\text{Internal}}{\text{Resolution}} = \frac{360}{500 * 128} * \frac{1}{1} * \frac{1}{1} * 1000 = 5{,}625 \; \frac{\text{int. increments}}{\text{encoder pulse}}$$

One encoder increment corresponds to 5.625 internal increments.

One encoder increment corresponds to 0.005625 degrees (highest possible positioning resolution).

Example B: encoder at motor

Suppose the following conditions are provided:

- The incremental encoder is mounted on the motor.
- Encoder pulses = 2048 [pulses/rev.]
- Pulse multiplication = 128
- Internal precision = 1000 [increment/degree]
- Sensor ratio = 1:1
- Load ratio 1= 2.5:1 [motor speed/spindle speed]
- Load ratio 2= 1:1 [motor speed/spindle speed]

Gear stage 1

$$\frac{\text{Internal}}{\text{Resolution}} = \frac{360 \text{ degree}}{\text{MD31020} * \text{pulse rev.}} * \frac{\text{MD31080}}{\text{MD31070}} * \frac{\text{MD31050}}{\text{MD31060}} * \text{MD10210}$$

$$\frac{\text{Internal}}{\text{Resolution}} = \frac{360}{2048 * 128} * \frac{1}{1} * \frac{1}{2{,}5} * 1000 = 0{,}54932 \; \frac{\text{int. increments}}{\text{encoder pulse}}$$

One encoder increment corresponds to 0.54932 internal increments.

One encoder increment corresponds to 0.00054932 degrees (highest possible positioning resolution).

Gear stage 2

$$\frac{\text{Internal}}{\text{Resolution}} = \frac{360}{2048 * 128} * \frac{1}{1} * \frac{1}{1} * 1000 = 1{,}3733 \quad \frac{\text{int. increments}}{\text{encoder pulse}}$$

One encoder increment corresponds to 1.3733 internal increments.

One encoder increment corresponds to 0.0013733 degrees (highest possible positioning resolution).

7.5.4 Speeds and setpoint adjustment for spindle

Speeds, gear stages

Data for five gear stages is implemented for SINUMERIK 840D sl. These stages are defined by a minimum and maximum speed for the stage itself and by a minimum and maximum speed for the automatic gear stage change.

A new set gear stage is output only if the new programmed speed cannot be traversed in the current gear stage. For the sake of simplification, the oscillation times for gear stage changes can be specified directly in the NC; the oscillation function must otherwise be implemented in the PLC. The oscillation function is initiated via the PLC.
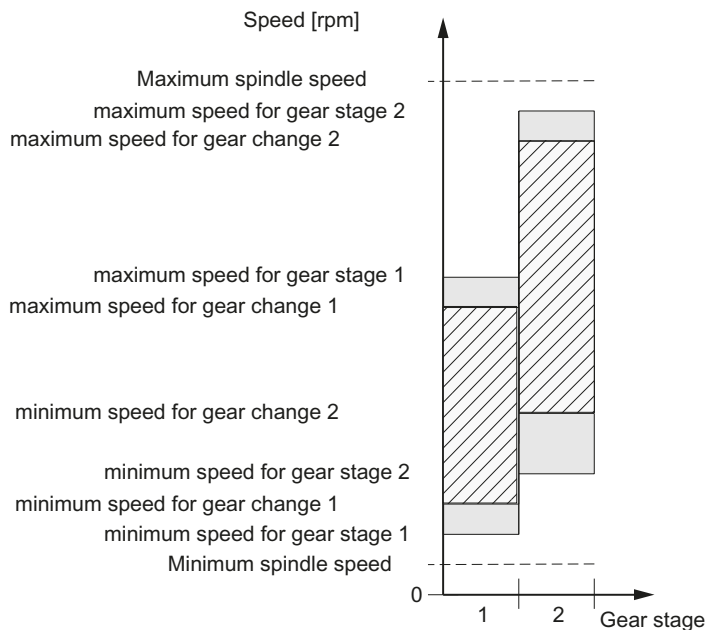
Figure 7-17   Example for speed ranges for automatic gear stage selection (M40)

Speeds for conventional operation

The speeds of the spindle for conventional mode are entered in the following machine data:

- MD32010 $MA_JOG_VELO_RAPID (rapid traverse in jog mode)
- MD32020 $MA_JOG_VELO (axis velocity in JOG mode)

The direction of rotation is specified via the appropriate directional keys for the spindle on the machine control panel.

Direction of rotation

The direction of rotation of a spindle corresponds to the traversing direction of an axis.

Setpoint matching

The speeds must be transferred with standardized values for the drive controller. The values are scaled in the NC using the selected load gear and the appropriate drive parameter.

Machine data

MD	Identifier	Meaning
31050	$MA_DRIVE_AX_RATIO_DENOM	Denominator load gearbox
31060	$MA_DRIVE_AX_RATIO_NUMERA	Numerator load gearbox
32010	$MA_JOG_VELO_RAPID	Rapid traverse in jog mode
32020	$MA_JOG_VELO	JOG axis velocity
35010	$MA_GEAR_STEP_CHANGE_ENABLE	Gear stage change possible
35020	$MA_SPIND_DEFAULT_MODE	Basic spindle setting
35030	$MA_SPIND_DEFAULT_ACT_MASK	Activate initial spindle setting
35040	$MA_SPIND_ACTIVE_AFTER_RESET	Spindle active after reset
35200	$MA_GEAR_STEP_SPEEDCTRL_ACCEL[n]	Acceleration in speed control mode
35220	$MA_ACCEL_REDUCTION_SPEED_POINT	Speed limit for reduced acceleration
35230	$MA_ACCEL_REDUCTION_FACTOR	Reduced acceleration
35400	$MA_SPIND_OSCILL_DES_VELO	Oscillation speed
35410	$MA_SPIND_OSCILL_ACCEL	Oscillation acceleration
35430	$MA_SPIND_OSCILL_START_DIR	Oscillation start direction
35440	$MA_SPIND_OSCILL_TIME_CW	Oscillation time for M3 direction
35450	$MA_SPIND_OSCILL_TIME_CCW	Oscillation time for M4 direction

7.5.5 Position spindle

Functionality

The NC provides an oriented spindle stop function with which the spindle can be moved into a certain position and held there (e.g. for tool changing purposes). Several programming commands are available for this function which define the approach and program processing.

- To absolute position (0-360 degrees)

- Incremental position (+/- 999999.99 degrees)

- Positioning without influence of block change (SPOSA)

- Block change when block end position is reached (calculated by interpolation)

The controller brakes the spindle down to position-control speed at the acceleration rate for speed operation.

If the position-control speed has been reached, the controller branches into position-control mode and the acceleration rate for position-control mode and the K_V factor become active.

The interface signal "Exact stop fine" is output to indicate that the programmed position has been reached (block change when position reached).

Acceleration rate for position-control mode must be set such that the current limit is not reached. Acceleration rate must be entered separately for each gear step.

If the spindle is positioned from zero speed, it is accelerated up to a maximum speed corresponding to position-control speed; the direction is defined via machine data. If no reference is present, the direction of motion is specified as in MD35350 $MA_SPIND_POSITIONING_DIR . The contour monitoring function is activated as soon as the control mode switches to position control.

Machine data

MD	Identifier	Meaning
35300	$MA_SPIND_POSCTRL_VELO	Position-control activation speed
35350	$MA_SPIND_POSITIONING_DIR	Direction of rotation when positioning from standstill
35210	$MA_GEAR_STEP_POSCTRL_ACCEL	Acceleration in position-control mode
36000	$MA_STOP_LIMIT_COARSE	Exact stop coarse
36010	$MA_STOP_LIMIT_FINE	Exact stop fine
32200	$MA_POSCTRL_GAIN	K_V factor
36400	$MA_CONTOUR_TOL	Contour monitoring

Literature

Function Manual, Basic Functions; Spindles (S1)

7.5.6 Synchronizing spindle

Overview

To allow the spindle to be positioned from the NCK, its position has to be adjusted using the measuring system. This operation is called "synchronization". As a rule, synchronizing is done to the zero mark of the connected encoder or to a reference cam as zero mark substitute.

The following machine data defines the actual position of the spindle at the zero-mark position:

- MD34100 $MA_REFP_SET_POS (reference point value)

The zero-mark offset is entered in the following machine data:

- MD34090 $MA_REFP_MOVE_DIST_CORR (reference point offset)

The following machine data specifies which signal is used for synchronization:

- MD34200 $MA_ENC_REFP_MODE (referencing mode)
  1 = Encoder zero mark
  2 = Bero

When is synchronization necessary?

The spindle will be synchronized:

- After the NC has powered up when the spindle is moved using a programming command

- After a request for resynchronization by the PLC

  NST DB31,... DBX16.4 (resynchronize spindle 1)

  NST DB31,... DBX16.5 (resynchronize spindle 2)

- After each gear stage change for an indirect measuring system

  MD31040 $MA_ENC_IS_DIRECT (direct measuring system) = 0

- When the encoder limit frequency falls below the programmed value after a speed has been programmed which is above the encoder limit frequency.

NOTICE
If the spindle encoder is not mounted directly on the spindle and there are gear ratios between the encoder and spindle (e.g. encoder mounted on motor), then a BERO signal connected to the drive (SERVO) must be used for synchronization. The control system then automatically resynchronizes the spindle after each gear stage change. The user does not have to contribute anything here.
In general, backlash, gearbox elasticity and the BERO hysteresis reduce the accuracy achievable during synchronization.

Machine data

MD	Identifier	Meaning
34100	$MA_REFP_SET_POS	Reference point value
34090	$MA_REFP_MOVE_DIST_CORR	Reference point offset
34200	$MA_REFP_MODE	Referencing mode

7.5.7 Spindle monitoring

Spindle stationary

The maximum permissible spindle speed up to which spindle standstill is detected, is set using machine data:

- MD36060 $MA_STANDSTILL_VELO_TOL (max. speed "Spindle stationary")

If the actual speed falls below this speed limit, the NC/PLC interface signal is set:

- DB31,... DBX61.4 = 1 (spindle stationary)

Enabling path feed

Precondition:

- The spindle is in the open-loop control mode
- MD35510 $MA_SPIND_STOPPED_AT_IPO_START == TRUE (feed enable for "Spindle stationary")

The path feed is enabled when both conditions are fulfilled:

- (actual speed of the spindle) < (MD36060 $MA_STANDSTILL_VELO_TOL)
- DB31,... DBX61.4 == 1 (spindle stationary)

Spindle in setpoint range

If the spindle reaches the tolerance range specified in the following machine data, then the interface signal IS DB31,... DBX83.5 (spindle in setpoint range) is set:

- MD35150 $MA_SPIND_DES_VELO_TOL (spindle speed tolerance)

The path feedrate is then released in the following set machine data:

- MD35510 $MA_SPIND_STOPPED_AT_IPO_START (feed enable for "Spindle stopped")

Maximum spindle speed

The maximum spindle speed can be set using the following system data:

- Machine-dependent maximum speed via machine data
  MD35100 $MA_SPIND_VELO_LIMIT (max. spindle speed)

- Process-dependent maximum speed via immediately effective setting data
  SD43235 $SA_SPIND_USER_VELO_LIMIT (max. spindle speed)

The NC limits the spindle speed to the lower of the two values.

Error response:

If the speed is nevertheless exceeded by the speed tolerance (drive error), the following signal is output:

- DB31,... DBX83.0 = 1 (speed limit exceeded)

- Alarm "22150 Maximum number of chucks exceeded"

The following machine data also limits the speed of the spindle:

- MD36200 $MA_AX_VELO_LIMIT (velocity-monitoring threshold)

When the speed is exceeded, an alarm is generated.

In position-control mode (e.g. SPCON), the NC limits the specified maximum speed specified in the machine or setting data to 90% of the maximum value (control reserve).

Gear stage speed min./max.

The default of a max./min. gear stage speed is entered in the following machine data:

- MD35130 $MA_GEAR_STEP_MAX_VELO_LIMIT (maximum speed for gear stage)

- MD35140 $MA_GEAR_STEP_MIN_VELO_LIMIT (minimum speed for gear stage)

The speed cannot leave this range when the appropriate gear stage is engaged.

Programmed spindle speed limitations

The following functions can be used to specify a spindle speed limitation in an indexing program:

- G25 S... (min. spindle speed)

- G26 S... (max. spindle speed)

The limitation is active in all operating modes.

The function LIMS=... can be used to specify a spindle speed limit for G96 (constant cutting rate):

- LIMS=... (speed limitation (G96))

This limitation is only effective when G96 is active.

Encoder frequency limit

If the encoder frequency limit in the following machine data is exceeded, synchronization of the spindle is lost and spindle functionality is reduced (thread, G95, G96):

● MD36300 $MA_ENC_FREQ_LIMIT (encoder frequency limit)

The spindle will be re-synchronized automatically once the encoder frequency falls below the value defined in the following machine data:

● MD36302 $MA_ENC_FREQ_LIMIT_LOW (encoder frequency limit at which the encoder is turned on again)

The encoder frequency limit value must be such that the mechanical encoder speed limit is not exceeded or else the synchronization from high speeds will be incorrect.

Overview of the speed limit values
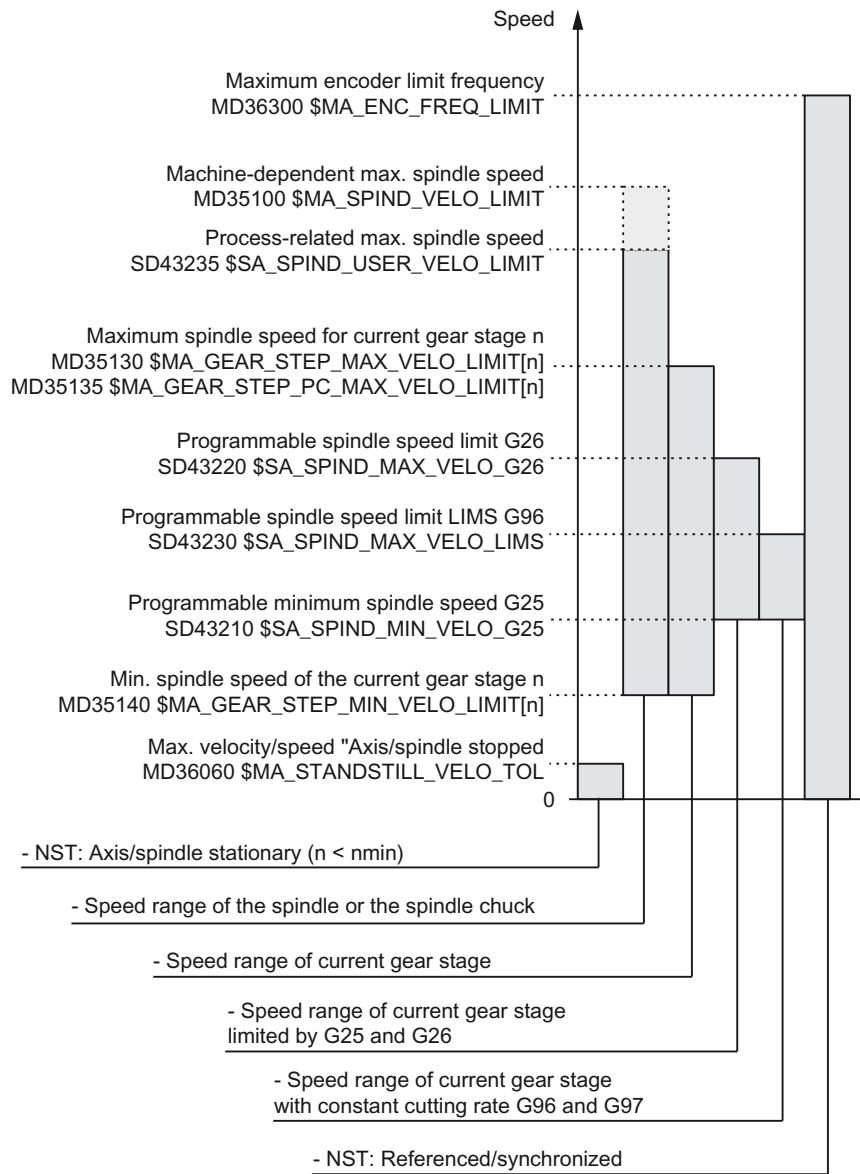
Literature

Function Manual Basic Functions; Spindles: Spindle monitoring (S1)

7.6   System data

7.6.1   Resolutions

Overview

The following types of resolution, e.g. resolution of linear and angular positions, velocities, accelerations and jerk, must be differentiated as follows:

- The **input resolution**, i.e. the input of data from the user interface or using the part programs.

- The **display resolution**, i.e. the display of data on the user interface.

- The **computational resolution**, i.e. the internal representation of the data input through the user interface or the part program.

Input and display resolution

The input and display resolution is specified via the control panel, whereby the display resolution of position values can be changed with MD9004 $MM_DISPLAY_RESOLUTION (display resolution).

MD9011 $MM_DISPLAY_RESOLUTION_INCH (INCH measuring system display resolution) can be used to configure the display resolution for position values with inch setting. This allows you to display up to six decimal places with the inch setting.

For the programming of part programs, the input resolutions listed in the Programming Guide apply.

Computational resolution

The computational resolution defines the maximum number of effective decimal places for all data the physical unit of which is referred to a length or an angle, e.g. position values, velocities, tool offsets, zero offsets, etc.

The desired computational resolution is defined using the machine data

- MD10200 $MN_INT_INCR_PER_MM (computational resolution for linear positions)

- MD10210 $MA_INT_INCR_PER_DEG (computational resolution for angular positions)

.

The default assignment is:

- 1000 increments/mm

- 1000 increments/degrees

The computational resolution thus also determines the maximum achievable precision for positions and selected offsets. However, it is essential that the measuring system is adapted to this degree of precision.

Note

Although the computational resolution is generally independent of the input/display resolution, it should have at least the same resolution.

Rounding

The precision of angle and linear positions is limited to the computational resolution by rounding the product of the programmed value with the computational resolution to an integer number.

Example of rounding:

Computational resolution: 1000 increments/mm
Programmed path: 97.3786 mm
Effective value = 97.379 mm

Note

To keep rounding easily understandable, it is better to use powers of 10 for the computational resolution (100, 1000, 10,000).

Display resolution

In MD9004 $MM_DISPLAY_RESOLUTION (display resolution), you can set the number of decimal places after the decimal point for the position values on the operator panel.

Input and display limit values

Limitation of the input values depends on the display features and on the input options on the operator panel. The limit is ten digits plus comma and sign.

Example of programming in the $^1/_{10}$ - µm range:

All the linear axes of a machine are to be programmed and traversed within the range of values 0.1 to 1000 mm.

In order to position accurately to 0.1 µm, the computational resolution must be set to $\geq 10^4$ incr./mm.

MD10200 $MN_INT_INCR_PER_MM = 10000 [incr./mm]:

Example of related part program:

N20 G0 X 1.0000 Y 1.0000
;Axes move to position X=1.0000 mm, Y=1.0000 mm

N25 G0 X 5.0002 Y 2.0003
;Axes move to position X=5.0002 mm, Y=2.0003 mm

Machine data

MD	Identifier	Comment
9004	$MM_DISPLAY_RESOLUTION	Display resolution
9011	$MM_DISPLAY_RESOLUTION_INCH	Display resolution for INCH system of measurement
10200	$MN_INT_INCR_PER_MM	Computational resolution for linear positions
10210	$MN_INT_INCR_PER_DEG	Computational resolution for angular positions

Literature

Function Manual, Basic Functions; Velocities, Setpoint-Actual Value Systems, Closed-Loop Control (G2)

7.6.2 Normalization of phys. units of machine data and setting data

Scaling of physical quantities

Machine and setting data that have a physical unit are interpreted in the input/output units listed in the table "Scaling physical units of machine and setting data" by default, depending on the scaling system (metric/inch).

The internally used units which the NC uses are independent and fixed.

Physical unit	Input/output units for the basic system		Internally used unit
	Metric	Inch	
Linear position	1 mm	1 inch	1 mm
Angular position	1 degree	1 degree	1 degree
Linear velocity	1 mm/min	1 inch/min	1 mm/s
Angular velocity	1 rpm	1 rpm	1 deg./s
Linear acceleration	1 m/s^2	1 inch/s^2	1 mm/s^2
Angular acceleration	1 rev/s^2	1 rev/s^2	1 degree/s^2
Linear jerk	1 m/s^3	1 inch/s^3	1 mm/s^3
Angular jerk	1 rev/s^3	1 rev/s^3	1 degree/s^3
Time	1 sec	1 sec	1 sec
Position controller servo gain	1 s^{-1}	1 s^{-1}	1 s^{-1}
Rev. feedrate	1 mm/rev	1 inch/rev	1 mm/degree
Compensation value linear position	1 mm	1 inch	1 mm
Compensation value angular position	1 degree	1 degree	1 degree

User-defined

The user can define different input/output units for machine and setting data. This also requires an adjustment between the newly selected input/output units and the internal units via the following machine data:

- MD10220 $MN_SCALING_USER_DEF_MASK (Activation of the scaling factors) and
- MD10230 $MN_SCALING_FACTORS_USER_DEF[n] (Scaling factors of the physical quantities)
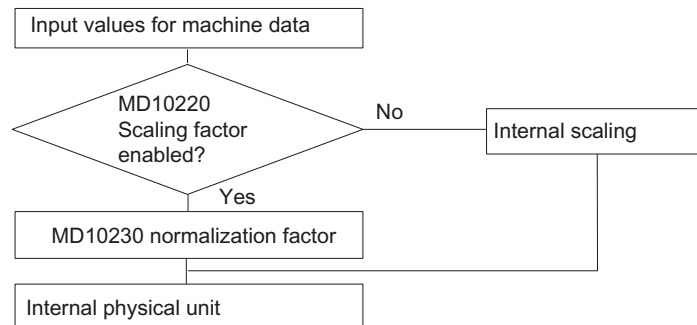
The following applies:

Input/output unit selected=

MD10230 $MN_*SCALING_FACTORS_USER_DEF[n] * internal unit*

The selected input/output unit, expressed in the internal units 1 mm, 1 degree and 1 s must therefore be entered in MD10230 $MN_SCALING_FACTORS_USER_DEF[n].

Table 7-1   Bit number and index for user definition

Physical unit	MD10220 Bit number	MD10230 Index n
Linear position	0	0
Angular position	1	1
Linear velocity	2	2
Angular velocity	3	3
Linear acceleration	4	4
Angular acceleration	5	5
Linear jerk	6	6
Angular jerk	7	7
Time	8	8
K_V factor	9	9
Rev. feedrate	10	10
Compensation value linear position	11	11
Compensation value angular position	12	12

Example 1:

The data input/output of the linear velocities should be in m/min rather than mm/min (initial state). The internal unit is mm/s.

MD10220 $MN_SCALING_USER_DEF_MASK Bit2 = 1 is used to enter the scaling factor for linear velocities as a user-defined value. The scaling factor is calculated using the following formula:

$$\text{MD10230 \$MN\_SCALING\_FACTORS\_USER\_DEF[n]} = \frac{\text{Selected input/output unit}}{\text{Internal unit}}$$

$$\text{MD10230 \$MN\_SCALING\_FACTORS\_USER\_DEF[n]} = \frac{1\ \frac{m}{min}}{1\ \frac{mm}{s}} = \frac{\frac{1000}{60}\ \frac{mm}{s}}{1\ \frac{mm}{s}} = \frac{1000}{60} = 16.667$$

→ MD10230 $MN_SCALING_FACTORS_USER_DEF[2] = 16.667

Index 2 specifies the "linear velocity".

Example 2:

In addition to the change in example 1, the machine data input/output of linear accelerations is to be performed in ft/s^2, instead of m/s^2 (initial state) (the internal unit is mm/s^2).

MD10220 $MN_SCALING_USER_DEF_MASK = ‚H14'; (bit no. 4 and bit no. 2) of Example 1 as hex value

$$\text{MD10230 \$MN\_SCALING\_FACTORS\_USER\_DEF[n]} = \frac{1\ \frac{ft}{s^2}}{1\ \frac{mm}{s^2}} = \frac{12*25.4\ \frac{mm}{s^2}}{1\ \frac{mm}{s^2}} = \frac{1000}{60} = 304.8$$

→ MD10230 $MN_SCALING_FACTORS_USER_DEF[4] = 304.8

Index 4 specifies the "linear acceleration".

Machine data

MD	Identifier	Comment
10220	$MN_SCALING_USER_DEF_MASK	Activation of scaling factors
10230	$MN_SCALING_FACTORS_USER_DEF[n]	Scaling factors of physical quantities
10240	$MN_SCALING_SYSTEM_IS_METRIC	Basic system metric
10250	$MN_SCALING_VALUE_INCH	Conversion factor for switchover to inch system
10260	$MN_CONVERT_SCALING_SYSTEM	Basic system switchover active
10270	$MN_POS_TAB_SCALING_SYSTEM	Measuring system of position tables
10290	$MN_CC_TDA_PARAM_UNIT	Physical units of the tool data for CC
10292	$MN_CC_TOA_PARAM_UNIT	Physical units of the tool edge data for CC

7.6.3 Modifying scaling machine data

The scaling of machine data having physical units is defined by the following machine data:

- MD10220 $MN_SCALING_USER_DEF_MASK (activation of standardizing factors)
- MD10230 $MN_SCALING_FACTORS_USER_DEF (standardizing factors of the physical quantities)
- MD10240 $MN_SCALING_SYSTEM_IS_METRIC (basic system metric)
- MD10250 $MN_SCALING_VALUE_INCH (conversion factor for switchover to INCH system)
- MD30300 $MA_IS_ROT_AX (rotary axis)

When scaling machine data are modified, all machine data affected by this modification due to their physical unit are converted with the next NCK reset.

Example: Redefining an A1 axis from linear to rotary axis.

The control has been started up with default values. Axis A1 is declared as a linear axis.

- MD30300 $MA_IS_ROT_AX[A1] = 0 (no rotary axis)
- MD32000 $MA_MAX_AX_VELO [A1] = 1000 [mm/min] (max. axis velocity).

Axis A1 is now declared as a rotary axis containing the following machine data:

- MD30300 $MA_IS_ROT_AX[A1] = 1 (rotary axis)
- MD32000 $MA_MAX_AX_VELO [A1] = 1000 [mm/min] (max. axis velocity).

With the next NCK reset, the control system recognizes that axis A1 is defined as a rotary axis and standardizes MD32000 $MA_MAX_AX_VELO to [rev./min] with reference to a rotary axis.

- MD30300 $MA_IS_ROT_AX[A1] = 1 (rotary axis)
- MD32000 $MA_MAX_AX_VELO [A1]= 2.778 [rev./min]

Note

If a scaling machine data item is altered, then the control outputs alarm "4070 Scaling data changed".

Modifying manually

The following procedure is recommended when modifying scaling machine data manually:

1. Set all scaling machine data
2. Carry out NCK reset
3. Set all dependent machine data after the NC has powered up.

7.6.4 Loading default machine data

The default machine data can be loaded in different ways.

HMI startup

HMI startup via the HMI standard user interface: Operating area menu "Diagnostics" > "NC/PLC"

- Button: "Delete NCK Data"

- Button: "NCK RESET"

NOTICE
With deleting the NCK data, all user data are lost.
To avoid data loss, a series commissioning file should be created before the NCK data are deleted. The way to create a series machine start-up file is laid out in the Chapter "Creating a series machine start-up file".

MD11200 $MN_INIT_MD

Using the entry values listed below in MD11200 $MN_INIT_MD (loading the standard machine data for the "next" NC boot), you can load various data storage areas with default values at the next NC boot.

After setting the machine data, an NCK reset must be carried out:

1. NCK RESET: The machine data is activated.

2. NCK RESET: Depending on the entry value, the corresponding machine data is set to its standard values and the MD11200 $MN_INIT_MD is reset to value "0".

Input values

MD11200 $MN_INIT_MD = **1**
At the next NC power-up, all machine data (with the exception of the memory configuring data) are overwritten with default values.

MD11200 $MN_INIT_MD = **2**
At the next NC boot, all memory-configuring machine data are overwritten with default values.

7.6.5 Switching over the measuring system

Switching over the measuring system

The measuring system of the complete machine is switched in "Machine" operating area → "Settings" → "Switch to inch" ↔ "Switch to metric". The actual switchover of the system of measurement is performed internally by writing all the necessary machine data and subsequently activating them with a Reset (po).

MD10240 $MN_SCALING_SYSTEM_IS_METRIC and the corresponding G70/G71/G700/G710 settings in MD20150 $MC_GCODE_RESET_VALUES are switched over automatically and consistently for all configured channels. The value of machine data: MD20150 $MC_GCODE_RESET_VALUES[12] varies between G700 and G710. This process takes place independently of the protection level currently set.

Supplementary conditions

The switchover occurs only under the following supplementary conditions:

- MD10260 $MN_CONVERT_SCALING_SYSTEM=1.
- Bit 0 of MD20110 $MC_RESET_MODE_MASK is set in every channel.
- All channels are in the Reset state.
- Axes are not traversing with JOG, DRF or PLC control.
- Constant grinding wheel peripheral speed (GWPS) is not active.

Actions such as part program start or mode change are disabled for the duration of the switchover.

If the switchover cannot be performed, this is indicated by a message in the user interface. These measures ensure that a consistent set of data is always used for a running program with reference to the system of measurement.

System data

When switching over the measuring system, from the view of the user, all length-related specifications are converted to the new measuring system automatically. This includes:

- Positions
- Feedrates
- Acceleration rates
- Jerk
- Tool offsets
- Programmable, settable and work offsets external and DRF offsets
- Compensation values
- Protection zones

- Machine data

- JOG and handwheel factors

After the switchover, all data is available in physical quantities. Data, for which no unique physical units are defined, is not converted automatically.

- R parameters

- GUDs (**G**lobal **U**ser **D**ata)

- LUDs (**L**ocal **U**ser **D**ata)

- PUDs (**P**rogram global **U**ser **D**ata)

- Analog inputs/outputs

- Data exchange via FC21

The user is prompted to take the current valid measuring system MD10240 $MN_SCALING_SYSTEM_IS_METRIC into consideration.

The current system of measurement setting can be read at the PLC interface via the "inch system" signal DB10.DBX107.7. DB10.DBB71 can be used to read out the "system of measurement change counter".

Machine data

Number	Identifier	Comment
10240	$MN_SCALING_SYSTEM_IS_METRIC	Basic system metric
10250	$MN_SCALING_VALUE_INCH	Conversion factor for switchover to inch system
10260	$MN_CONVERT_SCALING_SYSTEM	Basic system switchover active
32711	$MA_CEC_SCALING_SYSTEM_METRIC	System of measurement of sag compensation

Literature

Function Manual, Basic Functions; Velocities, Setpoint-Actual Value Systems, Closed-Loop Control (G2)

7.6.6 Traversing ranges

Computational resolution and traversing ranges

The range of values of the traversing range depends directly on the selected computational resolution.

The pre-setting of the machine data for the computational resolution is set as follows:

- 1000 inc./mm
- 1000 inc./deg.

The following traversing ranges result:

	Traversing range in the metric system	Traversing range in the inch system
Linear axes	± 999,999.999 [mm; deg.]	± 399,999.999 [inch; deg.]
Rotary axes	± 999,999.999 [mm; deg.]	± 999,999.999 [inch; deg.]
Interpolation parameters I, J, K	± 999,999.999 [mm; deg.]	± 399,999.999 [inch; deg.]

See also

Resolutions (Page 216)

7.6.7 Positioning accuracy of the control system

Computational resolution and traversing ranges

The positioning accuracy depends on:

- The computational accuracy (internal increments/(mm or degrees))
- The actual-value resolution (encoder increments/(mm or degrees)).

The less-precise resolution of both determines the positioning accuracy of the NC.

The input resolution, the position-control and interpolation clock do not affect the accuracy.

Machine data

Number	Identifier	Name / remarks
10200	$MN_INT_INCR_PER_MM	Computational resolution for linear positions
10210	$MN_INT_INCR_PER_DEG	Computational resolution for angular positions
31020	$MA_ENC_RESOL[n]	Encoder pulses per revolution

7.6.8 Cycle times

Cycle times

For SINUMERIK 840D sl, the system clock cycle, the position-control cycle and the interpolation cycle of the NC are based on the DP cycle time that is configured in the STEP 7 hardware configuration.

NOTICE
If you change the cycle times, check the behavior of the controller in all operating modes before you finish commissioning.

Boundary conditions:

- For axes with Safety Integrated, the following applies: Max. sampling time 12 ms
- Maximum number of SERVO axes = 6 per CU (integrated) or NX

The lower the chosen cycle times (PROFIBUS DP cycle), the higher the control quality for the drive and better the surface quality on the workpiece.

Basic system cycle

The system clock cycle is set fixed to the ratio of 1:1 with regard to the DP cycle time. The active value is displayed in the machine data MD10050 $MN_SYSCLOCK_CYCLE_TIME (system cycle). It cannot be changed.

You must adjust the **system clock cycle** by changing the DP cycle time using the STEP 7 hardware configuration.

See also: Creating a SIMATIC S7 project (Page 37)

Position-control cycle

The position-control cycle (MD10061 $MN_POSCTRL_CYCLE_TIME) is set to the fixed ratio 1:1 with regard to the system clock cycle. It cannot be changed.

Position-control cycle offset

The position-control cycle offset T_M is automatically determined in the default setting (MD10062 $MN_POSCTRL_CYCLE_DELAY=0).

The effective position-control offset is displayed in the MD10063[1]. The following values can be read out via the MD10063 $MN_POSCTRL_CYCLE_DIAGNOSIS:

- MD10063[0]= T_{DX}
- MD10063[1]= T_M
- MD10063[2]= $T_M + T_{pos\ max}$

The following conditions must be met for explicit specification of the position-control cycle offset (MD10062 $MN_POSCTRL_CYCLE_DELAY!=0$):

● Cyclic communication with the DP slaves (drives) must be completed before the position controller is started.

Condition: $T_M > T_{DX}$

● The position controller must be completed before the DP cycle / system cycle is completed.

Condition: $T_M + T_{Position\ control\ max} < T_{DP}$
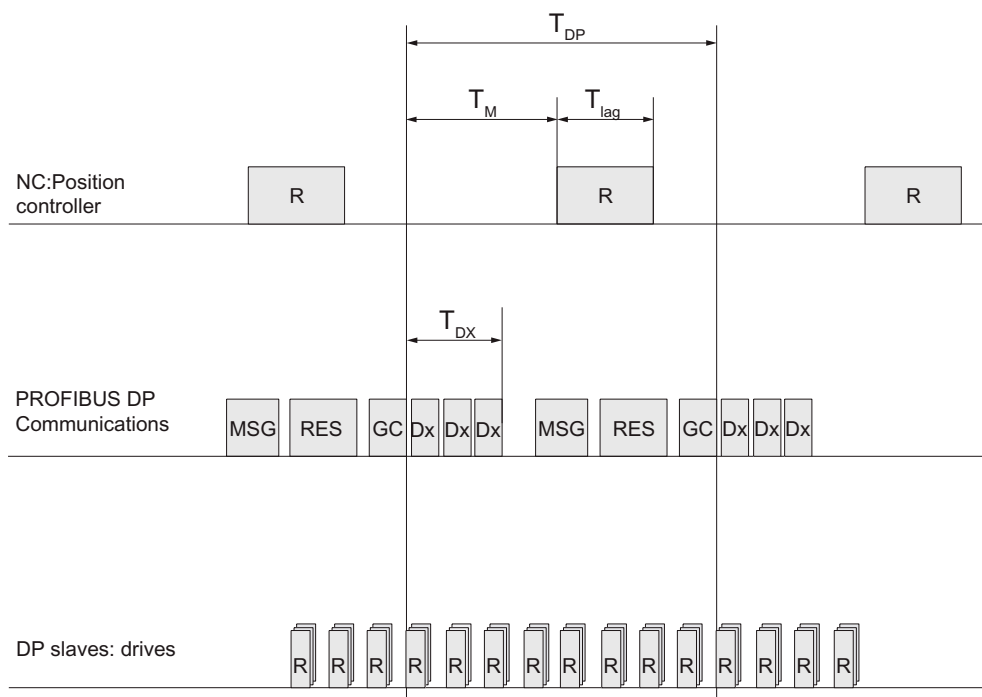
GC	Global control: Broadcast message for cyclic convergence of the equidistance between DP master and DP slaves
Dx	Useful data exchange between the DP master and DP slaves
MSG	Non-cyclic services such as DP/V1, token passing
R	CPU time
RES	Reserve: "Active pause" until the isochronous (equidistant) cycle has expired
Tpos	Computing time requirements for the position controller
TDP	DP cycle time: DP cycle time
T_{DX}	Data exchange time: Total transfer time for all DP slaves
T_M	Master time: Offset of the start time for NCK position control

Figure 7-18   Position control-cycle offset compared to PROFIBUS DP cycle

Error response

● Alarm: "380005 PROFIBUS DP: Bus access conflict, type t, counter z"

Cause of errors / error handling

- t = 1

  The position-control cycle offset selected is too small. The cyclic PROFIBUS communication with the drives was not yet completed with the start of the position controller.

  – Remedy: Increase the position-control cycle offset.

- t = 2

  The position-control cycle offset selected is too large. The cyclic PROFIBUS communication with the drives started before the position controller had finished. The position controller requires more CPU time than available within the DP cycle.

  – Remedy: Decrease the position-control cycle offset or increase the DP cycle time.

Interpolation cycle

The interpolation cycle may be chosen freely as a whole multiple of the position-control cycle.

- MD10070 $MN_IPO_SYSCLOCK_TIME_RATIO (factor for the interpolation cycle)

Error response:

- Alarm 4240: "CPU time overflow at the IPO or position controller level"

Cause of errors / error handling

The DP cycle time / position-control cycle, the interpolation cycle, or the NC CPU time share is set in such a way that not enough CPU time is available for one of the two cyclic levels of the NCK (position controller or interpolator).

Remedy: Calculate the maximum values for $T_{pos\,max}$ and $T_{IPO\,max}$ (see above) and adapt the following machine data:

MD	Identifier	Comment
10050	$MN_SYSCLOCK_CYCLE_TIME	The system cycle is always equal to the equidistant PROFIBUS DP cycle.
10060	$MN_POSCTRL_SYSCLOCK_TIME_RATIO	Factor for the position-control cycle is permanently fixed to the factor 1.
10061	$MN_POSCTRL_CYCLE__TIME	Position-control cycle
10062	$MN_POSCTRL_CYCLE_DELAY	Position-control cycle offset
10063	$MN_POSCTRL_CYCLE_DIAGNOSIS	[0] = DP cycle time [1] = Position-control cycle offset [2] = Position-control cycle offset + max. computation time needed by the position controller
10070	$MN_IPO_SYSCLOCK_TIME_RATIO	Factor for the interpolation cycle can be freely selected in integer multiples.
10185	$MN_NCK_PCOS_TIME_RATIO	Computation time ratio NCK

References

Special Functions, Function Manual; Cycle Times (G3)

7.6.9   System utilization

System utilization

The system utilization is displayed channel-specific in the "Diagnostics" → Menu forward key → "System utilization" operating area:
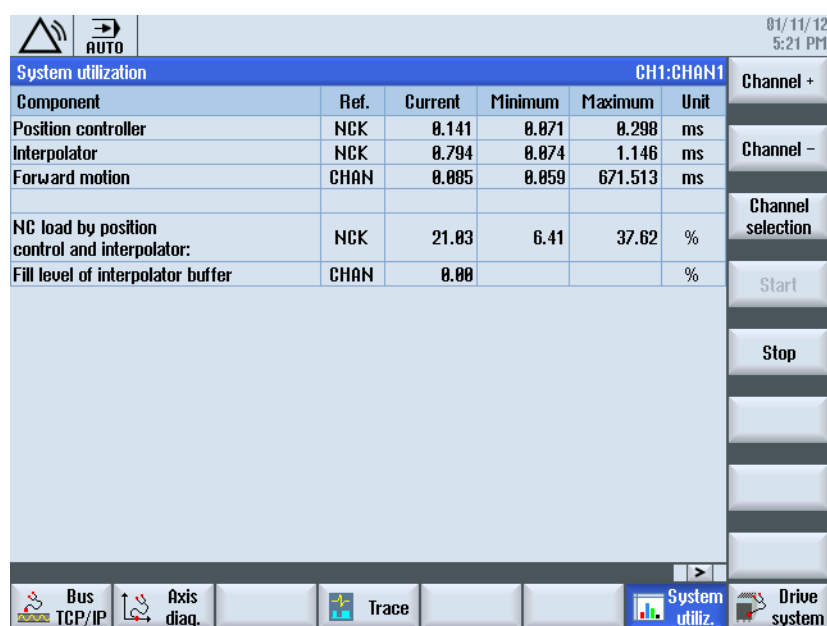
Figure 7-19   System utilization

The displayed values have the following significance:

Component	Display
Position controller	Total utilization of the system: Current, minimum and maximum utilization of the NCK in milliseconds.
Interpolator	
Preprocessing	• MD10050 $MN_SYSCLOCK_CYCLE_TIME (system clock cycle)
	• MD10061 $MN_POSTCTRL_CYCLE_TIME (position-control cycle)
	• MD10070 $MN_IPO_SYSCLOCK_TIME_RATIO (factor for the interpolation cycle)
	• MD10071 $MN_IPO_CYCLE_TIME (interpolation cycle)
	• MD11510 $MN_IPO_MAX_LOAD (time required for synchronized actions)

Component	Display
Position controller and interpolator NC load	In order to have sufficient reserves for the program processing, the maximum load in typical operations should not exceed 75%. The current load on the average should not exceed 50%. MD10185 $MN_NCK_PCOS_TIME_RATIO = 90 (default setting)
Interpolator buffer level	This display indicates whether batch preparation for batch processing can commence. Jerky processing in continuous-path mode, if for instance a number of short traversing blocks have been programmed in succession, is a typical indicator of the IPO buffer idling. Capacity indication is channel-specific. MD28060 $MC_MM_NUM_IPO_BUFFER_SIZE is displayed as a percentage.

See also

7.6.10 Velocities

Max. axis velocity and spindle speed

The maximum possible axis velocities and spindle speeds depend on the machine design, drive dynamics and the encoder frequency limit of the individual drives.

Max. programmable tool path velocity

The maximum programmable tool path velocity results from the maximum axis velocities of the axes involved in the path programmed.

Max. tool path velocity

The maximum tool path velocity at which traversing is possible within a part program block results as follows:

$$V_{max.} = \frac{\text{Progr. path length in part program block [mm or degrees]}}{\text{Interpolation cycle [s]}}$$

Upper limit

To guarantee that part program blocks are executed continuously (control margin), the NC limits the tool path velocity within a part program block to 90% of the max. possible tool path velocity as follows:

$$V_{max.} \leq \frac{\text{Progr. path length in part program block [mm or degrees]}}{\text{Interpolation cycle [s]}} * 0.9$$

For example, in the case of part programs generated by means of a CAD system which contain extremely short blocks, this limiting of the path velocity can result in a strong reduction of the path velocity over several part program blocks.

A compressor function can be used to avoid such velocity drops.

Lower limit

The minimum tool path or axis velocity at which traversing is possible results from:

$$V_{min} \geq \frac{10^{-9}}{\text{comput. resolution } [\frac{\text{incr.}}{\text{mm or degrees}}] * \text{IPO cycle [s]}}$$

If V_{min} is not reached, no traversing motion is carried out.

Literature

You can find further details in:

- Programming Manual Work Preparation: Special motion commands (COMPON, COMPCURVE)
- Function Manual, Basic Functions; Velocities, Setpoint-Actual Value Systems, Closed-Loop Control (G2)

7.7 Memory configuration

Memory division

On the SINUMERIK 840D sl, the persistent data is divided into various independent areas: Siemens, manufacturer, user.

The memory available in the NCK is displayed on the user interface in the: "Commissioning" → "NC" → "NC memory" operating area.

The figure below shows how NCK persistent data is divided:
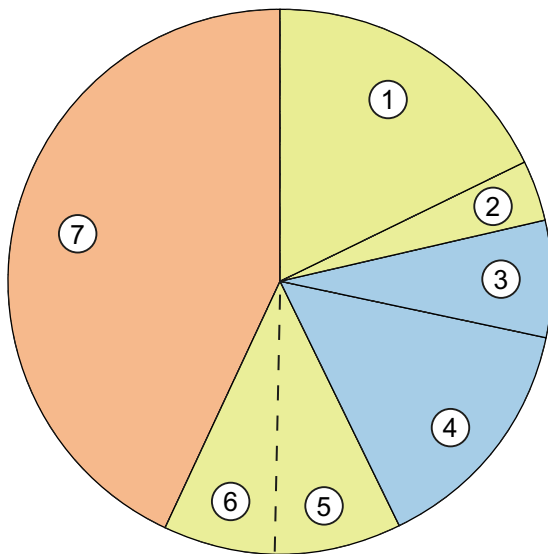
①	Part programs and OEM cycles can be set via MD 18352 $MN_U_FILE_MEM_SIZE	User
②	In addition to part programs and OEM cycles that can be set via MD 18353 $MN_M_FILE_MEM_SIZE	User
③	Siemens cycles	Siemens
④	Reserved	Siemens
⑤	RAM in NCK	User
⑥	RAM in the NCK that contains the system and user data currently being processed by the NCK. Numbers for tools, frames, etc., are set by default.	User
⑦	Additional memory (software option): can be used for RAM in the NCK, part programs and cycles	User

- Additional 2 MB CNC user memory (6FC5800-0AD00-0YB0)

- Additional 128 KB PLC user memory (6FC5800-1AD00-0YB0)

- Additional user memory on CompactFlash card of the NCU (6FC5800-0AP12-0YB0)

Figure 7-20   Memory division

7.8 Application example

Advanced Surface (option)

Advanced Surface is a function for machining milled surfaces in the tool and mold making area.

Software option

You require the following software option in order to use this function: "Advanced Surface" (MLFB: 6FC5800-0AS07-0YB0).

The machine and setting data influenced by this functionality as well as their contents are listed below. The values are recommended settings.

7.8.1 Preconditions, G code

Introduction

Dynamic G groups are used for the Advanced Surface option.

Preconditions

- The machine axes have been optimized.
- The dynamic G groups have been set-up and parameterized for the following machining sections:
  - Roughing (DYNROUGH)
  - Semi-finishing (DYNSEMIFIN)
  - Finishing (DYNFINISH)

Recommendations

- Dynamic G groups

  The following classification of dynamic G groups is recommended (G code group 59):

DYNNORM	→ 2.5D machining without AS
DYNPOS	→ Positioning mode (e.g. tool change, thread cutting) without AS
DYNROUGH	→ Milling with AS
DYNSEMIFIN	→ Milling with AS
DYNFINISH	→ Milling with AS

Note

DYNNORM is the initial setting of the G group (default).

For Advanced Surface, the precondition is that jerk limited velocity control is active. Jerk-limited velocity control is selected using the G code SOFT.

- COMPCAD

  Using COMPCAD, it is possible to combine part programs with short linear blocks, with the associated tolerance, using polynomials.

  This path compression technique has been developed so that the surface character, which the milling paths form, is retained.

- G645

  G645 (G code group 10) switches to the continuous path mode (Look Ahead).

  G645 has the ability to insert smoothing elements in existing contour elements so that acceleration steps (jumps) do not occur.

- FIFOCTRL

  FIFOCTRL (G code group 4) switches to the automatic pre-processing memory control.

  The feed is adapted so that the pre-processing memory does not become empty.

- FFWON

  FFWON (G code group 24) switches to the parameterized pre-control (speed or acceleration pre-control). FFWON can only be used if pre-control is parameterized. This must be ensured by the machine suppliers.

Commands for 5-axis machining

The following commands are important for 5-axis machining:

- TRAORI enables the defined transformation and must be programmed alone in the block.
- UPATH (G code group 45) switches to the path parameter that was developed for 5-axis interpolation.
- ORIAXES (G code group 51) linearly interpolates the orientation axes in the block up to the end of block.
- ORIWKS (G code group 25) defines the workpiece coordinate system for orientation interpolation.

CYCLE832 (High-Speed Settings)

Cycle CYCLE832 (High Speed Settings) optimally supports Advanced Surface. This cycle has been developed for this purpose and sets the above mentioned commands and the tolerance.

Commands CTOL (Chord TOLerance) and OTOL (Orientation TOLerance)

Commands CTOL (Chord TOLerance for chord tolerance) and OTOL (Orientation TOLerance) can be used if the tolerance is programmed without support of CYCLE832.

Activating the G code

Activation can be realized either using "Programming in the part program" or when commissioning machines, by re-configuring the RESET response (see $MC_GCODE_RESET_VALUES).

Programmable program sequence without CYCLE832

This produces the following program sequence for customers who do not use CYCLE832 or if the G commands do not correspond to the machine initial setting:

```
SOFT
FFWON
FIFOCTRL
G645
COMPCAD
DYNROUGH or DYNSEMIFIN or DYNFINISH {depending on the machining
phase}
TRAORI(<Transformation number>) {for 5-axis programs and
transformation}
ORIAXES
ORIMKS
```

7.8.2 Preconditions, machine data

Pre-assignment for 3- and 5-axis machining

The subsequently listed machine data should be set as follows:

MD	Name	Description	Rec. value	Comment
10200	$MN_INT_INCR_PER_MM	Internal calculation resolution, linear axis	100000	10000 for export version
10210	$MN_INT_INCR_PER_DEG	Internal calculation resolution, rotary axis	=MD10200	10000 for export version
18360	$MN_MM_EXT_PROG_BUFFER_SIZE	Maximum reload memory when executing from external	500	Against jamming
18362	$MN_MM_EXT_PROG_NUM	Number of external programs that can be simultaneously processed	2	
20150	$MC_GCODE_RESET_VALUES[3]	Initial setting of G group 4	3	FIFOCTRL
20150	$MC_GCODE_RESET_VALUES[19]	Initial setting of G group 20	2	SOFT

MD	Name	Description	Rec. value	Comment
20150	$MC_GCODE_RESET_VALUES[44]	Initial setting of G group 45	2	UPATH (for 5-axis machining)
20150	$MC_GCODE_RESET_VALUES[50]	Initial setting of G group 50	2	ORIAXES (for 5-axis machining)
20170	$MC_COMPRESS_BLOCK_PATH_LIMIT	Maximum length of POLY generated by the compressor	20	
20172	$MC_COMPRESS_VELO_TOL	Maximum deviation of the path feed for COMCAD	1000	Default setting
20443	$MC_LOOKAH_FFORM[0-1]	Activates the extended Look Ahead in the associated technology group (DYNNORM, DYNPOS)	0	Default setting
20443	$MC_LOOKAH_FFORM[2-4]	Activates the extended Look Ahead in the associated technology group (DYNROUGH, DYNSEMIFIN, DYNFINISH)	1	
20482	$MC_COMPRESSOR_MODE	Behavior of the compressor tolerance	300	
20490	$MC_IGNORE_OVL_FACTOR_FOR_ADIS	Control of G642	1	
20560	$MC_G0_TOLERANCE_FACTOR	Factor for tolerance for COMPCAD, G645, OST, ORISON	3	
20600	$MC_MAX_PATH_JERK [0-4]	Path jerk	10000	Should not be effective
20602	$MC_CURV_EFFECT_ON_PATH_ACCEL[0-1]	Ratio of translatory acceleration to the centripetal acceleration	0	Should not be effective
20602	$MC_CURV_EFFECT_ON_PATH_ACCEL[2]	Ratio of translatory acceleration to centripetal acceleration with DYNROUGH	0,65	Must be effective so that for active curvature smoothing, the jerk is not quite so significantly exceeded!
20602	$MC_CURV_EFFECT_ON_PATH_ACCEL[3]	Ratio of translatory acceleration to centripetal acceleration with DYNSEMIFIN	0,6	Must be effective so that for active curvature smoothing, the jerk is not quite so significantly exceeded!
20602	$MC_CURV_EFFECT_ON_PATH_ACCEL[4]	Ratio of translatory acceleration to centripetal acceleration with DYNFINISH	0.5 (determine using the circularity test)	Limit rotational acceleration especially for "large" machines!

MD	Name	Description	Rec. value	Comment
20606	$MC_PREPDYN_SMOOTHING_ON[0-1]	Activates curvature smoothing	0	Default
20606	$MC_PREPDYN_SMOOTHING_ON[2-4]	Activates curvature smoothing	1	
21104	$MC_ORI_IPO_WITH_G_CODE	G code for orientation interpolation	1	
28060	$MC_MM_IPO_BUFFER_SIZE	Memory, interpolator for number of G1 blocks	150	
28070	$MC_MM_NUM_BLOCKS_IN_PREP	Memory, preparation (pre-processing)	80	
28520	$MC_MM_MAX_AXISPOLY_PER_BLOCK	Maximum number of axis polynomials per block	5	
28530	$MC_MM_PATH_VELO_SEGMENTS	Number of memory elements for limiting the path velocity	5	
28533	$MC_MM_LOOKAH_FFORM_UNITS	Memory for extended Look Ahead	18	
28540	$MC_MM_ARCLENGTH_SEGMENTS	Number of memory elements to display the arc length function	10	
28610	$MC_MM_PREPDYN_BLOCKS	Memory, curvature smoothing	10	
29000	$OC_LOOKAH_NUM_CHECKED_BLOCKS	Number of Look Ahead blocks (this must be the same as N28060)	150	
42470	$SC_CRIT_SPLINE_ANGLE	COMP criteria for target point analysis (should be >30°)	36	Default
42471	$SC_MIN_CURV_RADIUS	Factor for compressor tolerance (should be 0.3-3)	1	
42500	$SC_IS_MAX_PATH_ACCEL	Limits the path acceleration via SD	10000	
42502	$SC_IS_SD_MAX_PATH_ACCEL	Activates the path acceleration via SD	0	
42510	$SC_SD_MAX_PATH_JERK	Limits the path jerk via SD	10000	
42512	$SC_IS_SD_MAX_PATH_JERK	Activates path jerk via SD	0	

Optimize the drive. 8

You can optimize the drives in the "Commissioning" > "Optimization/Test" operating area.
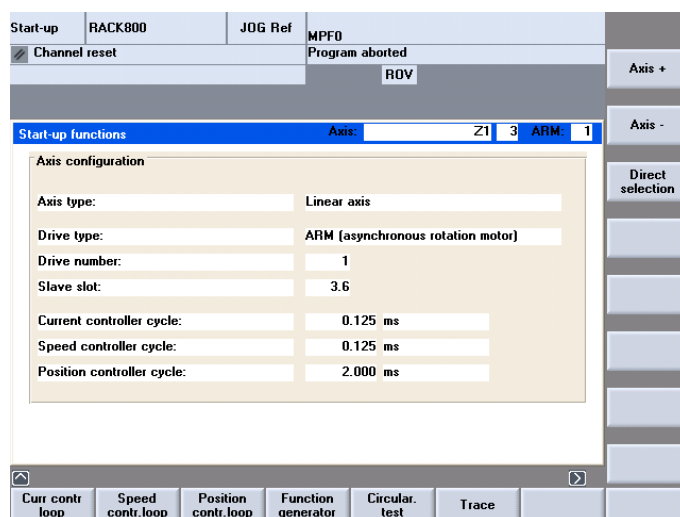
Figure 8-1   Optimization/test

The following functions are available:

- Frequency response measurements for the following control loops:

    – Current controller

    – Speed controller

    – Position controller

- Automatic controller setting

- Function generator

- Circularity test

- Trace

    – Servo trace

    – Drive trace

Measuring functions

The measuring functions make it possible to assess the automatic controller action of the respective control loop (frequency response) by the integrated FFT analysis (Fast Fourier Transformation) without external measuring equipment.

The measurement results are represented graphically as a Bode diagram. HMI file functions can be used to archive the diagrams for documentation purposes and to simplify remote diagnostics.

Circularity test

The circularity test serves to set and assess the dynamic response for interpolating axes and to analyze the contour accuracy on the quadrant transitions (circular contours) achieved by means of friction compensation (conventional quadrant error compensation).

Literature

Function Manual Extended Functions, K3 Compensation, Section "Circularity test"

Servo trace

Servo trace provides a graphically assisted analysis of the time response of position controller and drive data.

Drive trace

Drive trace provides a graphically assisted analysis of the time response of drive signals.

8.1 Measuring functions

Explanation

A range of measuring functions allows the time and/or frequency response of drives and closed-loop controls to be displayed in graphic form on the screen. For this purpose, test signals with an adjustable interval are connected to the drives.

Measurement/signal parameters

The test setpoints are adapted to the application in question by means of measurement or signal parameters, the units of which are determined by the relevant measuring function or operating mode. The measurement or signal parameter units are subject to the following conditions:

Table 8- 1   Quantity and units for measurement or signal parameters

Size	Unit
Velocity	Metric system: Specification in mm/min or rev/min for translatory or rotary movements Inch system: Specification in inch/min or rev/min for translatory or rotary movements
Distance	Metric system: Specification in mm or degrees for translatory or rotary movements Inch system: Specification in inch or degrees for translatory or rotary movements
Time	Specified in ms
Frequency	Specified in Hz

Note

The default setting for all parameters is 0.

Preconditions for starting measuring functions

To ensure that no erroneous traversing movements due to part programs can be carried out, the measuring functions have to be started in <JOG> mode.

CAUTION
When traversing movements are carried out within the framework of measuring functions, no software limit switches and working area limitations are monitored, since these are carried out in follow-up mode.
Prior to starting traversing movements, the user must therefore ensure that the axes are positioned such that the traversing limits specified within the framework of the measuring functions are sufficient to prevent collision with the machine.

Starting measuring functions

Measuring functions initiating a traversing movement are only selected using the specific softkey. The actual start of the measuring function and thus of the traversing movement is always carried out with <NC-START> on the machine control panel.

If the main screen of the measuring function is quitted without the traversing movement being initiated, the selection of the traversing function is canceled.

Once the traversing function has been started, the main screen can be exited without any affect on the traversing movement.

Note

<JOG> mode must be selected when measuring functions are started.

Further safety notices

The user must ensure that when the measuring functions are used:

- The <EMERGENCY STOP> button is always within reach.
- No obstacles are in the traversing range.

Canceling measuring functions

The following events will cancel active measuring functions:

- Hardware limit switch reached
- Traversing range limits exceeded
- Emergency stop
- Reset (mode group, channel)
- NC STOP

- No controller enabling command
- Canceling drive enable
- Canceling traversing enable
- Selection of parking (in position-controlled operation).
- Feed override = 0%
- Spindle override = 50%
- Change in operating mode (JOG) or operating mode JOG not selected
- Actuation of traversing keys
- Actuation of handwheel
- Alarms leading to axis shutdown

8.2 Frequency response measurements

8.2.1 Current control loop measurement

Functionality

The current control loop only needs to be measured for diagnostic purposes if there is a fault or if there is no standard data for the motor / power unit combination (third-party motor).

CAUTION
The user must take special safety measures when measuring the current control loop (e.g. secure drive clamping) for hanging axes without external counterweight.

Operating path

Operating path for measuring the current control loop: Operating area switchover > "Commissioning" > "Optimization/Test" > "Current control loop"

Measuring functions

The following measuring functions are available for measuring the current control loop:

Measuring type	Measured variable
Reference frequency response (downstream of the current setpoint filter)	Torque-generating actual current value / torque-generating current setpoint
Setpoint step change (downstream of the current setpoint filter)	Measured variable 1: Torque-generating current setpoint Measured variable 2: Torque-generating actual current value

Measurement

The measurement sequence is divided into the following steps:

1. Setting the traverse range monitoring and the enable logic

2. Selecting the measurement type

3. Setting the parameters, softkey: "Measuring parameters"

4. Displaying the measurement results, softkey: "Display"
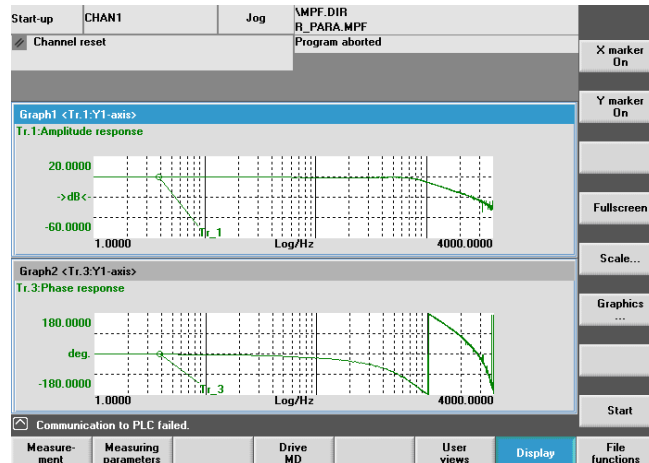
Figure 8-2   Current controller

Measuring parameters

- Amplitude

  Magnitude of the test signal amplitude. Given in percent of the peak torque. Values from 1% to 5% are suitable.

- Bandwidth

  The frequency range analyzed with the measurement.

  The bandwidth depends on the current controller sampling time.

  Example:

  125 µs current controller sampling time, set bandwidth 4000 Hz

8.2.2   Speed control loop measurement

Functionality

The response characteristics for the motor measuring system are analyzed when measuring the speed control loop. Various measurement parameter lists are available depending on the basic measurement setting which has been selected.

Operating path

Operating path for measuring the speed control loop: Operating area switchover > "Commissioning" > "Optimization/Test" > "Speed control loop"

Measuring functions

The following measurement functions are available for measuring the speed control loop:

Measuring type	Measured variable
Reference frequency response (downstream of the speed setpoint filter)	Actual speed value motor encoder/speed setpoint after filter
Reference frequency response (upstream of the speed setpoint filter)	Actual speed value motor encoder/speed setpoint after filter
Setpoint step change (downstream of the speed setpoint filter)	Measured variable 1: • Speed setpoint downstream of the filter • Actual torque value Measured variable 2: Actual speed value motor encoder
Interference frequency response (fault downstream of the current setpoint filter)	Actual speed value motor encoder / torque setpoint fct. generator
Disturbance variable step change (fault downstream of the current setpoint filter)	Measured variable 1: • Torque setpoint fct. generator • Actual torque value Measured variable 2: Actual speed value motor encoder
Speed-controlled system (excitation downstream of the current setpoint filter)	Actual speed value motor encoder/actual torque value
Frequency response of the mechanical parts [1]	Actual speed value measuring system 1/actual speed value measuring system 2
1) The machine axis in question must have both a direct and an indirect measuring system to determine the frequency response of the mechanical parts.	

Measurement

The measurement sequence is divided into the following steps:

1. Setting the traverse range monitoring and the enable logic
2. Selecting the measuring type and measured variable

3. Setting the parameters, softkey "Measuring parameters"

4. Displaying the measurement results, softkey "Display"
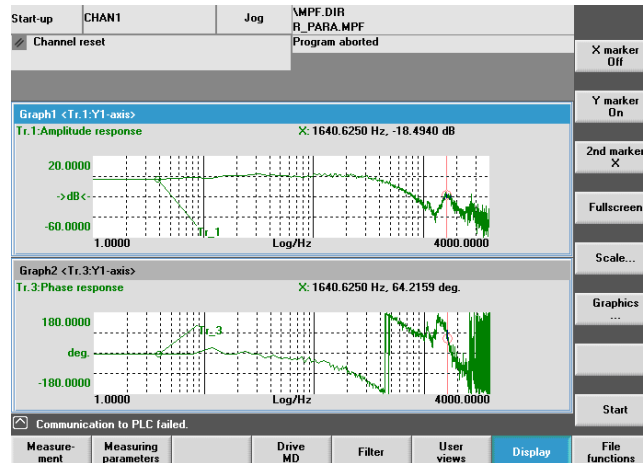
Figure 8-3　　Speed controller

In the example shown, the speed control loop has not yet been optimized.

A suitable filter parameterization is used to optimize the dynamic response. This can be called with the "Filter" softkey.

The following figure shows the standard settings for a low-pass filter at 1999 Hz (encoder mounting frequency).
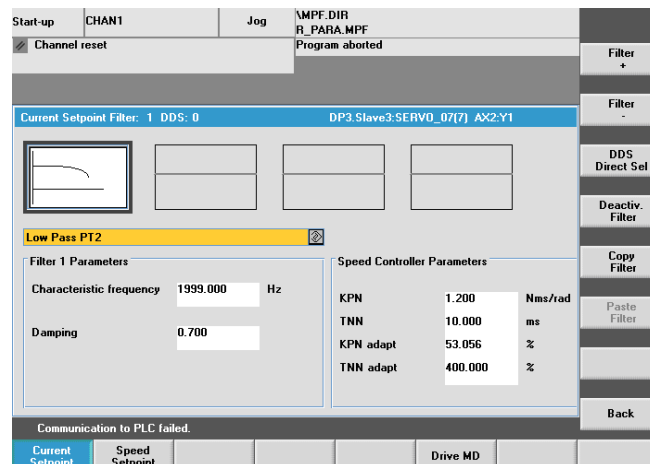
Figure 8-4　　Standard settings of the speed control loop filter
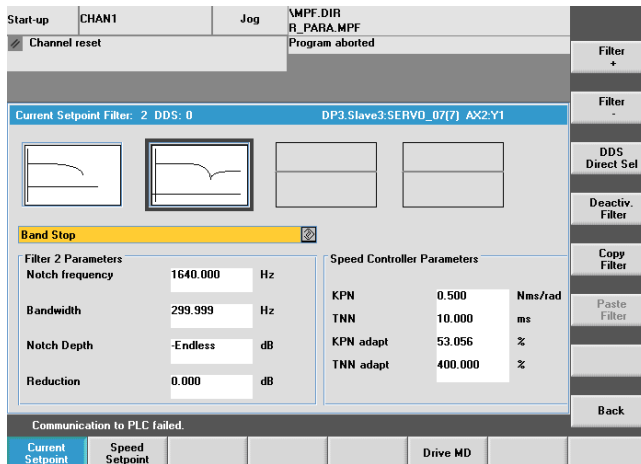
Figure 8-5   Speed control loop filter with rejection band 1190 Hz

The use of a rejection band at 1190 Hz and adaptation of the proportional gain results in the following optimized setting for the speed control loop.

Figure 8-6   Optimized speed control loop

8.2.3   Position control loop measurement

Functionality

This measuring function basically analyzes the response to the active position measuring system. If the function is activated for a spindle without a position measuring system, an alarm is displayed. Depending on the measured variable selected, various measurement parameter lists are displayed.

Operating path

Operating path for measuring the speed control loop: Operating area switchover > "Commissioning" > "Optimization/Test" > "Position control loop"

Measuring functions

The following measuring functions are available for measuring the position control loop:

Measuring type	Measured variable
Reference frequency response	Actual position/position setpoint
Setpoint step change	Measured variable 1: Position setpoint Measured variable 2: • Actual position value • System deviation • Following error • Actual speed value
Setpoint ramp	Measured variable 1: Position setpoint Measured variable 2: • Actual position value • System deviation • Following error • Actual speed value

Measurement

The measurement sequence is divided into the following steps:

1. Setting the traverse range monitoring and the enable logic

2. Selecting the measuring type and measured variable

3. Setting the parameters, softkey: "Measuring parameters"

4. Displaying the measurement results, softkey: "Display"

The following figure shows an optimized position control loop in which the K_v factor has been adapted via the machine data MD32200 $MA_POSCTRL_GAIN.

Figure 8-7　　Optimized position control loop

Reference frequency response measurement

The reference frequency response measurement determines the transmission ratio of the position controller in the frequency range (active position measuring system).

The setpoint filters, control loop gain (K_v factor) and feedforward control must be parameterized such that resonance is avoided wherever possible over the entire frequency range.

Measuring parameters

- Amplitude

  This parameter determines the magnitude of the test signal amplitude. It should be set to the smallest possible value (e.g. 0.01 mm).

- Bandwidth

  The bandwidth parameter is used to set the analyzed frequency range. The larger this value, the finer the frequency resolution and the longer the measurement time. The maximum value is specified by the position controller cycle ($T_{position\ controller}$):

  Bandwidth$_{max}$ [Hz] = 1 / (2 * $T_{position\ controller}$ [sec])

  Example:

  Position controller cycle: 2 ms

  Bandwidth$_{max}$ = 1 / (2 * 2*10^{-3}) = 250 Hz

- Averaging

  The accuracy of the measurement and measurement duration increase with this value. A value of 20 is normally suitable.

- Settling time

  This value represents the delay between recording of the measured data and injection of the test setpoint and offset. A value of between 0.2 and 1 s is recommended. Do not set too low a value for the settling times or the frequency response and phase diagrams will be distorted.

- Offset

  The measurement requires a slight speed offset of a few motor revolutions per minute. The offset must be set such that no speed zero crossings occur at the set amplitude.

Measurement: Setpoint step change and setpoint ramp

The transient or positioning response of the position control in the time range, and in particular the effect of setpoint filters, can be assessed with the step and ramp stimulation functions.

Possible measured variables:

- Actual position value (active position measuring system)
- Control deviation (following error)

Measuring parameters

- Amplitude

  Determines the magnitude of the specified setpoint step change or ramp.

- Measurement time

  This parameter determines the period of time to be recorded (maximum: 2048 position controller cycles).

- Settling time

  This value represents the delay between measured data recording / test setpoint output and the injection of the offset.

- Ramp time

  With default setting: The position reference value is specified with the "Setpoint ramp" according to the set ramp time. In this case, the acceleration limits which currently apply to the axis or spindle are effective.

- Offset

  The step is stimulated from standstill or starting from the constant traverse speed set in this parameter.

  If an offset value other than zero is input, the step change is stimulated during traversal. For the sake of clarity, the displayed actual position value does not include this speed offset.
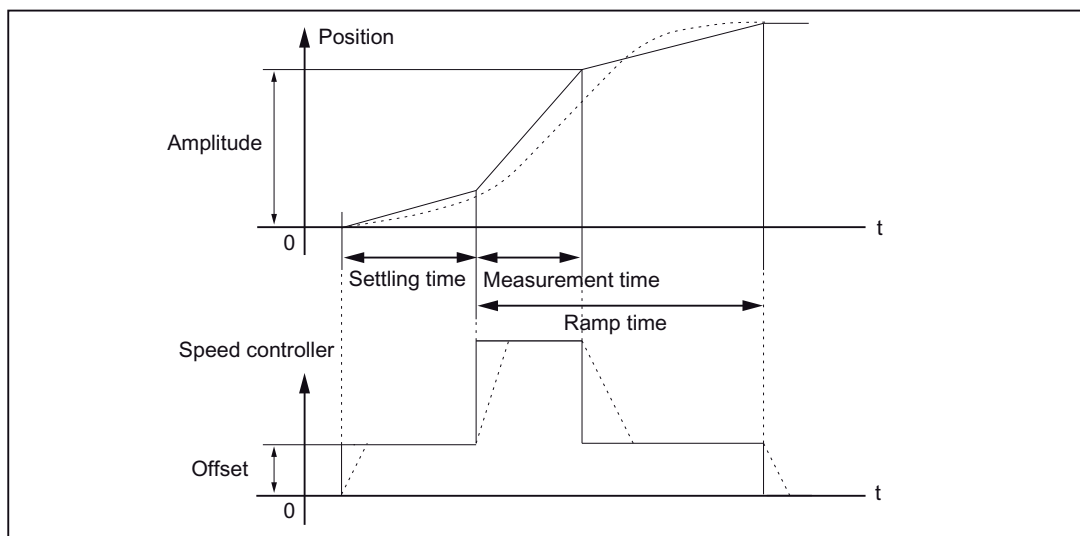
Figure 8-8   Signal chart for position setpoint/ramp measuring function

At maximum axis velocity, there is a (virtual) step change in the velocity (continuous line).

The curves represented by the dashed line correspond to a realistic, finite value. The offset component is excluded from the display graphic in order to emphasize the transient processes.

Measurement: Setpoint step change

To avoid overloading the mechanical system of the machine, the step height is limited to the value specified in the machine data during the "Setpoint step change" measurement:

- MD32000 $MA_MAX_AX_VELO (maximum axis velocity)

This may result in failure to achieve the desired step height.

Measurement: Setpoint ramp

With measurement "Setpoint ramp", the following machine data influence the measurement result:

- MD32000 $MA_MAX_AX_VELO (maximum axis velocity)

  The maximum axis velocity limits the ramp gradient (velocity limitation). The drive does not reach the programmed end position (amplitude).

- MD32300 $MA_MAX_AX_ACCEL (maximum axis acceleration)

  The maximum axis acceleration limits the velocity change (acceleration limitation). This leads to "rounding" on the transitions at the beginning and end of the ramp.

CAUTION
In normal cases the machine data corresponds exactly with the load capacity of the machine kinematics and should not be changed (increased) as part of the measurements: • MD32000 $MA_MAX_AX_VELO (maximum axis velocity) • MD32300 $MA_MAX_AX_ACCEL (maximum axis acceleration)

8.3 Circularity test measurement

Functionality

The circularity test serves to set and assess the dynamic response for interpolating axes and to analyze the contour accuracy on the quadrant transitions (circular contours) achieved by means of friction compensation (conventional quadrant error compensation).

Operating path

Operating path to circularity test: Operating area switchover > "Commissioning" > "Optimization/Test" > "Circularity test"

Measuring parameters

The parameters are entered in the "Measurement" menu.

- Axis names and axis numbers

- Circle that is to be traversed and the actual position values recorded

  The parameter settings in the input fields "Radius" and "Feed" must correspond to the values from the part program that controls the circular motion of the axes, taking account of the feed override switch setting.

- The "Measuring time" display field shows the measuring time calculated from the "Radius" and "Feed" values for recording the actual position values during the circular movement.

  If only parts of the circle can be represented (i.e. measuring time too short) the measuring time can be increased in the menu by reducing the feed value. This also applies if the circularity test is started from the stationary condition.

Display mode

The following parameter assignments for programming the mode of representation of measurement results can also be made:

- Display based on mean radius

- Display based on programmed radius

- Scaling of the diagram axes

If the calculated measuring time exceeds the time range that can be displayed from the trace buffers (maximum measuring time = position-control cycle frequency * 2048), a coarser sampling rate is used for recording (n * position-control cycle frequency), so that a complete circle can be displayed.
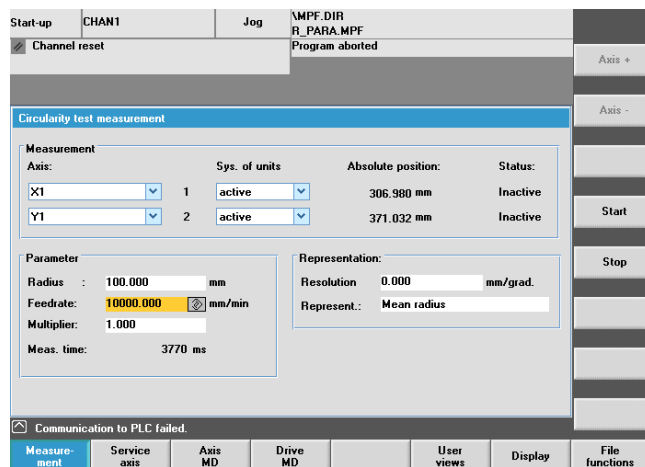
Figure 8-9   Circularity test measurement parameters

The two drives selected for measurement must describe a circular interpolation (G2/G3) with the parameters shown in the example via a part program:

Radius=100 mm, F=10000 mm/min

Measurement

The measurement sequence is divided into the following steps:

1. Setting the parameters, softkey "Measurement" (see above figure).

2. Start measurement with "Start" softkey.

   The selected axes run in the part program.

3. Displaying the measurement results, softkey "Display".

   A switchover is made to the graphic illustration of the recorded circular diagram (see following figure).

Note

If required, a QEC / backlash compensation can be performed via MD32200 $MA POSCTRL_GAIN for the K_V factor optimization.
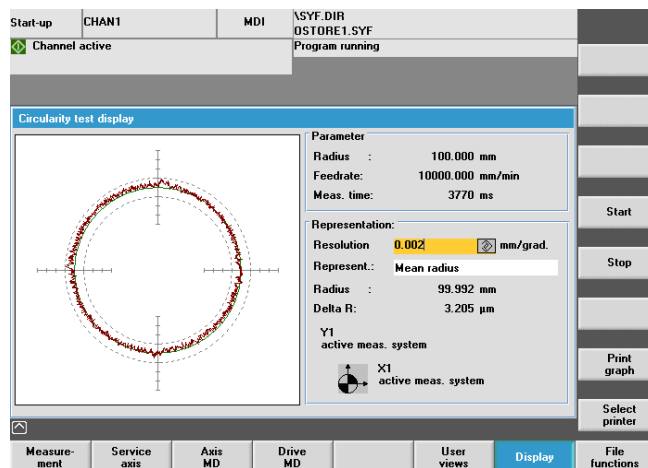
Figure 8-10   Circularity test measurement

8.4 Trace

8.4.1 Trace overview

Introduction

A trace shows signals over a time interval (signal charts)

The following functions are available:

- Servo trace

  Servo trace offers functions for recording and graphically illustrating the temporal characteristics of values for servo signals, e.g. actual position value, following error etc.

- Drive trace

  Drive trace offers functions for recording and graphically illustrating the temporal characteristics of values for signals from the drive system, e.g. actual speed value, actual current value etc.

  It must be possible for the signals to be recorded to be interconnected via a BICO source.

8.4.2 Servo trace

Basic servo trace display

The basic display of the servo trace function is reached via the operating area "Commissioning" > "Optimization/Test" > "Trace" > "Servo trace".
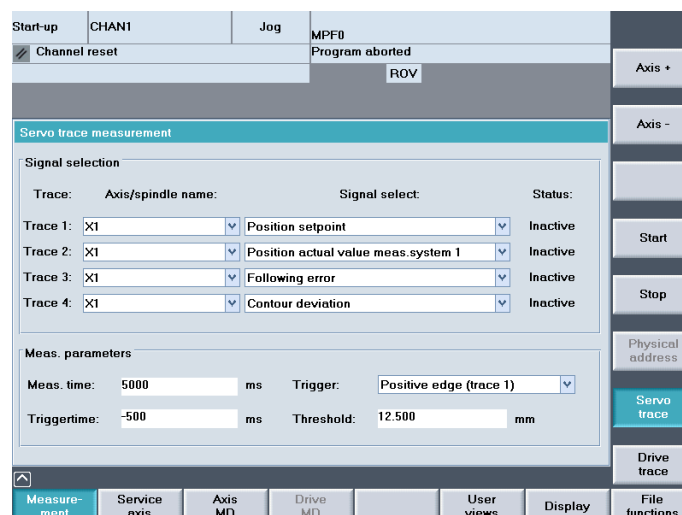
Figure 8-11   "Servo trace measurement" basic display

Parameterization in the basic display

The following selection is made in the basic display for the servo trace measurement:

- Axis/spindle selection
- Measuring signal
- Measurement time
- Trigger time
- Trigger type
- Trigger threshold

Signal selection

"Axis/spindle name" input field

The cursor must be positioned on the "Axis/spindle name" list box of the trace concerned. You can select it with the softkeys "Axis+" and "Axis-" or by accepting a value from the drop-down list box.

"Signal selection" input field

The cursor must be positioned on the "Signal selection" list box of the trace concerned. The selection is made through acceptance from the drop-down list box.

The available selection options depend on the existing configuration and activated functions.

Measuring parameters

"Measuring duration" input field

The measuring time is written directly into the "Measuring duration" input field.

"Trigger time" input field

Direct entry of pre-triggering or post-triggering. With negative input values (leading sign minus -) recording begins at the set time before the trigger event.

With positive input values (without sign) recording starts the time set after the triggering event.

Condition: Trigger time + measuring duration ≥ 0.

"Trigger" input field

The trigger type is displayed in the "Trigger" drop-down list box. The trigger always refers to Trace 1. When the trigger condition is satisfied, Traces 2 to 4 are started simultaneously.

Settable trigger conditions:

- "No trigger", i.e. measurement starts by pressing softkey "Start" (all traces are started time-synchronized)

- "Positive edge"

- "Negative edge"

- "Trigger event from the part program"

  The trace can be started via an NC part program in conjunction with the system variable $AA_SCTRACE [axis identifier].

Reference

SINUMERIK 840D sl / 840Di sl System Variable Manual

"Threshold" input field

Direct input of the trigger threshold.

The threshold is only effective with trigger types "Positive edge" and "Negative edge".

The unit refers to the selected signal.

Softkeys "Axis+" and "Axis-"

Selection of the axis/spindle when the cursor is positioned on the appropriate "Axis/spindle name" list field.

You can also select the axis/spindle directly in the list box from the drop-down list using the cursor.

Softkeys "Start" and "Stop"

Trace function recording is started with the softkey "Start".

With the "Stop" softkey or RESET, you can cancel a running measurement.

8.4.3 Drive trace

Basic drive trace display

The basic display of the "Drive trace" function is reached from the "Commissioning" > "Optimization/Test" > "Trace" > "Servo trace" operating area.
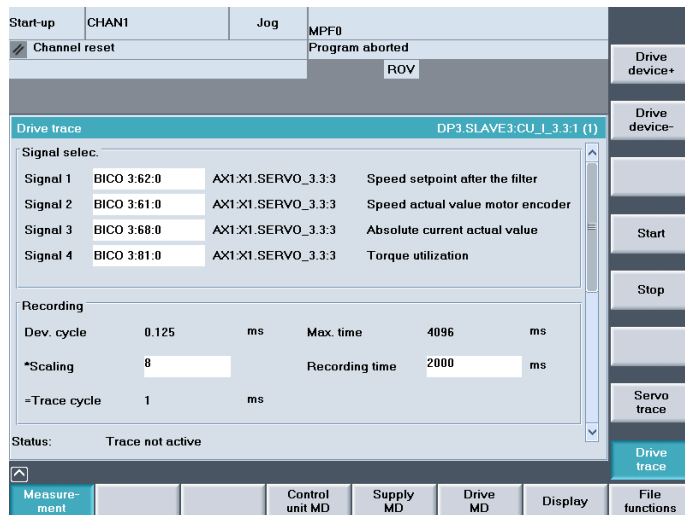
Figure 8-12   Basic "drive trace" display

When you are in the field for signal selection for a signal, you can press the <SELECT> button to move to a window in which you can determine the signal for interconnecting.
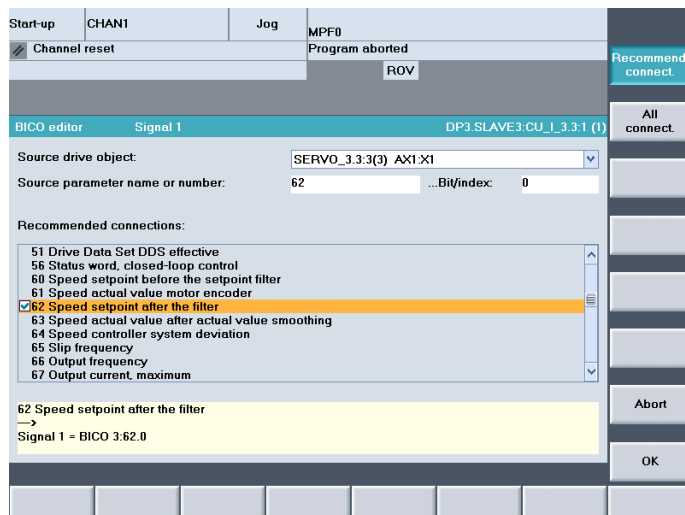
Figure 8-13   Drive trace interconnections

If you scroll through the basic display, the following parameters are displayed:
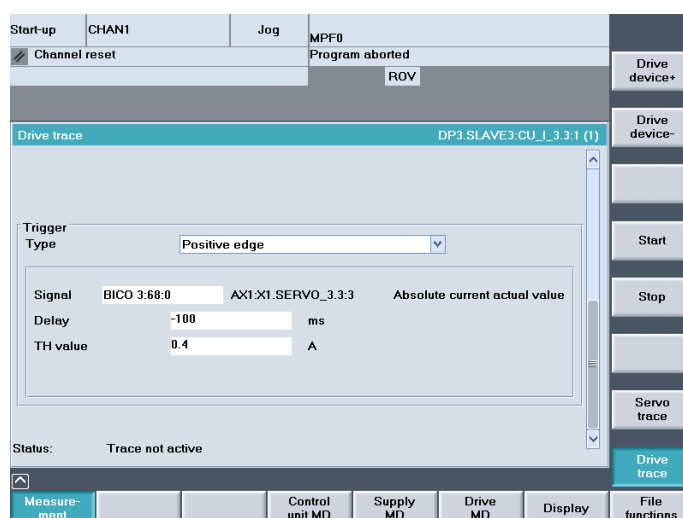
Figure 8-14   Basic drive trace display, "Trigger" parameter

"Trigger type" entry field

The trigger type is displayed in the "Trigger" drop-down list.

Settable trigger conditions:

- "Immediate recording", i.e. no trigger Start the measurement by pressing the "Start" softkey.
- "Positive edge"
- "Negative edge"
- "Entry in the hysteresis band"
- "Exiting the hysteresis band"
- "Trigger on bit mask"

"Trigger on positive edge / negative edge" trigger function

The threshold value for bit-coded values in the form of a decimal value entered in relation to the selected parameter, i.e. it is the weighting value of the individual bits in the sum of all parameters. The trigger function enables the triggering to larger/smaller values depending on the positive/negative edge, i.e. it cannot be explicitly triggered on a bit.

Example:

Signal = CU_I_3_3_1:r722

Threshold value = 3

This means, when the "Positive edge" trigger is used, the trigger is active for the value 3 or higher; the reverse is true when the "Negative edge" trigger is used. To activate the value 3 and the trigger, bits 0,1 (decimal value 3) or bit 2 (decimal value 4) is required.

"Trigger on bit mask" trigger function

The trigger is set to bit 3 in parameter r0722. If the entered values of the bit mask and the trigger condition are same, the trigger starts for the change from low to high, i.e. in this case, bit 3 of the parameter r0722.

Example:

Signal = CU_I_3_3_1:r722

Bit mask = 8

Trigger condition = 8

If the values are different, the trigger is started for a change from high to low of the bits that are defined in the bit mask until the value of the trigger condition is reached. In this example, the trigger starts when bit 1 changes from high to low and bit 0 is still high.

Example:

Signal = CU_I_3_3_1:r722

Bit mask = 3

Trigger condition = 1

Note

When the "Trigger on bit mask" function is used, only bit-coded values can be used (parameters with physical quantity are excluded).

Parameterization in the basic display

The following selection is made in the basic display for the drive trace measurement:

- Drive unit selection
- Signal selection
- Record
- Trigger

"Trigger time"/"Delay" entry field

Direct entry of pre-triggering or post-triggering. With negative input values (leading sign minus -) recording begins at the set time before the trigger event.

With positive input values (without sign) recording starts at the time set after the triggering event.

Secondary condition: Trigger time + measuring time ≥ 0.

Signal selection

Signals to be recorded, e.g. actual speed value, actual current value, etc.

It must be possible to interconnect the signals to be recorded, i.e. a BICO source.

Trigger signal

The trigger (signal) can be used to specify the event with which the recording of values is to start, e.g. the actual speed value is not to be recorded straightaway when the drive trace starts but only when the actual current value is > 10 A (here the actual current value trigger is > 10 A).

Literature

SINAMICS S120 Parameter Manual

"Drive unit+" and "Drive unit-" softkeys

Selection of the drive unit in which recording is to take place.

"Start" and "Stop" softkeys

Trace function recording is started with the "Start" softkey.

Figure 8-15   Drive trace recording

You can cancel an active recording with the "Stop" softkey or RESET.

8.5 Further optimization options

Introduction

You can adapt the following parameters in the operating area "Commissioning" > "Machine data" > "Drive MD" for the drive optimization.

Speed adjustment

- Spindle drive:

  p500 = 102, speed setpoint in p322 corresponds to setpoint 4000 0000hex

- Feed drive:

  p500 = 101, speed setpoint in p311 corresponds to setpoint 4000 0000hex

The speed setpoint can be diagnosed in the corresponding drive in r2050[1+2] or r2060[1].

Brake behavior OFF3

Depending on the requirements, the brake behavior for each drive can be adjusted to the signal 2.OFF3. Default setting: p1135 = 0, brake with maximum current.

Parameters p1135, p1136, p1137 can be used to set a flatter braking ramp for drive-specific parameterization.

Maximum braking ramp setting: 600 secs

8.6 Drive optimization using SINUMERIK Operate

8.6.1 Automatic servo optimization

Introduction

With the SINUMERIK Operate sl user interface under the "Commissioning" > "Automat. Servo Opt." menu, you have the following options for automatic axis optimization:

● Selection of individual axis for optimization

● Selection of one strategy from many options

● Reconfiguration of measurement conditions

● Chart display and activities protocol for optimization process

● Display of current measurement and at the same time the average of previous measurements

● Checking and processing of optimization results for speed and position controller

● Accept or reject results
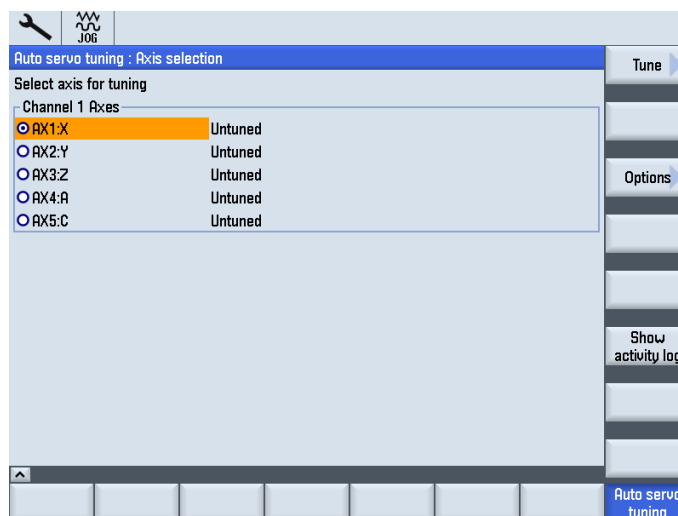
Figure 8-16   Basic display for automatic optimization of SERVO axes

The "Optimization" function can be used for all individual axes (SERVO and direct drives).

Note

The master slave axes for automatic optimization are not supported by SINUMERIK Operate Version 2.6 SP1.

Master slave axes can be optimized as individual axes if they are not coupled.

8.6.2 Overview of navigation

Overview:

When optimizing an axis, you navigate via various dialogs. The following figure shows the navigation for optimizing an axis:
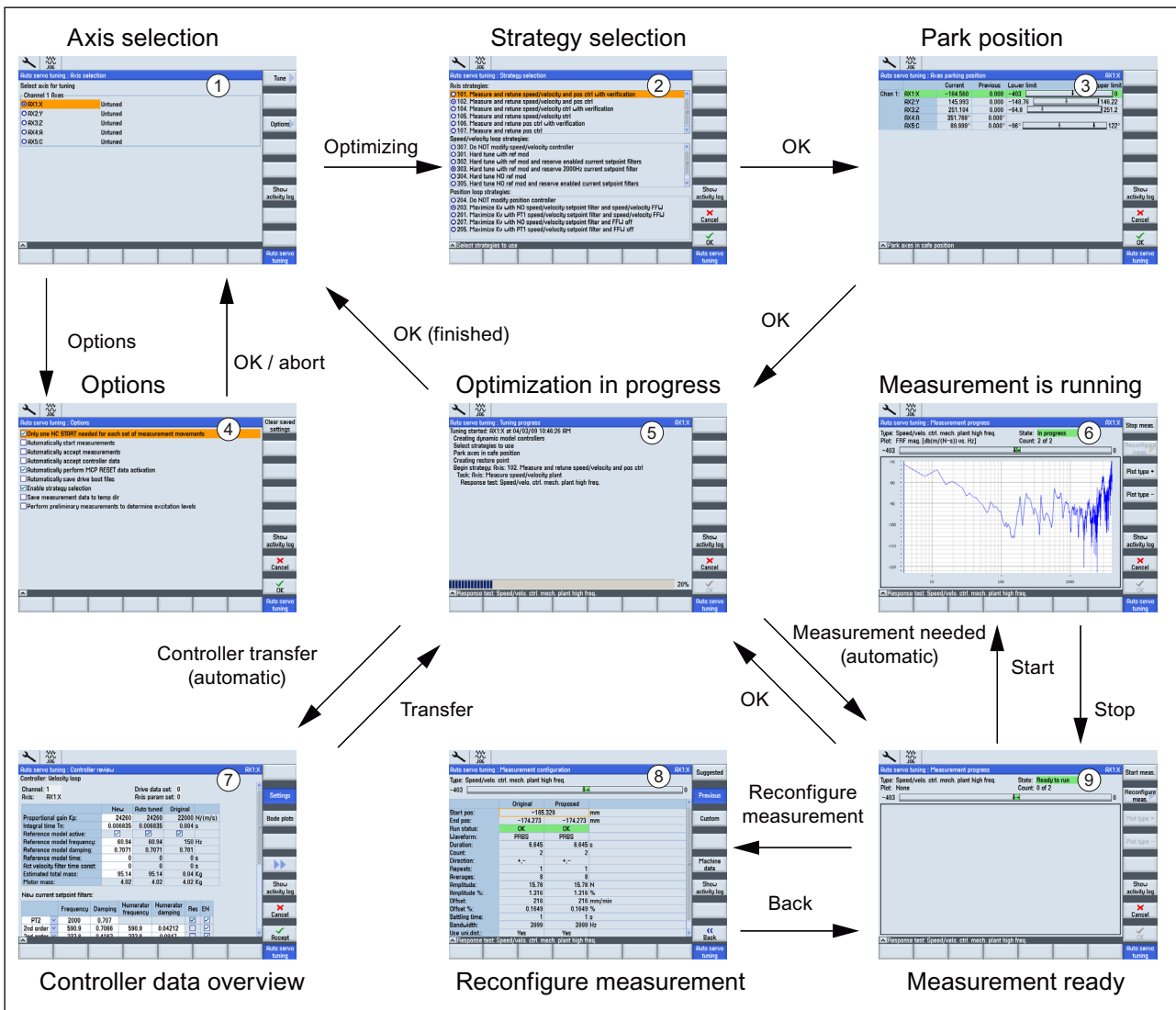
Figure 8-17   Navigation for automatic optimization of an individual axis

---

Note

The following section "General operating sequences for automatic servo optimization" uses the numbers shown in the above diagram (e.g. dialog screen "Strategy selection" ②).

8.6.3 Setting options

Introduction

The general behavior of the automatic servo optimization can be controlled in the main screen using the "Options" softkey.
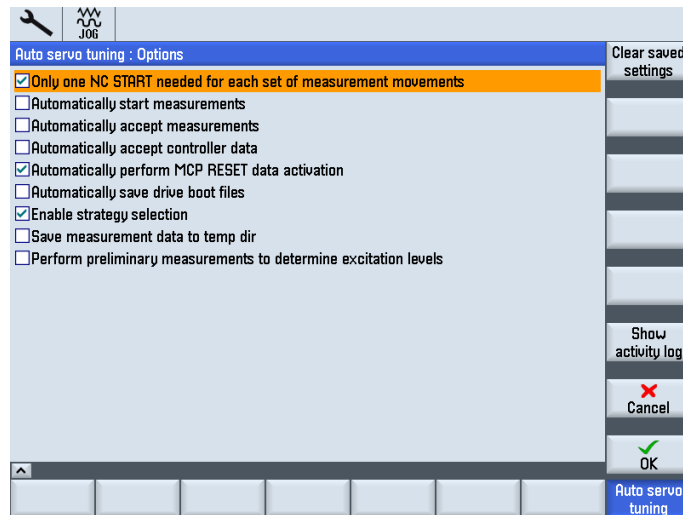
Figure 8-18   Options

Options

- Perform all measurements of each measurement series with the first NC start:

  All repeats (e.g. motion in the positive and negative axis direction) within a measurement series are automatically started.

- Start measurements automatically:

  The start screen of each measurement series is skipped and the measurement process is directly started with the default measurement parameters.

- Automatic confirmation of the measurement:

  The final screen of each measurement series (is used to evaluate the measurement results -> if required, adapt measurement parameters and restart measurement series) is skipped. The algorithm changes directly to the next optimization step.

- Automatic acknowledgement of the controller data:

  The "controller data overview" display is skipped. The controller data determined by the algorithm are directly activated.

- Automatic data activation using the operator panel reset:

  The "Operator panel reset" signal is generated by the algorithm. If this option is deactivated, "Operator panel reset" is requested using a dialog screen.

- Automatically backup drive boot files (ACX format):

  After completing the optimization of a machine axis, the drive data are automatically saved on the CompactFlash Card in the ACX format. If this option is deactivated, the query is realized via a dialog screen.

- Permit strategy selection:

  The dialog screen to select the optimization strategies for the speed and position controller is displayed.

- Backup measurement data in temporary directory:

  The recorded measurement data are saved in a temporary directory.

- Perform preliminary measurement to determine the excitation:

  Activate a preceding (additional) measurement for each measurement series to more precisely determine the measurement parameters. This is especially recommended when measuring directly-driven machine axes for the first time.

8.6.4 General operating sequences for automatic servo optimization

General operating sequences

1. In the "Commissioning" operating area, press the "Automat. servo opt." softkey.

The "Axis selection" dialog screen appears ①.
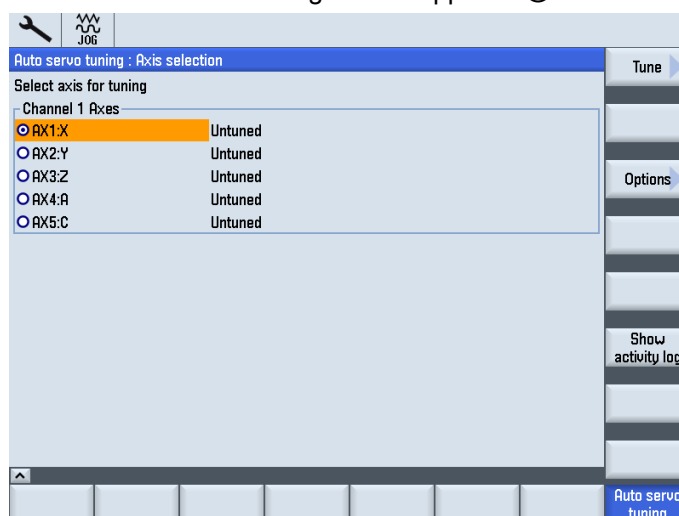
Figure 8-19   Axis selection
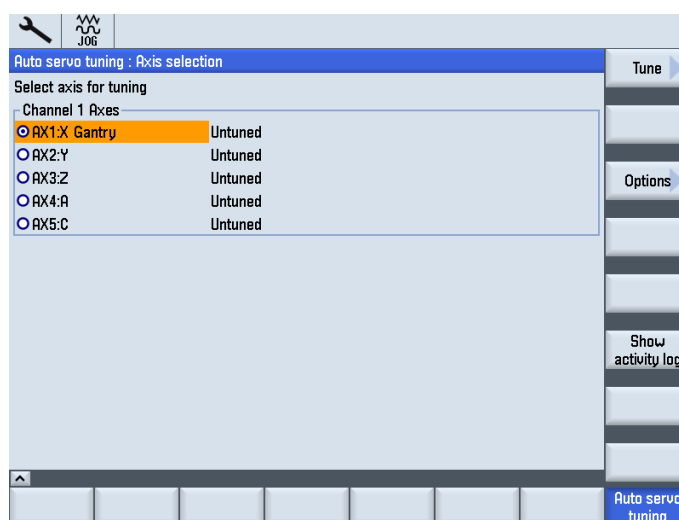
Figure 8-20   Axis selection, gantry axis grouping

2. Use the cursor keys to select an axis for optimization.

Note

For "Gantry axis groups", only the leading axis is displayed with the "Gantry" note. Synchronous axes are hidden, but when selecting the leading axis, are measured and optimized.

---

3. In the "Axis selection" dialog ①, press the "Optimize" softkey.

4. In the "Strategy selection" dialog ②, select the strategy for optimization.
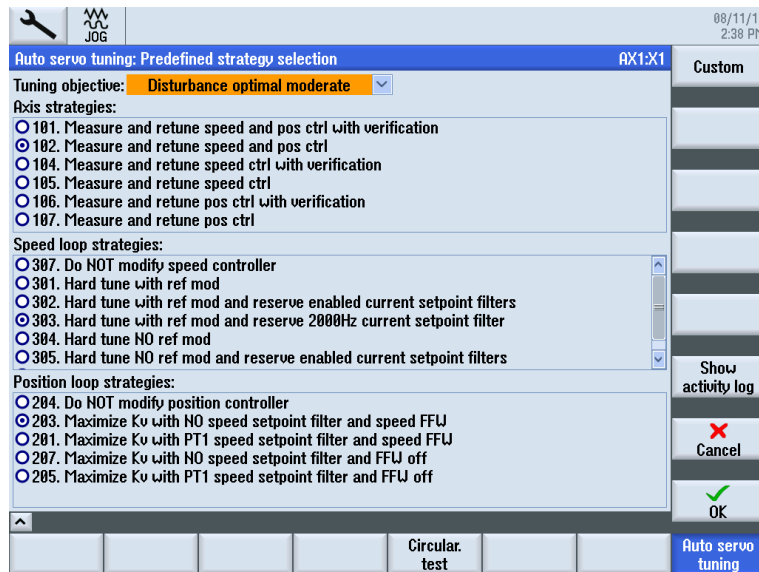
Figure 8-21   Strategy selection

For example in a typical strategy, the mechanical controlled system of the speed control is measured and gains and filters defined for optimized dynamic behavior.

Note

A user-specific strategy (Page 274) can be set using the vertical "User-defined" softkey.

5. Press "OK".

6. In the "Axis park position" dialog ③, move the axes on the machine into a safe position for optimization.
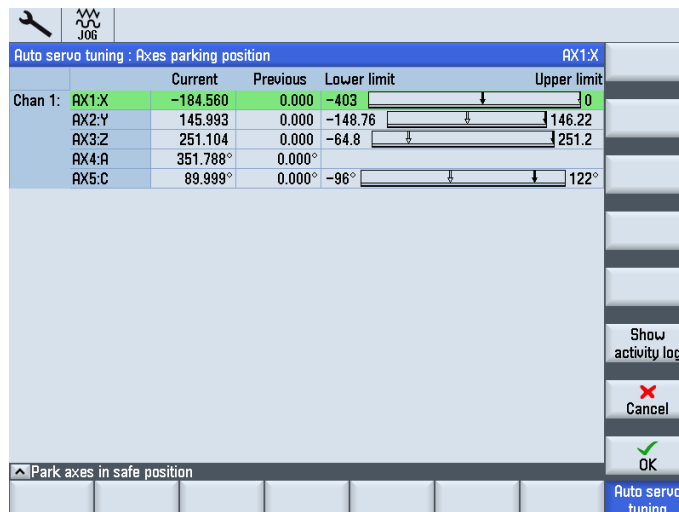
Figure 8-22   Axis park position

> ⚠ **DANGER**
>
> Automatic servo optimization based on analysis of measurements. The measurements require the axis to move. Ensure that all axes are in a safe position and no collisions will occur during the traversing motion that is required.

7. Press "OK".

   Optimization is started ⑤.
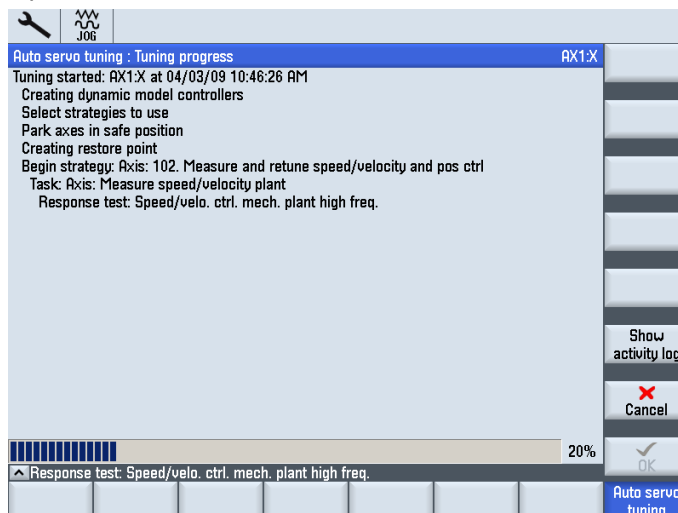
Figure 8-23   Optimization in progress

If measurement can only be continued after the necessary inputs have been made, then this is signaled using input prompts (screen forms).

This is required because you need to initiate certain machine processes (e.g. measurements which require an <NC START>).

You can abort the coordination process at any stage of automatic servo optimization.

Once optimization has been aborted, all original machine data which was present in the controller and in the drives before optimization was started is restored.

Note

After the measurement has been completed, you can perform the measurements again. In this case, the quality of the measurement data can be influenced by changing the excitation parameters using the "Measurement configuration" dialog.
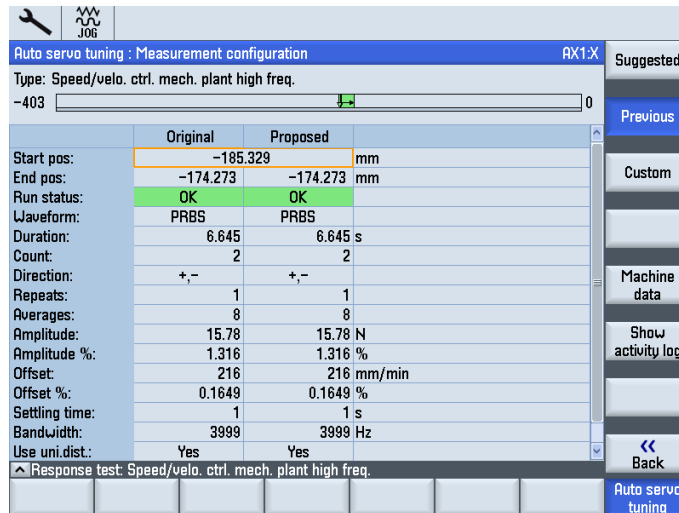
Figure 8-24   Measurement configuration

8. If the optimization process has completed some optimizations for a control loop, a "Controller data overview" dialog ⑦ appears.
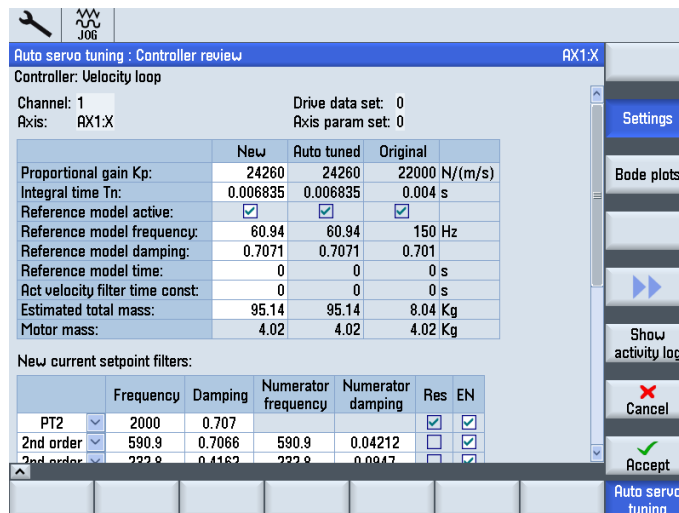
Figure 8-25   Controller data overview
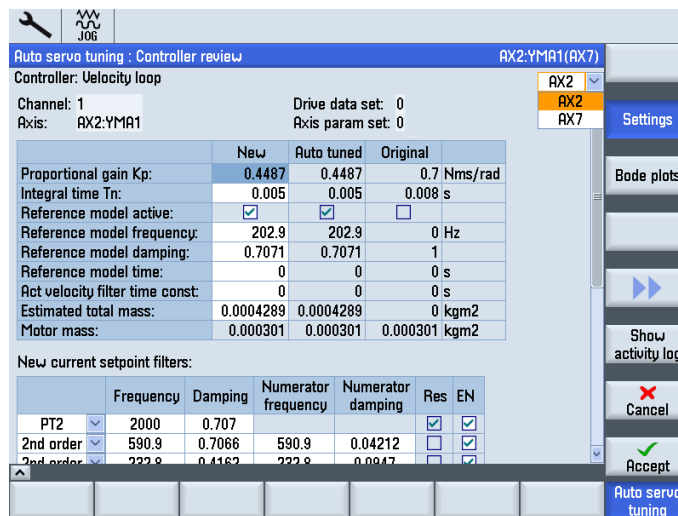
Figure 8-26   Controller data, overview gantry axis group

You can modify and check the results and either accept or reject the proposed control parameters.

Note

Alternatively the optimized values can also be displayed graphically as a Bode diagram using the "Bode diagram" softkey function.

9. Select "Transfer" to transfer the calculated values.

10. If you accept the settings for closed-loop speed control by pressing "Transfer", the drive data is updated, and the strategy then runs the measurements for closed-loop position control, "Measurement is running" dialog ⑥.
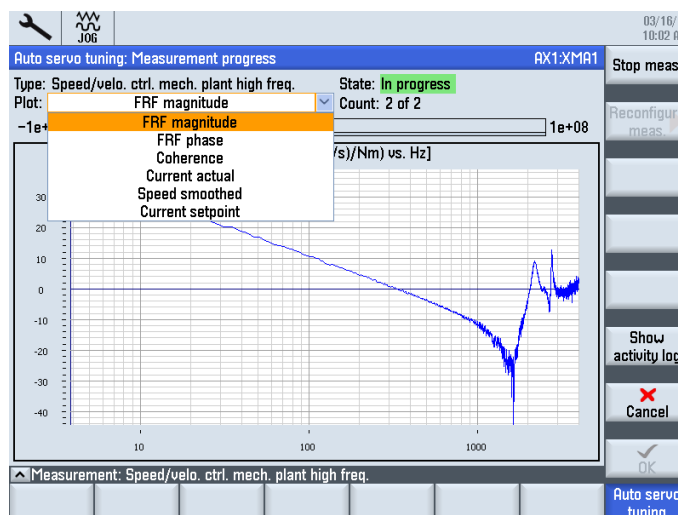
Figure 8-27   Measurement is running
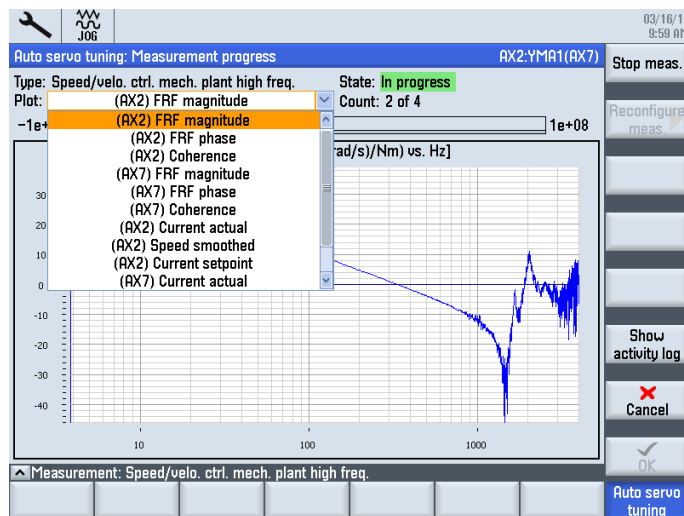
Figure 8-28   Measurement running, gantry axis group

11.Once the optimum values for closed-loop position control have been selected, the data is transferred to the CNC and drives, and the strategy runs the next stage which may be, e.g. to measure for verification.

8.6.5   Setting the user-specific strategy

Introduction

You can go to the area "Design user-specific strategy" in dialog ② "Strategy selection" using the vertical "User defined" softkey.

Various settings can be selected or deselected in order to control the behavior of the automatic servo optimization.

Setting areas

For the user-specific strategy, settings of the general axis strategy are handled separately from the settings specifically for the speed and position controller.

- "Axis" setting range

  Activating/deactivating individual measurements and optimization steps for the selected machine axis - including entering the measurement parameters.
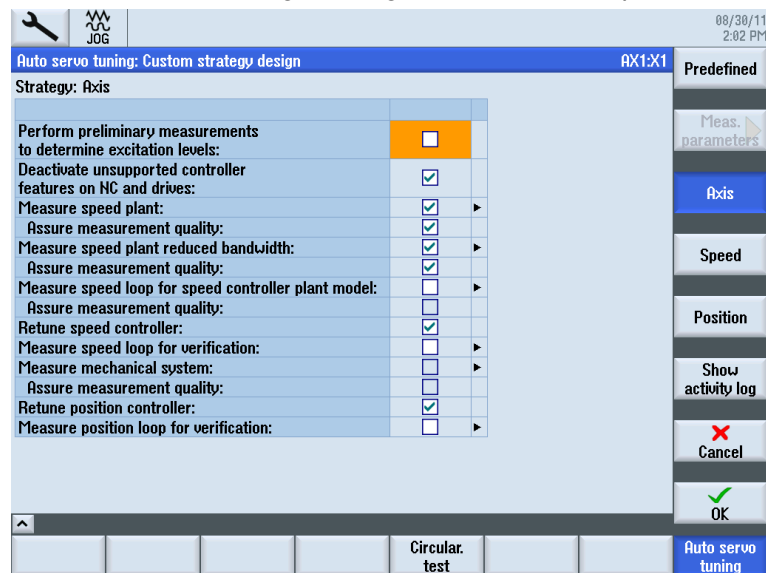
Figure 8-29   Setting the user-specific strategy

- "Speed" setting range

  Settings exclusively for optimizing the speed and velocity controller of the selected machine axis.

- "Position" setting range

  Settings exclusively to optimize the position controller of the selected machine axis.

Manual filters

The commissioning engineer can use manual filtering to set and reserve one or more of the filters supported by the drive.

"Reserved" in this context means that the "Automatic servo optimization" function treats this filter as being reserved and so is not available for automatically adjustable filters. Although the "Automatic servo optimization" function does not change the manual setting of this filter, it takes it into account for its tuning algorithm.

The checkboxes have the following significance:

Reserved	Activated	Meaning and effect
☐	☐	This current setpoint filter can be used and changed by the "Automatic servo optimization" function.
☐	✓	
✓	☐	This filter is not activated in the controller and so does not act in the control:
✓	✓	This filter is activated in the controller and so acts in the control:

8.6.6 Additional optimization stages - commissioning interpolation axes

Additional optimization stages

Additional optimization stages should be undertaken for axes which make up a collection of interpolations. These optimization steps should be undertaken manually by the commissioning engineer using the options provided in HMI Advanced or the start-up (commissioning) tool:

e.g.:

● Circularity test measurement (Page 254)

● Adaptation of servo gains (e.g. smallest servo gain in all interpolating axes without DSC see Position control loop measurement (Page 248))

● When using speed feed forward control, transfer equivalent time constants of the slowest axis (highest value) into all interpolating axes (see Speed control loop measurement (Page 245)).

Commissioning of PLC-controlled drives

9

9.1 Introduction to PLC drives

Permissible version combinations

For PLC-controlled drives connected via PROFIBUS DP, the following applies:

- Supply and disposal directly from the PLC user program.

- Integrated in the part program operations using an H command.

Note

In certain version combinations, the integration functions are checked for compatibility.

SINUMERIK CNC V4.5 software supports the following versions:
- CU310-2 DP with SINAMICS firmware version 4.5
- CU320-2 DP with SINAMICS firmware version 4.5
- CU310 DP with SINAMICS firmware version 2.6 SP2
- CU320 DP with SINAMICS firmware version 2.6 SP2

All other SINAMICS drives can be connected to the PLC as standard slaves in accordance with the PROFIdrive profile and are not included in the quantity structure, according to the following "Quantity structure" table.

SINAMICS drives with PROFINET connection are supported from CNC software V4.5 SP1.

Operator control options for PLC drives

PLC drives, which are connected to the external PROFIBUS DP/MPI X136, cannot be commissioned with SINUMERIK Operate.

PLC drives of the SINAMICS S120 CU320-2 DP type communicate on the external PROFIBUS DP-X126 (as PN-IO 0x80E5). The PLC drives are supported with the following operating options:

- Automatic device configuration (Page 79)

- SINUMERIK operating software:

  – Guided commissioning (Page 76) with the drive wizards for SERVO DOs.

    Note

    Other guided commissioning wizards (e.g. vector control) are not provided by SINUMERIK Operate. To do this, the STARTER commissioning software appropriate for the version can be used.

  – Manual commissioning (Page 102) performed by experienced commissioning engineers.

- All parameters of the drive DOs are shown in the operating area "Commissioning" → "Machine data", e.g.

  – "Control Unit MD" for the DO1 drive unit

  – "Infeed MD" for DriveCLiQ Line Module DO2

  – "Drive MD" for drive control DO

    Parameters of the integrated drives with SINUMERIK view as well as external drives with SINAMICS view are displayed.

- Series commissioning support, where the parameters of these external drives are also handled (backing-up/loading) also in the series commissioning drive archive.

- Topology views including a list of all of the drive units of this type which have been found.

- Diagnostics with alarms from these PLC drives whose time stamp is synchronized with the system.

  In this case, it is necessary that the following general machine data is pre-assigned:

  – MD13120[…] $MN_CONTROL_UNIT_LOGIC_ADDRESS

    I/O address on a DO1 telegram, type SINUMERIK telegram 390

  – MD13150 $MN_SINAMICS_ALARM_MASK

    Set bit 2 -> faults of external drives are displayed

    Set bit 10 -> alarms of external drives are displayed

Quantity structure

Scaling	SINUMERIK 840D sl NCU type:		
	710.3 PN	720.3 PN	730.3 PN
Drives (drive control DOs[1]) in total [3]:	15	40	50
• of which, assigned to the NC, maximum[3]:	8	31	31
• resulting from this, those not assigned to the NC, minimum:	7	9	19
• not assigned to the NC, maximum:	15	40	50
Drives units (DO1) with drive control objects, in total[3]:	9	13	15
• of which, at the virtual, integrated PROFIBUS, maximum[3]:	4	6	6
• of which, at the virtual, integrated PROFIBUS, minimum:	1	1	1
• of which at the DP interface[2] minimum:	5	7	9
• of which at the DP interface[2] maximum:	8	12	14

[1] Drive control DO

[2]   X126 → PROFIBUS DP of the integrated PLC
  X136 → PROFIBUS DP/MPI of the integrated PLC

[3] The sum is monitored using Alarm 380077

Supplementary conditions

The additional operator control options for the PLC drives produces the following general conditions:

- Because the PLC drives create an additional communication load, the number of these drive objects (DO) limits depending on the NCU ⇒ note the quantity structure:

  Alarm 380077 "PROFIBUS/PROFINET: Too many DOs: currently %2, maximum %3 in DO group %1"

- Depending on the versions used, the texts displayed for the SINAMICS parameters and alarms can be incomplete.

- The extended operator control options are guaranteed in conjunction with the drive unit, infeed and the axis drive SERVO-DO. This is the reason that a device-granular view is considered. All SERVO-DOs of a drive unit can either be assigned to the NC or PLC.

- As a maximum, all NC axis assignments can be made on axis drives at the external PROFIBUS DP (X126).

- If the drives are assigned to the NC and distributed across several buses, such as DP and DP integrated, then it must be ensured that each equidistant bus has the same clock cycle settings.

Note

For SINUMERIK 840D sl, note the following:

- A DO1 drive unit is required for the internal virtual PROFIBUS DP3 for access to the onboard I/O including probe.
- ADI4 can only be assigned to NC axes. The number of ADI4 does not reduce the maximum number of managed DO1 drive units.
- A 611U connected to SINUMERIK solution line is not supported; it has not been checked as far as its reactions are concerned - and has therefore not been released.

Note

PROFIBUS DP

For all drive units connected to an external PROFIBUS DP (X126) , note the following:

- In the configuration, the user must take into account the supply as well as the switch-on and switch-off behavior in interaction with the other axes and their supply.
- For the terminal wiring, observe the "Machine Configuration Guidelines" system manual. In the simplest case, the feedback of the Line Module to the PLC drives must be wired (see also: Terminal assignment (Page 71)).

9.2 Example: Configuration of the drive components

Overview

The SINAMICS drive system for PLC-drives communicates with the PLC via the PROFIBUS DP X126 interface. The commissioning described in this chapter orientates itself on the following example configuration of the SINAMICS drive line-up:
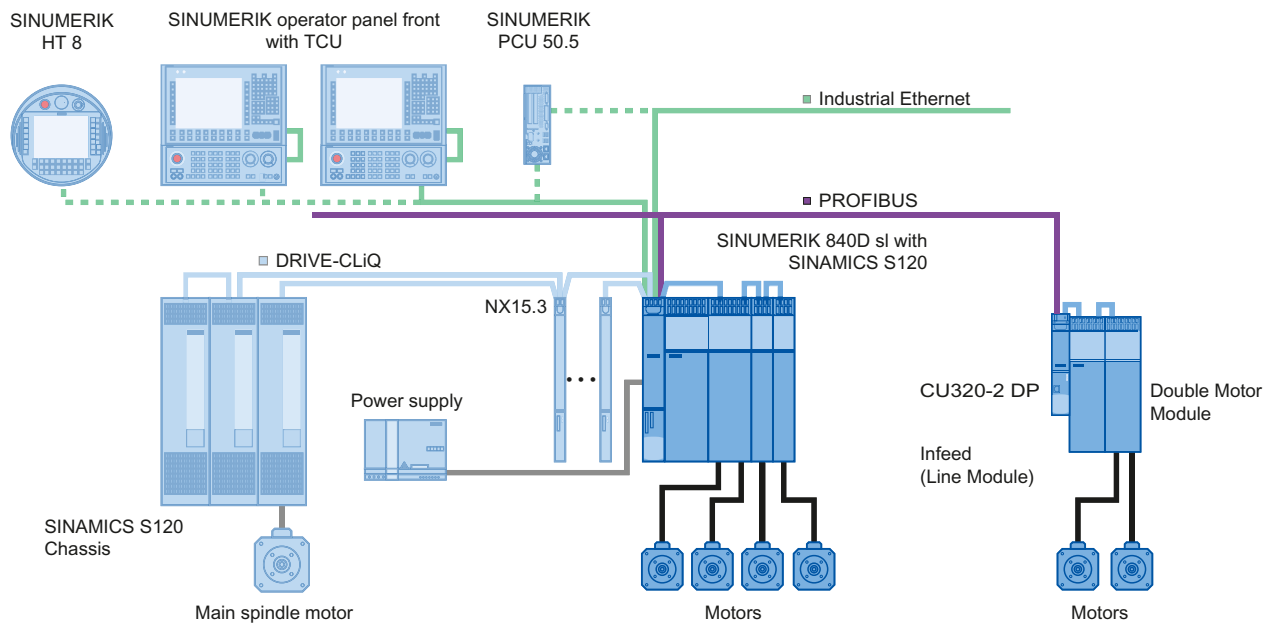
Figure 9-1   Configuration

Already commissioned are:

● NCU 720.3 PN and NX15.3 with additional components.

In this section, the following will be put into operation:

● CU320-2 DP with an infeed (Line Module) and a Double Motor Module.

9.3 Commissioning PLC drives

9.3.1 Commissioning the PLC

Overview

The following steps are performed when commissioning PLC drives for the first time:

1. Commissioning the PLC

2. Generation of the PLC user program

3. Commissioning the PLC drives

4. Commissioning NCK ⇔ drive communication

Precondition

- You have connected the PG/PC to the PLC (see Connect PG/PC with the PLC (Page 35)).

- You have started the SIMATIC Manager and created a project (see SIMATIC S7 project overview (Page 37)).

- You have inserted a SIMATIC Station-300 in the project (see Inserting SINUMERIK NCU to the HW Config (Page 38)).

- You have started HW Config.

- On the integrated PROFIBUS you have configured an NCU 720.3 PN and NX15.3.

Communication interfaces

The PLC must be notified of the PROFIBUS communication interfaces of SINAMICS. You generate a SIMATIC S7 project using the SIMATIC Manager.

To do this, perform the following steps:

- Insert S120 CU320-2 DP in HW Config.

- Configure the properties of the PROFIBUS interface.

- Compile the configuration and then download it to the PLC.

See also: PLC commissioning (Page 35) for the integrated drive.

Note

The toolbox must have been installed. The GSD file for SINAMICS S120 from the SINUMERIK toolbox is required for configuration.

The following telegrams are primarily supported:
- SIEMENS telegram 136
- SIEMENS telegram 390

Inserting an S120 CU320-2 DP component

Procedure:

1. Navigate in the catalog to "PROFIBUS DP" → "SINAMICS" → "SINAMICS S120" → "S120 CU320-2 DP":
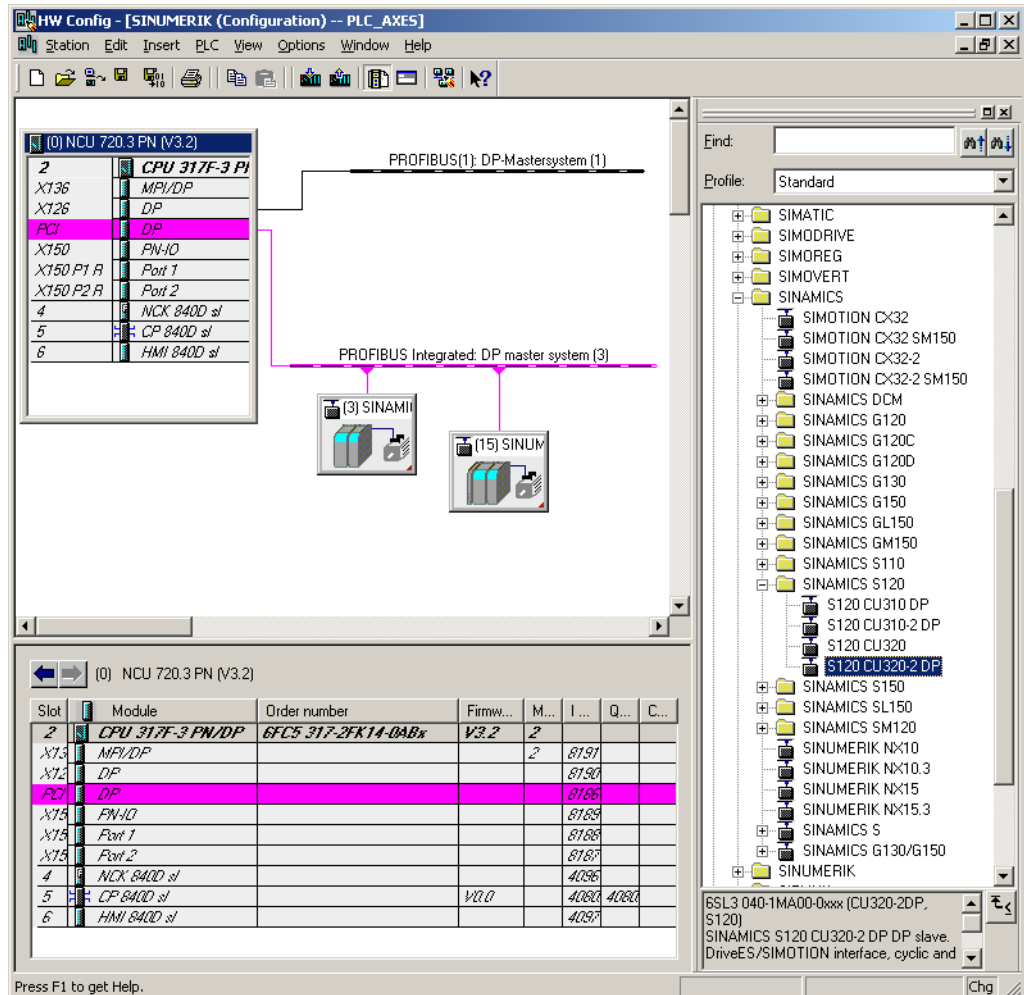
2. Keeping the left mouse key pressed, drag the "S120 CU320-2 DP" in the station window to PROFIBUS (1): DP master system.

3. After releasing the mouse key, configure the properties of the SINAMICS PROFIBUS interface:
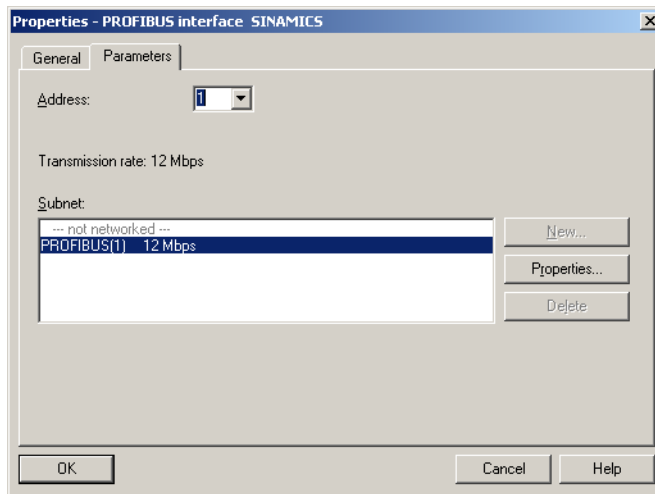
4. Confirm with "OK".
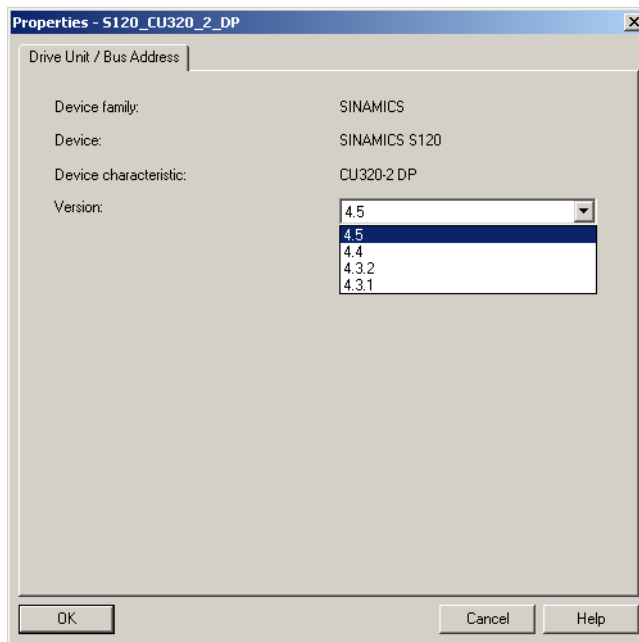
5. In the "Version" selection box, select the firmware version of the Control Unit.

Note

The firmware version must match the version of the CompactFlash card on the CU320-2 DP. Refer to the upgrade instructions for the versions that have been released for PLC drives.

---

6. Confirm with "OK".

7. In the Profibus DP master system (SINUMERIK NCU) under "Properties" → "Network settings" → "Options" and under the "Equidistance" tab activate the option "Activate equidistant bus cycle".
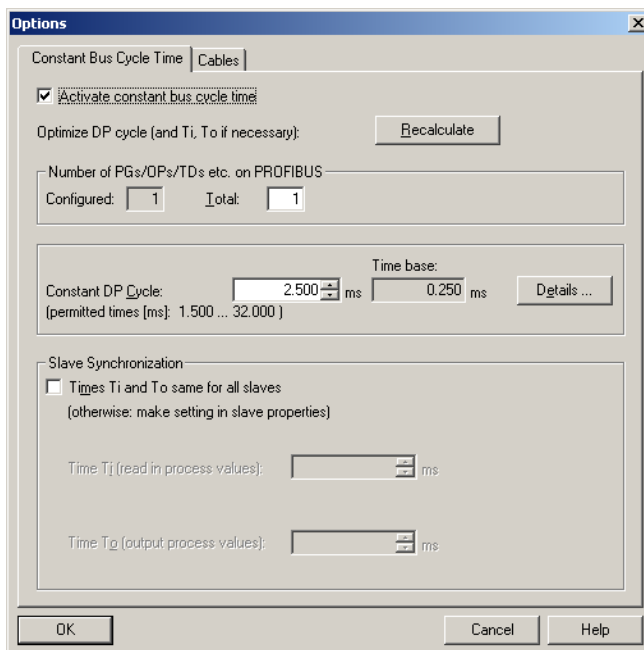
8. In the "DP Slave Properties" of the CU320-2 DP under the tab "Clock synchronization", activate the option "Synchronize drive to equidistant DP cycle".
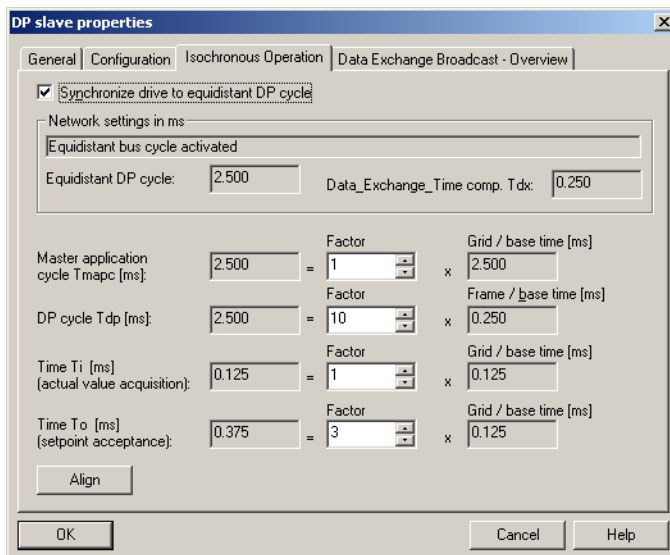
9. In the "DP Slave Properties" dialog box, select the "Configuration" tab.
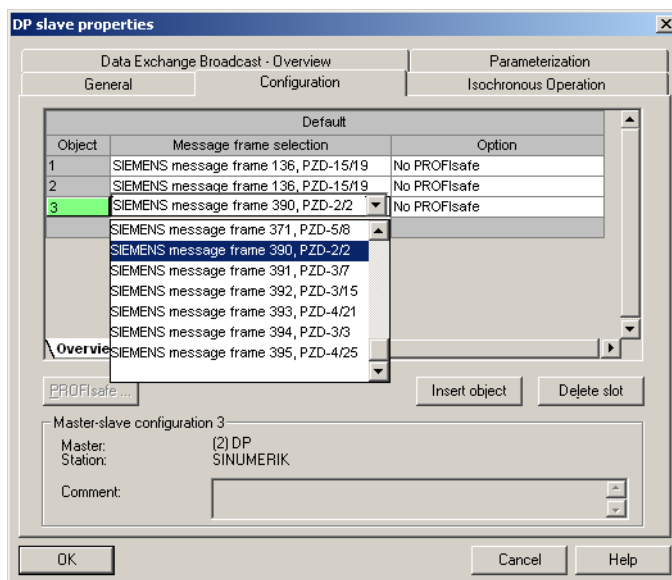
10. Select in the "Overview" the telegrams required for the individual objects (axes and CU320-2 DP):

    – "Siemens telegram 136, PZD-15/19" for example, for speed-controlled axes

    – "Siemens telegram 390, PZD-2/2" for CU320-2 DP

    Note

    SIEMENS telegram 390 is required for the time stamp of the PLC alarms.

    ---

11. Change under "Configuration" to the "Details" view in order to display the associated generated input and output addresses for the individual objects:
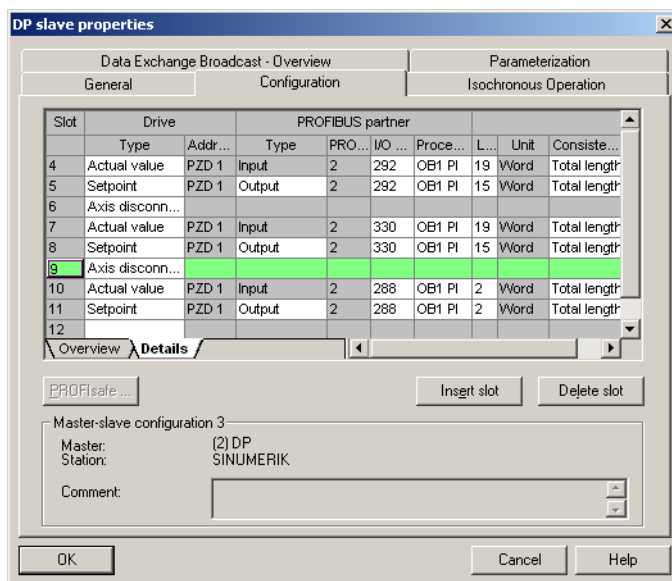
To support automatic device commissioning, the input and output addresses must be identical because the addresses in the PLC user program are required for FB283.

See also: Generate PLC user program (Page 288)

12.Confirm with "OK".
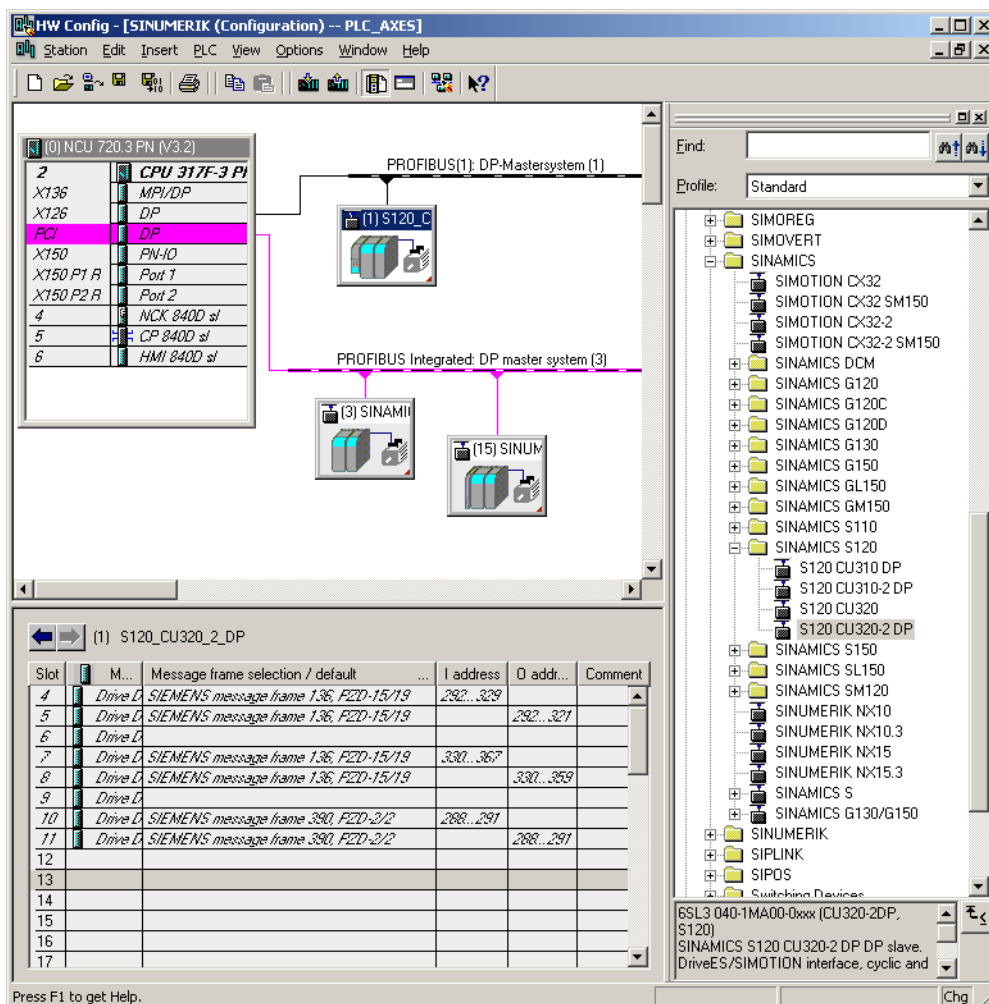
Saving/compiling/loading into the module

Procedure:

1. Select the "Station" → "Save and compile" menu.

2. Click the "Load in module" button to load the configuration to the PLC.

   See also: End the hardware configuration and load it to the PLC (Page 48).

   The next step is to create the PLC user program.

9.3.2 Generate PLC user program

Preconditions

This chapter describes the configuration of PLC drives that are not to be operated as NC axes. In the PLC user program the following expansions of the function blocks are required:

- You will need additional S7 function blocks from the SINAMICS toolbox ≥ V2.1.

  The SINAMICS toolbox is in the SINUMERIK toolbox in directory BSP_PROG. The path depends on the version, e.g. \8x0d\040504\BSP_PROG\SINAMICS_V21.zip

  This Zip file contains a manual in several languages.

- It is also available on the Internet at the following link:

  SINAMICS Toolbox V2.1
  (http://support.automation.siemens.com/WW/view/en/25166781)

Example with constant speed (fan, pump)

Procedure:

1. You have already created a project and find yourself on the main screen of the SIMATIC Manager.

2. Select the "File" → "Open" menu and then click the "User projects" tab.

3. Open the project example.

4. Copy the FB283, FC70, DB70 and DB283 blocks as well as all UDT300xx into your existing project.

5. As the DB70 could be used by another program, rename DB70 as DB111!

6. Create a new FC73. Do not use the FC73 from the SINAMICS toolbox.

   In our example, 4000_{hex} corresponds to the rated speed in drive parameter p2000.

7. Edit the OB1, FC70 and FC73 blocks in accordance with the following examples.

Example of OB1

```
...
...
CALL FC70
CALL FC73
...
...
```

Example of FC70

```
CALL FB 283, DB283
        NR_ACHS_DB := 111
        LADDR := 300                          //Logical I/O address
        LADDR_DIAG := 8186                    //Diagnostics address
        WR_PZD := P#DB111 DBX172.0 Byte 8     //Source range for outputs
        RD_PZD := P#DB111 DBX212.0 Byte 8     //Target range for inputs
        CONSIST := TRUE
        RESTART := FALSE
        AXIS_NO := B#16#3                     //Drive object number
```

Signals "WR_PZD" and "RD_PZD"

The "WR_PZD" and "RD_PZD" signals for FC70 in the example have the following meaning:

Signal	Type	Type	Range of values	Comment
WR_PZD	I	Any	P#Mm.n byte x P#DBno.DBXm.n byte x	Target range for process data, master → slave (control words / setpoints)
				Here, generally the axis DB is used, i.e. in the pointer, the same DB number must be specified as formal parameter "NR_ACHS_DB".
				The length of the pointer is 30 bytes for Siemens telegram 136.
RD_PZD	I	Any	P#Mm.n byte x P#DBno.DBXm.n byte x	Target range for process data, slave → master (status words / actual values)
				Here, generally the axis DB is used, i.e. in the pointer, the same DB number must be specified as formal parameter "NR_ACHS_DB".
				The length of the pointer is 38 bytes for Siemens telegram 136.

Example of FC73

```
        UN E 30.0            //E.g. switch for the enable
        SPB frei

        L W#16#47E           //Set all enables
        T DB111.DBW 172

        U E 3.7              //MCP483 - reset
        = DB111.DBX 173.7    //Reset fault memory
        BEA

free:   L W##16#47E          //All enable signals except ON/OFF1
        T DB111.DBW172
        L W##16#4000         //Rated speed in drive parameter p2000
        T DB111.DBW174       //Set speed high
```

Download the project to the PLC

You have completed the programming of the user program: Now load the project to the PLC (Page 76).

Commissioning the PLC has been completed

For the synchronization of PLC and NCK a reset (warm restart) of the system is required: Triggering a reset (warm restart) for NCK and drive system (Page 76) The LED show the following state:

- NCU: RUN LED illuminates GREEN continuously.
- NCU: Status display shows a "6" with a flashing point.
- CU320-2 DP: RDY LED illuminates GREEN continuously.

⇒ PLC and NCK are in cyclic operation. The initial commissioning of the PLC is completed.

See also

You commission the devices, infeed(s) and drives in the next step:

Guided commissioning of SINAMICS drives (Page 76)

9.3.3 Commissioning PLC drives

Preconditions

The following steps have already been performed:

- The PLC project was loaded to the PLC.
- To perform a synchronization, you have initiated a reset (warm restart) for the NCK and the drive system.
- The PLC and NCK are in the following state after a reset (warm restart):
    - RUN LED illuminates GREEN continuously.
    - Status display shows a "6" with a flashing point.
    ⇒ PLC and NCK are in cyclic operation.

Automatic device configuration

The following description for commissioning briefly discusses the procedure:

1. Select the "Commissioning" → "Drive system" operating area.

2. Press the "Drive unit" softkey to start the automatic device configuration. During commissioning, alarms in the display area for alarms/messages are output.

3. Confirm with "OK". You will then be guided through the individual steps of the automatic device configuration.
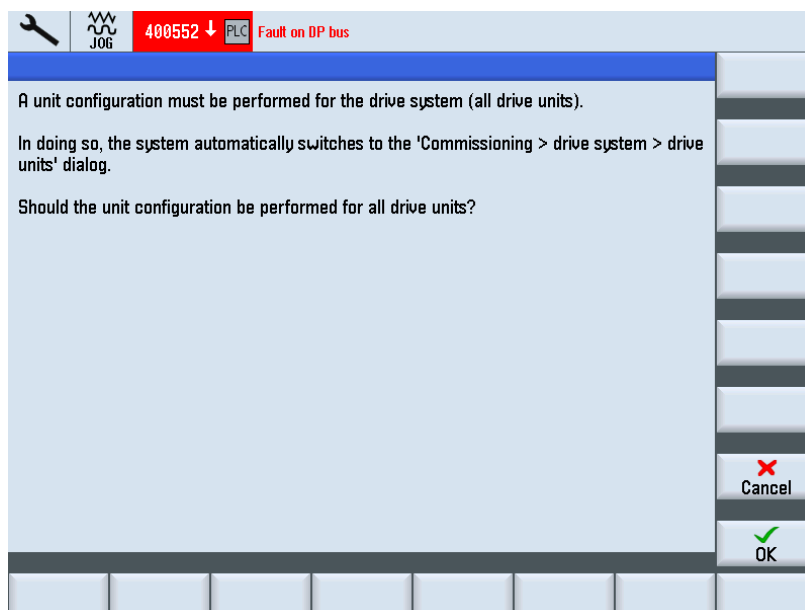
The further commissioning corresponds to the SINAMICS commissioning via an integrated PROFIBUS. You are guided through the automatic device configuration up to commissioning of the individual drive objects that have still not been commissioned.

See also

For additional commissioning steps, please refer to Chapter Commissioning NC-controlled drives (Page 67) from Chapter Automatic device configuration (Page 79).

9.3.4 Checking the communication to the drive

Check configuration

The PLC alarms of the drives that communicate using the PROFIBUS X126 interface must have an identical time stamp with the NCK.

For the configuration in the hardware configuration, define the associated Siemens telegram 390 for the CU320-2 DP. The corresponding logical input and output addresses of this communication interface are entered in the following machine data item:

- MD13120[n] CONTROL_UNIT_LOGIC_ADDRESS
- MD13120[1]...[5] are reserved for NX expansion modules.

Note

You can view these logical addresses in the HW configuration when configuring the DP Slave properties of SINAMICS components under "Details".

Procedure:

1. Check the logical address for CU320-2 DP in the "Commissioning" → "Machine data" → "General MD" operating area:

   MD13120[6] = 288

2. Press "Reset (po) ...) to refresh the changed machine data.

This completes the commissioning of the PLC drives.

9.4 Safety functions for PLC drives

Introduction

This section only partially describes how a PLC drive can be integrated in a safety-related application. In this case, the published supplement of the PROFIdrive profile that includes drive-based safety functions via the PROFIsafe supplement with telegram 30 is used.

Basic procedure

The following steps are necessary to integrate drive-based safety functions:

- Configuration with SIMATIC Manager under HW Config.
- Embedding in safe programmable logic (SPL).
- Configuration of test cases with SinuCom NC ATW that must go through an acceptance procedure.

Literature

For the implementation, reference is made to the following function manuals for safety functions which are binding for the safety-related version:

- SINUMERIK 840D sl "Safety Integrated" Function Manual
- SINAMICS S120 "Safety Integrated" Function Manual, Chapter: "Structure of telegram 30".

9.4.1 Configuring PROFIsafe

Precondition

In order to configure PROFIsafe, it is necessary that the "S7 Configurations Pack" option is installed.

Configuring the operating sequence for PROFIsafe

Procedure:

1. For this telegram, select the PROFIsafe telegram 30 in the "Option" selection field.
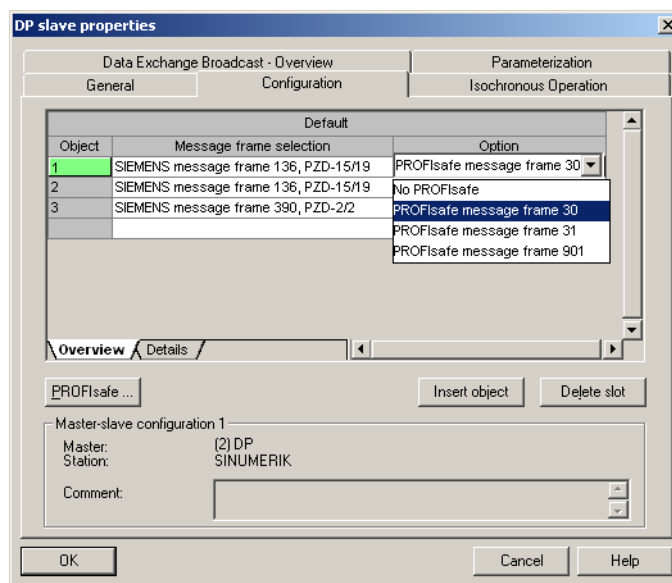
2. Under the "Details" tab, set the input/output addresses. The PROFIsafe option requires an additional 6 bytes.
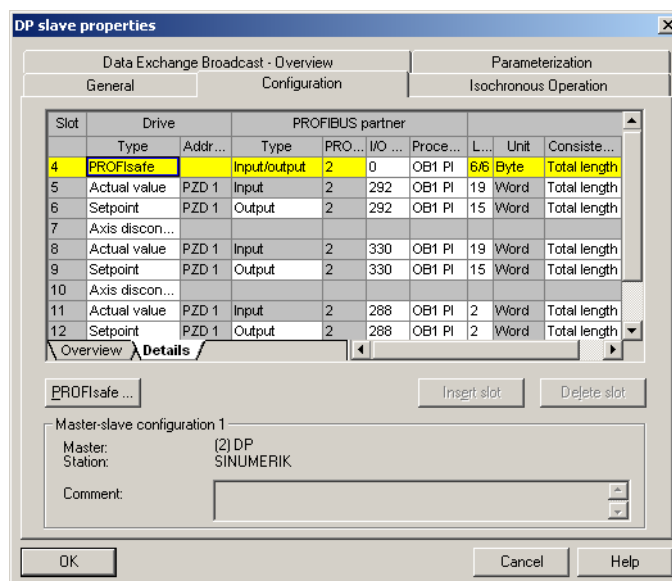
3. Press the "PROFIsafe ... " button to set the F parameters.

4. To change the "F_Dest_Add" parameter, in the column, select "F_Dest_Add" in the "Parameter Name" column and click the "Change value ..." button.
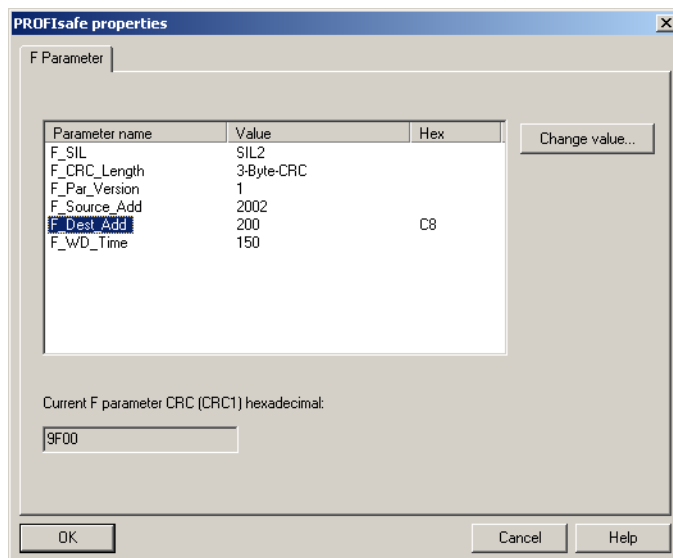
5. Check the following values/settings:

    –   The value of the "F_Dest_Add" parameter must be entered as a hexadecimal value in p9610 and p9810 of the corresponding drive (e.g. 200_{dec} corresponds to $C8_{hex}$).

    –   The value of the "F_Source_Add" must match the other used PROFIsafe modules and also be entered in MD10385 $MN_PROFISAFE_MASTER_ADRESS.

    –   It must be ensured that the same source address is set for all PROFIsafe modules.

Result of the PROFIsafe configuring:
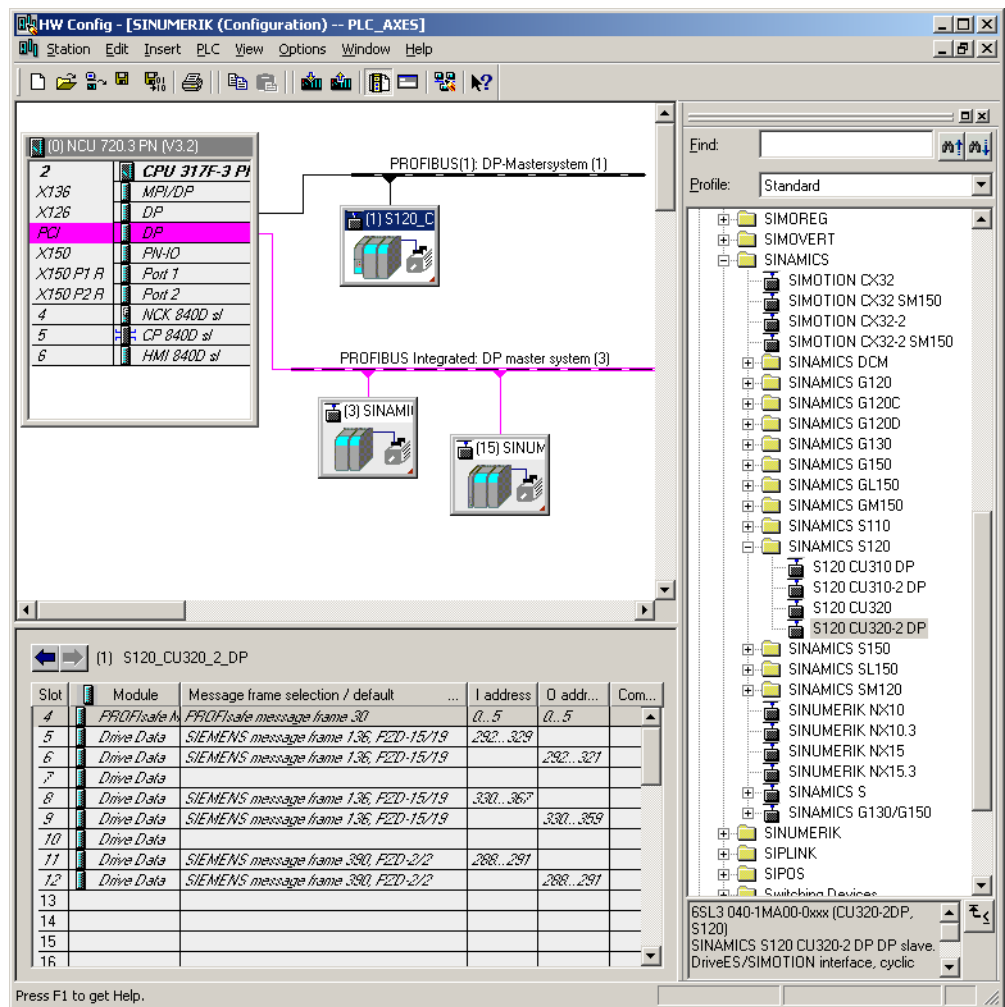
9.4.2 Example: Embedding in safe programmable logic (SPL)

Introduction

The following machine data and files must be taken into account when embedding telegram 30 in a safe programmable logic:

- NC machine data
- Drive machine data
- "safe.SPF" file
- PLC program expansion

NC machine data

- Not bold: Values already used by PROFIsafe / F-Send/F-Rec.

- **Bold:** Values that have been added as a result of telegram 30.

The SPL PROFIsafe configuration for the basic safety functions STO without SSI are then shown as example:

Archive excerpt	Comment
CHANDATA(1)	
N10385 $MN_PROFISAFE_MASTER_ADDRESS='H50007d2'	
N10386 $MN_PROFISAFE_IN_ADDRESS[0]='H50000c8'	;=> entry from HW Config
N10387 $MN_PROFISAFE_OUT_ADDRESS[0]='H50000c8'	;=> entry from HW Config
...	
N10390 $MN_PROFISAFE_IN_ASSIGN[0]=9011	;=> INSE[9] for S_STW1.0 No Safe Torque Off
	;=> INSE[10] for S_STW1.1 No Safe Stop 1
	;=> INSE[11] for S_STW1.7 INTERNAL_EVENT_ACK
	; No extended functions
...	
N10400 $MN_PROFISAFE_OUT_ASSIGN[0]=9011	;=> OUTSE[9] for S_ZSW1.0 Power removed
	;=> OUTSE[10] for S_ZSW1.1 Safe Stop 1 not active
	;=> OUTSE[11] for S_ZSW1.7 INTERNAL_EVENT
	; No extended functions
...	
N13300 $MN_PROFISAFE_IN_FILTER[0]='H83'	
...	
N13320 $MN_PROFISAFE_OUT_FILTER[0]='H83'	
...	

Drive machine data

- Values that have been added as a result of telegram 30:

    p9601=p9801=0x8

    p9610=p9810=0xC8

"safe.SPF" file

Program example	Comment
IDS = 40 DO $A_OUTSE[09] = $A_INSE[2]	;If the cover is locked then deselect STO
IDS = 41 DO $A_OUTSE[10] = $A_INSE[2]	;If the cover is locked then deselect SS1

PLC program expansion

```
Program example                                  Comment
U    "SPL".SPL_DATA.INSEP[2];                     // => cover switch locked?
=    "SPL".SPL_DATA.OUTSEP[9];                     // $A_OUTSE[9] =1 => Deselect STO
=    "SPL".SPL_DATA.OUTSEP[10];                    // $A_OUTSE[10] =1 => Deselect SS1
//Enable signal OFF1 set:
UN   "SPL".SPL_DATA.INSEP[9];                      // => No STO?
UN   "SPL".SPL_DATA.INSEP[10];                     // => No SS1?
U    E    0.0;                                     // of course, only if OFF1 is also requested
                                                      by switch

=
"CU320_A".Speed_Control.WR_PZD_DREHZAHL.STW1
.Aus1 ;
```

9.4.3 Configuration of test cases with SinuCom NC SI-ATW that must go through an acceptance procedure

Precondition

SinuCom NC SI-ATW, which can be used for the acceptance of safety-related SINUMERIK Safety Integrated functions, can also be used to accept certain drive-based safety functions. The following example for STO (Safe Torque Off)/SH (safe standstill) of an external SINAMICS CU3xx device shows these functions.

The Safety Integrated alarms from 27000 to 27901 are already displayed by default.

Note

For safety-related acceptance, the function manuals, as specified in ChapterSafety functions for PLC drives (Page 293), are binding.

Basic operator input options when ATW is running

The tests for the drives of the CU320 are integrated into the ATW using the "Function inter-relationships". For the parameters there are two options:

1. The contents of the parameters are entered into the result box.

2. The "setpoint/reference" values are located in the condition box and are only confirmed in the result box with "OK" if there is a match.

Test 1: Checking the version parameters
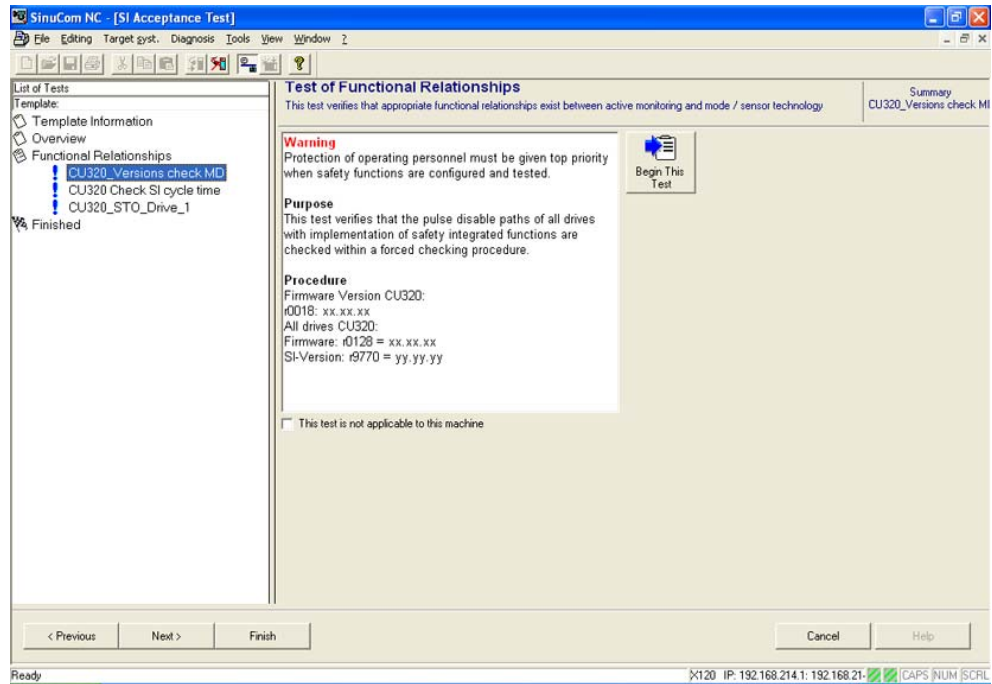
Figure 9-2   Test 1: Checking the version parameters
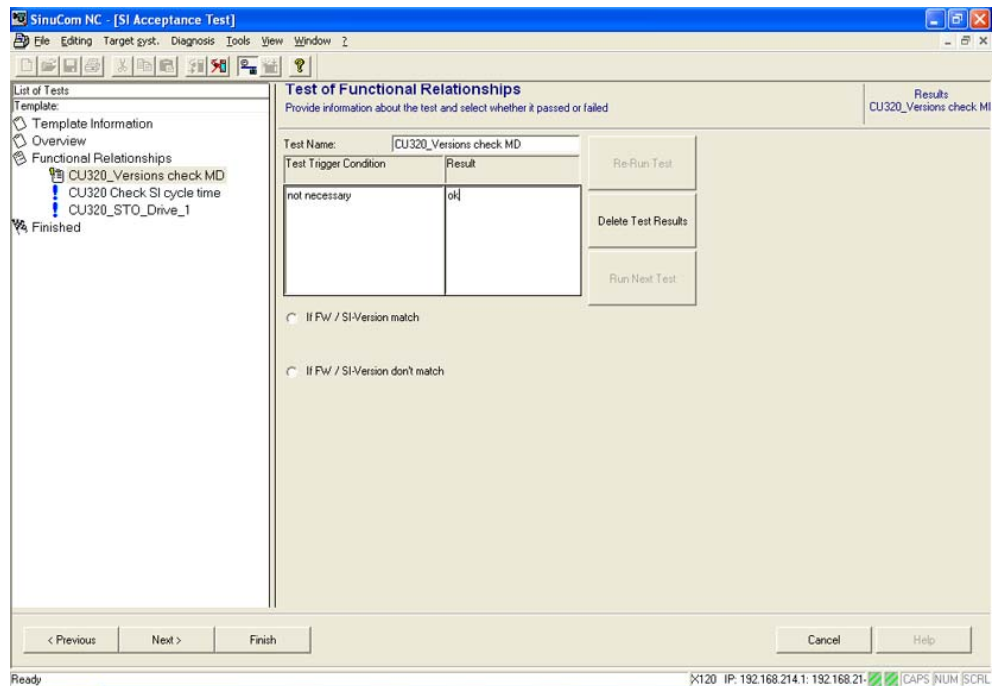
Figure 9-3   Test 1: Checking the version parameters

Test 2: Checking the SI monitoring clock cycles
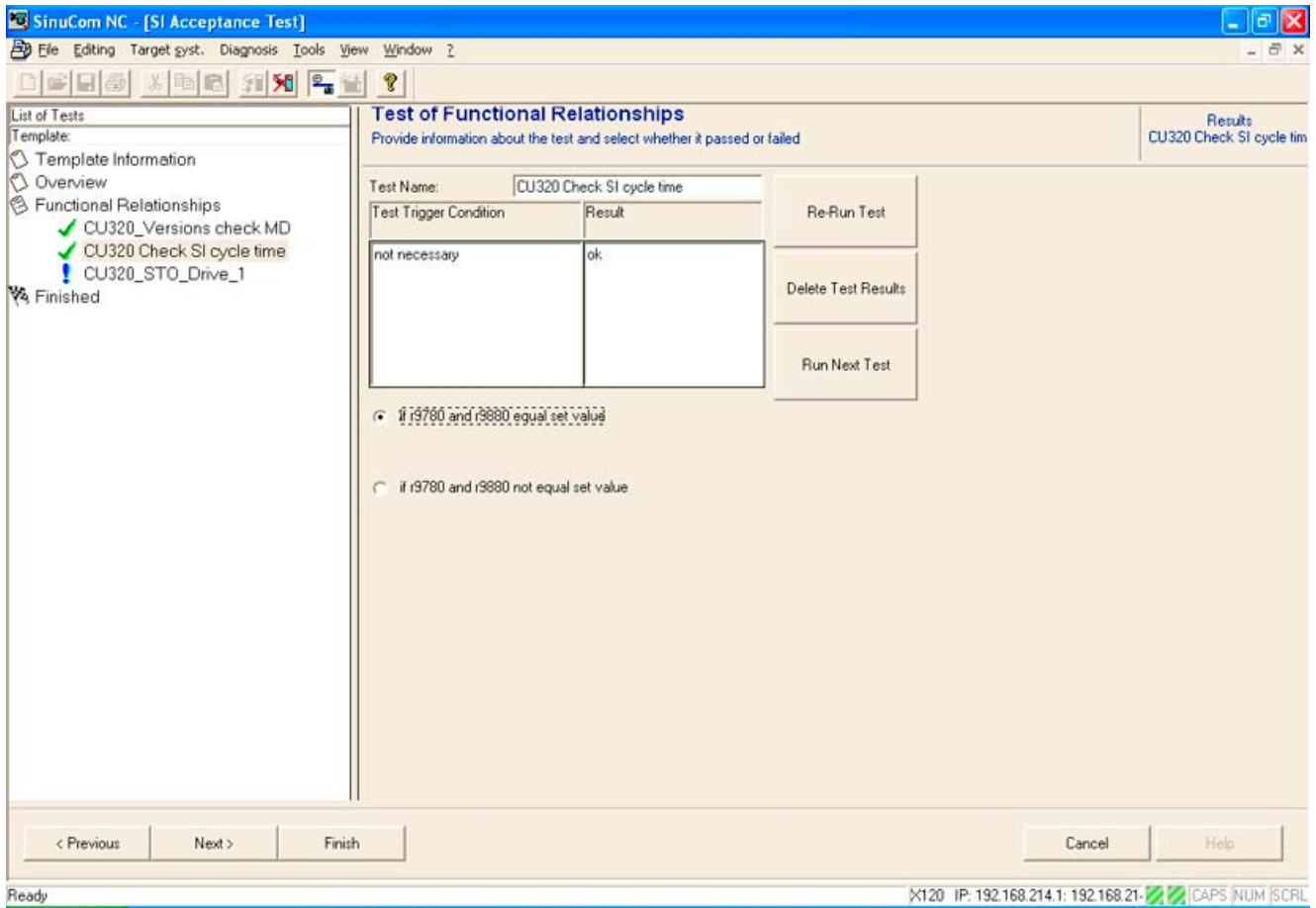
Figure 9-4   Test 2: Checking the SI monitoring clock cycles

Test 3: Testing the safety-related shutdown (STO). There is a test for each drive.
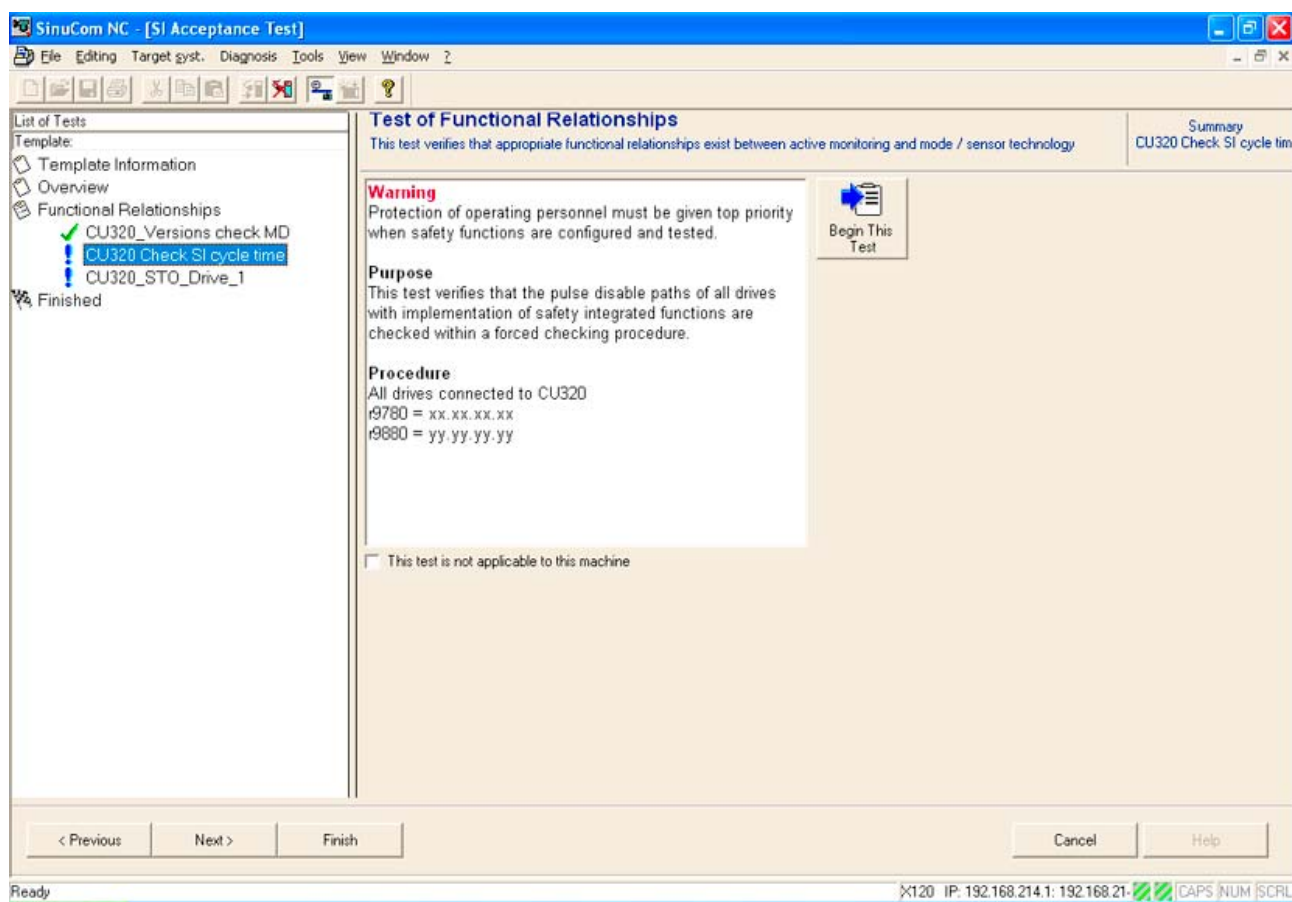
Figure 9-5   Testing the safety-related shutdown
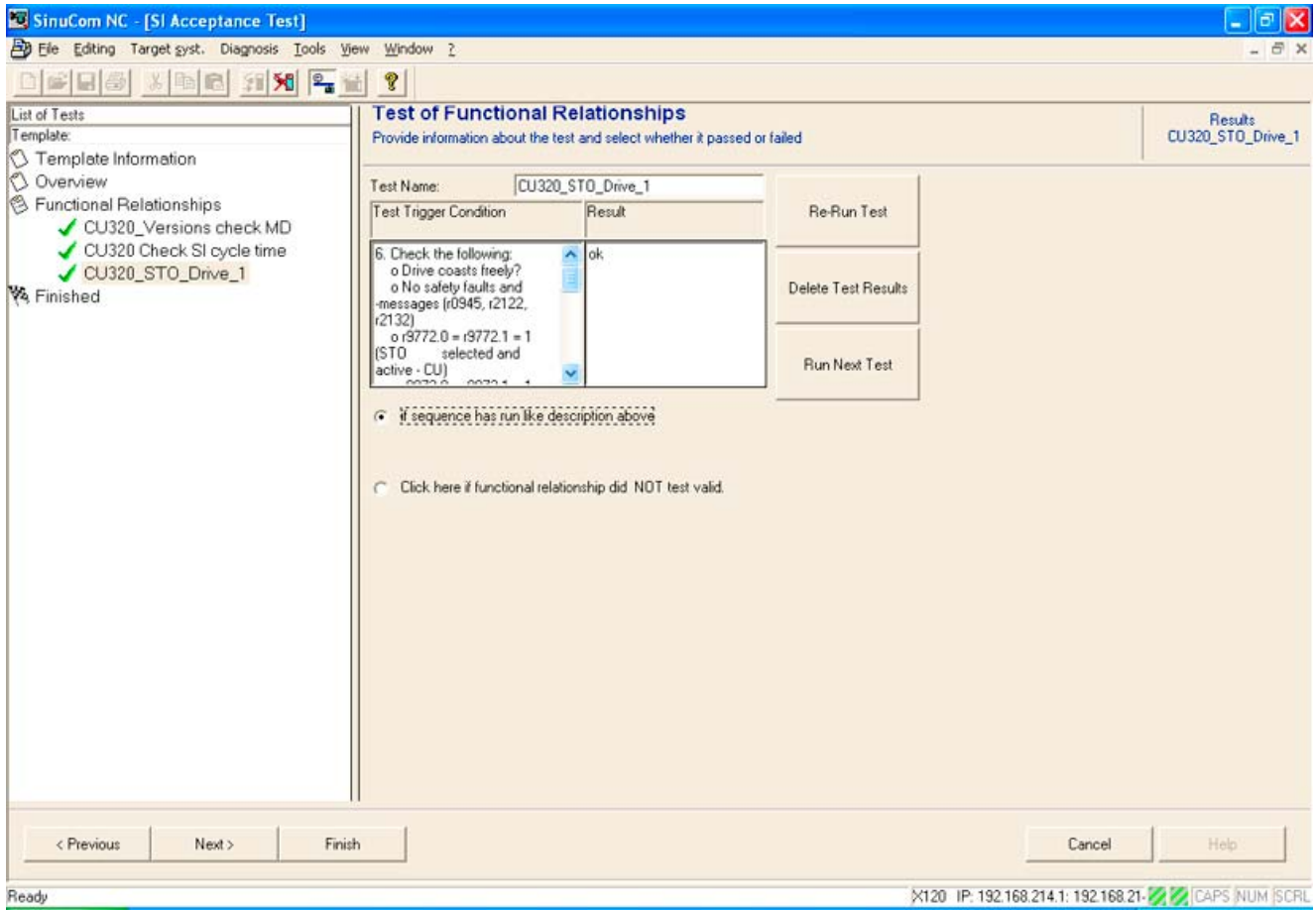
Figure 9-6   Testing the safety-related shutdown

Saving and managing data

10

10.1 Saving data

Time of the data backup

The following times are recommended for performing a data backup:

- After a commissioning
- After changing machine-specific settings
- After replacing a hardware component
- For a software upgrade
- Before the activation of memory-configuring machine data

Data backup for DRIVE-CLiQ motors:

We would recommend backing up the DRIVE-CLiQ motor data onto a CompactFlash card. Parameter p4692 = "1" must be set.

Creating and importing a commissioning archive

There are the following ways to create and reload archives:

- The "Commissioning archive" softkey offers the following selection:
  - Creating a commissioning archive
  - Creating a PLC hardware upgrade archive (only SDBs)
  - Importing a commissioning archive
  - Creating an original status archive
  - Reading in an original status archive
- The "System data" softkey can be used to select and import specific archives from the data structure.

A commissioning archive is saved as a file of the ".arc" type.

Note

Archives of this type can be processed with the SinuCom ARC commissioning and service software.

What data is saved?

Components	data
NC data	• Machine data • Setting data • Option data • Global (GUD) and local (LUD) user data • Tool and magazine data • Protection zone data • R parameters • Zero offsets • Compensation data • Workpieces, global part programs and sub-programs • Standard and user cycles • Definitions and macros
• With compensation data	• QEC - quadrant error compensation • CEC - operation/angularity compensation • EEC - leadscrew pitch / encoder error compensation **Note:** It only makes sense to archive machine-specific compensation data if the commissioning file is reloaded into the same controller.
• With compile cycles	The compile cycles (* .elf) option is displayed only if compile cycles are also available.
PLC data	• OB (organization blocks) • FB (function blocks) • FC (functions) • DB (data blocks) • SFB (system function blocks) • SFC (system functions) • SDB (system data blocks). System data blocks are only used to back up the hardware configuration (not the program logic).

Components	data
Drive data	Either in binary or ASCII format
HMI data	• Texts: PLC alarm texts, cycle alarm texts, part program message texts from the machine manufacturer • Templates: Individual templates, workpiece templates • Applications: Software applications, for example of the machine manufacturer • Configurations • Configuration: Configurations, incl. display machine data • Help: Online help files • Version data • Reports: For example, action log, screenshots • Program lists • Dictionaries: For Chinese simplified and Chinese traditional (IME) • Data backups: Channel data, axis data, etc. in ASCII format • Programs on a local drive: Programs that are in the user memory area of the CompactFlash card.

10.1.1   Backup of PLC data

PLC operating state

When creating a commissioning archive with PLC data, the PLC image that is saved during this process depends on the operating state of the PLC at the time of creation:

• Original image

• Instantaneous image

• Inconsistent image

The operating state of the PLC can be changed in the following ways:

• With SIMATIC STEP 7 Manager

• With the PLC mode selector on the NCU:

   Position " 2" → STOP, position " 0" → RUN

Operating sequence for original image

The original image of the PLC is represented by the PLC-data state immediately after loading the S7 project into the PLC.

1. Set the PLC to the STOP operating state.

2. Load the appropriate S7 project into the PLC using SIMATIC Manager STEP 7.

3. Create a commissioning archive with PLC data.

4. Set the PLC to the RUN operating state.

Operating sequence for instantaneous image

If you cannot create an original image, you can save an instantaneous image as an alternative.

1. Set the PLC to the STOP operating state.

2. Archive the PLC data.

3. Set the PLC to the RUN operating state.

Operating sequence for inconsistent image

An inconsistent image results if a commissioning file with PLC data is created and the PLC is in the RUN state (cyclic operation). The data blocks of the PLC are saved at different times with contents that have changed in the meanwhile. This may result in a data inconsistency that, once the data backup has been copied back to the PLC, may under certain circumstances result in a PLC stop in the user program.

NOTICE
The creation of a commissioning file with PLC data while the PLC is in RUN state (cyclic operation) may result in an inconsistent PLC image in the commissioning archive. After this commissioning archive has been copied back, the data inconsistency in the PLC user program may under certain circumstances result in a PLC stop.

10.1.2 Creating a commissioning archive

Precondition

The following access levels are required:

- In order to create a commissioning archive, at least access level 4 (key-operated switch 3) is required.

- In order to import a commissioning archive, at least access level 2 (service) is required.

To prevent a topology error, Control Unit parameter p9906 (topology comparison stage of all components) should be set to "Medium" to import a commissioning archive.

Creating a commissioning archive

Series commissioning means bringing a series of control systems to the same initial state as regards their data. A commissioning archive contains NC, PLC, drive and HMI data. Compensation data of the NC can also be optionally saved. For a data backup, the drive data is saved as binary data that cannot be read.

Procedure:

1. To create a commissioning archive, select: "Commissioning" → forward key → "Commissioning archives" → "Creating a commissioning archive" option operating area:
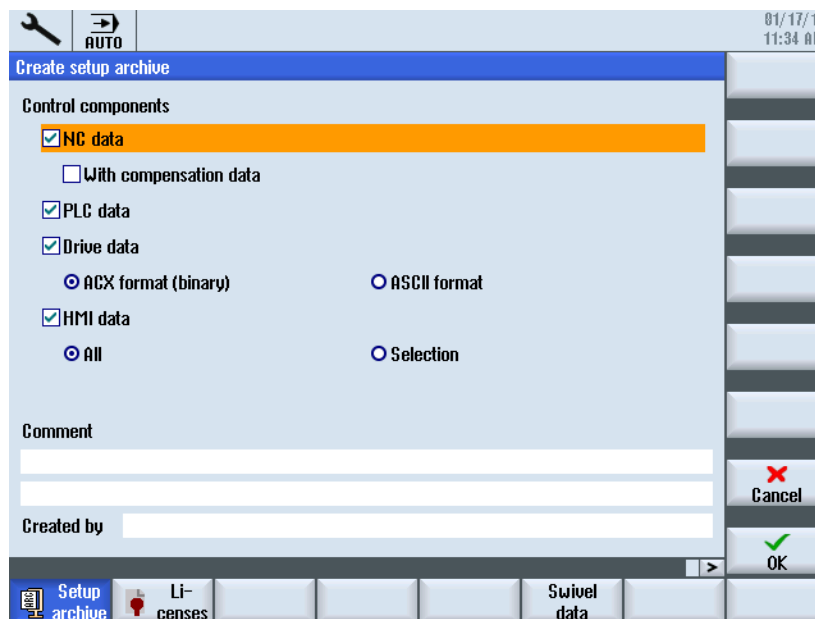
Figure 10-1   Commissioning archives

2. Select the data to be backed up:

   – NC data: With/without compensation data

   – PLC data

   – Drive data: Binary/ASCII

   – HMI data: All/selection

3. Enter an archive name.

4. The following directories are offered as a storage location for the archive:

   – Archives/user or archives/manufacturer on CompactFlash card or PCU 50

   – A logical drive, e.g. USB FlashDrive

Memory locations

Archives can be stored in the following directories:

- Archives/user or archives/manufacturer on CompactFlash card or PCU 50

  Absolute path specification: /**user**/sinumerik/data/archive or /**oem**/sinumerik/data/archive

- All configured logical drives (USB, network drives)

Note

USB FlashDrive

USB FlashDrives are not suitable as persistent memory media.

10.2 Managing data

Application

The "Manage data" function is used to support and simplify the commissioning and provides functions for backup, load and comparison of machine, setting, compensation and drive data.

In contrast to a commissioning archive, only a single control object (axis, channel, servo, infeed, etc.) is saved in ASCII format (*.TEA). This file can be edited and transferred to other control objects of the same type. The "Manage data" function is also the basis for copying DO for SINAMICS drives.

Managing data

The "Manage data" function offers the following options:

- Transfer data within the controller
- Save data to a file
- Load data in a file
- Compare data

The function is called from "Commissioning" → "Machine data" → "Manage data".

Example of "transfer data within the controller":
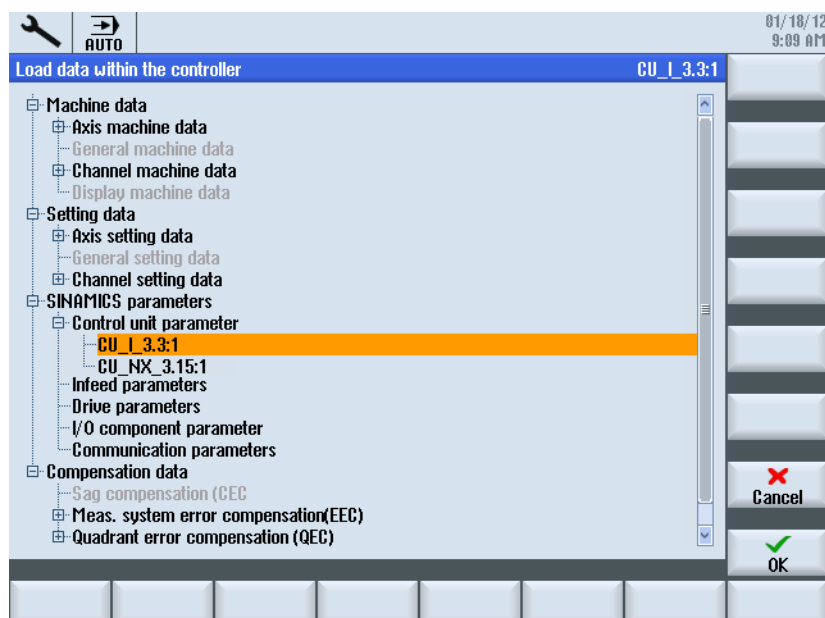
Figure 10-2   Managing data

The following data can be saved and stored under the following absolute path on the CompactFlash card:

- **user**/sinumerik/hmi/data/backup/ec for compensation data
- **user**/sinumerik/hmi/data/backup/md for machine data
- **user**/sinumerik/hmi/data/backup/sd for setting data
- **user**/sinumerik/hmi/data/backup/snx for SINAMICS parameters

10.2.1 How to transfer data within the controller

Transfer data within the controller

NOTICE
Protection of the machine
For safety reasons, the machine and setting data should be transferred only for blocked enables.

Procedure:

1. Select the "Data transfer within the controller" option.
2. Select the source data in the data structure and confirm with "OK".
3. In the drop-down list, select an object, e.g. a different axis or a different drive object, to which you want to transfer the data and confirm with "OK".
4. Observe the safety instructions and check the enable signals at the machine and the drive.
5. For drive data, the "Load" softkey is used to transfer the data to the target object.

10.2.2 To save and load data

Save data to a file

Procedure:

1. Select the "Save data to a file" option.

2. In the data structure, select the data that you want to save to a file and confirm with "OK".

3. Select as the storage location, a directory or a USB storage medium and enter a name.

Note

SINAMICS parameters

Three files are created when you save the drive data:

- A binary file (*:ACX) that cannot be read.
- An ASCII file (*.TEA) that can be read or edited in the ASCII editor.
- A log file (*.log) that contains message texts (error situation) or is empty (successful storage).

Loading data from a file

NOTICE
Protection of the machine
For safety reasons, the machine and setting data should be transferred only for blocked enables.

Procedure:

1. Select the "Load data from a file" option.

2. In the data structure, select the saved file and confirm with "OK".

3. In the drop-down list, select an object, e.g. a different axis or a different drive object, to which you want to transfer the data and confirm with "OK".

4. Observe the safety instructions and check the enable signals at the machine and the drive.

5. For drive data, the "Load" softkey is used to transfer the data to the target object.

10.2.3   How to compare data

Compare data

You can select different data sources for the data comparison: Store the current data in files on the controller or data.

Procedure:

1. Select the "Compare data" option.

2. In the data structure, select the data that you want to compare.

3. Press the "Add to list" softkey to transfer the data to the list in the lower area of the display.

4. Press the "Delete from list" softkey to remove the data again.

5. If the list contains more than two data objects, you can activate the checkbox to compare two or more data objects from the list.

6. Press the "Compare" softkey to start the comparison. The display of the comparison results can take some time for extensive parameter lists.

7. Press the "Legend" softkey to display or hide the legend. The following display is the default:

   – Different parameters are displayed.

   – The same parameters are not displayed.

   – Parameters not available everywhere are displayed.

Licensing

<div style="text-align: right; font-size: 3em; font-weight: bold;">11</div>

11.1 SINUMERIK License Key

Basic information on license keys

If a license is required for a product, then with the purchase of the license the purchaser receives a CoL as proof for the rights to use this product and a corresponding license key as to the "technical representative" of this license. In conjunction with software products, the license key usually must be available on the hardware on which the software product is executed.

SINUMERIK license keys

Depending on the software product, there are license keys with different technical properties. The essential properties of a SINUMERIK license key are:

- Hardware reference
  The hardware serial number included in the SINUMERIK license key provides a direct link between the license key and the hardware on which it can be used. In other words, a license key created for the hardware serial number of a specific CompactFlash card is only valid for this CompactFlash card and will be rejected on other CompactFlash cards as invalid.

- Total number of assigned licenses
  A SINUMERIK license key not only refers to a single license, instead it is the "technical representative" of all licenses that are assigned to the hardware at the time of its generation.

Content of the CompactFlash card

The CompactFlash card contains not only the system and user software as well as the retentive system and user data, but also the data relevant for the license management of SINUMERIK software products of a controller:

- Hardware serial number

- License information including the license key

The CompactFlash card thus represents the identity of a SINUMERIK controller. For this reason, assigning licenses to a controller always occurs using the hardware serial number.

This has the advantage that the CompactFlash card can be inserted into a replacement NCU in the event of failure and all data is retained.

CompactFlash card as a spare part

If the CompactFlash card of a SINUMERIK controller is replaced, for example, because of defective hardware, the license key loses its validity and the system is no longer operational.

In case of defective hardware of the CompactFlash card, contact the "Technical Support". They will then send you a new license key without delay. The following data is required:

● Hardware serial number of the defective CompactFlash card

● Hardware serial number of the new CompactFlash card

Note

Only CompactFlash cards can be used that were released as spare part, as only these are known to the license database.

Determining the hardware serial number

The hardware serial number is a permanent part of the CompactFlash card. It is used to identify a control system uniquely. The hardware serial number can be determined by:

● Certificate of License (CoL)

● SINUMERIK user interface

● Label on the CompactFlash card

Note
Hardware serial number and CoL

The hardware serial number is located only on a CoL of the system software or if the license was ordered bundled, in other words the system software came together with options.

11.2 Web License Manager
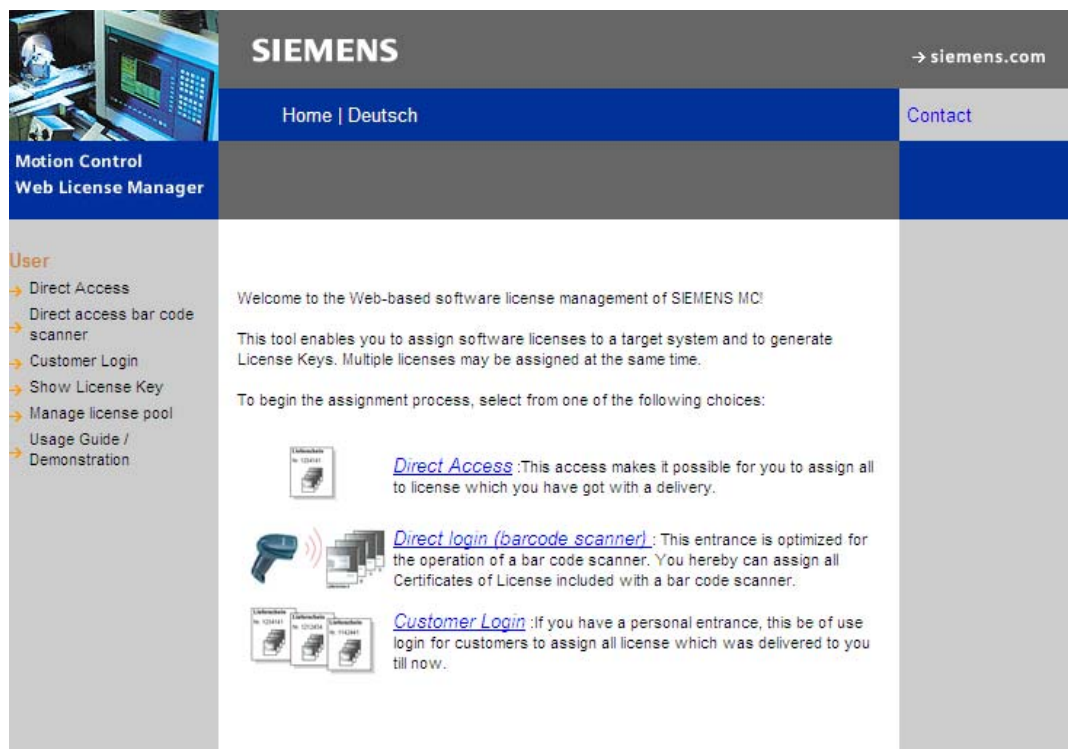
Overview

The use of the installed system software and the options activated on a SINUMERIK control system require that the licenses purchased for this purpose are assigned to the hardware. In the course of this assignment, a license key is generated from the license numbers of the system software, the options, as well as the hardware serial number. Here, a license database administered by Siemens is accessed via the Internet. Finally, the license information including the license key is transferred to the hardware.

The license database can be accessed using the Web License Manager.

Web License Manager

By using the Web License Manager, you can assign licenses to the hardware in a standard Web browser. To conclude the assignment, the license key must be entered at the controller via the user interface.

Internet links

Web License Manager (http://www.siemens.com/automation/license)

Siemens Industry Mall (http://mall.automation.siemens.com)

11.3 License database

License database access

The license database contains all relevant license information required for the license management of SINUMERIK software products. The central management of the license information in the license database ensures that the existing license information regarding a piece of hardware is always up to date.

Direct access

The direct access in the Web License Manager is made with:

- License number
- Delivery note number

The direct access enables the direct assignment of licenses for which the license numbers are available, e.g. in the form of a CoL.

Direct access with barcode scanner

The direct access in the Web License Manager is made with:

- Hardware serial number
- Product selection

The direct access enables the assignment of licenses with a barcode scanner for which the license numbers are available as a barcode, for example in the form of a CoL.

Customer login

The customer login in the Web License Manager is made with:

- User name
- Password

The customer login enables the assignment of all the licenses available to the machine manufacturer that are delivered at the time of the login and have not yet been assigned to any machine. Here, the license numbers of licenses that can still be assigned need not be directly at hand, instead these are displayed from within the license database.

Note

Obtaining access data

You can obtain the address data for the customer login from the Siemens Industry Mall under the associated selected region with: "> Register" (above).

11.4 How to perform the assignment

Assigning a license to a piece of hardware

1. Determine the hardware serial number and the product name ("type of hardware") on the user interface via the licensing dialog:

    Commissioning > menu forward key > Licenses > Overview operating area

    Note

    Ensure that the hardware serial number displayed is also really the one you want to make the assignment for. The assignment of a license to a piece of hardware cannot be reversed via the Web License Manager.

2. Go to the Internet page of the Web License Manager.

3. Click the appropriate access to the license database:

    –   Direct access

    –   Direct access (barcode scanner)

    –   Customer login

4. Follow the instructions in the Web License Manager.

    A progress bar shows you the individual steps:
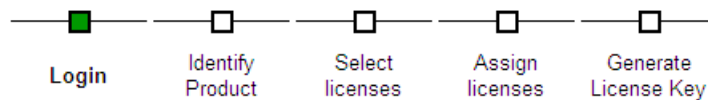
5. Check the details of the selected licenses before confirmation of the assignment process.

    Note

    After confirmation, the generated license key irrevocably links the selected licenses with the specified hardware.

6. Confirm the assignment process.

7. After completing the assignment process, enter the license key displayed on the Web License Manager into the license dialog of the user interface.

    Commissioning > menu forward key > Licenses > Overview operating area

8. Press the <INPUT> button to confirm the input of the new license key.

Displaying the license key and sending via e-mail

For archiving or for documentation of the associated machine, you can also send a license report with the grouping of all assigned licenses. Follow the instructions in the Web License Manager under "Display License Key".

11.5 Import licensing terms

Product

A product is marked by the data below within the license management of SINUMERIK → software products:

- Product designation
- Order number:
- → License number

Software product

The term software product is generally used to describe a product that is installed on a piece of → hardware to process data. Within the license management of SINUMERIK software products, a corresponding → license is required to use each software product.

Certificate of License (CoL)

The CoL is the proof of the → license. The product may only be used by the holder of the → license or authorized persons. The CoL includes the following data relevant for the license management:

- Product name
- → License number
- Delivery note number
- → Hardware serial number

Hardware

In the context of license management of SINUMERIK → software products, hardware refers to the component of a SINUMERIK control system to which → licenses are assigned on the basis of its unique identifier. The license information is also saved to non-volatile memory on this component, e.g. on a → CompactFlash card.

CompactFlash card

As the carrier of all non-volatile data in a SINUMERIK solution line control system, the CompactFlash card represents the identity of this control system. The CompactFlash card is a memory card that can be plugged into the → control unit from outside. The CompactFlash card also contains the following data relevant for the license management:

- → Hardware serial number
- License information including the → license key

Hardware serial number

The hardware serial number is a permanent part of the → CompactFlash card. It is used to identify a control system uniquely. The hardware serial number can be determined by:

- → Certificate of License
- User interface
- Label on the CompactFlash card

License

A license gives the user the legal right to use a → software product. Evidence of this right is provided by the following:

- → Certificate of License (CoL)
- → License key

License number

The license number is the feature of a → license used for its unique identification.

License key

The License Key is the "technical representative" of the sum of all the → licenses that are assigned to one particular piece of → hardware, which is uniquely marked by its → hardware serial number.

Option

One option is a SINUMERIK → software product that is not contained in the basic version and which requires the purchase of a → license for its use.

Cycle protection (option)

<div style="text-align: right; font-size: 3em;">12</div>

12.1 Overview, cycle protection

Functionality

With cycle protection, cycles can be encrypted and then stored, protected in the controller. The processing of cycles with cycle protection in the NC is possible without restrictions.

> **Software option**
>
> You require the following software option in order to use this function: "Lock MyCycles" (MLFB: 6FC5800-0AP54-0YB0).

Note

This type of encryption is in compliance with export restrictions and embargo regulations.

In order to protect the manufacturer's know-how, any type of view is inhibited for cycles with cycle protection. If service is required the machine manufacturer must provide the unencrypted cycle.

Note

End user

When using encrypted cycles of a machine manufacturer, when problems occur, then only the service department of the machine manufacturer should be contacted.

Machine manufacturer

When using encrypted cycles, the machine manufacturer must ensure that original, unencrypted cycles are archived with the appropriate version management.

Copying encrypted cycles

The encrypted cycle can be copied and can therefore be used at other machines.

- **Using encrypted cycles at only one machine**

  If the cycle must not be used at another machine, then the cycle can be permanently linked to a particular machine. The machine data MD18030 $MN_HW_SERIAL_NUMBER can be used for this purpose.

  When the controller boots, the unique hardware serial number of the CompactFlash card is saved in this machine data. If a cycle is to be permanently linked to a machine, then in the call header of the cycle, the serial number of the CompactFlash card must be queried (MD18030 $MN_HW_SERIAL_NUMBER). If the cycle identifies a serial number that does not match, then an alarm can be output in the cycle and so prevents further processing. As the code of the cycle is encrypted, there is always a fixed link to a defined hardware.

- **Using encrypted cycles for several machine data**

  If a cycle is to be permanently linked to several, defined machines, the cycle must be entered into each hardware serial number. The cycle must be re-encrypted with these hardware serial numbers.

Handling encrypted cycles

A _CPF file can be deleted or unloaded just like an _SPF or _MPF file. All the encrypted _CPF files are also backed-up when an archive is generated.

- An encrypted cycle cannot be directly selected for processing. It can only be called from a program - or directly in MDI.

- An encrypted cycle cannot be processed with the "Process external" function.

12.2 Preprocessing

File extensions

The cycle to be protected is encrypted on an external PC using the Lock MyCycles program. The encrypted cycle has the extension _CPF (Coded Program File).

The following prededefined extensions are relevant for the file extensions:

- _ .MPF "Main Program File" for unencrypted main programs; ASCII format

- _ .SPF "Sub-Program File" for unencrypted sub-programs; ASCII format

- _ .CYC "Cycle" for pre-compiled file; binary format

The following file extensions are available for encrypted cycles:

- _ .CPF "Coded Program File" for encrypted files in binary format

The _CPF files are either loaded to /_N_CST_DIR , /_N_CMA_DIR or /_N_CUS_DIR. These files are visible there and can be processed just like the previous part programs (_MPF, _SPF). To execute a _CPF file, a Power On is required after loading the cycles.

If no power on is performed, the processing of a _CPF file causes the following alarm:

15176 "Program %3 can be executed only after power on".

Note

A machine manufacturer cycle can be called from a main program using the cycle name and an extension, for example _SPF. This is possible in the CALL, PCALL command or also directly with the name.

If this machine manufacturer cycle is loaded encrypted as _CPF, all sub-program calls with extension must be changed to _CPF.

Preprocessing

As well as _SPF files, encrypted files can be preprocessed. To activate preprocessing, the MD10700 $MN_PREPROCESSING_LEVEL machine data must be set. Pre-processing is always recommended for runtime reasons.

For pre-processing, an NC program (_MPF) or cycle (_SPF) must be converted from the ASCII format into the binary format (compiled). The following NC alarm is issued if, at the time of execution, the compilation is older than the encrypted cycle file:

15176 "Program%3 can be executed only after power on".

12.3   Call as sub-program

Sub-program calls without extensions

A directory can include an encrypted file file _CPF and also an unencrypted file _SPF with the same name, e.g. CYCLE1. If the unencrypted _SPF file is pre-processed, then the following are located in directory:

- CYCLE1.SPF ; unencrypted cycle
- CYCLE1.CYC ; compilation unencrypted cycle
- CYCLE1.CPF ; encrypted cycle

For a call in the part program without extension, e.g. N5 CYCLE1(1.2) the call is made with the following priority:

- CYCLE1.CYC
- CYCLE1.SPF
- CYCLE1.CPF

If only the encrypted file (*.CPF) is in a directory, for a call without extension, nothing has to be changed. The encrypted file or its compilation is called. In the case of service, an unencrypted file (*.SPF) is loaded. As this file has a higher priority, for the same call without extension, this file is called.

Note

An unencrypted file and its compilation have a higher priority than an encrypted file.

Sub-program calls with extensions

Sub-program calls with extension are:

- Direct call N5 CYCLE1_SPF
- Indirect sub-program call (CALL) N5 CALL "CYCLE1_SPF"
- Sub-program call with path data (PCALL) N5 PCALL /_N_CMA_DIR /_N_CYCLE1_SPF

The following extensions are possible:

- N3_MPF; calls the unencrypted file.
- N5 _SPF ; calls the unencrypted cycle.
- N10 _CYC ; calls the compilation of the unencrypted cycle.
- N15 _CPF ; calls the encrypted cycle or its compilation.

If a previous unencrypted cycle CYCLE1 is called with _SPF and this is now only loaded encrypted as _CPF, then all of the calls must be adapted.

NC language commands with absolute path data

Using the following commands, files can be accessed in the passive file system from the part program. In this case, absolute path data with extensions are used.

● WRITE: Data cannot be attached to a _CPF file, return 4 "incorrect file type".

● READ: Lines cannot be read from a _CPF file, return 4 "incorrect file type".

● DELETE: _CPF files can be deleted.

● ISFILE: A check can be made as to whether a _CPF file is available.

● FILEDATE

● FILETIME

● FILESIZE

● FILESTAT

● FILEINFO

All commands can also be called for _CPF files. The commands then supply the corresponding information.

12.4   Processing the program

Actual block display

If an encrypted cycle is executed, then DISPLOF is always active, independent of the programmed PROC attributes. DISPLOF and DISPLON in the block have no effect. If an alarm occurs in the cycle, when programming ACTBLOCNO, the block number is not output in the alarm line, but always just the line number.

Basic block display

If a _CPF cycle is executed, for an active basis block display, the absolute end of block is still displayed. In the single block, this information corresponds to the display of the actual axis values and can also be entered there.

Version display

If a version is entered in the header of an encrypted _CPF cycle, then this version is displayed in the contents screen of a cycle directory, just the same as for unencrypted cycles.

Simulation

The absolute end values are displayed during the processing of a _CPF file in the simulation.

New installation/upgrading

13

13.1 With the help of an NCU service system

Introduction

The CNC software on the CompactFlash card can be newly installed or upgraded.

- A reinstallation is required if there is no CNC software on the CompactFlash card (see Chapter New installation (Page 327)).

- An upgrade is required if an older CNC software is available on the CompactFlash card (see Chapter Upgrading (Page 334)).

Tools for reinstallation/upgrade

The following tools allow you to perform a reinstallation/upgrade:

- USB FlashDrive

- WinSCP on PC/PG

- VNC viewer on PC/PG

Literature

A reinstallation/upgrade always requires a bootable USB FlashDrive. In order that this USB FlashDrive is capable of being booted, an "NCU Service System" must be installed on it.

This description and other details can be found in:

Base Software and Operating Software Commissioning Manual, NCU operating system (IM7)

13.1.1 New installation

Introduction

No CNC software was installed on the CompactFlash Card. The CompactFlash Card is empty.

You have the following options of initiating a new installation of the CNC software:

- Automatic installation using USB-FlashDrive

- Installation using USB-FlashDrive

- Installation using WinSCP on PG/PC
- Installation using VNC Viewer on PG/PC

13.1.1.1 Automatic installation of the CNC software using USB-FlashDrive

Flow diagram

Automatic installation of the CNC software using the USB-FlashDrive

Installation of the NCU Service Systems on the USB-FlashDrive

USB-FlashDrive with "NCU Service System" available? — No

Open Windows Explorer

Insert USB-FlashDrive in the PC/PG

Path to the DVD supplied:
\Vol_hmi-sl\standard (export)\
emergency_bootsys_ncu\
sw_update\autoexec.sh

Copy "autoexec.sh" and "<cnc-sw>tgz" to the USB-FlashDrive (root directory)

Rename <cnc-sw>.tgz as full.tgz

Remove USB-FlashDrive

Power OFF NCU

NCU Power OFF? — No

SIM/NCK -> 7
PLC -> 0

Insert USB-FlashDrive into the NCU (X125)

Power ON NCU

>- RDY LED flashes green (approx. 5 sec)

RDY LED red? — Yes

See cause of the error in the file autoexec.log (e.g. CompactFlash Card too small)

No

RDY LED OFF? — No

Yes

Power OFF NCU

Remove USB-FlashDrive

SIM/NCK -> 1
PLC -> 3

Power ON NCU

PLC general reset

SIM/NCK -> 0
PLC -> 0

END

Figure 13-1   Automatic installation using USB-FlashDrive

13.1.1.2 Installation of the CNC software using USB-FlashDrive

Flow diagram

```
┌─────────────────┐
│ Installation of │
│  the CNC        │
│  software using │
│  USB-FlashDrive │
└────────┬────────┘
         │
         │      ┌──────────────────┐
         │      │ Installation of  │
         │      │ the NCU Service  │
         │      │ Systems on the   │
         │      │ USB-FlashDrive   │
         │      └────────▲─────────┘
         ▼               │
    ◇ USB-FlashDrive     │
      with "NCU Service  │ No
      System" available ─┘
         │
         ▼
┌─────────────────┐
│ Open            │
│ Windows Explorer│
└────────┬────────┘
         │
         ▼
┌─────────────────┐
│ Insert USB-     │
│ FlashDrive into │
│ the PC/PG       │
└────────┬────────┘
         │          Notice: File name of the
         ▼          "<cnc-sw>tgz" only lower case!
┌─────────────────┐
│ Copy            │
│ "<cnc-sw>tgz"   │
│ to the          │
│ USB-FlashDrive  │
│ (root directory)│
└────────┬────────┘
         │
         ▼
┌─────────────────┐       ┌──────────────┐
│ Remove USB-     │       │ Power OFF NCU│
│ FlashDrive      │       └──────▲───────┘
└────────┬────────┘              │
         │                       │
         ▼                       │
     ◇ NCU Power OFF? ── No ─────┘
```

Insert the USB-FlashDrive into NCU (X125)

◇ System TCU ? ── No ──▶ ◇ System PCU ?

Connect a standard PC keyboard to the PCU or Opxx USB front

SIM/NCK -> 0
PLC -> 0

SIM/NCK -> 0
PLC -> 0

1

2

Figure 13-2   Installing the control software using USB-FlashDrive

Flow diagram - installation of the system TCU (1) continued
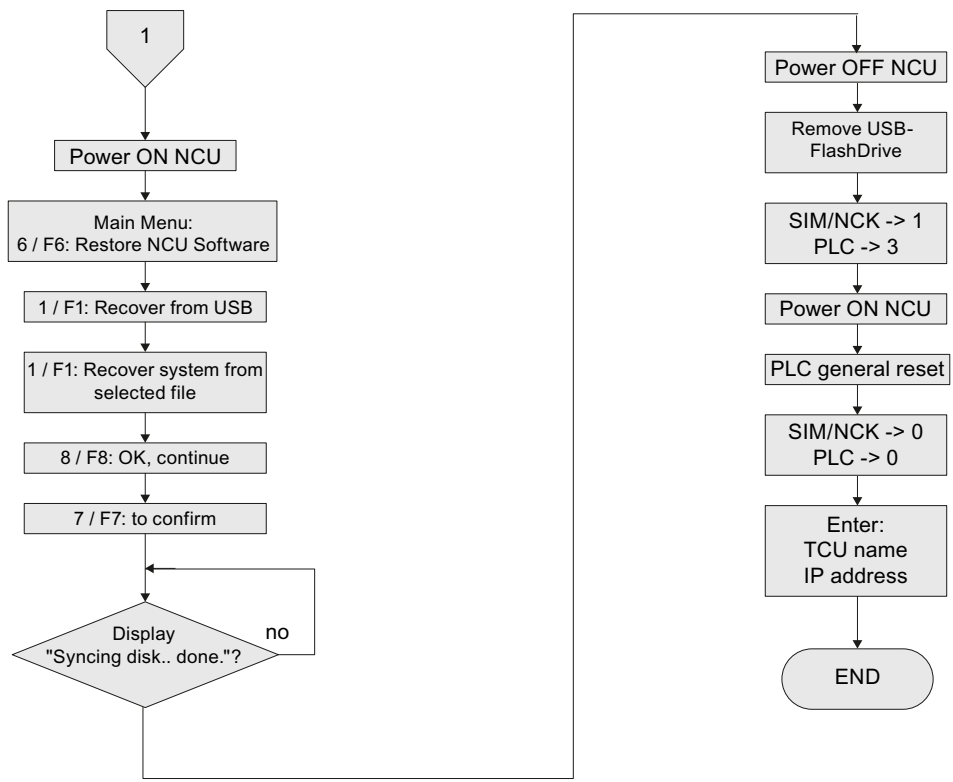
Figure 13-3   Installing the control software using USB-FlashDrive - continued (TCU system)

Flow diagram - installation of the system PCU (2) continued
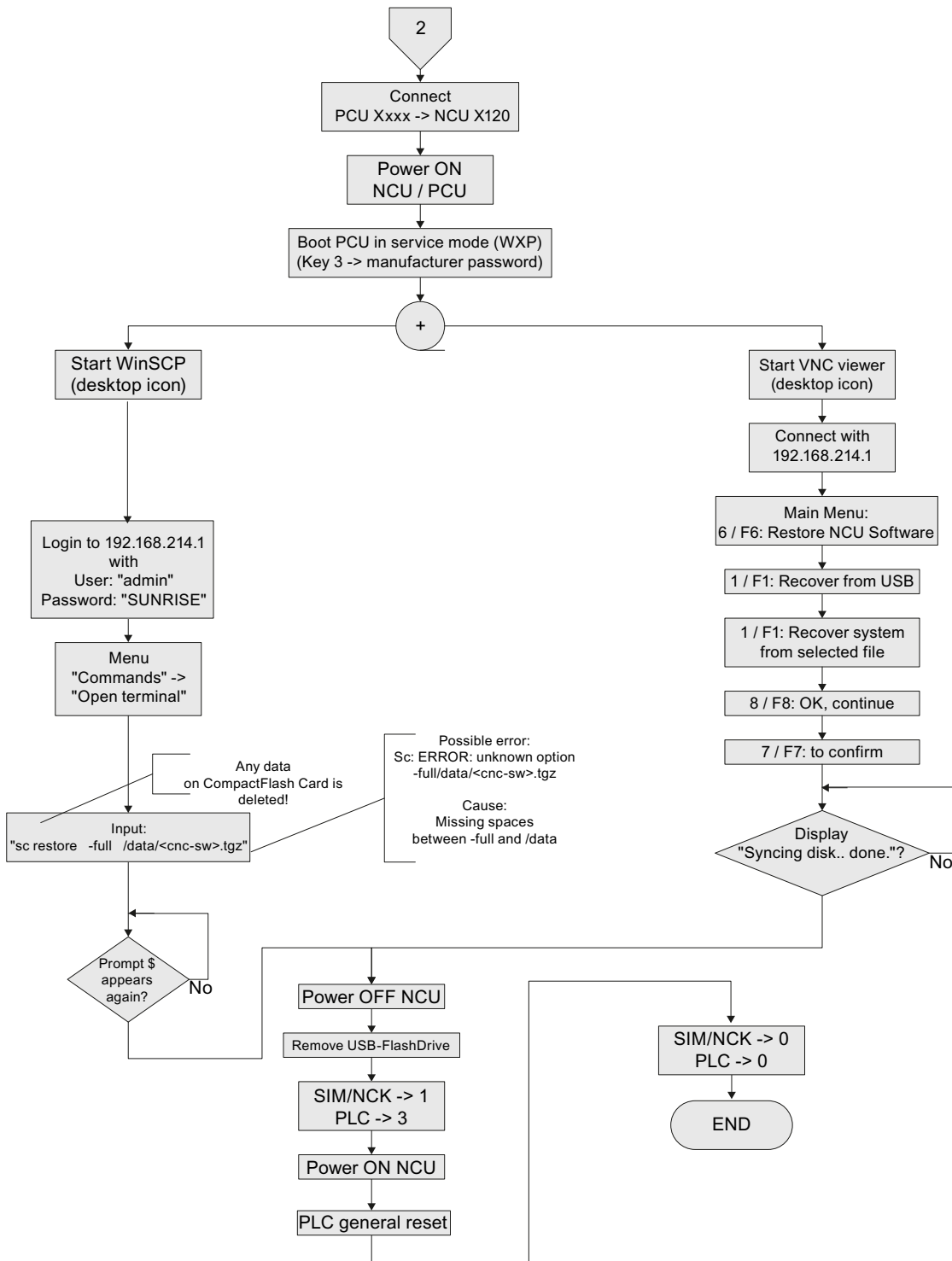
Figure 13-4   Installing the control software using USB-FlashDrive - continued (PCU system)

13.1.1.3 Installation of the CNC software using WinSCP on PC/PG

Flow diagram

Installation of the software using WinSCP on PC/PG

USB-FlashDrive with NCU Service System available? — No → Installation of the NCU Service Systems on the USB-FlashDrive

Copy "<cnc-sw>.tgz" to USB-FlashDrive (root directory)

NCU Power OFF ? — No → Power OFF NCU

Insert USB-FlashDrive into the NCU (X125)

Connect NCU (X127) <-> PC/PG

PWR ON NCU

Start WinSCP on PC/PG

If a new connection is not established under "Network connections", deactivate the "Local Area Connection" and activate again.

Login at 192.168.215.1 with User: "admin" Password:"SUNRISE"

Menu "Commands" -> "Open terminal"

"/data" corresponds to USB stick at the NCU X125

Any data on the CF card is deleted!

Possible error: Sc :ERROR: unknown option -full/data/<cnc-sw>.tgz

Cause: Missing spaces between -full and /data

Input: sc restore -full /data/<cnc-sw>.tgz

Display "Syncing disk.. done."? — No

Power OFF NCU

Remove USB-FlashDrive

SIM/NCK -> 1 PLC -> 3

Power ON NCU

PLC general reset

SIM/NCK -> 0 PLC -> 0

END

Figure 13-5   Installation using WinSCP on PG/PC

13.1.1.4 Installation of the CNC software using VNC Viewer on PC/PG

Flow diagram

```
┌─────────────────────────┐                              ┌─────────────────────────────┐
│ Installation of the CNC │                              │        Main Menu:           │
│   software using        │                              │ 6 / F6: Restore NCU Software│
│    VNC Viewer           │                              └─────────────────────────────┘
│   on the PC/PG          │                              ┌─────────────────────────────┐
└─────────────────────────┘                              │ 1 / F1: Recover from USB    │
                                                         └─────────────────────────────┘
        ┌─────────────┐     ┌──────────────────┐         ┌─────────────────────────────┐
     USB-FlashDrive   │ No  │ Installation of  │         │ 1 / F1: Recover system from │
     with NCU Service │────▶│ the NCU Service  │         │      selected file          │
       System         │     │  System on the   │         └─────────────────────────────┘
      available?      │     │  USB-FlashDrive  │         ┌─────────────────────────────┐
        └─────────────┘     └──────────────────┘         │ 8 / F8: OK, continue        │
                                                         └─────────────────────────────┘
┌─────────────────────────┐                              ┌─────────────────────────────┐
│        Copy             │                              │ 7 / F7: to confirm          │
│    "<cnc-sw>tgz"        │                              └─────────────────────────────┘
│        to               │                                       ┌──────────────┐  No
│   USB-FlashDrive        │                                    Display          │───┐
│   (root directory)      │                                "Syncing disk.. done."?│
└─────────────────────────┘                                       └──────────────┘
        ┌─────────────┐   ┌──────────────────┐            ┌─────────────────────────────┐
     NCU Power        │No │  Power OFF NCU   │            │      Power OFF NCU          │
       OFF ?          │──▶│                  │            └─────────────────────────────┘
        └─────────────┘   └──────────────────┘            ┌─────────────────────────────┐
                                                         │      Remove                 │
┌─────────────────────────┐                              │   USB-FlashDrive            │
│      Insert             │                              └─────────────────────────────┘
│  USB-FlashDrive into    │                              ┌─────────────────────────────┐
│   the NCU (X125)        │                              │      SIM/NC -> 1            │
└─────────────────────────┘                              │      PLC -> 3              │
┌─────────────────────────┐                              └─────────────────────────────┘
│     Connect             │                              ┌─────────────────────────────┐
│  NCU (X127) <-> PC/PG   │                              │      Power ON NCU          │
└─────────────────────────┘                              └─────────────────────────────┘
┌─────────────────────────┐                              ┌─────────────────────────────┐
│    Power ON NCU         │                              │    PLC general reset       │
└─────────────────────────┘                              └─────────────────────────────┘
┌─────────────────────────┐                              ┌─────────────────────────────┐
│     Start               │                              │      SIM/NC -> 0            │
│  VNC Viewer on PC/PG    │                              │      PLC -> 0              │
└─────────────────────────┘                              └─────────────────────────────┘
┌─────────────────────────┐  ┌──────────────────────┐
│      Input              │  │ If a new connection  │            ┌──────────┐
│  VNC Server: 192.168.   │  │ is not established   │            │   END    │
│      215.1              │  │ under "Network       │            └──────────┘
└─────────────────────────┘  │ connections",        │
                             │ deactivate the       │
                             │ "Local Area          │
                             │ Connection" and      │
                             │ activate again.      │
                             └──────────────────────┘
```

Figure 13-6   Installation using VNC Viewer on PG/PC

13.1.2 Upgrading

Introduction

NOTICE
An upgrade is possible as of CNC software 2.xx.
An upgrade from other software versions is not permitted. In this case, a new installation is required.

- When the software is upgraded, all user data is kept on the CompactFlash card in the directories /user, /addon, /oem. The license key is kept as well.
- Backup data before each upgrade:
  - NC/PLC/drive archive
  - Load the PLC project into the PC/PG (STEP 7)
  - License key
- Prior to overwriting a licensed CompactFlash card, a backup of the license key is absolutely necessary.

  The key is available in the 'keys.txt' file and stored under the path /card/keys/sinumerik

  The backup of the key can be performed, for example, with WinSCP, from the PG/PC.
- The licenses are permanently assigned to the CompactFlash card (card ID) and can only be used on this card.

Note

The license key can be read back via Web License Manager (Page 315) using the card number.

Upgrade options

You have the following options of upgrading the CNC software:

- Automatic upgrade using USB-FlashDrive
- Upgrade using USB-FlashDrive
- Upgrade using WinSCP on PG/PC
- Upgrade using VNC Viewer on PG/PC

Note

Before the upgrade, you can backup the complete CompactFlash card. Using Restore, you can write back this backup to the CompactFlash card.

Note

For an automatic upgrade with autoexec.sh from the USB-FlashDrive, the CompactFlash card is first backed up.

The backup file "card_img.tgz" is saved under the following directory:

/machines/[machine name+serial number of the CompactflashCard]

An existing data backup is not overwritten. In this case, the operation is exited with an error.

The upgrade is made once the backup has been successfully completed.

13.1.2.1 Backup/Restore

Introduction

Before the upgrade, you can backup the complete CompactFlash Card. Using Restore, you can write back this backup to the CompactFlash Card.

Automatic backup of the complete CompactFlash Card
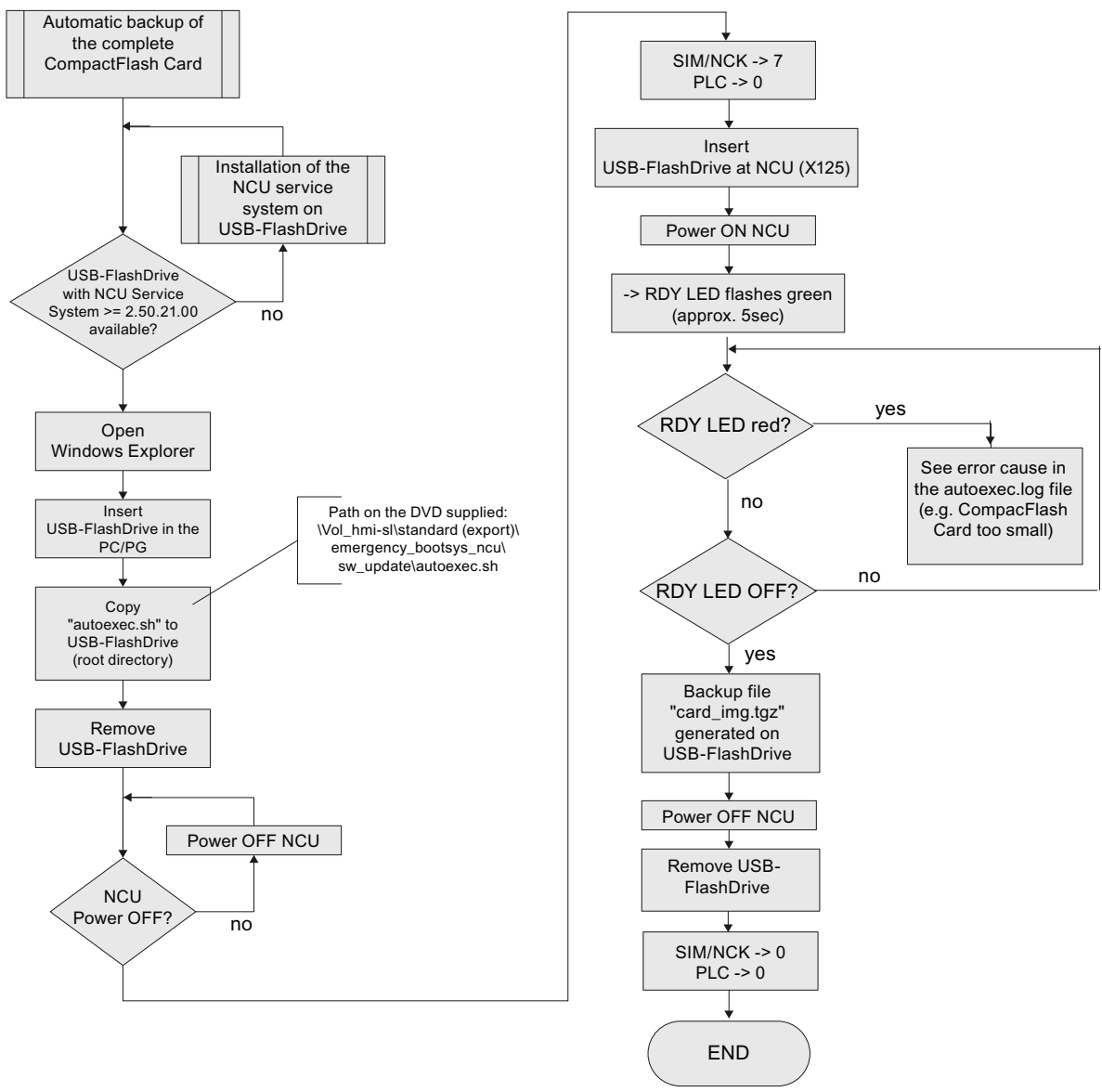
Flow diagram

Figure 13-7   Automatic backup of the complete CompactFlash Card

Automatic restoration of the complete CompactFlash Card
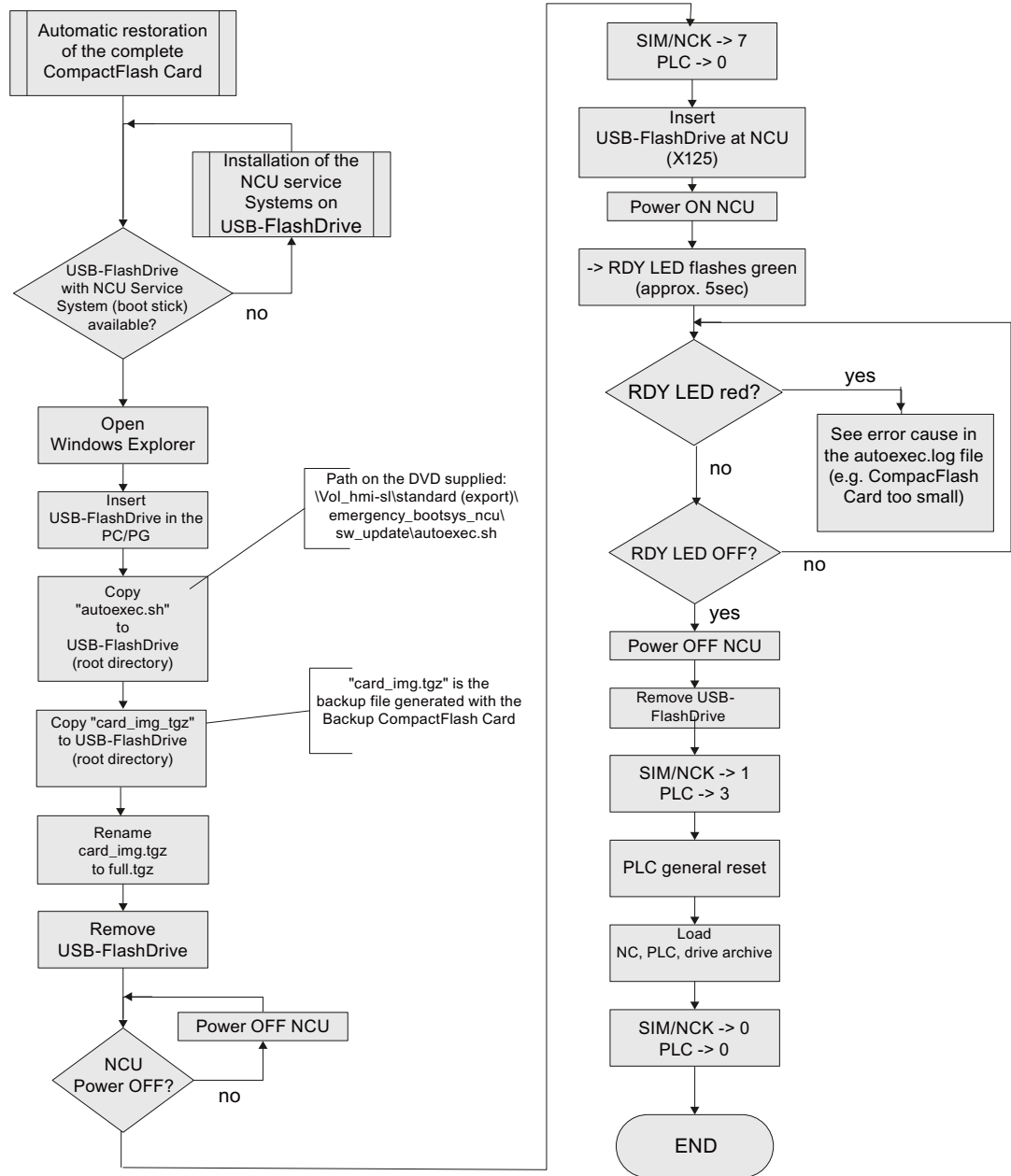
Flow diagram

Figure 13-8   Automatic restoration of the complete CompactFlash Card

13.1.2.2   Automatic upgrade of the CNC software using USB-FlashDrive
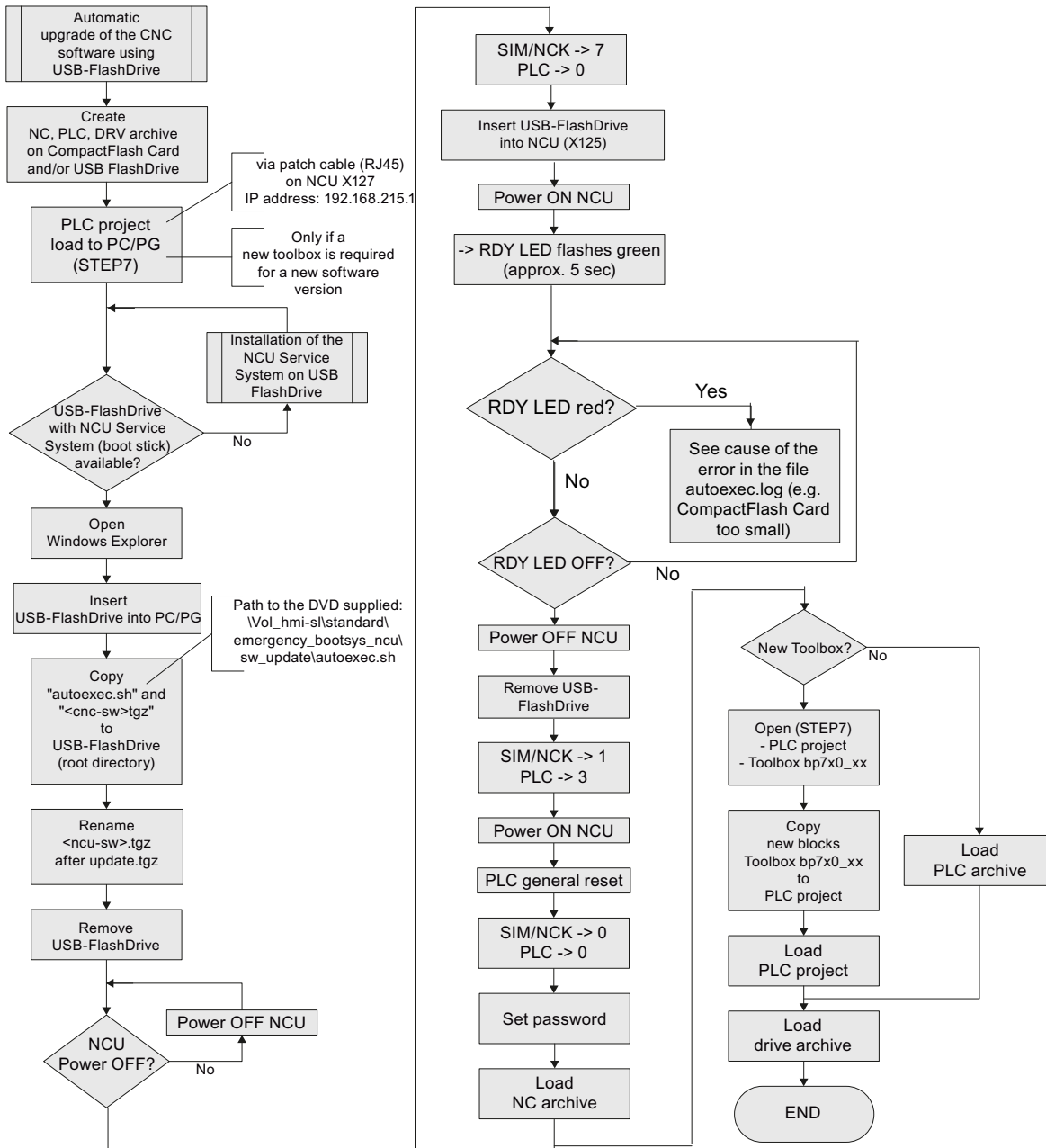
Flow diagram

Figure 13-9   Automatic upgrade of the CNC software using USB-FlashDrive

13.1.2.3 Upgrading the CNC software using USB-FlashDrive
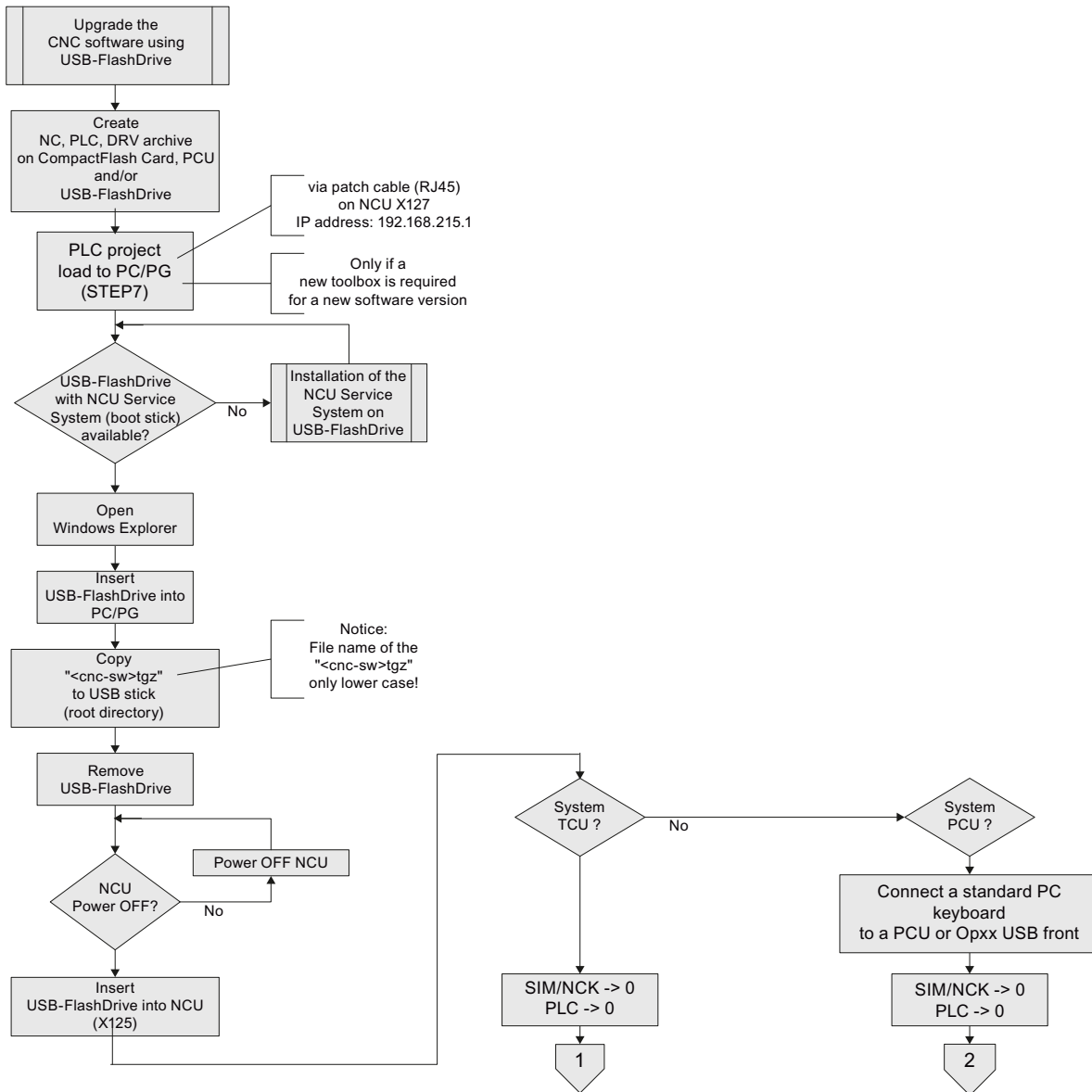
Flow diagram

Figure 13-10 Upgrading the CNC software using USB-FlashDrive

Flow diagram - continued system TCU (1)
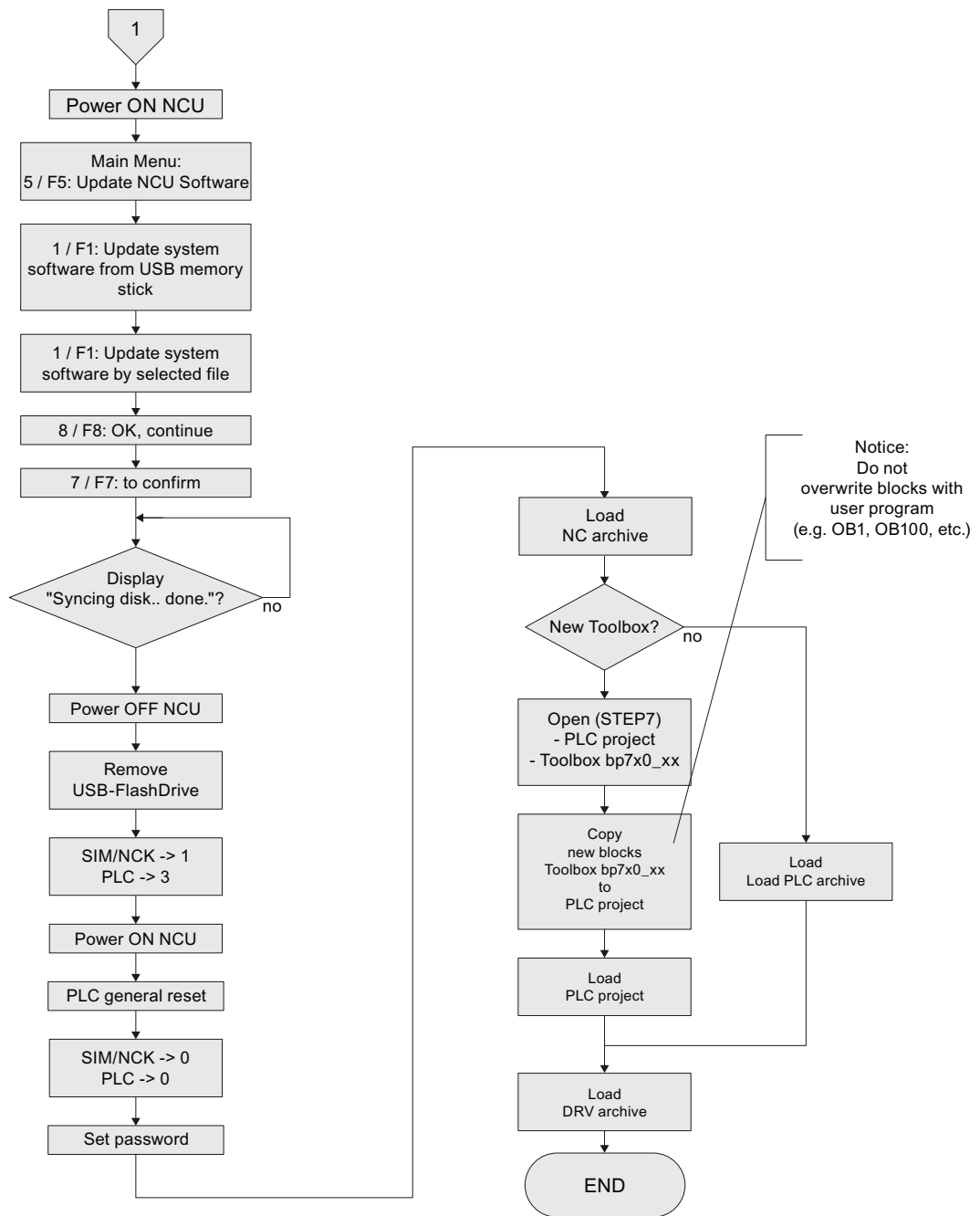
Figure 13-11 Upgrading the CNC software using USB-FlashDrive - continued (TCU system)

Flow diagram - continued PCU system (2)
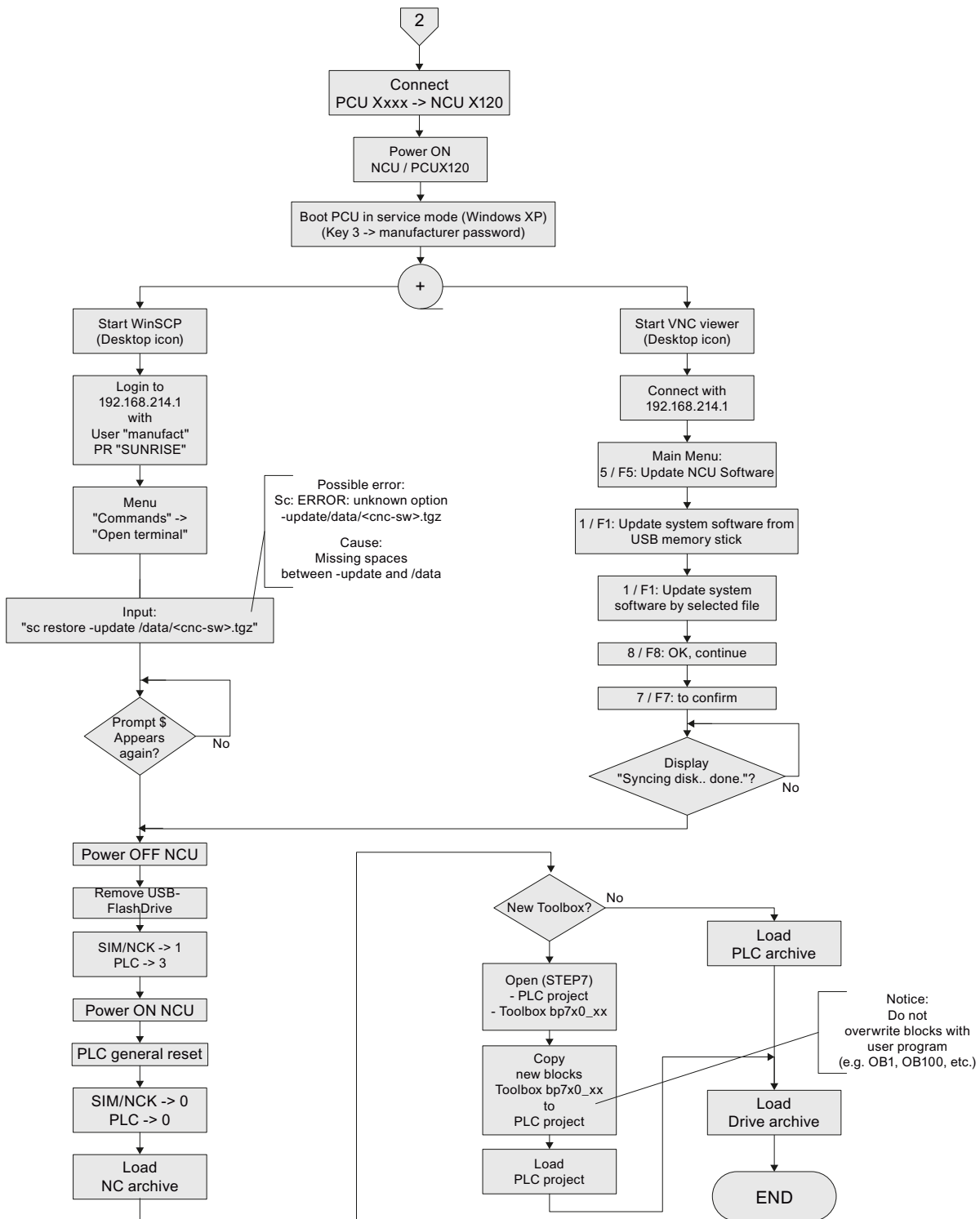
Figure 13-12 Upgrading the CNC software using USB-FlashDrive - continued (PCU system)

13.1.2.4 Upgrading the CNC software using WinSCP on PC/PG
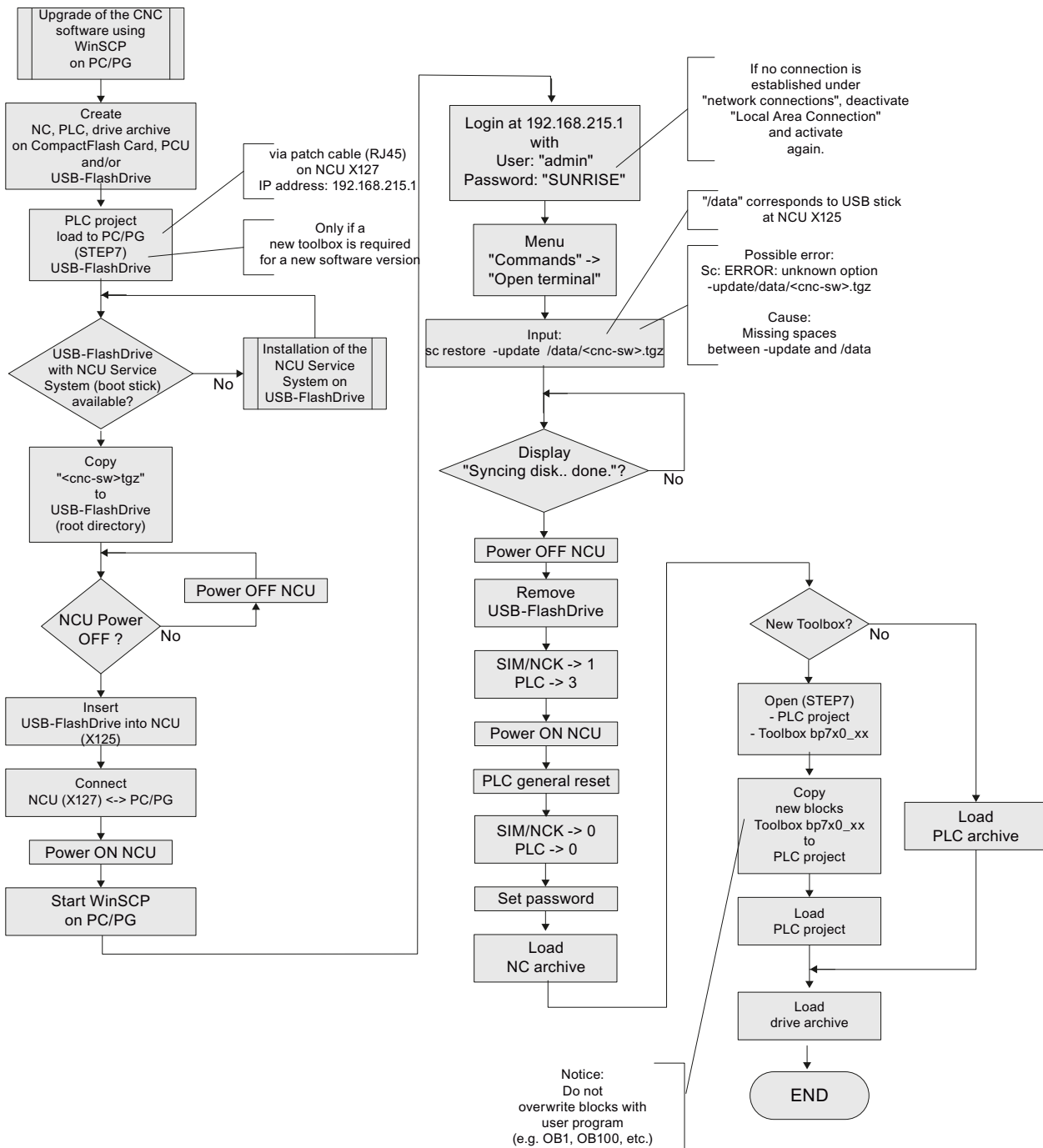
Flow diagram

Figure 13-13 Upgrading the CNC software using WinSCP on PG/PC

13.1.2.5 Upgrading the CNC software using VNC Viewer on PC/PG

Flow diagram
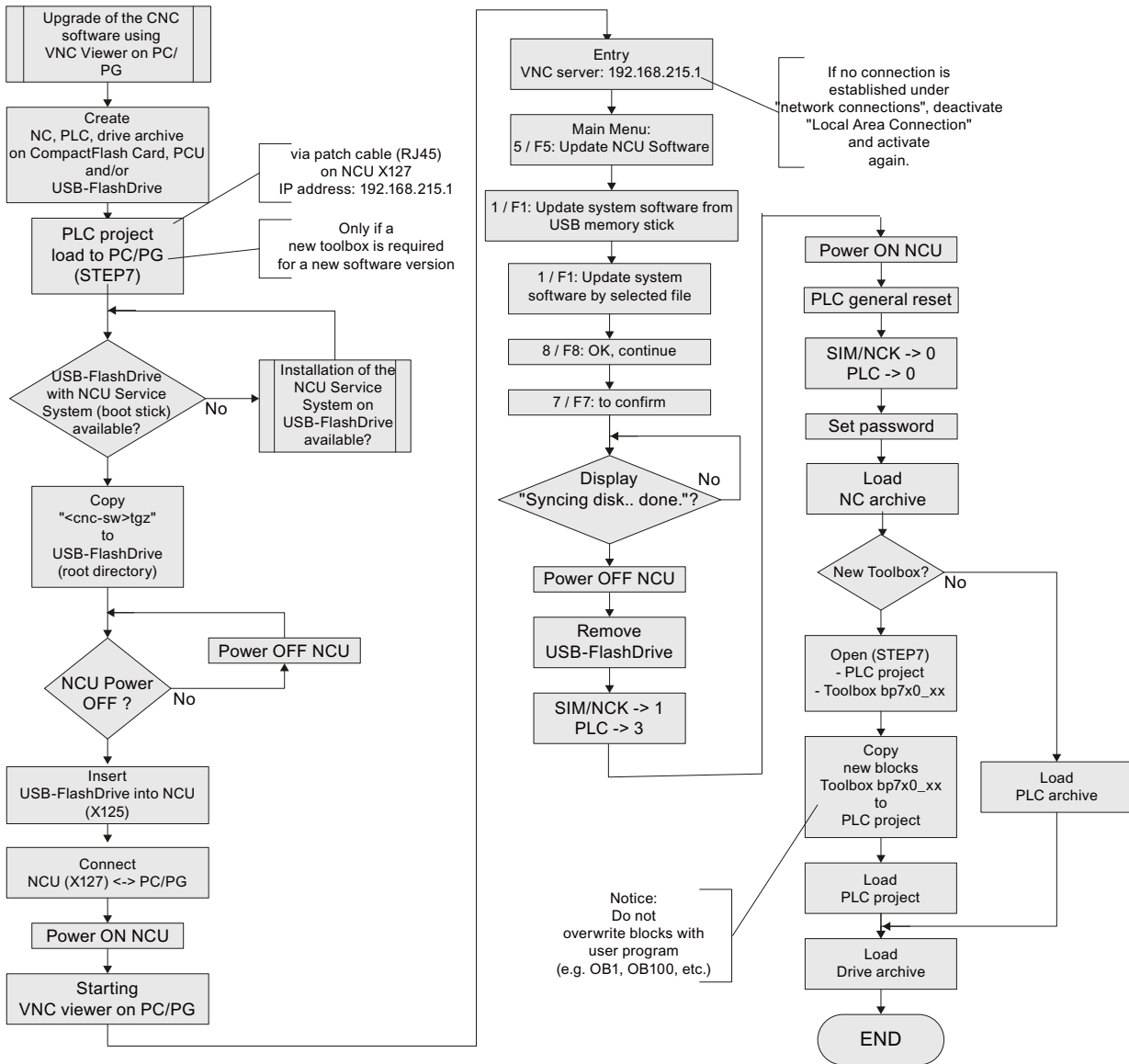
Figure 13-14 Upgrading the CNC software using VNC Viewer on PC/PG

13.2 With the help of the "Create MyConfig" software

Precondition

Precondition for the configuring of a package for the automatic reinstallation/upgrade is that the "Create MyConfig" software as of version 4.5 is installed on your PG/PC.

Basic procedure

The descriptions for reinstallation/upgrading with Create MyConfig include the basic steps for configuring and subsequent automatic reinstallation/upgrading of an NCU.

The "Create MyConfig Expert" software also provides detailed online help.

13.2.1 Automatic reinstallation with Create MyConfing (CMC)

Preconditions

The following preconditions must be met for the CompactFlash card of the NCU:

- The CompactFlash card of the NCU is empty or contains executable NCU software.

  If any CNC software and possibly irrelevant user data are on the CompactFlash card, then these are lost when the software is newly installed.

- You have a <name>.tgz file (cnc-sw.tgz) with the actual software.

- You want to initiate a new installation of the NCU via a USB FlashDrive.

- If the CompactFlash card is empty or does not contain executable CNC software, you need a USB FlashDrive with installed "NCU Service System".

Operating sequence

In order to configure a package for the reinstallation of the CNC software with "Create MyConfig Expert":

1. Start the "Create MyConfig Expert" software.

   With this software you configure an Installer package that initiates a reinstallation from the USB Flashdrive to the CompactFlash card of the NCU.

2. Create a new project under "File" > "New" > "New Project".
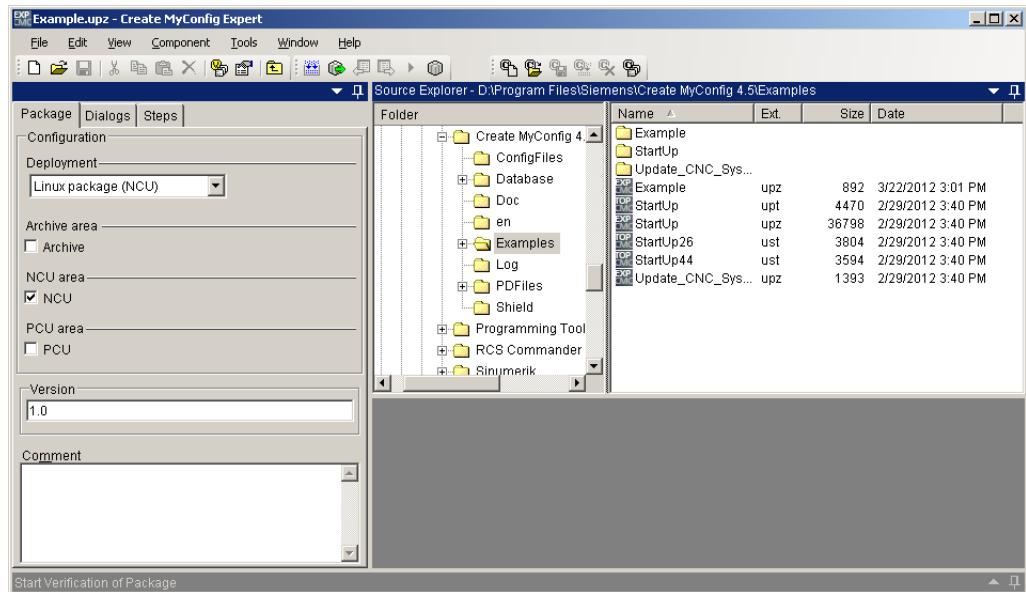
3. Activate the "NCU" area under the "Package" tab.

4. Activate the "NCU software" window from the "Dialogs" tab.
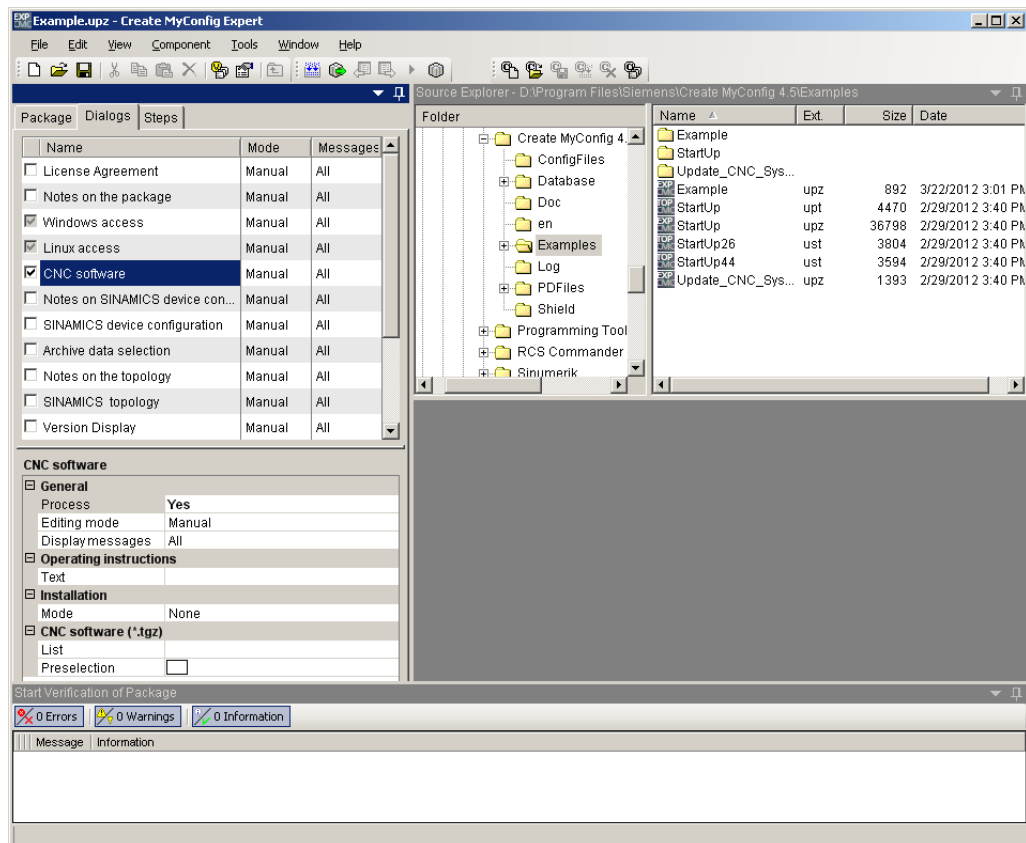
5. In the context menu, select > right mouse button > "Edit mode for all dialog boxes" > "Automatic".

Figure 13-15   Automatic edit mode

6. In the "CNC software" window under "Installation", select the "New installation" mode.
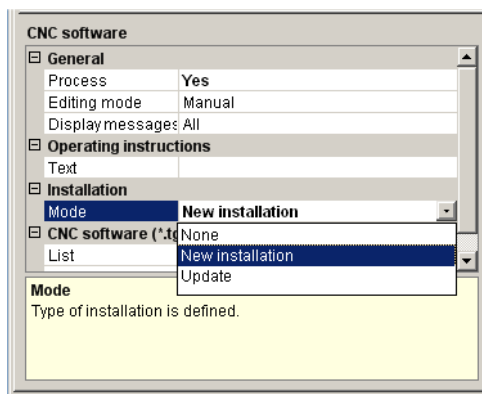
7. For the file "<name>.tgz" you have the following options:

– The file is embedded in the project or linked to the project.

For the automatic reinstallation, insert the "<name>.tgz" file in the project under "CNC software (*.tgz)". To do this, enter the name of the tgz file in the "Preselection" area.

– Copy the file on the USB FlashDrive into the root directory in which the package is located. You only enter the name with the prefix "./" in the "Preselection" field under "CNC software (*.tgz)": ./<name>.tgz

The file is automatically selected while the package is running.

8. Create a package "<name>.usz" via the menu "File" > "Transfer" > "Linux package (NCU).

    Create MyConfig Expert saves the project and performs a check routine.

    The package is placed in the root directory on the USB FlashDrive, and depending on the configuration, also the "<name>.tgz" file.

    Note

    The USB-FlashDrive must only be bootable if the CompactFlash card of the NCU does not contain executable CNC system software.

    ---

9. Insert the USB FlashDrive into a USB socket (X125 or X135) of the NCU.

10. Switch the control system off and on again.

    Provided that when configuring you configured the "Edit mode of all dialogs" > "Automatic", then the package is automatically executed when the control system boots-up. The dialogs are displayed, but require no operator actions.

    The CNC software has been installed once the package has been completed.

    A logbook about the activities that have been performed can be saved. The logbook documents all activities performed during the new installation.

11. Switch-off the controller.

12. Remove the USB FlashDrive.

13. Commissioning work can continue after the control system has been switched on.

Optional additional functions for the installation of the CNC software

In the same package - after the CNC software has been installed - the following actions can be optionally configured, which can either run completely automatically or conditionally at the machine:

- Loading an SDB Archive
- SINAMICS device configuration
- Renaming DO, SINAMICS components and DO numbers
- Assignment of the drives to NC axes
- Manipulation of display machine data
- Manipulation of individual NC and drive data
- Loading PLC user programs or individual blocks
- Installation of user software
- Copying, deleting and manipulating files on the CompactFlash card
- Conditional execution of actions, executing, deleting, copying and manipulating
- Messages and interactions to the operator

13.2.2 Automatic upgrade with Create MyConfig (CMC)

Introduction

Note

For details on upgrading the versions of CNC software, read the "siemensd.rtf" (German) or "siemense.rtf" (English) file on the product CD of Create MyConfig.

When the software is upgraded, all user data is kept on the CompactFlash card and in the control areas NCK, PLC and drives. The NCK and drive data are automatically migrated into the new CNC software version. Archives neither have to be created nor imported again.

The "NCK commissioning switch" and "PLC mode selector switch" remain during the upgrade in position "0".

In conjunction with an upgrade, using the same package, the automatic generation of a backup can be configured, which is then stored on the USB FlashDrive. It is not necessary to first generate an archive.

Note

After the CNC software has been upgraded, adaptations may be required. Using the Create MyConfig Expert, these adaptations can also be configured and therefore automatically executed.
For information about the necessary adaptations, please refer to the upgrade instructions of the respective CNC software versions.

Operating sequence

In order to configure a package for the upgrade of the CNC software with "Create MyConfig Expert":

1. You have started the "Create MyConfig Expert" software.

    Using this software, you configure a package that initiates an upgrade of the CNC software on the CompactFlash card of the NCU.

2. You have created a new project under "File" > "New" > "New Project".
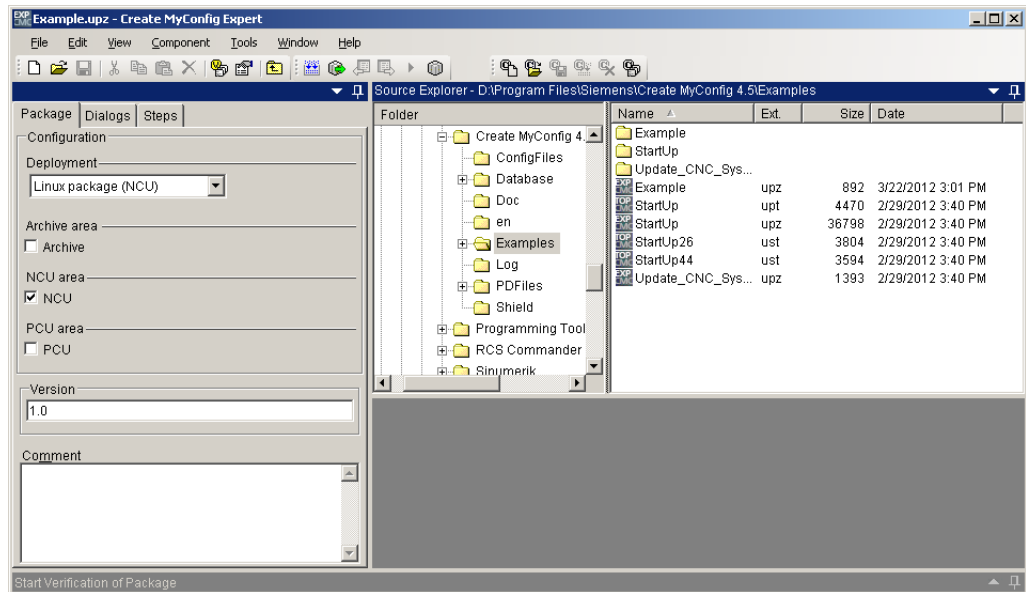
3. Activate the "NCU" area under the "Package" tab.

4. Activate the "NCU software" window from the "Dialogs" tab.
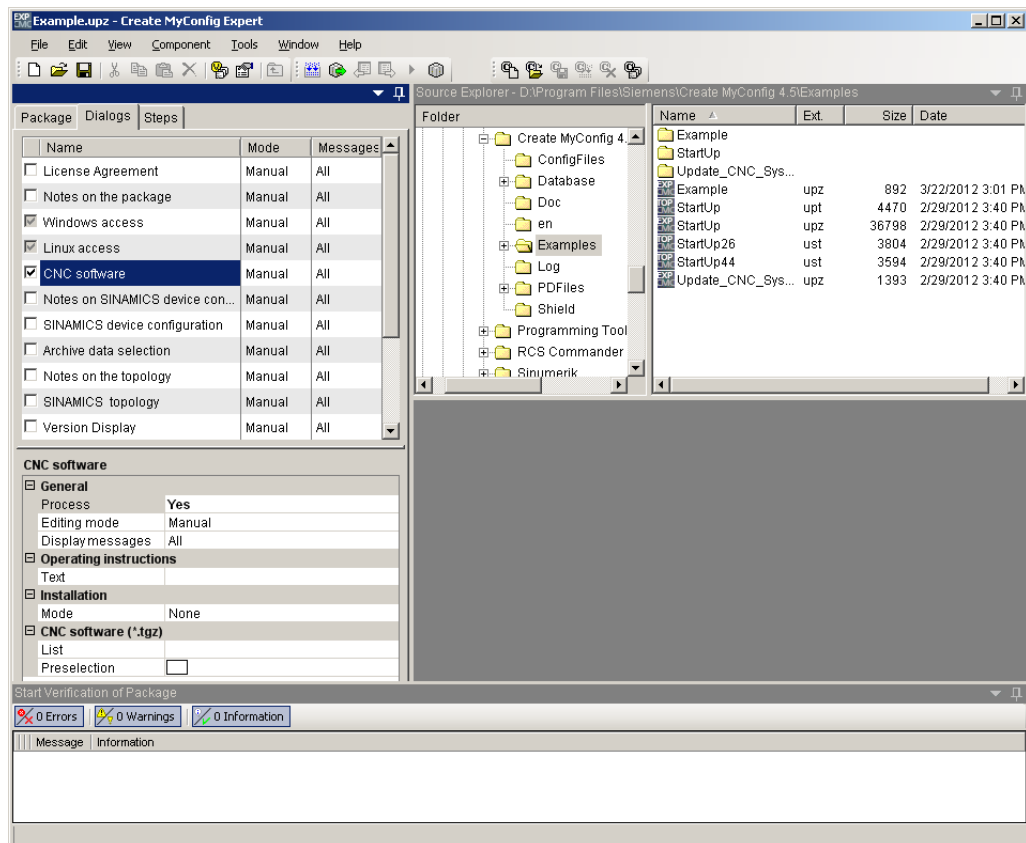
5. In the context menu, select > right mouse button > "Edit mode for all dialog boxes" > "Automatic".
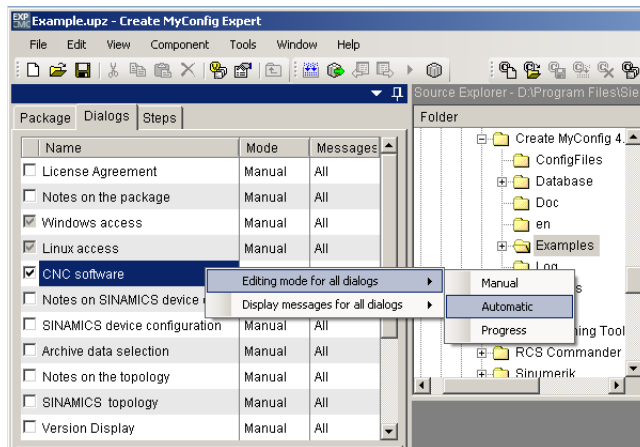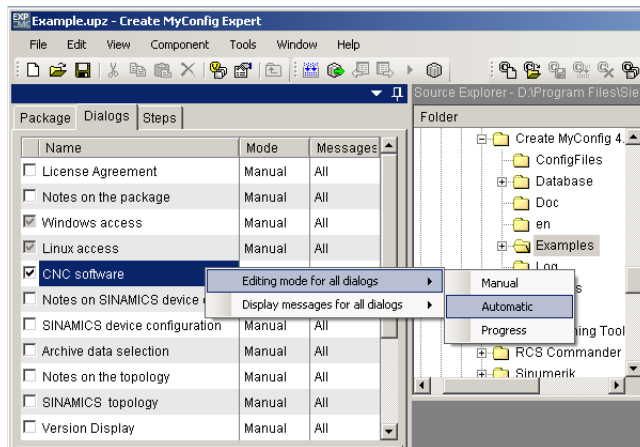

6. In the "CNC software" window under "Installation", select the "Upgrade" mode.
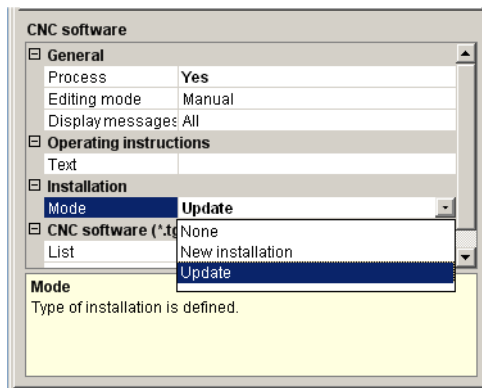
7. For the <name>.tgz files you have the following options:

   – The file is embedded in the project or linked to the project.

   For the automatic reinstallation, insert the "<name>.tgz" file in the project under "CNC software (*.tgz)". To do this, enter the name of the tgz file in the "Preselection" area.

   – Copy the file on the USB FlashDrive into the root directory in which the package is located.

   You only enter the name with the prefix "./" in the "Preselection" field under "CNC software (*.tgz)": ./<name>.tgz

   The file is automatically selected while the package is running.

8. Create a package "<name>.usz" via the menu "File" > "Transfer" > "Linux package (NCU).

   Create MyConfig Expert saves the project and performs a check routine.

   The package is placed in the root directory on the USB FlashDrive, and depending on the configuration, also the "<name>.tgz" file.

9. Insert the USB FlashDrive into a USB socket (X125 or X135) of the NCU.

10. Switch the control system off and on again.

   Provided that when configuring you configured the "Edit mode of all dialogs"
   → "Automatic", then the package is automatically executed when the control system
   boots-up. The CNC software has been upgraded and all data is available again after the
   package has been completed on the NCU.

   A logbook about the activities that have been performed can be saved. The logbook
   documents all activities performed during the upgrade.

11. Switch-off the controller.

12. Remove the USB-FlashDrive.

13. The machine is ready for operation again after switch-on.

Optional additional functions when upgrading the CNC software

In the same package - after the CNC software has been installed - the following actions can
be optionally configured, which can either run completely automatically or conditionally at the
machine:

- Manipulation of display machine data

- Manipulation of individual NC and drive data

- Loading PLC user programs or individual blocks

- Installation of user software

- Copying, deleting and manipulating files on the CompactFlash card

- Conditional execution of actions, executing, deleting, copying and manipulating

- Messages and interactions to the operator

Fundamentals

14

14.1 Basic information on SINAMICS S120

14.1.1 Rules for wiring the DRIVE-CLiQ interface

Topology rules

When wiring components with DRIVE CLiQ, the following rules apply: The rules are subdivided into **obligatory rules**, which must be observed, and **optional rules**, which enable automatic topology detection if they are adhered to.

Obligatory rules:

- A maximum of 198 DRIVE-CLiQ node components can be connected for each NCU.

- Up to 16 nodes can be connected to a DRIVE-CLiQ socket.

- A maximum of 7 nodes can be connected in one row. A row is always considered from the perspective of the closed-loop control module.

- Ring wiring is not permitted.

- Components must not be double-wired.

Optional rules:

When the optional rules for the DRIVE-CLiQ wiring are observed the components concerned will be automatically assigned to the drives:
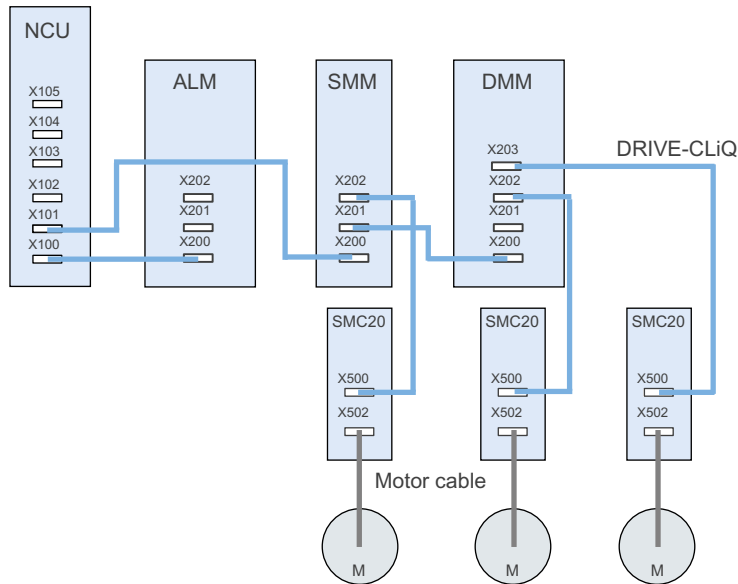
NCU	SINUMERIK control system
ALM	Active Line Module
SMM	Single Motor Module
DMM	Double Motor Module
M	Motor

Figure 14-1   topology

- For one motor module, the related motor encoder must also be connected.

- Due to the improved performance utilization, use as many of the DRIVE-CLiQ points on the NCU as possible.

- It is essential you comply with the optional rules when using the macro. This is the only way to achieve a proper assignment of the drive components.

14.1.2 Drive objects and drive components

Example of a drive line-up

The components that belong to the drive group are reflected in the parameterization in a drive object. Each drive object has its own parameter list.

Using the example of a SINAMICS S120 drive line-up, the significance of the drive components on drive objects is shown:
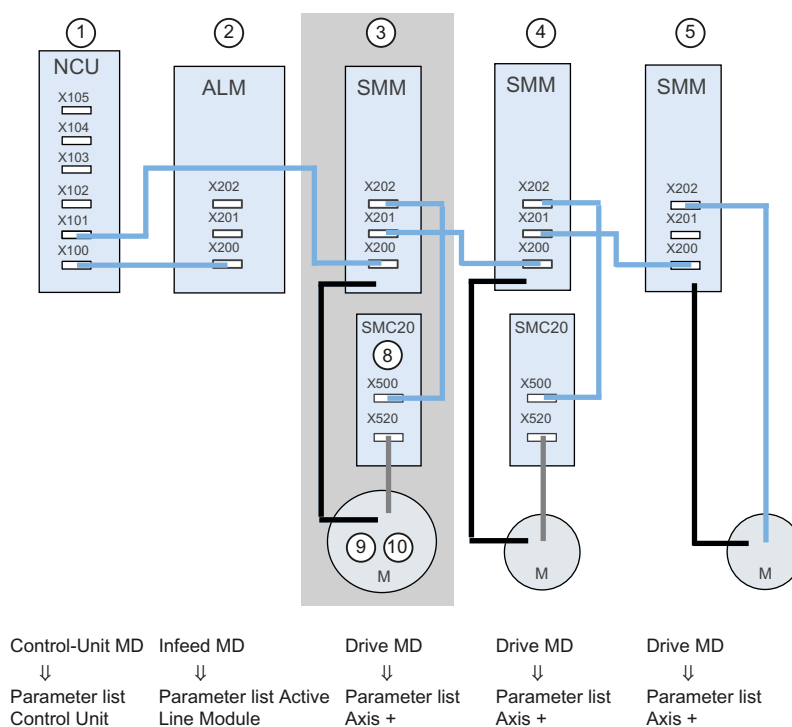
Drive object DO3 comprises the following components:

③   Single Motor Module

⑧   SMC20

⑨   Motor encoder

⑩   Motor

Figure 14-2   Drive group

The component number is assigned by the drive after detection of the DRIVE-CLiQ topology. You can see the respective component numbers in the parameter list for the relevant drive object in the operator area "Start-up" → "Machine data" → "Drive MD" → "Axis + ":

Parameter	Parameter designation
p0121	Power unit component number
p0131	Motor component number
p0141	Encoder interface (Sensor Module) component number
p0142	Encoder component number

14.1.3 BICO interconnection

Introduction

Each drive unit contains a large number of interconnectable input and output variables as well as internal control variables.

BICO technology (binector connector technology) allows the drive to be adapted to a wide variety of conditions.

Digital and analog signals, which can be connected freely by means of BICO parameters, are identified by the prefix BI, BO, CI, or CO in their parameter name.

These parameters are identified accordingly in the parameter list or in the function diagrams.

There are:

● Binectors (digital), with
 BI: binector input, BO: binector output

● Connectors (analog), with
 CI: connector input, CO: connector output

Interconnecting signals using BICO technology

To interconnect two signals, a BICO input parameter (signal sink) must be assigned to the required BICO output parameter (signal source).

Visualization of the BICO interconnection

Under the following menu you can create a BICO interconnection to the components involved in the SINAMICS drive lineup.
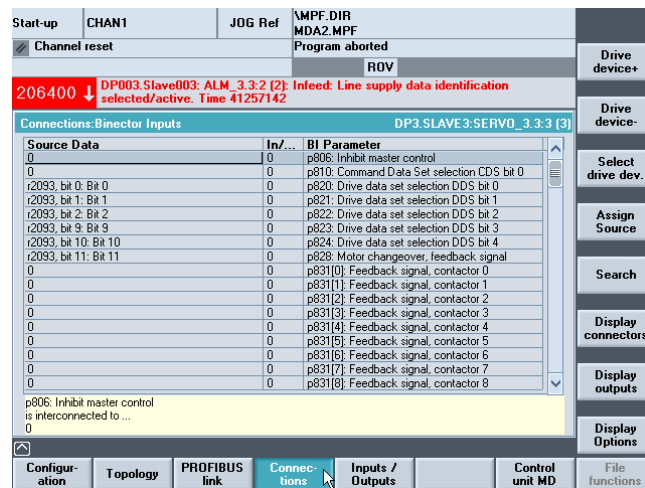
Figure 14-3   "Connections" menu

References

SINAMICS S120 List Manual

14.2 Transfer telegrams

Introduction

The transfer telegrams from NCK to the drive are transferred via an internal PROFIBUS on the NCU. They are:

- Send telegrams (drive->NCK)
- Receive telegrams (drive->NCK)

Telegrams

The telegrams are standard telegrams with pre-defined assignment of the process data. These telelgrams are interconnected in the drive object using BICO technology.

The drive objects that can exchange process data include the following:

1. Active line module (A_INF)
2. Basic line module (B_INF)
3. Motor module (SERVO)
4. Control unit (CU)

The order of the drive objects in the telegram is displayed on the drive page via the parameter list in the "Commissioning" > "Machine data" > "Control Unit MD" operating area in p978[0...15] and may also be changed through it.

Literature

SINAMICS S120 Commissioning Manual

Receive words/send words

By selecting a telegram via p922 of the related drive object (operating area "Commissioning" > "Machine data" > "Drive MD"), the process data is determined which is transferred between the master and slave.

From the perspective of the slave, the received process data comprises the receive words and the process data to be sent the send words.

The receive and send words are comprised of the following elements:

- Receive words: Control words or setpoints
- Send words: Status words or actual values

Telegram types

What types of telegrams are available?

- Standard telegrams

  The standard telegrams are structured in accordance with the PROFIdrive Profile V3.1. The internal process data links are set up automatically in accordance with the telegram number setting.

- Manufacturer-specific telegrams

  The manufacturer-specific telegrams are structured in accordance with internal company specifications. The internal process data links are set up automatically in accordance with the telegram number setting.

The telegram length for communication with the drive must be defined in the hardware configuration. The telegram length to be chosen depends on the axis functions required, e.g. the number of encoders or the functions in the drive.

Note

If you change the telegram length of a drive component in HW Config, you also must adjust the selection of the telegram type in the configuration of the interface in the NCK.

The following vendor-specific telegrams can be set via p0922:

Telegram number:		
for axes (SERVO)	**116:**	Speed setpoint, with 2 position encoders, torque reduction and DSC, plus load, torque, power and current actual values
	118:	Speed setpoint, with 2 external position encoders, torque reduction and DSC, plus load, torque, power and current actual values
	136:	DSC with torque pre-control, 2 position encoders (encoder 1 and encoder 2), 4 trace signals
for Control Unit	**390:**	Telegram without measuring probe for NX expansion
	391:	Telegram for up to two probes for NCU

Note

The telegrams 136, 390 and 391 are preset by default via HW Config. It is recommended not to change these.

14.2.1 Structure of the telegram with the process data for SINUMERIK 840D sl

Telegrams for receiving

The following table contains the structure of the telegrams with the process data for receiving the **control words (STW) and setpoints (NCK → drive).**

Table 14- 1   Process data (PZD)

PZD	Telegram 116 / 118	Telegram 136	Telegram 390	Telegram 391
PZD 1	STW1	STW1	STW1	STW1
PZD 2	NSOLL_B	NSOLL_B	Digital outputs	Digital outputs
PZD 3			--	STW_PROBES
PZD 4	STW2	STW2	--	--
PZD 5	M_RED	M_RED	--	--
PZD 6	G2_STW	G1_STW	--	--
PZD 7	G3_STW	G2_STW	--	--
PZD 8	XERR	XERR	--	--
PZD 9			--	--
PZD 10	KPC	KPC	--	--
PZD 11			--	--
PZD 12	--	M_VST	--	--
PZD 13	--	DSC_STW	--	--
PZD 14	--	--	--	--
PZD 15	--	T_SYMM	--	--

Telegrams for sending

The following table contains the structure of the telegrams with the process data for sending the **status words (ZSW) and actual values (drive → NCK).**

Table 14- 2   Process data (PZD)

PZD	Telegram 116 / 118	Telegram 136	Telegram 390	Telegram 391
PZD 1	ZSW1	ZSW1	ZSW1	ZSW1
PZD 2	NIST_B	NIST_B	Digital inputs	Digital inputs
PZD 3			--	ZSW_PROBES
PZD 4	ZSW2	ZSW2	--	TIMESTAMP_PROBE_1N
PZD 5	MELDW	MELDW	--	TIMESTAMP_PROBE_1P
PZD 6	G1_ZSW	G1_ZSW	--	TIMESTAMP_PROBE_2N
PZD 7	G1_XIST1	G1_XIST1	--	TIMESTAMP_PROBE_2P
PZD 8			--	--
PZD 9	G1_XIST2	G1_XIST2	--	--
PZD 10			--	--
PZD 11	--	G2_ZSW	--	--

PZD	Telegram 116 / 118	Telegram 136	Telegram 390	Telegram 391
PZD 12	--	G2_XIST1	--	--
PZD 13	--		--	--
PZD 14	--	G2_XIST2	--	--
PZD 15	--		--	--
PZD 16	AIST_GLATT (NCK: AA_LOAD)	AIST_GLATT (NCK: AA_LOAD)	--	--
PZD 17	MSOLL_GLATT (NCK: AA_TORQUE)	MSOLL_GLATT (NCK: AA_TORQUE)	--	--
PZD 18	PIST_GLATT (NCK: AA_POWER)	PIST_GLATT (NCK: AA_POWER)	--	--
PZD 19	ITIST_GLATT (NCK: AA_CURR)	ITIST_GLATT (NCK: AA_CURR)	--	--

14.2.2 Process data for receiving and sending

Process data for receiving

The process data for the control words and setpoints are interconnected in the receive buffer.

Overview of control words and setpoints

The table below provides an overview of the process data that are interconnected as target at the receive buffer.

Abbreviation	Name
STW1	Control word 1
STW2	Control word 2
NSOLL_A	Speed setpoint A (16-bit)
NSOLL_B	Speed setpoint B (32-bit)
G1_STW	Encoder 1 control word
G2_STW	Encoder 2 control word
G3_STW	Encoder 3 control word
XERR	Positional deviation
KPC	Position controller gain factor
M_RED	Torque reduction
A_STW1	Control word for A_INF/B_INF (infeed)
STW_PROBES	Control word probes

Note

The drive signals are interconnected to the PZD automatically when a telegram type is allocated (parameter p0922).

Process data for sending

The process data for the control words and setpoints are interconnected in the send buffer.

Overview of status words and actual values

The table below provides an overview of the process data that are interconnected as source at the transmit buffer.

Abbreviation	Name
ZSW1	Status word 1
ZSW2	Status word 2
NIST_A	Speed setpoint A (16 bit)
NIST_B	Speed setpoint B (32 bit)
G1_ZSW	Encoder 1 status word
G1_XIST1	Encoder 1 actual position value 1
G1_XIST2	Encoder 1 actual position value 2
G2_ZSW	Encoder 2 status word
G2_XIST1	Encoder 2 actual position value 1
G2_XIST2	Encoder 2 actual position value 2
G3_ZSW	Encoder 3 status word
G3_XIST1	Encoder 3 actual position value 1
G3_XIST2	Encoder 3 actual position value 2
MELDW	Message word
A_ZSW1	Status word for A_INFEED (infeed)
LOAD	Drive load
TORQUE	Drive torque setpoint
POWER	Drive efficiency
CURR	Drive actual current
ZWS_PROBES	Status word probe
TIMESTAMP_PROBE_1N	Time stamp probe 1 falling edge
TIMESTAMP_PROBE_1P	Time stamp probe 1 rising edge
TIMESTAMP_PROBE_2N	Time stamp probe 2 falling edge
TIMESTAMP_PROBE_2P	Time stamp probe 2 rising edge

References

SINAMICS S120 Commissioning Manual

14.3 Bits of the control and status words

14.3.1 NCK to drive

Introduction

The NCK transfers data to the drive using message frames via a PROFIBUS interface (internal PROFIBUS). Setpoints exist for speed control and torque and are preceded by a control word in the message frame.

PLC interface for STW1

Signal provided by NCK	VDI interface (PLC)	Remarks	Bit in STW1	Meaning
Axis controllable from NCK: • Servo enable • Measuring system selected and OK • Pulse enable • …	DB(AX).DBX2.1 DB(AX).DBX1.5/6 DB(AX).DBX21.7		0	OFF1
always "1", "TRUE"	No signal		1	OFF2
always "1", "TRUE"	No signal		2	OFF3
VDI signal pulse enable	DB(AX).DBX21.7		3	Enable inverter
HLGSS	DB(AX).DBX20.1		4	Ramp-function generator enable
HLGSS	DB(AX).DBX20.1		5	Ramp-function generator Start
		NCK controlled in parallel to STW1 bit0	6	Setpoint enable
(DriveReset) is generated by: • "RESET signal" or CANCEL key, if a drive fault is simultaneously present (ZSW1.bit3 or ZSW1.bit6)	No signal	Signal "OFF1" is automatically set to FALSE internally, simultaneously to "DriveReset" (user must NOT manipulate the servo enable separately!).	7	Reset fault memory
Selection of NC function generator (via PI service from HMI)	No signal	The user cannot influence the function generator selection via the VDI interface.	8	Activate function generator
always "0", "FALSE"	No signal	Signal not used	9	Reserved

Signal provided by NCK	VDI interface (PLC)	Remarks	Bit in STW1	Meaning
is "1", "TRUE", if the NC can control the associated drive AND the drive requests the control (ZSW1.bit9)	No signal		10	Control requested
"always "0", "FALSE"	No signal	Signal not used	11	Reserved
"Release holding brake"	DB(AX).DBX20.5		12	Open holding brake
always "1", "TRUE"	No signal	Signal is used as the identifier to shut down the drive's ramp-function generator (isochronous Profibus drive)	13	Ramp-up time zero for controller enable
always "1", "FALSE"	No signal	Signal not used	14	Open-loop torque-controlled mode
Customer-specific signal	no Signal for SINAMICS,		15	In conjunction with SINUMERIK the signal is not used, not aPROFIDRIVE standard signal

PLC interface for STW2

Signal provided by NCK	VDI interface (PLC)	Remarks	Bit in STW2	Meaning
Drive-parameter-set switchover	DB(AX).DBX21.0	Bit A	0	Parameter-set switchover, bit0
	DB(AX).DBX21.1	Bit B	1	Parameter-set switchover, bit1
	DB(AX).DBX21.2	Bit C	2	Parameter-set switchover, bit2
1. Speed setpoint filter	DB(AX).DBX20.3	Not used for SINUMERIK or SINAMICS (ineffective)	3	1. Speed setpoint filter
Ramp-function generator disable	DB(AX).DBX20.4	Not used for SINUMERIK or SINAMICS (ineffective)	4	Ramp-function gen. inactive
Always "FALSE"		not used	5	Reserved
Integrator inhibit, speed controller	DB(AX).DBX21.6		6	Integrator inhibit, speed controller
Selection of "parking axis" by shutting down the encoder bit on the VDI interface	DB(AX).DBX1.5 = FALSE & DB(AX).DBX1.6 = FALSE		7	Selection of "parking axis"

Signal provided by NCK	VDI interface (PLC)	Remarks	Bit in STW2	Meaning
Traversing to fixed endstop	No signal	Drive fault "speed controller at limit" deactivated	8	Suppress fault 608, "speed controller at limit"
Motor changeover/selection	DB(AX).DBX21.3	Bit A	9	Motor changeover, bit0
	DB(AX).DBX21.4	Bit B	10	Motor changeover, bit1
Motor being selected	DB(AX).DBX21.5		11	Motor being selected
Master sign-of-life	No signal		12	Master sign-of-life
			13	
			14	
			15	

14.3.2 Drive to NCK

Introduction

The drive transfers the data to the NCK using message frames via a PROFIBUS interface (internal PROFIBUS). Actual values exist for the speed control and torque and are preceded by a status word in the message frame.

PLC interface for ZSW1

Meaning	Bit in ZSW1	Comment	VDI interface (PLC)	Signal processing in the NCK
Ready to start	0		No signal	
Ready-to-operate/no fault	1		No signal	
Status, controller enable	2	For a combination bit 2 from ZSW1 = 0 and simultaneously bit 11 from MeldW = 1, the drive is in an independent state.	DB(AX).DBX92.4	
Fault active	3		No signal	Alarm 25201/25202, is used to activate error deletion on the NCK.
No OFF2 pending.	4		No signal	Not used
No OFF3 is active	5		No signal	Not used
Power-on inhibit	6		No signal	Used on the NCK to generate the "Acknowledge fault memory" signal.
Warning present	7		No signal	No evaluation

Meaning	Bit in ZSW1	Comment	VDI interface (PLC)	Signal processing in the NCK
nset = nact	8		No signal	No evaluation
Control requested	9	Signal is primarily set by the drive.	No signal	The NCK itself then sets the associated STW1.bit9, if the drive in the NC is known to be "operational" and "ready" (e.g. bus booted, etc.).
Comparison value reached	10		No signal	No evaluation
Reserved	11		No signal	No evaluation
Reserved	12		No signal	No evaluation
Function generator active	13		DB(AX).DBX61.0	Drive test "travel request"
Only used in "positioning mode": Open-loop torque-controlled mode	14	Irrelevant for SINUMERIK	No signal	No evaluation
Only used in "positioning mode": Spindle positioning ON	15	Irrelevant for SINUMERIK	No signal	No evaluation

PLC interface for ZSW2

Meaning	Bit in ZSW2	Comment	VDI interface (PLC)	Signal processing in the NCK
Parameter set	0	Bit A	DB(AX).DBX93.0	Active drive parameter set
	1	Bit B	DB(AX).DBX93.1	
	2	Bit C	DB(AX).DBX93.2	
1. speed-setpoint filter inactive	3	Signal from SINAMICS not used	DB(AX).DBX92.3	As the signal from SINAMICS is not used: signal always "0", ""FALSE"
Ramp-function gen. inactive	4		DB(AX).DBX92.1	Ramp-function-generator disable active
Holding brake open	5		DB(AX).DBX92.5	Holding brake open
Integrator inhibit, speed controller	6		DB(AX).DBX93.6	Speed controller integrator disabled
Status: Parking axis	7	Axis parked via SINAMICS	No signal	NCK cannot respond to the "axis parked" state => alarm 25000, An alarm is output if the drive parks even though parking was not requested.
Suppress "speed controller at limit" fault	8		No signal	
Motor data set	9	Bit A	DB(AX).DBX93.3	Active motor
	10	Bit B	DB(AX).DBX93.4	

Meaning	Bit in ZSW2	Comment	VDI interface (PLC)	Signal processing in the NCK
Motor being changed over	11		No signal	
Slave sign-of-life	12		No signal	Drive sign-of-life
	13			
	14			
	15			

PLC interface for MeldW

Meaning	Bit in MeldW	Comment	VDI interface (PLC)	Signal processing in the NCK
Ramp-up function completed	0		DB(AX).DBX94.2	Ramp-up function completed
M<Mx	1		DB(AX).DBX94.3	M<Mx
Nact<Nmin	2		DB(AX).DBX94.4	Nact<Nmin
Nact<Nx	3		DB(AX).DBX94.5	Nact<Nx
DC-link overvoltage	4		DB(AX).DBX95.0	Signal not available for SINAMICS 120!
Variable signaling function	5		DB(AX).DBX94.7	Signal not available for SINAMICS 120!
Motor temperature pre-warning	6		DB(AX).DBX94.0	Motor temperature pre-warning
Heatsink-temperature prewarning	7		DB(AX).DBX94.1	Heatsink-temperature prewarning
Nsetp=Nact	8		DB(AX).DBX94.6	
Reserved	9		kein Signal	No evaluation
Power module current not limited	10		DB(AX).DBX95.7	Signal not available for SINAMICS 120!
Reserved	11	Speed controller active	DB(AX).DBX61.6& DB(AX).DBX61.7	
Reserved	12	Drive Ready	DB(AX).DBX93.5	
Pulses enabled	13	Only for SINAMICS S120 with message-frame types 101ff direct on VDI interface	DB(AX).DBX93.7	
Reserved	14	Only in conjunction with positioning mode, irrelevant for SINUMERIK	No signal	No evaluation
Reserved	15	Only in conjunction with positioning mode, irrelevant for SINUMERIK	No signal	No evaluation

14.4 Axis data

Introduction

The term "axis" is often used either as a single term in conjunction with SINUMERIK 840D sl or in compounded form, e.g. machine axis, channel axis, etc. To provide an overview of the philosophy used as the basis, here is a brief explanation of this term.

Definition

Generally, 4 types of axes are distinguished:

1. Machine axes
2. Channel axes
3. Geometry axes
4. Special axes

Machine axes

Machine axes are the motion units existing on a machine, which can also be designated as linear or rotary axes, depending on their usable movement.

Channel axes

The total of all machine, geometry and special axes assigned to a channel is designated as channel axes.

In this context, the geometry and special axes constitute the program-technological part of the machining process, i.e. they are used for programming in the parts program.

The machine axes constitute the physical part of the machining process, i.e. they carry out the programmed traversing movements on the machine.

Geometry axes

The geometry axes constitute the rectangular Cartesian basic coordinate system of a channel.

Generally, (Cartesian arrangement of the machine axes) direct imaging of the geometry axes to the machine axes is possible. If the arrangement of the machine axes, however, is not Cartesian at right angles, the imaging is performed using a kinematic transformation.

Special axes

Additional axes are all other channel axes that are not geometry axes. Unlike for geometry axes (Cartesian coordinate system), no geometric context is defined for additional axes, neither between additional axes or with respect to geometry axes.

Literature

Function Manual Basic Functions; Axes, Coordinate Systems, Frames, Workpiece numbers IWS: Axes

14.4.1 Axis assignment

Assigning axes

The assignment of geometry axes to channel axes and channel axes to machine axes, as well as the definition of the names of the different axis types is realized via machine data.

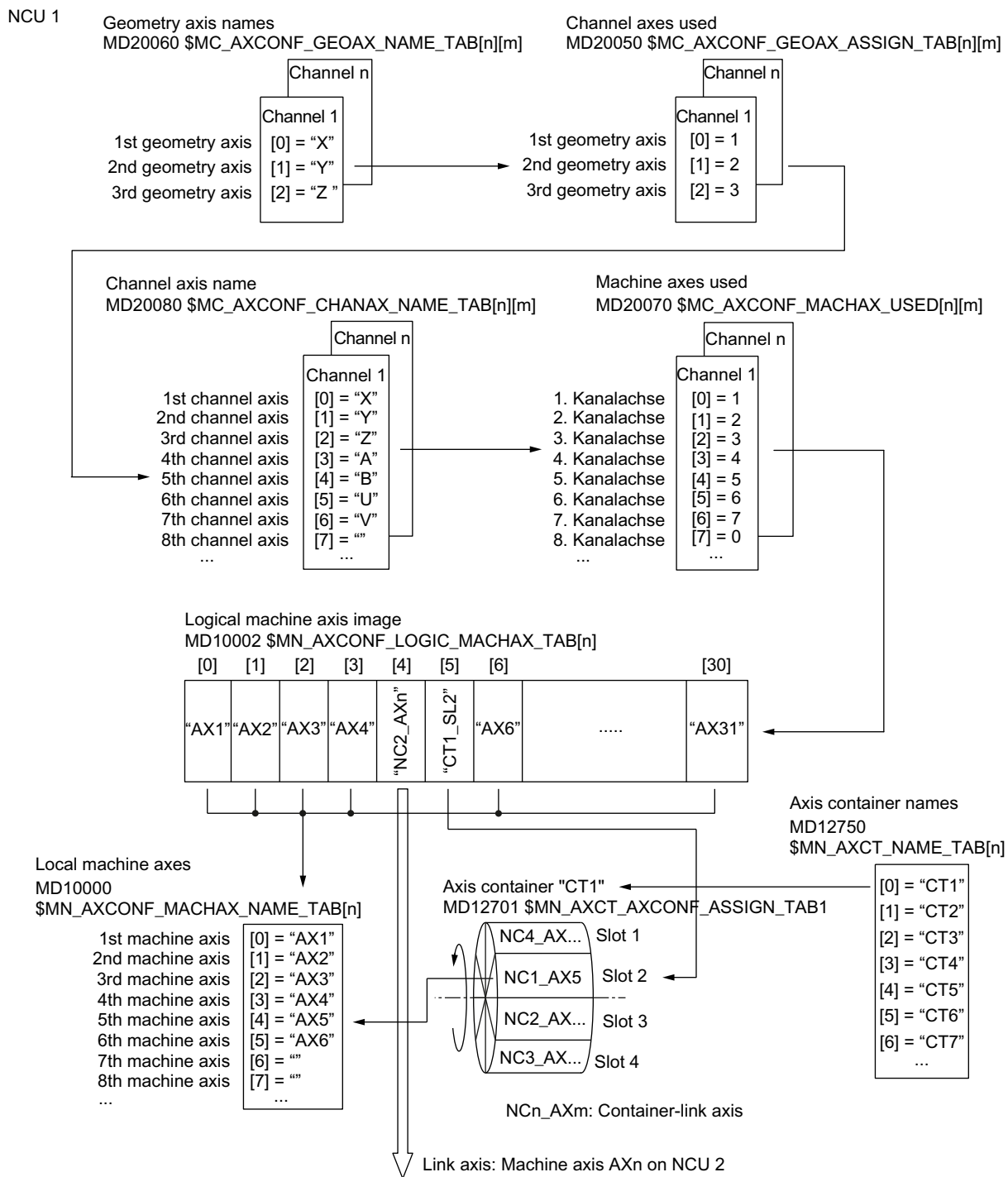The following diagram illustrates this relationship:

Figure 14-4   Axis assignment

> **Note**
>
> **Geometry and special axes**
>
> A maximum of three channel axes can be declared as geometry axes. The geometry axes must be assigned to the channel axes in ascending order without any gaps.
>
> All channel axes that are not geometry axes are special axes.

Channel axis gaps

Normally, using MD20070, a channel axis is assigned to one machine axis. Not every channel axis must be assigned to a machine axis. Each channel axis that cannot be assigned to a machine axis (MD20070 [n] = 0), represents a channel axis gap.

Channel axis gaps allow the creation of a uniform configuration of the channel axes over different machine versions of a series. Each channel axis of the series has a defined task or function. If the function and therefore the machine axis does not exist at a specific machine, the corresponding channel axis is not assigned to a machine axis:

MD20070 $MC_AXCONF_MACHAX_USED[<channel axis>] = 0

Advantages:

- Commissioning archive with uniform basic configuration
- Simple post configuration for the specific machine
- Flexible portability of part programs

Enabling channel axis gaps

The use of channel axis gaps must be enabled using the machine data:

MD11640 $MN_ENABLE_CHAN_AX_GAP = 1 (channel axis gap allowed).

If the use of channel axis gaps has not been enabled, then the value 0 for channel axis n in the following machine data terminates the allocation of additional machine axes to possible channel axes from channel axis n onwards:

MD20070 $MC_AXCONF_MACHAX_USED[<channel axis n>]

Boundary conditions:

- Regarding the number of channel axes and the indexing, a channel axis gap counts just the same as axes.

- Ensure that a geometry axis is not assigned to a channel axis, that is not assigned to a machine axis (channel axis gap). **No** alarm is displayed!

- Transformation: When configuring a channel axis in the following machine data, which is not assigned a machine axis (channel axis gap), then Alarm 4346 / 4347 displayed:

  - MD24110 ff. $MC_TRAFO_AXES_IN1...8

  - MD24120 ff. $MC_TRAFO_GEOAX_ASSIGN_TAB1...8

Example

The 5th channel axis "B" in MD20070 is not assigned to a machine axis.

If channel axis gaps are enabled, six machine axes (1 - 4, 5, 6) are available.

If channel axis gaps are not enabled, then there are four machine axes (1 - 4) available.
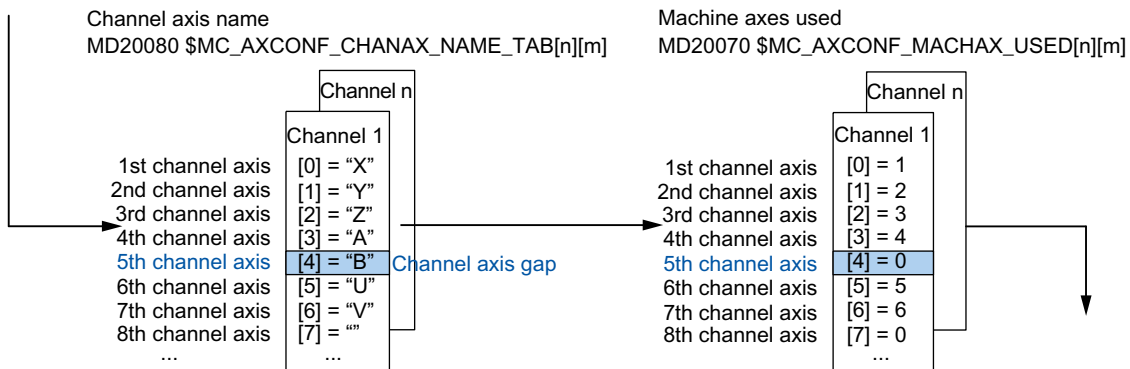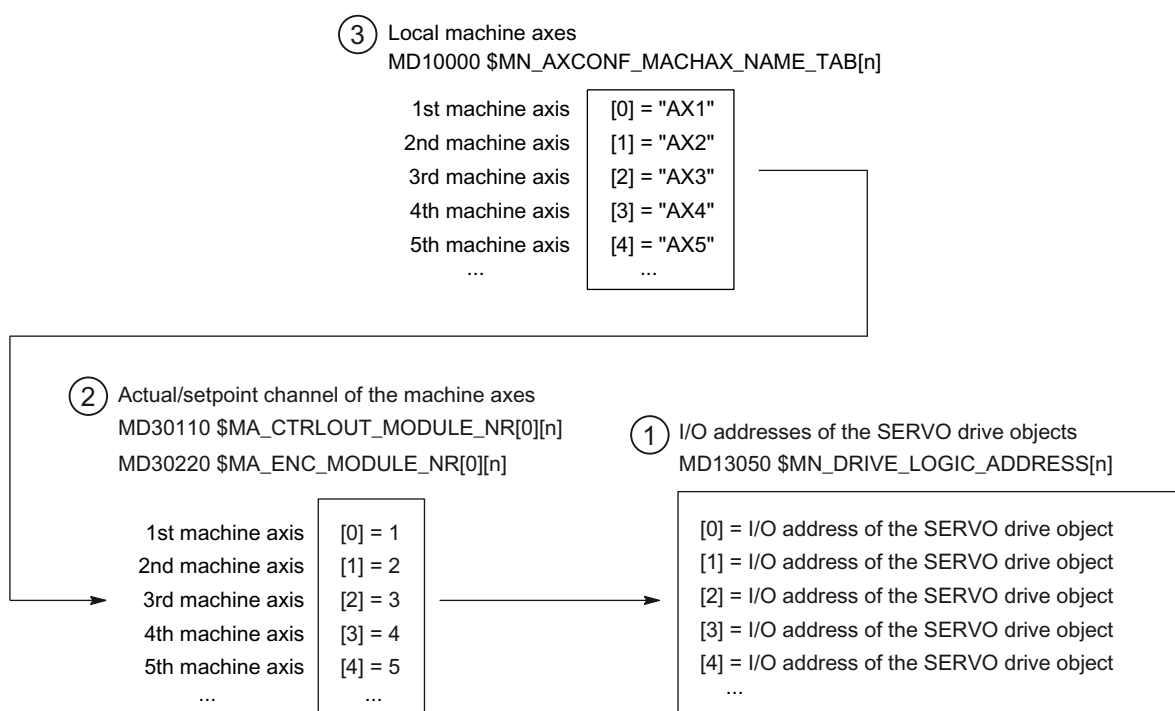
NCU 1

Figure 14-5 Axis configuration with channel axis gap

14.4.2 Drive assignment

Drive assignment

The assignment of machine axes to the drive objects SERVO is realized using machine data. The following diagram illustrates this relationship.

(3) Local machine axes
MD10000 $MN_AXCONF_MACHAX_NAME_TAB[n]

1st machine axis	[0] = "AX1"
2nd machine axis	[1] = "AX2"
3rd machine axis	[2] = "AX3"
4th machine axis	[3] = "AX4"
5th machine axis	[4] = "AX5"
...	...

(2) Actual/setpoint channel of the machine axes
MD30110 $MA_CTRLOUT_MODULE_NR[0][n]
MD30220 $MA_ENC_MODULE_NR[0][n]

1st machine axis	[0] = 1
2nd machine axis	[1] = 2
3rd machine axis	[2] = 3
4th machine axis	[3] = 4
5th machine axis	[4] = 5
...	...

(1) I/O addresses of the SERVO drive objects
MD13050 $MN_DRIVE_LOGIC_ADDRESS[n]

[0] = I/O address of the SERVO drive object
[1] = I/O address of the SERVO drive object
[2] = I/O address of the SERVO drive object
[3] = I/O address of the SERVO drive object
[4] = I/O address of the SERVO drive object
...

① Using the machine data, the NC is informed about the I/O addresses of the SERVO drive objects defined in the S7 project in "HW Config":

MD13050 $MN_DRIVE_LOGIC_ADDRESS[n] (I/O address of the drive)

② Using the machine data of the setpoint and actual value assignment, the machine axes are assigned to the particular SERVO drive objects:

- MD30110 $MA_CTRLOUT_MODULE_NR[0] (setpoint assignment)
- MD30220 $MA_ENC_MODULE_NR[0] (actual value assignment)

The logical drive number **m** to be entered into the two machine data, refers to the I/O address entered in (1) under index n = (**m** - 1).

③ Using machine data, MD10000 $MN_AXCONF_MACHAX_NAME_TAB, the machine axes are allocated a unique name NC-wide.

Index n addresses the (n+1)th machine axis.

Figure 14-6   Drive assignment

Machine data

The following machine data are relevant for the assignment of channel axes to drives:

MD	Name	Meaning
10000	$MN_AXCONF_MACHAX_NAME_TAB	Machine axis name
10002	$MN_AXCONF_LOGIC_MACHAX_TAB	Logical machine axis image
13050	$MN_DRIVE_LOGIC_ADDRESS	I/O address of drive
20050	$MC_AXCONF_GEOAX_ASSIGN_TAB	Assignment of geometry axis to channel axis
20060	$MC_AXCONF_GEOAX_NAME_TAB	Geometry axis name in channel
20070	$MC_AXCONF_MACHAX_USED	Machine axis number valid in channel
20080	AXCONF_CHANAX_NAME_TAB	Name of channel axis in the channel
30110	$MA_CTRLOUT_MODULE_NR	Setpoint assignment
30220	$MA_ENC_MODULE_NR	Actual-value assignment

See also

Axis assignment (Page 369)

14.4.3 Axis names

Machine axes

Each machine, channel and geometry axis can/must be assigned an individual name unambiguously identifying it in its name range. The name of the machine axes are defined via the following machine date:

MD10000 $MN_AXCONF_MACHAX_NAME_TAB [n] (machine axis name)

Machine axis names must be unambiguous for the entire NC.

The names and the corresponding index defined in the machine date above is used for:

- Accessing axis-specific machine data (loading, saving, displaying)
- Reference point approach from the parts program G74
- Measuring
- Test point traversing from the parts program G75
- Traversing the machine axis from PLC
- Display of axis-specific alarms
- Display in the actual-value system (machine-related)
- DRF handwheel function

Channel axes

The name of the channel axes are defined via the following machine date:

MD20080 $MC_AXCONF_CHANAX_NAME_TAB[n] (name of the channel axis in the channel)

Channel axis names must be unambiguous for the entire channel.

Geometry axes

The name of the geometry axes are defined via the following machine data:

MD20060 $MC_AXCONF_GEOAX_NAME_TAB [n] (geometry axis in the channel)

Geometry axis names must be unambiguous for the entire channel.

The axis names for channel and geometry axes are used in the parts program for programming general traversing movements or to describe the workpiece contour. The axis names are used for

● Path axes

● Synchronized axes

● Positioning axes

● Command axes

● Spindles

● Gantry axes

● Coupled axes

● Guide value coupling axes

Machine data

The following machine data are relevant for the axis names:

MD	Name	Designation
10000	$MN_AXCONF_MACHAX_NAME_TAB	Machine axis name
20060	$MC_AXCONF_GEOAX_NAME_TAB	Geometry axis name in channel
20080	$MC_AXCONF_CHANAX_NAME_TAB	Channel axis name/special axis name in channel

14.5 Spindle data

14.5.1 Basic spindle setting

Introduction

The spindle mode of a machine axis is a subset of the general axis functionality. For this reason, the machine data required to start up an axis have also to be set for a spindle.

The machine data to parameterize a rotary axis as spindle are therefore to be found under the axis-specific machine data (from MD 35000 onwards).

Note

After the default machine data have been loaded, no spindle is defined.

Spindle definition

With the following machine data, a machine axis is declared to be an endlessly rotating rotary axis whose programming and display is carried out modulo 360 degrees.

- MD30300 $MA_IS_ROT_AX (rotary axis/spindle)
- MD30310 $MA_ROT_IS_MODULO (modulo conversion for rotary axis/spindle)
- MD30320 $MA_DISPLAY_IS_MODULO (display modulo 360 degrees for rotary axis/spindle)

The machine axis is converted to a spindle by defining the spindle number x (with x = 1, 2, ...max. number of channel axes) in machine data

- MD35000 $MA_SPIND_ASSIGN_TO_MACHAX (spindle number)

The spindle number must be unique within the channel axes of the channel to which the spindle is assigned.

Spindle modes

The spindle can have the following modes:

- Control mode
- Oscillation mode
- Positioning mode
- Synchronous mode, synchronous spindle

  References: Function Manual, Extended Functions; Synchronous Spindle (S3)

● Tapping without compensating chuck

   References: Programming Manual, Fundamentals; motion commands

● Axis operation: The spindle can be switched from spindle mode to axis mode (rotary axis) if the same motor is used for spindle and axis operation.

Basic spindle setting

The following machine data is used to specify a spindle mode as basic setting:

MD35020 $MA_SPIND_DEFAULT_MODE

Value	Spindle basic setting
0	Speed control mode, position control deselected
1	Speed control mode, position control activated
2	Positioning mode
3	Axis mode

Time when the basic position of the spindle becomes effective

The time when the basic setting of the spindle takes effect is set in the machine data:

MD35030 $MA_SPIND_DEFAULT_ACT_MASK

Value	Effective time
0	POWER ON
1	POWER ON and program start
2	POWER ON and RESET (M2 / M30)

14.5.2   Spindle modes

Functionality

If for certain machining tasks, e.g. on lathes with end-face machining, it is not sufficient to traverse the spindle exclusively under speed control via M3, M4, M5 or to position with SPOS, M19 or SPOSA, the spindle can be switched to position-controlled axis mode and traversed as a rotary axis.

Examples of rotary axis functions:

● Programming with axis name

● Zero offsets (G54, G55, TRANS, etc.)

- G90, G91, IC, AC, DC, ACP, ACN

- Kinematic transformations (e.g. TRANSMIT)

- Path interpolation

- Traversing as positioning axis

  References: Function Manual, Extended Functions; Section "Rotary axes (R2)"

Preconditions

- The same spindle motor is used for spindle mode and axis mode.

- The same position measurement system or separate position measurement systems can be used for spindle mode and axis mode.

- An actual position value encoder is a mandatory requirement for axis mode.

- For axis operation, the spindle must be referenced, e.g. with G74.

  Example:

Program code	Comment
M70	; Switch spindle over to axis mode
G74 C1=0 Z100	; Reference axis
G0 C180 X50	; Traverse axis position-controlled

Configurable M function

The M function used to switch the spindle to axis mode can be configured channel-specifically via the following machine data:

MD20094 $MC_SPIND_RIGID_TAPPING_M_NR

Note

The controller detects the transition to axis mode automatically from the program sequence. The explicit programming of the configured M function for switching the spindle to axis mode in the part program is therefore not necessary. However, the M function can continue to be programmed, e.g. to increase the readability of the part program.

Special features

- The feed override switch is active.

- The NC/PLC interface signal does not terminate the axis mode per default: DB21, ... DBX7.7 (reset).

- The NC/PLC interface signals:
  DB31, ... DBB16 to DBB19 and DBB82 to DBB91
  are not important if:
  DB31, ... DBX60.0 (axis / no spindle) = 0

- Axis mode can be activated in all gear steps.

  If the actual position value encoder is installed on the motor (indirect measuring system), the positioning and contouring accuracy can vary for the different gear steps.

- The gear step cannot be changed when the axis mode is active.

  The spindle must be switched to control mode.

  This is done with M41 ... M45 and M5, SPCOF.

- In the axis mode, the first parameter set is effective (machine data index = zero).

  References: Function Manual, Basic Functions; Chapter "Velocities, setpoint / actual value systems, closed-loop control (G2)" > "Closed-loop control" > "Parameter sets of the position controller"

Dynamic response

In axis mode, the dynamic limits of the axis apply, e.g.:

- MD32000 $MA_MAX_AX_VELO[<axis>] (maximum axis velocity)
- MD32300 $MA_MAX_AX_ACCEL[<axis>] (maximum axis acceleration)
- MD32431 $MA_MAX_AX_JERK[<axis>] (maximum axial jerk for path motion)

Feedforward control

The feedforward control mode active for the axis is retained.

A detailed description of the "Dynamic feedforward control" function can be found in:

References: Function Manual, Extended Functions; Chapter "Compensations (K3)" > "Dynamic feedforward control (following error compensation)"

Example: Resolution switchover for analog actuator

Switching to axis mode

```
Programming              Comment

SPOS=...
M5                       ; Controller enable off (by PLC)
                           → is output on PLC
M70                      ; Switch actuator (by PLC on account of M70)
                           Controller enable on (by PLC)
C=...                    ; NC traverses with axis parameter set
```

Switching to spindle mode

Programming	Comment
C=...	
M71	; → is output to PLC
	Closed-loop controller enable off (by PLC)
	Switch actuator (by PLC)
	Switched to spindle parameter set (1-5) internally in the NC, controller enable on (by PLC)
M3/4/5 or SPOS=...	; NC traverses with spindle parameter set

Change to spindle mode

The appropriate parameter set 1...5 is selected for the active gear stage.

The feedforward control is activated, except for tapping with compensating chuck, if the following applies:

MD32620 $MA_FFW_MODE (feedforward control mode) ≠ 0

Parameter set	Axis mode	Spindle mode
1	Valid	-
2	-	Valid
3	-	Valid
4	-	Valid
5	-	Valid
6	-	Valid

Spindle mode: Parameter set according to the gear stage

Master spindle

In the following machine data, a master spindle has been defined in the relevant channel:

- MD20090 $MC_SPIND_DEF_MASTER_SPIND (master spindle initial setting in channel)

The spindle number of the channel spindle which is to be the master spindle defined in machine data MD35000 $MC_SPIND_ASSIGN_TO_MACHAX (spindle number) is entered in this machine data.

Diverse spindle functions can be used in one channel, e.g.:

- Revolutional feed (G95)
- Tapping with compensation chuck (G63)
- Thread cutting (G33)
- Dwell time in spindle revolutions (G4 S...)

Spindle reset

The following machine data is used to define whether the spindle should remain active after a reset (DB21,... DBX7.7) or end of program (M02/M30):

- MD 35040 $MC_SPIND_ACTIVE_AFTER_RESET (spindle active after reset)

To cancel spindle movements, an independent spindle reset is required:

- DB31,... DBX2.2 (spindle reset)

References

Function Manual, Basic Functions; Spindles (S1)

14.6 Configure PROFIBUS components

Configuration of the PROFIBUS machine control panel

The following is required in the HW Config for a PROFIBUS machine control panel on the HMI:

- Configuration of the properties of the network interface for PROFIBUS
- Supplementation of the machine control panel and hand wheel in HW Config
- Modification of the machine control panel in OP100

14.6.1 Configure network interface for PROFIBUS

Introduction

In the STEP7 project, you configure the network interfaces PROFIBUS DP, via which you want to reach the machine control panel:

PROFIBUS DP operating sequence

1. Use the left mouse button to select NCU 720.1 and while holding down the mouse button drag it to the "Station design" station window.

2. After you release the mouse button, configure the properties of the PROFIBUS DP interface for socket X126 (machine control panel) in the dialog box.
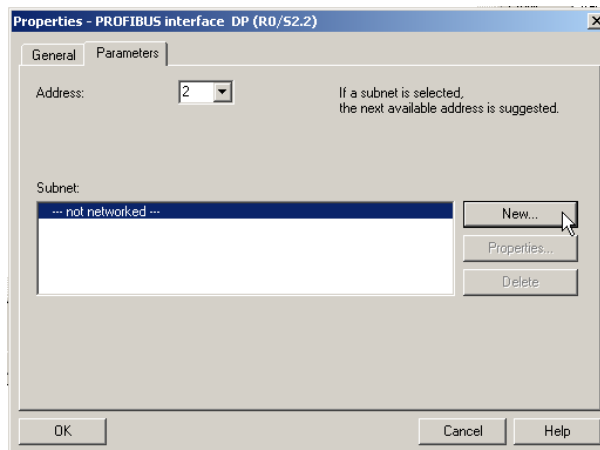
3. Click the following successively:

   – The "New..." button,

   – The "Network settings" tab in the "Properties new subnet PROFIBUS Subnet" dialog box.

4. Select the transmission speed of "12 Mbit/s" for the "DP" profile.
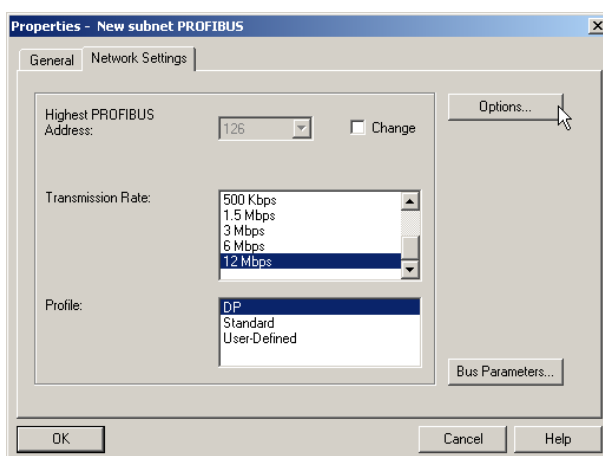
5. Click "Options" and then the "Isochronous mode" tab.
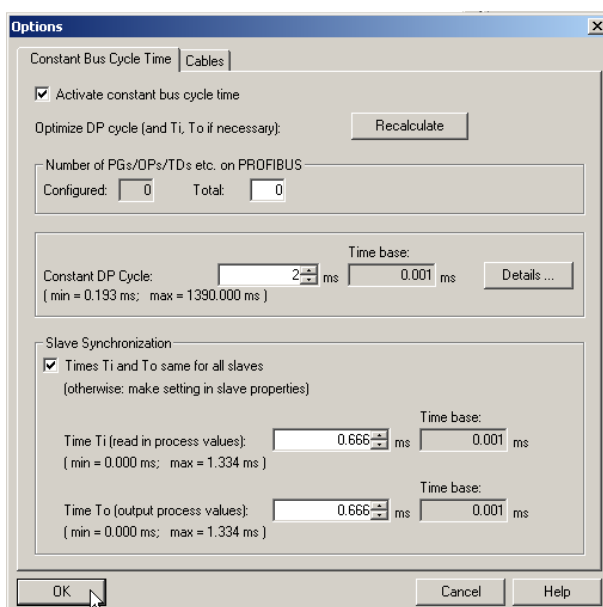
6. To enable reproducible access to peripherals (for handwheel mode), the PROFIBUS DP must have a constant bus cycle time. The following entries are necessary under Equidistance:

   – Click on the "Activate equidistance bus cycle" field.

   – Enter the cycle, e.g. "2 ms" for the "Equidistance DP cycle" (for integrated PROFIBUS) (see MD10050 $MN_SYSOCK_CYCLE_TIME).

   – Click the "Times Ti and To equal for all slaves" field.

   – The fields "Time Ti" and "Time To" must contain a value "< 2 ms".

7. Click "OK" three times.

8. The NCU module with SINAMICS S120 is inserted in the HW Config.

Note

With the <F4> key and confirmation of the prompt regarding "Reorganize", you can reorganize the display in the station window.
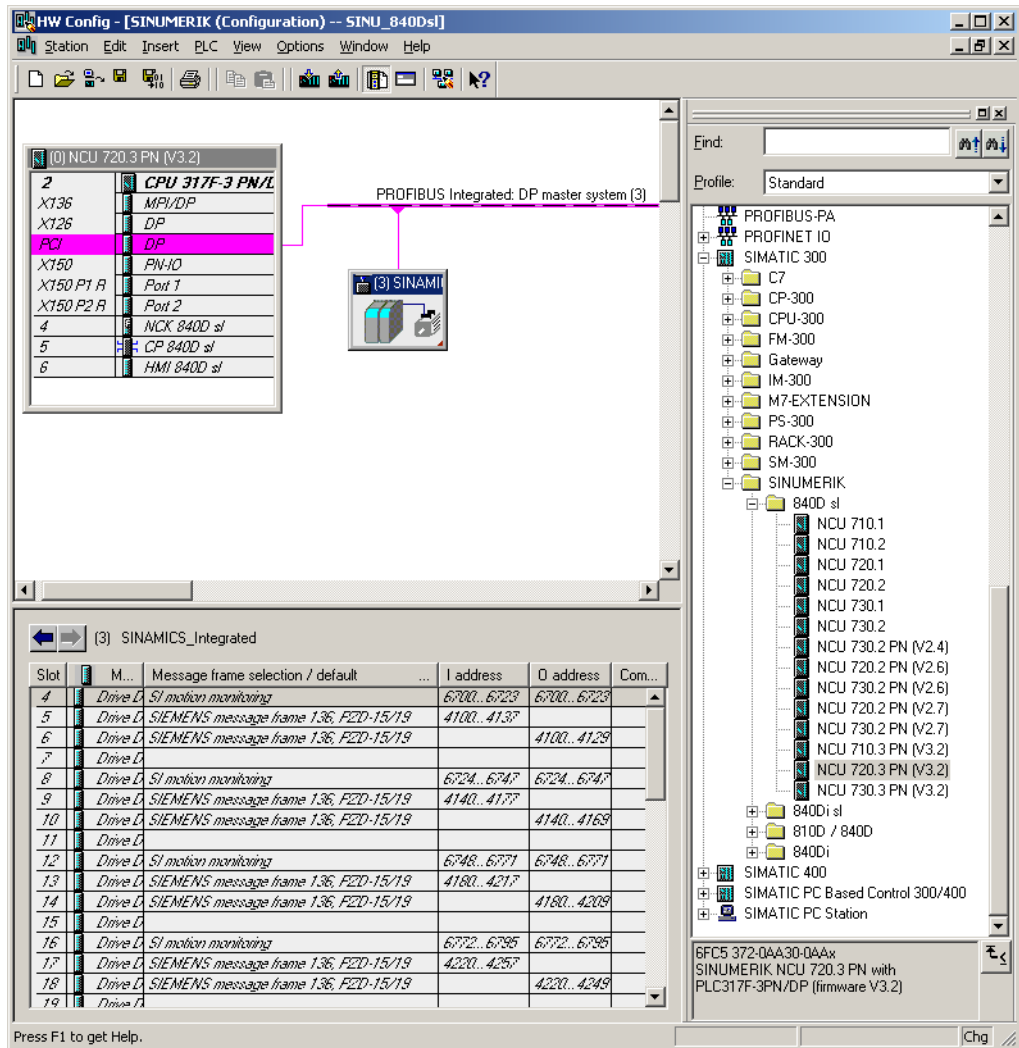
As the next step configure a machine control panel with handwheel.

14.6.2 Load GSD file (contains machine control panel)

Introduction

To expand the machine control panel, you need the device master data (GSD file) with the SINUMERIK MCP. This file contains information that a DP master system requires to link the MCP as DP slave in its PROFIBUS configuration.

Operating sequence

The file is a component of the STEP 7 package for NCU7x0 (Toolbox).

1. Search in the HW config under "Extras" > "Install GSD file…" in the installation directory of the toolbox for the corresponding GSD directory under:

   ..\8x0d\GSD\MCP_310_483

2. Choose the corresponding language you want to install.

3. Select "Install".

4. Exit with "Close".

14.6.3 Adding a machine control panel and handwheel in HW Config

Introduction

The machine control panel (MCP) can be connected via PROFIBUS to the PLC. In later configurations, this will also be possible over the network.

Operating sequence for adding an MCP in HW Config

You have created a NCU and a NX in the HW Config and installed the GSD file for the MCP.

1. Search under "PROFIBUS DP" > "Further field devices" > "NC/RC" > "MOTION CONTROL" for the "SINUMERIK MCP" module.

2. Click with the left mouse button to select the "SINUMERIK MCP" module and drag it to the chain for the "PROFIBUS DP master system" in the "Station design" station window.

3. After releasing the mouse button, the machine control panel is added (see figure below).

4. Select "MCP" and enter the PROFIBUS address 6 under "Object properties" > button "PROFIBUS..." > tab "Parameter" > input field "Address".

5. Click on "OK" twice.

   Now you can assign the slots of the machine control panel, e.g., "Standard + Hand wheel".
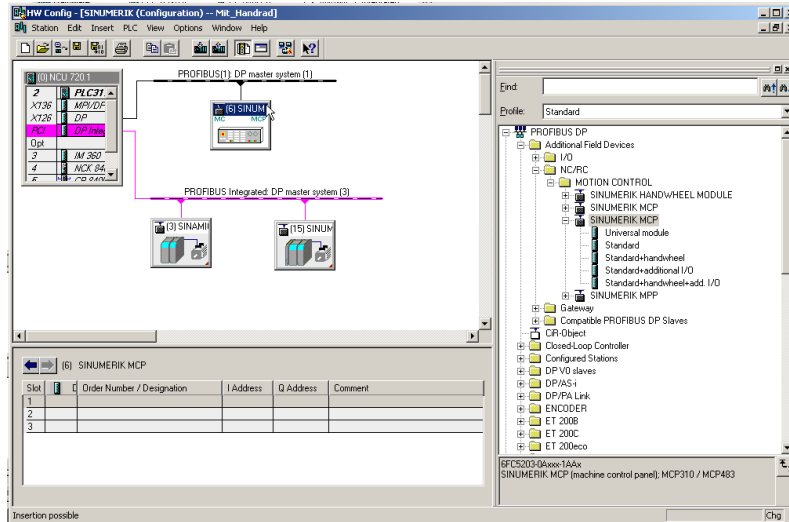
Figure 14-7   Machine control panel in HW Config

6. In the hardware catalog under "SINUMERIK MCP" click with the left mouse button to select the "Standard+Hand wheel" option and drag it to Slot 1 (see figure below).
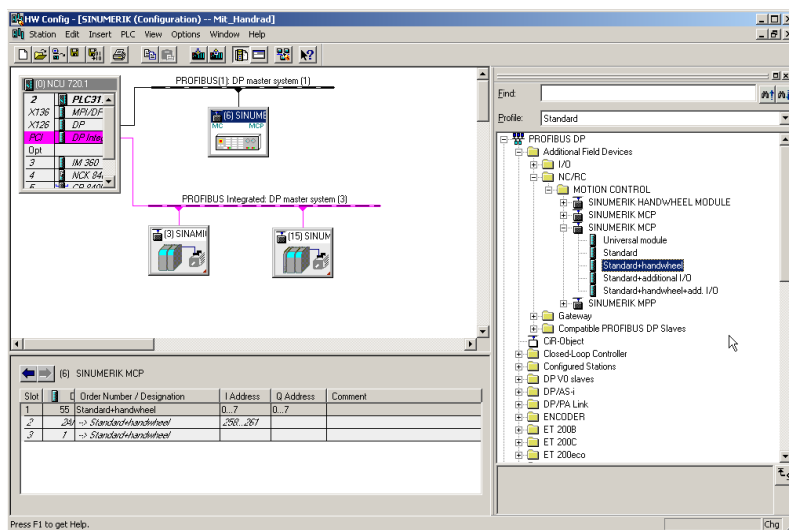

Figure 14-8   Standard+Handwheel for slot

You have configured a machine control panel with handwheel in HW Config.

Note

If a handwheel has been configured, equidistance is required. You set this when you configured the PROFIBUS DP. PROFIBUS address for the machine control panel is "6".

Save, compile and load the configuration to the PLC as the next operating sequence.

14.6.4 Modifying PROFIBUS machine control panel in OB100

Introduction

The PLC basic program automatically transfers the machine control panel signals (MCP signals) and the addresses of the MCP in the HW config if the configuration is set up as laid out below.

Operating sequence

- Under "Blocks", double-click on "OB100" to open it.

  In OB100, the parameters below have to be preset:

  ```
  MCPNum :=1

  MCP1IN := P#E 0.0

  MCP1OUT := P#E 0.0

  MCP1StatSend := P#E 8.0

  MCP1StatREc := P#E 12.0

  MCPBusAdresse := 6

  MCPBusType = B#16#33
  ```

Appendix A

A.1   Abbreviations

ACX	Compressed format from XML
ALM	Active Line Module
AS	Automation System
Command output disable	Command output disable
BERO	Proximity limit switch
BI	Binector Input
BICO	Binector Connector
BO	Binector Output
CF	CompactFlash
CI	Connector Input
CNC	Computerized Numerical Control
CO	Connector Output
CoL	Certificate of License
CP	Communications Processor:
CPU	Central Processing Unit Central processing unit
CU	Control Unit
DHCP	Dynamic Host Configuration Protocol: Protocol for automatic assignment of IP addresses from a DHCP server to a client computer
DIP	Dual In–Line Package: dual in-line arrangement
DO	Drive objects: Drive Object
DP	Distributed Peripherals
DRAM	Dynamic Random Access Memory
DRF	Differential resolver function: differential-synchro transmitter function
DRIVE-CLiQ	Drive Component Link with IQ
DSC	Dynamic Servo Control
DWORD	Doubleword
ESD	Electrostatic Sensitive Device
EQN	Designation for an absolute encoder with 2048 sine signals per revolution
EMC	Electro-Magnetic Compatibility
EN	European standard
GC	Global Control
GSD	Device master file
GUD	Global User Data
IBN	Commissioning
IPO	Interpolator cycle
JOG	JOG mode: manual mode for setting up the machine

LAN	Local Area Network
LED	Light Emitting Diode:
LR	Position controller
LUD	Local User Data
MAC	Media Access Control
MD	Machine data
MSGW	Message word
MLFB	Machine-readable product designation
MM	Motor Module
MCP	Machine Control Panel
NCK	Numerical Control Kernel: NC kernel with block preparation, travel range, etc.
NCU	Numerical Control Unit: NCK hardware unit
IS	Interface Signal
NX	Numerical Extension (axis extension module)
OB	Organization Block
OLP	Optical Link Plug
PIO	Process Output Image
PII	Process Input Image
PCU	PC Unit: computer unit
PELV	Protective Extra-Low Voltage
PG	Programming device
PLC	Programmable Logic Control: (component of the CNC controller)
PM	Power Module
PNO	PROFIBUS User Organization
PUD	Global Program User Data
PD	Process Data
RAM	Random Access Memory: (can be read and written)
RDY	Ready
REF	Reference point
RES	Reset
RTCP	Real Time Control Protocol
SD	Setting Data
SH	Safe standstill
SIM	Single Inline Module
SBC	Safe brake activation
SLM	Smart Line Module
SMC	Sensor Module Cabinet-Mounted
SME	Sensor Module Externally Mounted
SMI	Sensor Module Integrated
GWPS	Grinding wheel peripheral speed
TCU	Thin Client Unit
USB	Universal Serial Bus
STW	Status Word

A.2 Overview

SINUMERIK 840D sl Documentation Overview

General Documentation

SINUMERIK 840D sl	SINUMERIK 840D sl / 840Di sl / 802D sl	SINAMICS S120
Sales Brochure	Catalog NC 62	Catalog PM 21 SIMOTION, SINAMICS S120 and motors for production machines

User Documentation

SINUMERIK 840D sl	SINUMERIK 840D sl / 828D	SINUMERIK 840D sl / 828D	SINUMERIK 840D sl / 840Di sl / 828D / 802D sl	SINUMERIK 840D sl / S120
Operating Manual – Universal – Turning – Milling – HMI Advanced	Operating Manual – Turning – Milling	Programming Manual – Fundamentals – Job Planning – Measuring Cycles	Programming Manual – ISO Turning – ISO Milling	Diagnostics Manual

Manufacturer / Service Documentation

SINUMERIK 840D sl	SINUMERIK 840D sl / S120	SINUMERIK 840D sl / 828D	SINUMERIK 840D sl	SINUMERIK 840D sl / S120
Equipment Manual – NCU – operator components and networking	System Manual Guidelines for Machine Configuration	System Manual Ctrl Energy	Commissioning Manual – CNC: NCK, PLC, Drive – Basesoftware and Operating Software – Basesoftware and HMI Advanced	Parameter Manual – Part 1 – Part 2 – Detailed Machine Data Description – System Variables

Manufacturer / Service Documentation

SINUMERIK 840D sl / 828D	SINUMERIK 840D sl / 840Di sl / 802D sl / 828D	SINAMICS S120	SINUMERIK 840D sl	SINUMERIK
Function Manual – Basic Functions – Extended Functions – Special Functions – Synchronized Actions – Tool Management	Function Manual ISO Dialects	Function Manual Drive functions	Function Manual Safety Integrated	Configuration Manual EMC Design Guidelines

Info / Training

SINUMERIK	SINUMERIK	SINUMERIK
Beginners instructions Milling and turning	Training documents – Easy milling with ShopMill – Turning made easy with ShopTurn	Manuals Tool and mold making

Electronic documentation

DOConCD

My Documentation Manager

Glossary

Active Line Module

Controlled, self-commutating feed/feedback unit (with -> "IGBTs" in feed/feedback direction), which supplies the DC-link voltage for the -> "Motor Module".

Certificate of License (CoL)

The CoL is the proof of the → license. The product may only be used by the holder of the → license or authorized persons. The CoL includes the following data relevant for the license management:

- Product name
- → License number
- Delivery note number
- → Hardware serial number

CompactFlash card

As the carrier of all non-volatile data in a SINUMERIK solution line control system, the CompactFlash card represents the identity of this control system. The CompactFlash card is a memory card that can be plugged into the → control unit from outside. The CompactFlash card also contains the following data relevant for the license management:

- → Hardware serial number
- License information including the → license key

Control Unit

Central control module in which the closed-loop and open-loop control functions for one or more -> "SINAMICS" -> "Line Modules" and/or -> "Motor Modules" are implemented.
There are three types of Control Unit:
- SINAMICS Control Units, e.g. -> "CU320"
- SIMOTION Control Units, e.g. -> "D425" and -> "D435"
- SINUMERIK solution line Control Units, e.g. NCU710, NCU720 and NCU730

Control Word

Bit-coded -"Process data" word, transmitted by -> "PROFIdrive" at cyclic intervals to control the drive states.

Double Motor Module

Two motors can be connected to and operated with a Double Motor Module.
See –> "Motor Module" –> "Single Motor Module"
Former term: –> "Double-Axis Module"

Drive

The drive includes the motor (electric or hydraulic), the actuator (converter, valve), the
control unit, the measuring system, and supply components (line infeed module, pressure
reservoir).
For electric drives, a distinction is made between a converter system and an inverter system.
With a converter system (e.g. –> "MICROMASTER 4"), from the point of view of the user the
line infeed, the actuator, and the control component form a single device; with an invertor
system (e.g. –> "SINAMICS S"), the supply is ensured by means of -> "Line Module", thereby
realizing a DC line to which the –> "Invertors" (-> "Motor Modules") are connected. The (–>
"Control Unit") is implemented as a separate device and connected to the other components
by means of –> "DRIVE-CLiQ".

Drive Component

Hardware component connected to a –> "Control Unit" via –> "DRIVE-CLiQ", for example.
Drive units are for instance: -> "Motor Modules", -> "Line Modules", -> "Motors", -> "Sensor
Modules" and -> "Terminal Modules".
The overall layout of a Control Unit together with the connected drive components is called -
> "Drive unit".

Drive Group

A drive group comprises a -> "Control Unit" and the -> "Motor Modules" and -> "Line
Modules" connected via -> "DRIVE-CLiQ".

Drive Object

A drive object is an autonomous, individual software function with its own -> "Parameters"
and may also have its own -> "Faults" and -> "Alarms". Drive objects may exist by default
(e.g. On-Board I/O), can be created individually (e.g. –> "Terminal Board" 30, TB30) or also
as multiples (e.g. –> "Servo Control"). As a rule, each drive object has its own window for
parameterization and diagnostic purposes.

Drive Parameters

Parameters of a drive axis that include, for example, the parameters of the corresponding
controllers, as well as the motor and encoder data. The parameters of the higher-level
technology functions (positioning, ramp-function generator), however, are called –>
"Application Parameters".
See –> "Basic Unit System".

Drive System

A drive system includes all the components in a product family, e.g. SINAMICS. A drive system comprises, e.g, -> "Line Modules", -> "Motor Modules", -> "Sensors", -> "Motors", -> "Terminal Modules" and -> "Sensor Modules" as well as additional components (reactors, filters, cables, etc.).
See -> "Drive Unit"

Drive Unit

The drive unit includes all the components connected via –> "DRIVE-CLiQ" that are required for carrying out a drive task: -> "Motor Module" –> "Control Unit" –> "Line Module" and the required –> "Firmware" and –> "Motor"s, but not additional components, such as filters or reactors.
Several –> "Drives" can be implemented in a drive unit.
See –> "Drive System".

DRIVE-CLiQ

Abbreviation of "Drive Component Link with IQ".
Communication system for connecting the different components of a SINAMICS drive system (e.g. -> "Control Unit", -> "Line Modules", -> "Motor Modules", -> "Motors", and speed/position sensors.
The DRIVE-CLiQ hardware is based on the Industrial Ethernet standard with twisted-pair lines. The DRIVE-CLiQ line provides the send and receive signals, as well as the +24 V power supply.

DRIVE-CLiQ Hub Module Cabinet

The DRIVE-CLiQ Hub Module Cabinet (DMC) is a star coupler for multiplying –> "DRIVE-CLiQ sockets. The DMC can be clipped onto a rail. The DMC20 is available, for example.

See –> "Hub"

Encoders

An encoder is a measuring system that captures actual values for the speed and/or angular/position values and makes them available for electronic processing. Depending on the mechanical construction, encoders can be integrated in the –> "Motor" (–> "Motor Encoder") or mounted on the external mechanics (– "External Encoder"). Depending on the type of motion, a distinction is made between rotary encoders ("Rotary Transducers") and translatory encoders (e.g. -> Linear Encoders). In terms of measured value provision, a distinction is made between –> "Absolute Encoders" (Code Encoders) and –> "Incremental Encoders".
See –> "Incremental Encoder TTL/HTL" –> "Incremental Encoder sin/cos 1 Vpp" –> "Resolver".

External Encoder

Position encoder that is not built in or mounted on the –> "Motor", but fitted instead via a mechanical transmission element or mechanical intermediate element.
The external encoder (see –> "Externally-Mounted Sensor") is used for –> "Direct Position Detection".

Hardware

In the context of license management of SINUMERIK → software products, hardware refers to the component of a SINUMERIK control system to which → licenses are assigned on the basis of its unique identifier. The license information is also saved to non-volatile memory on this component, e.g. on a → CompactFlash card.

Hardware serial number

The hardware serial number is a permanent part of the → CompactFlash card. It is used to identify a control system uniquely. The hardware serial number can be determined by:

- → Certificate of License
- User interface
- Label on the CompactFlash card

Hub

Central connection device in a network with star-shaped topology. A hub distributes incoming data packages to all connected end devices.

See –> "DRIVE-CLiQ Hub Module Cabinet" (DMCxx)

Infeed

Input component of a converter system for generating a DC-link voltage to supply one or more -> "Motor Modules", including all the required components (e.g. -> "Line Modules", fuses, reactors, line filters, and firmware, as well as proportional computing power (if required) in a -> "Control Unit".

License

A license gives the user the legal right to use a → software product. Evidence of this right is provided by the following:

- → Certificate of License (CoL)
- → License key

License key

The License Key is the "technical representative" of the sum of all the → licenses that are assigned to one particular piece of → hardware, which is uniquely marked by its → hardware serial number.

License number

The license number is the feature of a → license used for its unique identification.

Line Module

A Line Module is a power component that generates the DC-link voltage for one or more –> "Motor Modules" from a 3-phase mains voltage.
In SINAMICS, the following three types of Line Module are available:
–> "Basic Line Module", –> "Smart Line Module" –> "Active Line Module".
The overall function of an infeed, including the required additional components like –> "Line Reactor", proportional computing power in a –> "Control Unit", switching devices, etc., is called –> "Basic Infeed", –> "Smart Infeed", and –> "Active Infeed".

Modular machine

The modular machine concept is based on a maximum reference topology created offline. The maximum design of a particular machine type is referred to as the maximum configuration in which all the machine components that may be used are pre-configured in the reference topology. By deactivating/deleting drive objects (p0105 = 2), sections of the maximum configuration can be removed.

If a component fails, the sub-topology can also be used to allow a machine to continue running until the spare part is available. In this case, however, no BICO source must be interconnected from this drive object to other drive objects.

NOTICE
Data backup
Before you make any changes, save the drive data in a commissioning archive!

Motor

For the electric motors that can be driven by –> "SINAMICS", a basic distinction is made between rotary and linear motors with regard to their direction of motion, and between synchronous and induction motors with regard to their electromagnetic operating principle. In SINAMICS, the motors are connected to a –> "Motor Module".
See –> "Synchronous Motor" –> "Induction Motor" –> "Built-In Motor" –> "Motor Encoder" -> "External Encoder" –> "Third-Party Motor".

Motor Encoder

An –> "Encoder" (e.g. –> "Resolver", –> "Incremental Encoder TTL/HTL", or –> "Incremental Encoder sin/cos 1 Vpp" that is integrated in or attached to the motor.
The encoder detects the motor speed. In the case of synchronous motors, it can also detect the rotor position angle (the commutation angle for the motor currents).
For drives without an additional –> "Direct Position Measuring System", it is also used as a –> "Position Encoder" for position control.
In addition to the motor encoders, –> "External Encoders" for –> "Direct Position Sensing" are available.

Motor Module

A Motor Module is a power component (DC-AC inventor) that supplies the power for the connected motor(s).
Power is supplied through the –> "DC Link" of the –> "Drive Unit".
A Motor Module must be connected to a –> "Control Unit" via –> "DRIVE-CLiQ". The open-loop and closed-loop control functions for the Motor Module are stored in the Control Unit.
–> "Single Motor Modules" and –> "Double Motor Modules" are available.

Option

One option is a SINUMERIK → software product that is not contained in the basic version and which requires the purchase of a → license for its use.

Option Slot

Slot for an optional module (e.g. in the –> "Control Unit").

Parameters

Variable quantity within the drive system that the user can read and, in some cases, write.
For –> "SINAMICS", all specifications defined in the –> "PROFIdrive" profile are defined by a parameter.
See –> "Visualization Parameters" and –> "Adjustable Parameters".

Product

A product is marked by the data below within the license management of SINUMERIK → software products:

- Product designation

- Order number:

- → License number

PROFIBUS

Field bus according to IEC 61158, Sections 2 to 6.
The abbreviation "DP" is no longer included because PROFIBUS FMS is not standardized and PROFIBUS PA (for Process Automation) is now part of the "general" –> "PROFIBUS".

Sensor Module

Hardware module for evaluating speed/position encoder signals and providing detected actual values as numerical values at a -> DRIVE-CLiQ Socket".
Three mechanical Sensor Module variants are available:
- SMCxx = Sensor Module Cabinet Mounted
- SME = Sensor Module Externally Mounted (with a high degree of protection)

Servo Control

For -> "Motors" equipped with a -> "Motor Encoder", this control type allows operation with a high level of -> "Accuracy" and -> "Dynamic Response".
In addition to speed control, position control can also be implemented.

Servo Drive

An electric servo drive comprises a motor, a –> "Motor Module", a –> "Servo Control" and, in most cases, a speed and position –> "Encoder"
Electric servo drives are normally extremely precise and have a high dynamic response. They are designed for cycle times less than 100 ms, and often have a short-time overload capacity which enables quick acceleration. Servo drives are available as rotary and linear drives and are used for machine tools, handling robots, and packaging machines.

SITOP power

Components for –> "Electronics Power Supply".
Example: 24 VDC

Smart Line Module

Unregulated line infeed/feedback unit with a diode bridge for the infeed and stall-protected, line-commutated feedback via -> "IGBTs".
The Smart Line Module supplies the DC-link voltage for the -> "Motor Modules".

Software product

The term software product is generally used to describe a product that is installed on a piece of → hardware to process data. Within the license management of SINUMERIK software products, a corresponding → license is required to use each software product.

Status Word

Bit-coded -> "Process data" word, transmitted by -> "PROFIdrive" at cyclic intervals to control the drive states.

Vector Control

Vector control (field-oriented control) is a high-performance control type for induction machines. It is based on an exact model calculation of the motor and two current components that simulate and accurately control the flux and torque by means of software algorithms, thereby enabling predefined speeds and torques to be observed and limited accurately and with a good dynamic response.
Two vector control types exist:
Frequency control (–> "Encoderless Vector Control") and speed-torque control with speed feedback (–> "Encoder").

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