SIEMENS

SINUMERIK 840D sl
SINAMICS S120

IBN CNC: NCK, PLC, drive

Commissioning Manual

Preface

Introduction 1

Safety information 2

Requirements for commissioning 3

Example configuration 4

Power on and boot up 5

Connect PG/PC with the PLC 6

PLC commissioning 7

Commissioning SINAMICS drives 8

Commissioning communication NCK<->Drive 9

NCK start-up 10

Optimize the drive. 11

Data backup and standard commissioning 12

Tips 13

Licensing 14

Fundamentals 15

Appendix A

Valid for

Control SINUMERIK 840D sl / 840DE sl Drive
SINAMICS S120

Software	Version NCU
Software for 840D sl / 840DE sl	1.5/2.5

01/2008
6FC5397-2AP10-4BA0

Safety Guidelines

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 corresponding 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 device/system may only be set up and used in conjunction with this documentation. Commissioning and operation of a device/system may only be performed by **qualified personnel**. Within the context of the safety notes in this documentation qualified persons are defined as persons who are authorized to commission, ground and label devices, systems and circuits in accordance with established safety practices and standards.

Prescribed Usage

Note the following:

⚠WARNING
This device may only be used for the applications described in the catalog or the technical description and only in connection with devices or components from other manufacturers which have been approved or recommended by Siemens. Correct, reliable operation of the product requires proper transport, storage, positioning and assembly as well as careful operation and maintenance.

Trademarks

All names identified by ® are registered trademarks of the 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.

Siemens AG
Automation and Drives
Postfach 48 48
90327 NÜRNBERG
GERMANY

Ordernumber: 6FC5397-2AP10-4BA0
℗ 01/2008

Copyright © Siemens AG 2008.
Technical data subject to change

Preface

Preface

Structure of the documentation

The SINUMERIK documentation is organized in 3 parts:

- General documentation
- User documentation
- Manufacturer/service documentation

An overview of publications, which is updated on a monthly basis and provides information about the language versions available, can be found on the Internet at:

http://www.siemens.com/motioncontrol
Select "Support" → "Technical Documentation" → "Overview of Publications".

The Internet version of DOConCD (DOConWEB) is available at:

http://www.automation.siemens.com/doconweb

Information about training courses and FAQs (Frequently Asked Questions) can be found at the following website:

http://www.siemens.com/motioncontrol under menu option "Support"

Target group

This document is designed for machine tool manufacturers. The present documentation provides all information required by the manufacturer to start up the software HMI sl.

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. However, no claim can be made regarding the availability of these functions when the equipment is first supplied or in the event of 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

If you have any technical questions, please contact our hotline:

	Europe / Africa
Phone	+49 180 5050 222
Fax	+49 180 5050 223
Internet	http://www.siemens.com/automation/support-request

	America
Phone	+1 423 262 2522
Fax	+1 423 262 2200
E-mail	techsupport.sea@siemens.com

	Asia / Pacific
Phone	+86 1064 719 990
Fax	+86 1064 747 474
E-mail	mailto:adsupport.asia@siemens.com

Note

National telephone numbers for technical support are provided under the following Internet address:

http://www.siemens.com/automation/service&support

Questions about this documentation

If you have any queries (suggestions, corrections) in relation to this documentation, please send a fax or e-mail to the following address:

Fax	+49 9131- 98 63315
E-mail	mailto:docu.motioncontrol@siemens.com

A fax form is available at the end of this document.

SINUMERIK Internet address

http://www.siemens.com/sinumerik

EC Declaration of Conformity

The EC Declaration of Conformity for the EMC Directive can be viewed/downloaded from the Internet at:

http://support.automation.siemens.com

under the Product Order No. 15257461or at the relevant branch office of the A&D MC Division of Siemens AG.

Table of contents

Preface **3**

1 Introduction **13**

1.1 Commissioning manuals for SINUMERIK 840D sl 13

1.2 Principle representation of SINUMERIK 840D sl components for commissioning 15

1.3 Initial commissioning procedure 19

2 Safety information **21**

2.1 Danger notices 21

2.2 ESD notices 23

3 Requirements for commissioning **25**

3.1 General prerequisites 25

3.2 Software and hardware requirements 26

3.3 Communication interfaces 28

3.4 Commissioning tool on PG/PC 29

4 Example configuration **31**

5 Power on and boot up **33**

5.1 Operating and display elements for run-up 33

5.2 NCK and PLC general reset 35

5.3 Boot completed 37

6 Connect PG/PC with the PLC **39**

6.1 Start SIMATIC Manager 39

6.2 Setting up the communication 40

7 PLC commissioning **41**

7.1 Creating a SIMATIC S7 project 41
7.1.1 Creating a project 42
7.1.2 Inserting a SIMATIC station 300 43
7.1.3 Insert NCU 7x0 in HW config 45
7.1.4 Configuring the properties of the network interfaces 46
7.1.5 Insert NX in HW Config 50
7.1.6 End hardware configuration and load to the PLC 53

7.2 Creating a PLC program 54
7.2.1 Insert PLC basic program 54
7.2.2 Modifying Ethernet machine control panel in OB100 56

7.3 Loading the project to the PLC 57

7.4 Configuring an Ethernet machine control panel 59

7.5 Triggering a reset (warm restart) for NCK and drive system ... 60
7.6 First commissioning of the PLC completed ... 62
8 Commissioning SINAMICS drives ... 63
8.1 Introduction to commissioning of SINAMICS drives ... 64
8.2 Activate the factory settings ... 66
8.3 First commissioning of the drive units ... 69
8.4 Updating the component firmware ... 74
8.5 Commissioning using a drive wizard ... 77
8.5.1 Parameterization of infeed ... 78
8.5.2 Parameterization of the drives ... 82
8.5.2.1 Commissioning of listed motor and encoder via SMC ... 84
8.5.2.2 Commissioning of third-party motor and additional second encoder via SMC ... 91
8.6 First commissioning of SINAMICS drive ended ... 99
9 Commissioning communication NCK<->Drive ... 101
9.1 Configuration input/output address and telegram ... 103
9.2 Configuration setpoint/actual value ... 104
9.3 Commissioning communication NCK<->Drive completed ... 106
10 NCK start-up ... 107
10.1 Overview Commissioning NCK ... 107
10.2 System data ... 108
10.2.1 Resolutions ... 108
10.2.2 Normalization of phys. units of machine data and setting data ... 111
10.2.3 Modifying scaling machine data ... 114
10.2.4 Loading default machine data ... 115
10.2.5 Switching over the measuring system ... 116
10.2.6 traversing ranges ... 118
10.2.7 Positioning accuracy of the control system ... 118
10.2.8 Cycle times ... 119
10.2.9 NCK utilization ... 123
10.2.10 Velocities ... 125
10.3 Memory configuration ... 127
10.4 Parameter sets of axis/spindle ... 129
10.5 Parameterize axis data ... 131
10.5.1 Incremental measuring system settings ... 131
10.5.2 Parameterization of absolute measuring systems ... 135
10.5.3 DSC (Dynamic Servo Control) ... 138
10.5.4 Rotary axes ... 140
10.5.5 Positioning axes ... 142
10.5.6 Indexed axes/"Hirth" axes ... 143
10.5.7 Position controller ... 145
10.5.8 Speed setpoint matching ... 150
10.5.9 Drift compensation ... 152
10.5.10 Velocity matching (axis) ... 153
10.5.11 Axis monitoring ... 156
10.5.12 Axis homing ... 164
10.5.12.1 Incremental measuring system ... 165

10.5.12.2 Distancecoded reference marks 168
10.5.12.3 Absolute encoders 171
10.5.12.4 Interface signals and machine data 174
10.6 Parameterization of spindle data 177
10.6.1 Setpoint/actual value channels of spindle 177
10.6.2 Gear stages 178
10.6.3 Spindle measuring systems 179
10.6.4 Speeds and setpoint adjustment for spindle 181
10.6.5 Position spindle 183
10.6.6 Synchronizing spindle 185
10.6.7 Spindle monitoring 187
10.6.8 Spindle data 190
11 Optimize the drive 195
11.1 Measuring functions 196
11.2 Frequency response measurements 199
11.2.1 Current control loop measurement 199
11.2.2 Speed control loop measurement 201
11.2.3 Position control loop measurement 204
11.3 Circularity test measurement 208
11.4 Servo trace 211
11.5 Further optimization options 214
12 Data backup and standard commissioning 215
12.1 Data backup 216
12.2 User data backup/Series commissioning 217
12.3 Preassignments when saving PLC data 218
12.4 Series commissioning 220
13 Tips 221
13.1 Configuration of the properties of the network interface for PROFIBUS 221
13.2 Separate NCK and PLC general reset 224
13.3 Configuring the communication between the PLC and the drive 226
13.4 Integrating PG/PC into the network (NetPro) 228
13.4.1 Integrating PG/PC into NetPro 229
13.4.2 PG/PC interface configuration 231
13.4.3 Assigning interfaces 234
13.4.4 Loading the HW config to NCU 237
13.5 Tips for commissioning SINAMICS drives 238
13.5.1 Component exchange SINAMICS S120 238
13.5.2 Drive diagnostics 239
13.5.3 Diagnostics for pending alarms 241
13.5.4 Drive (SERVO) parameter RESET, individual 242
13.5.5 Version display of the drives (SERVOs) 243
13.5.6 Checking/setting power supply data settings 244
13.5.7 Identification/Optimization "ALM > Infeed/Configuration" 245
13.6 NCU 7x0 and NX1x Terminal Assignment 246
13.7 Extending/checking the topology 250

13.7.1 Adding components to the topology ... 250
13.7.2 Check topology ... 256
13.8 Overview - Assignment of SINAMICS and NCK machine data for communication via PROFIBUS ... 257
13.9 Drive-object assignment for PROFIBUS connection ... 259
13.10 Commissioning NX <-> Drive ... 262
13.11 PROFIBUS machine control panel on the HMI ... 265
13.11.1 Configuration of the properties of the network interface for PROFIBUS ... 265
13.11.2 Load GSD file (contains machine control panel) ... 268
13.11.3 Adding a machine control panel and handwheel in HW Config ... 269
13.11.4 Modifying PROFIBUS machine control panel in OB100 ... 271
14 Licensing ... 273
14.1 Import licensing terms ... 273
14.2 Overview ... 274
14.3 Web License Manager ... 275
14.4 Automation License Manager ... 275
14.5 License database ... 276
14.6 CF Card and hardware serial numbers ... 277
14.7 SINUMERIK License Key ... 278
14.8 Assigning via Web License Manager ... 279
14.8.1 You can execute an assignment via direct access as follows ... 279
14.8.2 You can execute an assignment via customer login as follows ... 280
14.9 Assigning via Automation License Manager ... 282
14.9.1 Function Overview ... 282
14.9.2 Installing the Automation License Manager ... 283
14.9.3 Enabling/disabling SINUMERIK plug-ins ... 284
14.9.4 Assigning parameters to the TCP/IP communication with a control system ... 285
14.9.5 How to refresh the navigation view: "Manage" ... 288
14.9.6 Displaying the license information of a piece of hardware ... 289
14.9.7 Creating a control image (offline) ... 290
14.9.8 Performing a license requirement alignment for a piece of hardware ... 292
14.9.9 Transferring license information for a control image (offline) to a control system (online) ... 294
14.10 Internet links ... 295
15 Fundamentals ... 297
15.1 Basic information on SINAMICS S120 ... 297
15.1.1 Rules for wiring the DRIVE-CLiQ interface ... 297
15.1.2 Drive Objects (DO's) and Drive components ... 299
15.1.3 BICO interconnection ... 301
15.2 Transfer telegrams ... 303
15.2.1 Structure of the telegram with the process data for SINUMERIK 840D sl ... 305
15.2.2 Process data for receiving and sending ... 307
15.3 Control- and status-word bits for NCK<->drive communication ... 309
15.3.1 NCK to drive ... 309
15.3.2 Drive to NCK ... 311
15.4 PLC program ... 314

15.4.1 Fundamentals of creating a PLC user program 317

15.5 Machine and setting data 318
15.5.1 Machine data fundamentals 320
15.5.2 Handling the machine data 322

15.6 Protection levels 323
15.6.1 Protection level fundamentals 325

15.7 Axis data 326
15.7.1 Axis configuration 327
15.7.2 Axis assignment 330
15.7.3 Axis names 333
15.7.4 Setpoint/actual value channels 335

15.8 Spindle data 338
15.8.1 Spindle modes 339
15.8.2 Initial spindle state 339
15.8.3 Axis mode 340

A Appendix 345

A.1 Abbreviations 345

A.2 Small SINAMICS Glossary 347

A.3 Publication-specific information 353
A.3.1 Feedback on the documentation 353
A.3.2 Overview 355

Index 357

1 Introduction

1.1 Commissioning manuals for SINUMERIK 840D sl

Introduction

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

- CNC: NCK, PLC, drive
- CNC: Base software and HMI-embedded
- CNC: ShopMill
- CNC: ShopTurn

Basic steps for commissioning SINUMERIK 840D sl

Commissioning a SINUMERIK 840D sl is performed in 2 basic steps:

1. Step 1 (described in CNC: NCK, PLC, drive)
   - PLC commissioning
   - Drive commissioning
   - NCK commissioning
2. Step 2 (described in CNC: Base software and HMI-Embedded, CNC: ShopMill, CNC: ShopTurn)
   - Commissioning functions in NCK/PLC

References

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 first step (1) and in step (2):

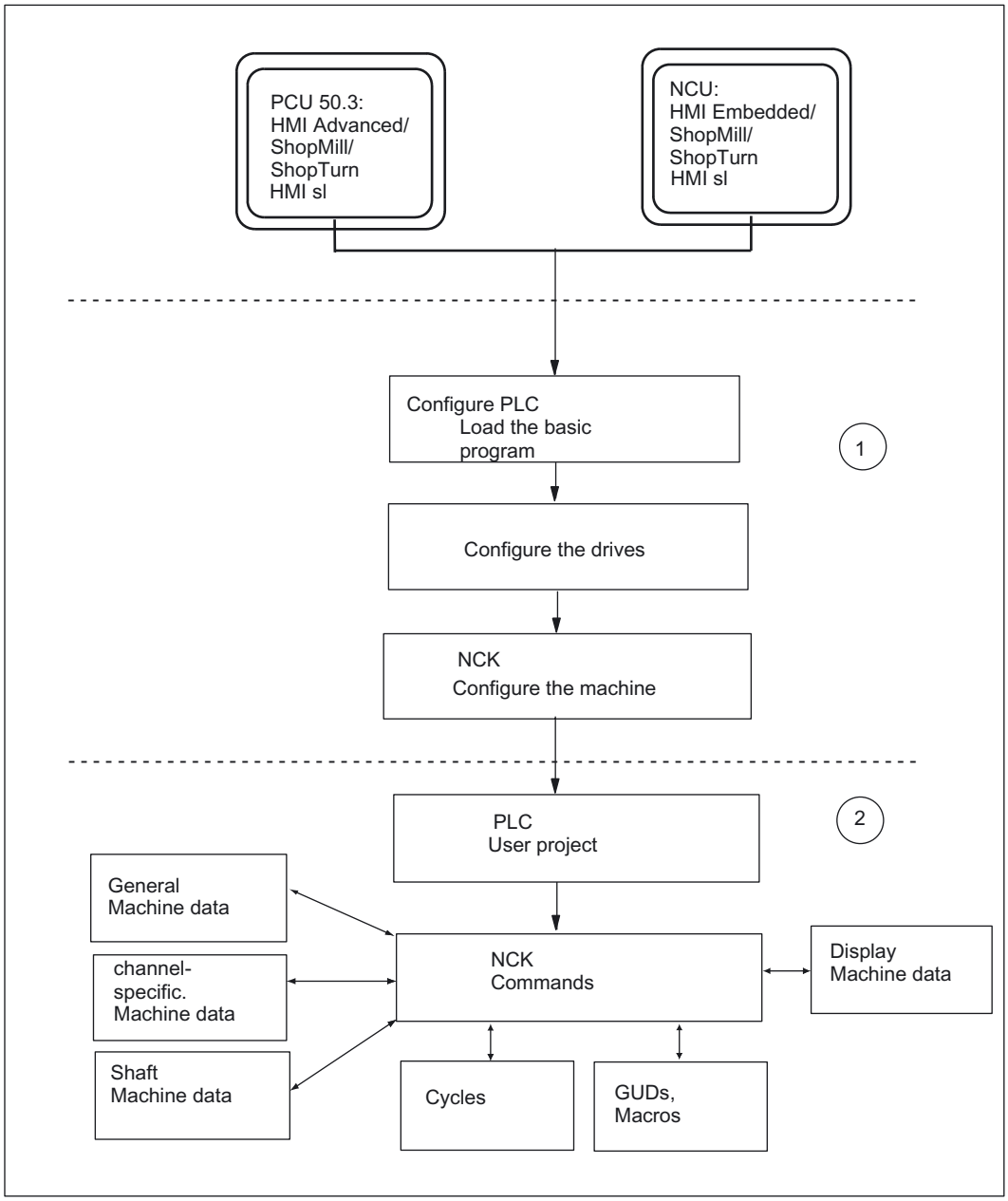


Figure 1-1 Commissioning overview

1.2 Principle representation of SINUMERIK 840D sl components for commissioning

Introduction

In principle, an NCU 7x0 contains the following components:

- HMI
- NCK
- PLC
- Drive
- CP

The HMI contained in the NCU is designated as **internal HMI** or as HMI-Embedded/ShopMill/ShopTurn/HMI sl.

In addition, a PCU 50.3 can be connected to each NCU, on which the HMI-Advanced then runs (additional optional ShopMill/ShopTurn, HMI sl). This HMI is then designated as **external HMI**.

For commissioning, the HMI Advanced Software is required or the commissioning tool derived from it.

For the commissioning of the PLC, a PG/PC with
SIMATIC STEP7 Version 5.3 Service Pack 3 is required.

In order to connect multiple communication partners to socket X120, a network switch or hub (e.g. DMC20) is required.

Commissioning components for internal HMI's

Commissioning of an internal HMI requires a PG/PC. This PG/PC is connected via Ethernet to socket X120.

The internal HMI displays its user interface via TCU (Thin Client Unit), which is connected via the Ethernet machine control panel (e.g. MCP 310) to socket X120.

Commissioning components for external HMI's

External HMIs are connected to socket X120.

A PC/PG is required for commissioning of the PLC of the external HMI. This PG/PC is connected via Ethernet to socket X127.

Note

To use the external HMI (PCU 50.3) without TCU, the internal HMI must be switched off.

Commissioning NCU 7x0 with internal HMI

The following figure illustrates an example of a hardware and software arrangement for the commissioning of an NCU 7x0 with internal HMI.

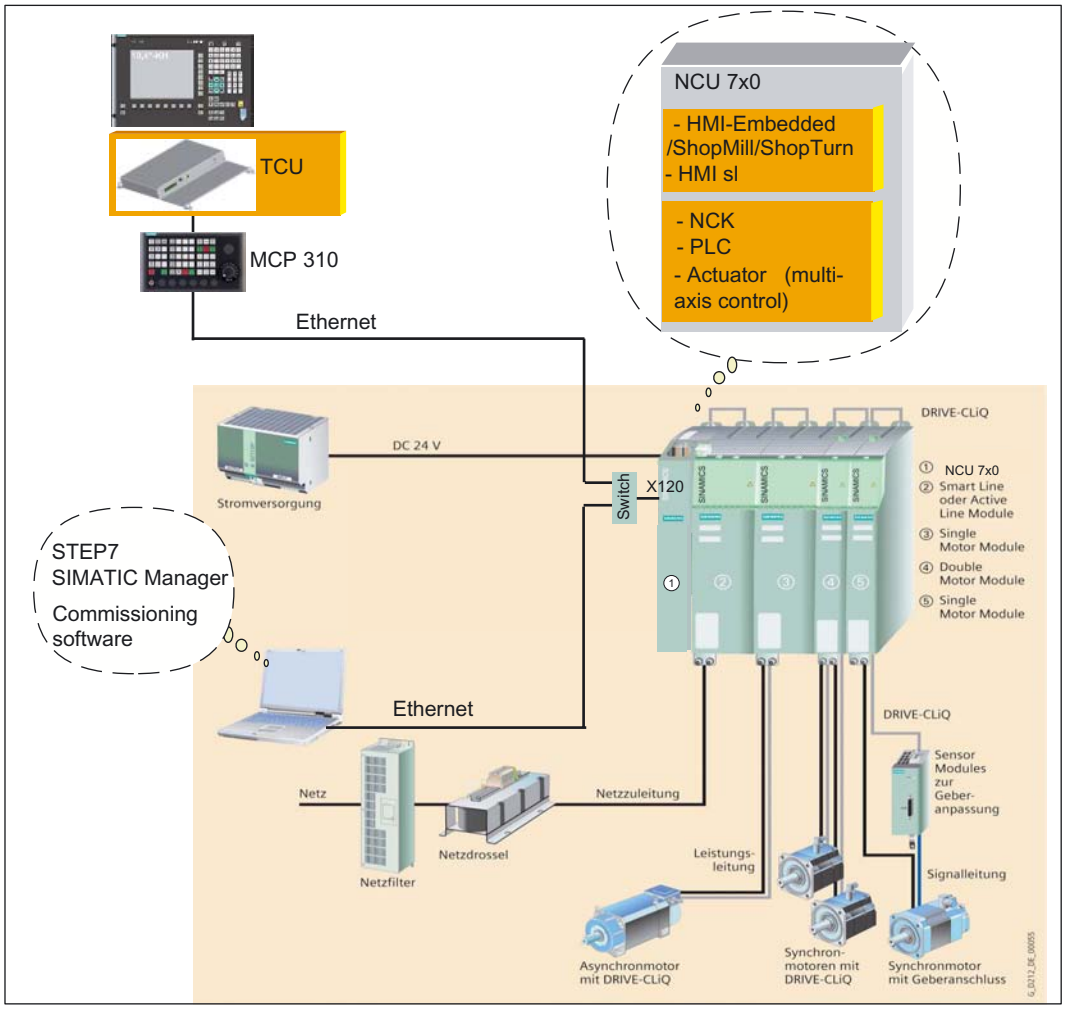


Figure 1-2 Principle representation SINUMERIK 840D sl

Commissioning NCU 7x0 with external HMI

The following figure illustrates an example of a hardware and software arrangement for the commissioning of an NCU 7x0 with PCU 50.3 with external HMI.

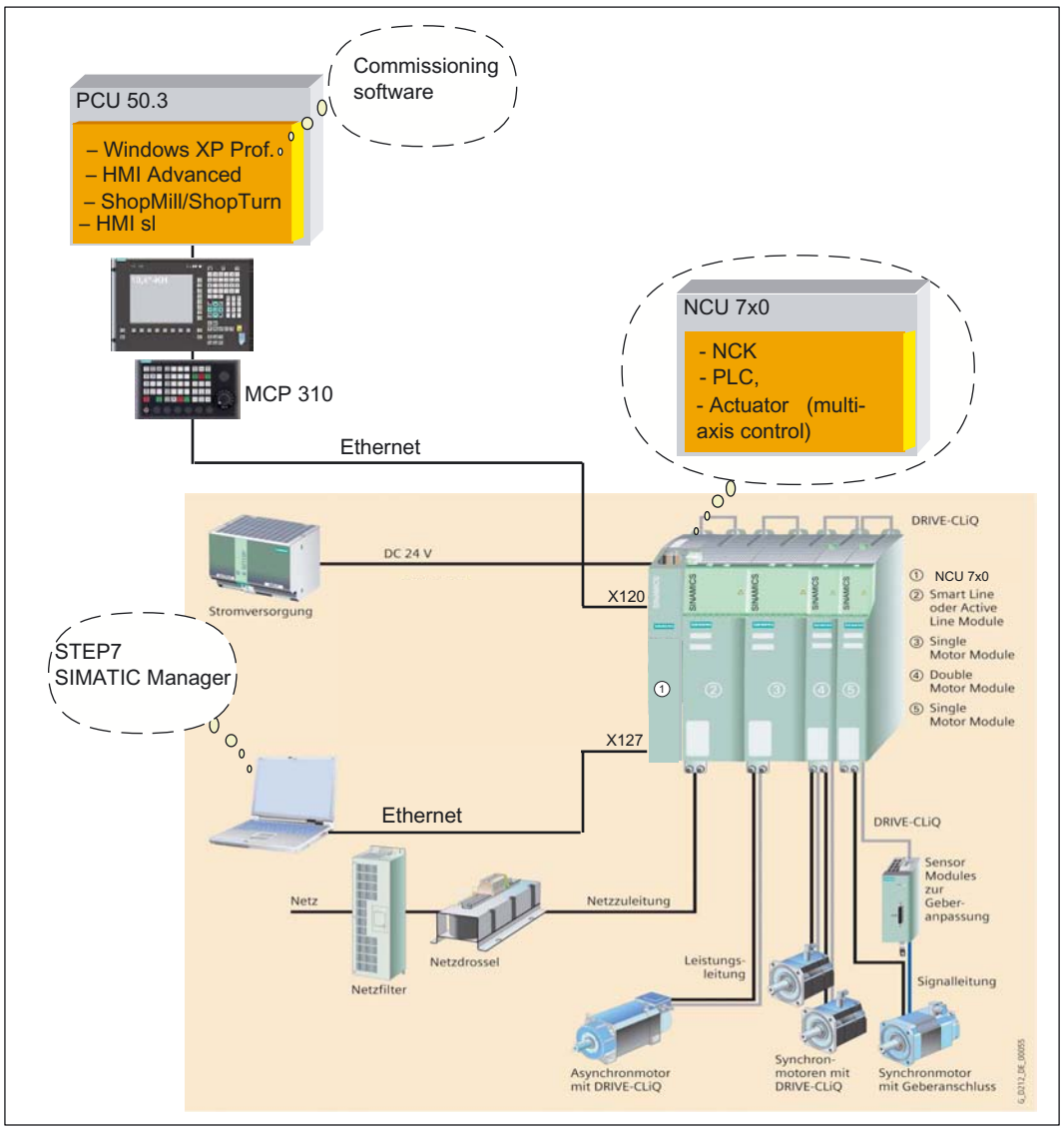


Figure 1-3 Principle representation of SINUMERIK 840D sl with PCU 50.3

Schematic representation of the NCU 7x0

The following figure is a schematic representation of the NCU 7x0:

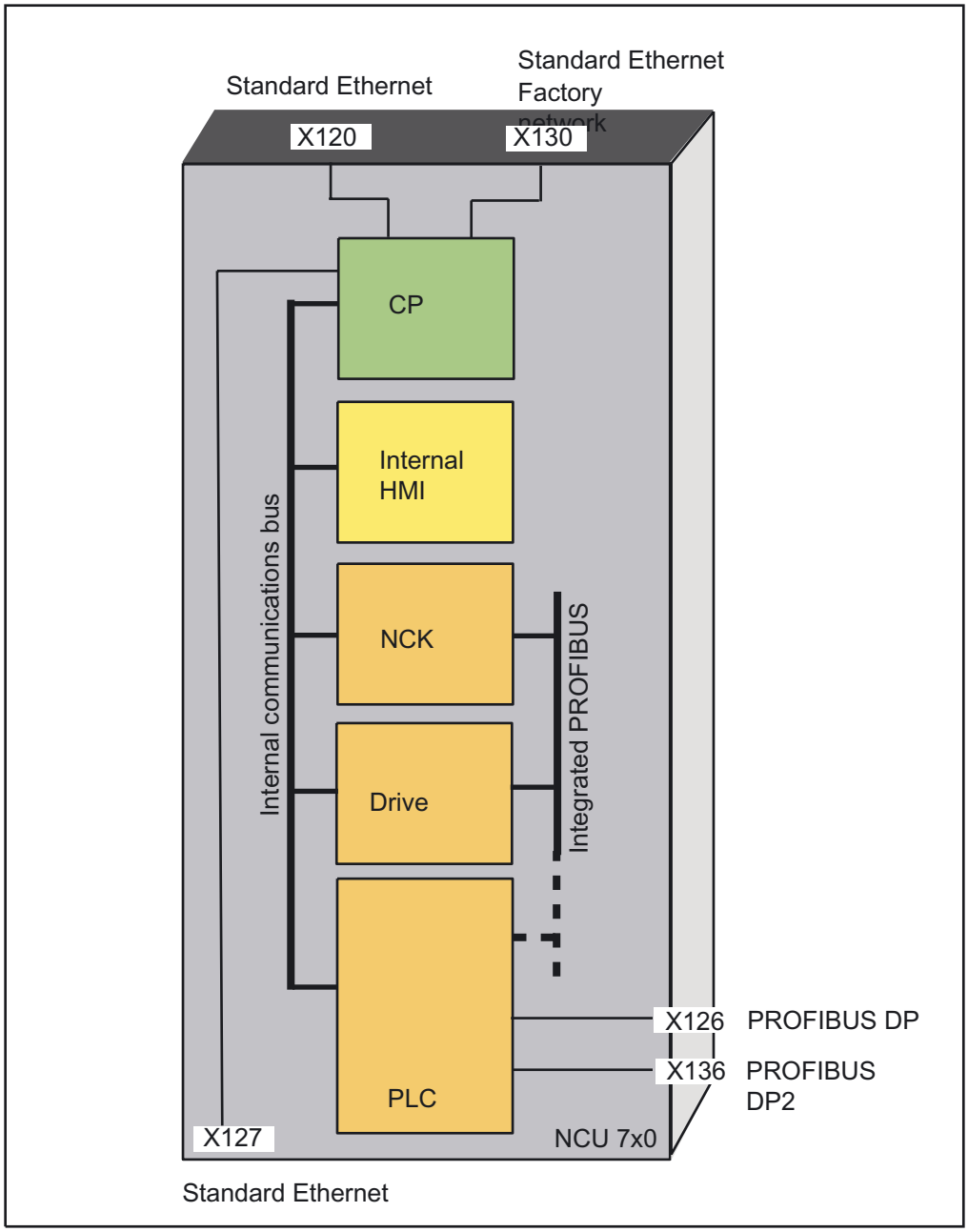


Figure 1-4 Schematic representation of NCU 7x0

1.3 Initial commissioning procedure

Introduction

The mechanical and electrical installation of the system must be completed. At the start of installation and start-up, it is important for the control and its components to run-up properly and essential that the system complies with the application EMC Guidelines.

Commissioning steps

The steps required for installation and start-up are described below. The order is recommended but not mandatory:

1. Checking the SINUMERIK 840D sl boot
2. Making a communication connection to the PLC
3. PLC installation and start-up
4. Commissioning SINAMICS drives
5. Commissioning communication NCK<->Drive
6. NCK commissioning
   - Assigning NCK machine data for communication
   - Scaling machine data
   - Parameterizing axis data
   - Parameterizing spindle data
   - Parameterizing the measuring systems
7. Drive Optimization

Note

For a drive unit with an NX module, observe the information in Section "Commissioning NX <-> drive".

See also

NCK and PLC general reset (Page 35)

Setting up the communication (Page 40)

Creating a SIMATIC S7 project (Page 41)

Commissioning SINAMICS drives (Page 63)

Commissioning communication NCK<->Drive (Page 101)

Overview Commissioning NCK (Page 107)

Further optimization options (Page 214)

Commissioning NX <-> Drive (Page 262)

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 VBG A2 must be adhered to, in particular § 8 "Permissible deviations when working on live components". Suitable electric tools should be used.

⚠ WARNING

Operating the equipment in the immediate vicinity (< 1.5 m) of mobile telephones with a transmitting power of > 1 W may lead to incorrect functioning of the devices.

Connecting cables and signal lines should be installed so that inductive and capacitive interference does not in any way impair the automation and safety functions.

SINAMICS equipment with three-phase motors conforms to EMC Directive 89/336/EEC in the configurations specified in the associated EC Certificate of Conformity.

⚠ DANGER

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.

EMERGENCY STOP devices EN 60204-1 (VDE 0113 Part 1) must remain active in all modes of the automation equipment. Resetting the EMERGENCY STOP device must not cause an uncontrolled or undefined restart.

Anywhere in the automation equipment where faults might cause physical injury or major material damage, in other words, where faults could be dangerous, additional external precautions must be taken, or facilities must be provided, that guarantee or enforce a safe operational state, even when there is a fault (e.g. using an independent limit value switch, mechanical locking mechanisms, EMERGENCY STOP devices)

2.2 ESD notices

CAUTION

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 control cabinet or the protective ground contact of a socket outlet).

NOTICE

Handling ESD-modules:

- 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 PCBs make absolutely sure that you do not touch component pins or printed conductors.
- Touch components only if:
  - You are permanently grounded via an ESD armband
  - You are wearing ESD shoes or ESD shoe-grounding-strips, if ESD flooring is available
- Modules may only be placed on electrically conductive surfaces (table with ESD top, conductive ESD foam plastic, ESD packaging bags, ESD transport containers).
- Keep modules away from visual display units, monitors or TV sets (minimum distance from screen 10 cm).
- Do not bring ESD-sensitive modules into contact with chargeable and highly-insulating materials, such as plastic, insulating table tops or clothing made of synthetic materials.
- Measurements on modules are allowed only if:
  - The measuring instrument is properly earthed (e.g., protective conductor) or
  - Before measuring with a floating measuring instrument, the probe is briefly discharged (e.g., touch the bare metal parts of the control housing).

Requirements for commissioning 3

3.1 General prerequisites

General

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

Limit values

In particular, the following must be observed:

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

Prerequirements for components involved

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

- When handling the components, all ESD measures are observed.
- 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.

Literature

- All information about the structure of SINAMICS S120 drive components are contained in:

  SINAMICS S120 Equipment Manual
- You can find all the instructions on how to connect the Ethernet interface here:

  Equipment Manual NCU
- To initialize an Ethernet, see also:

  HMI commissioning; TCU commissioning

3.2 Software and hardware requirements

Requirements

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

- Connection to NCU
  - Network switch or hub to socket X120
  - Ethernet connection of PG/PC to socket X120 or socket X127 when commissioning the HMI PLC external
  - Ethernet machine control panel to socket X120
  - Ethernet connection from TCU for internal HMI internal to Ethernet machine control panel or
  - Ethernet connection from PCU 50.3 for HMI external to Ethernet machine control panel
- Software prerequisites
  - SIMATIC STEP 7 as of Version 5.3 Service Pack 3 on PC/PG (SIMATIC Manager)
  - STEP7 package for NCU7x0 on PC/PG (Toolbox)
  - GSD file (Toolbox)
  - CompactFlash Card with software for internal HMI, NCK, PLC and drive
  - External HMI on PCU 50.3 or IBN tool on PC/PG for the commissioning of internal HMI

  Note

  The order numbers of the SINAMICS drives, motors and encoders should be at hand. These are used for parameterization.

- Hardware prerequisites
  - CompactFlash Card with software for internal HMI, NCK, PLC and drive attached in NCU
  - Dual ventilator fan/battery module (MLFB 6FC5348-0AA02-0AA0) to NCU (see following figure)

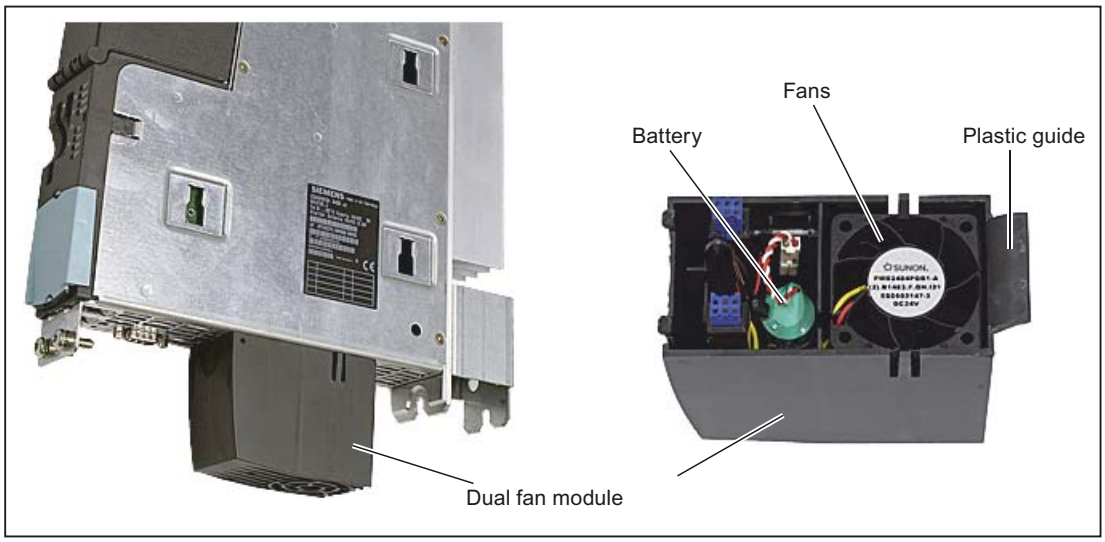


Figure 3-1 Dual fan/battery module

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.

3.3 Communication interfaces

Introduction

The figure below identifies the interfaces on the NCU that can be used for communication with the components involved in the installation and startup phase. They are:

- X120 Ethernet interface for TCU and/or PCU (a network switch or hub enables expansion)
- X130 Ethernet interface for factory network
- for PG/PC
  - currently X120 Ethernet interface, internal for HMI
  - X127 Ethernet interface, external for HMI (PLC commissioning)
- X126 PROFIBUS interface for machine control panel, for example

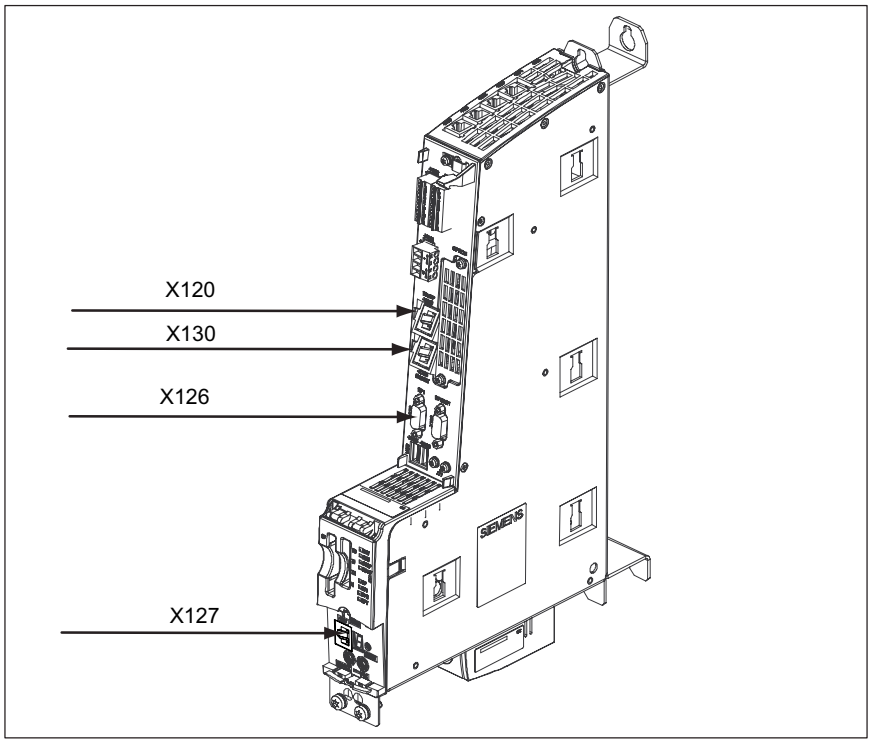


Figure 3-2 Interfaces on the NCU for installation and startup

Network configuration characteristics

For the individual, participating components that are connected with the NCU, the following properties are available for the network configuration.

Table 3-1 Network configuration

Component	socket	Which network?	IP address	Subnet ID
TCU/PCU 50.3 and currently PC/PG for commissioning of internal HMI	X120	Ethernet	192.168.214.1	255.255.255.0
Factory network	X130	Ethernet	Assigned by DHCP server, for example 10.10.255.200	
PG/PC for commissioning of PLC external HMI	X127	Ethernet	192.168.215.1 or DHCP Server	255.255.255.248

3.4 Commissioning tool on PG/PC

Precondition

If a SINUMERIK 840D sl (internal HMI), consisting of a TCU, NCU 7x0 and SINAMICS S120 drive components is commissioned, the commissioning tool on the PG/PC is required.

To carry out a commissioning with PG/PC with the commissioning tool, the following points are required:

- Commissioning tool is installed and started on the PG/PC.
- There is an Ethernet connection to NCU (currently X120).
- Since the standard Ethernet IP address is pre-assigned in the commissioning tool for X120 (192.168.214.1), there are no additional requirements.
- If another Ethernet interface is used, e.g. connected to socket X127, then this must be adapted accordingly in the commissioning tool by selecting HMI > Change standard address (for example, 192.168.215.1 for socket X127).

Example configuration

4

Overview

The commissioning described in this manual orientates itself on an example configuration of the SINAMICS drive line-up.

The following figure roughly shows the components.

- An NCU 710 with:
  - A Single Motor Module for a motor with SMI (Sensor Module Integrated)
  - A Double Motor Module for two motors each with an SMC 20 (Sensor Module Cabinet)
- An NX 15 with:
  - A Single Motor Module for a motor with two SMC 20 for the encoder
- An Active Line Module

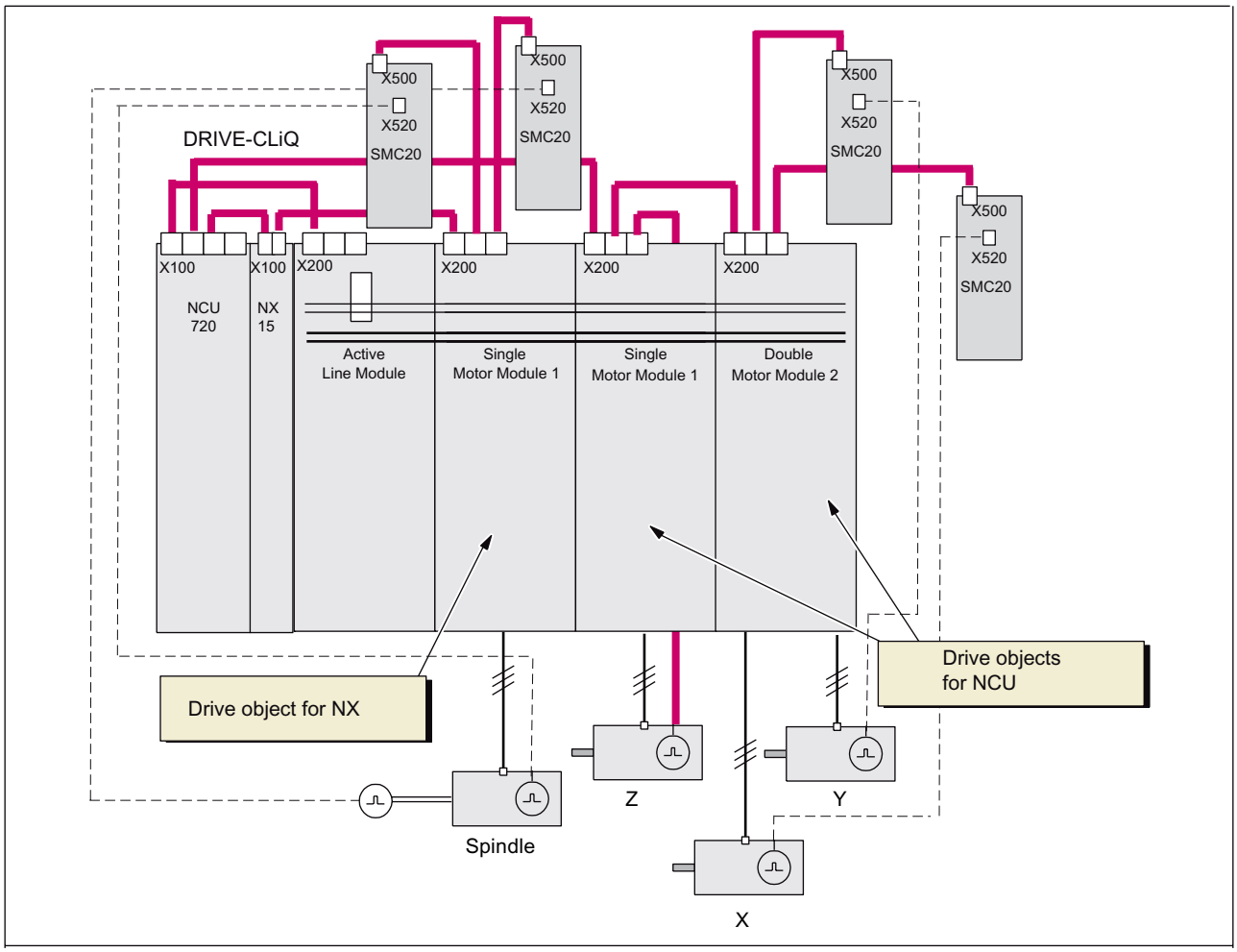


Figure 4-1 Example configuration

Reference

For further available DRIVE-CLiQ components of the SINAMICS drive line-up, see Catalog NC 61, Edition 2007/2008, SINUMERIK & SINAMICS; Order No.: E86060-K4461-A101-A2

Power on and boot up

5

5.1 Operating and display elements for run-up

Introduction

The figure below shows the operating and display elements of the NCU, which are important for switch-on and run-up of the SINUMERIK 840D sl:

- Various error and status LEDs
- Status display (seven-segment display)
- RESET button
- NCK start-up switch (left)
- PLC mode selector switch (right)
- CompactFlash slot

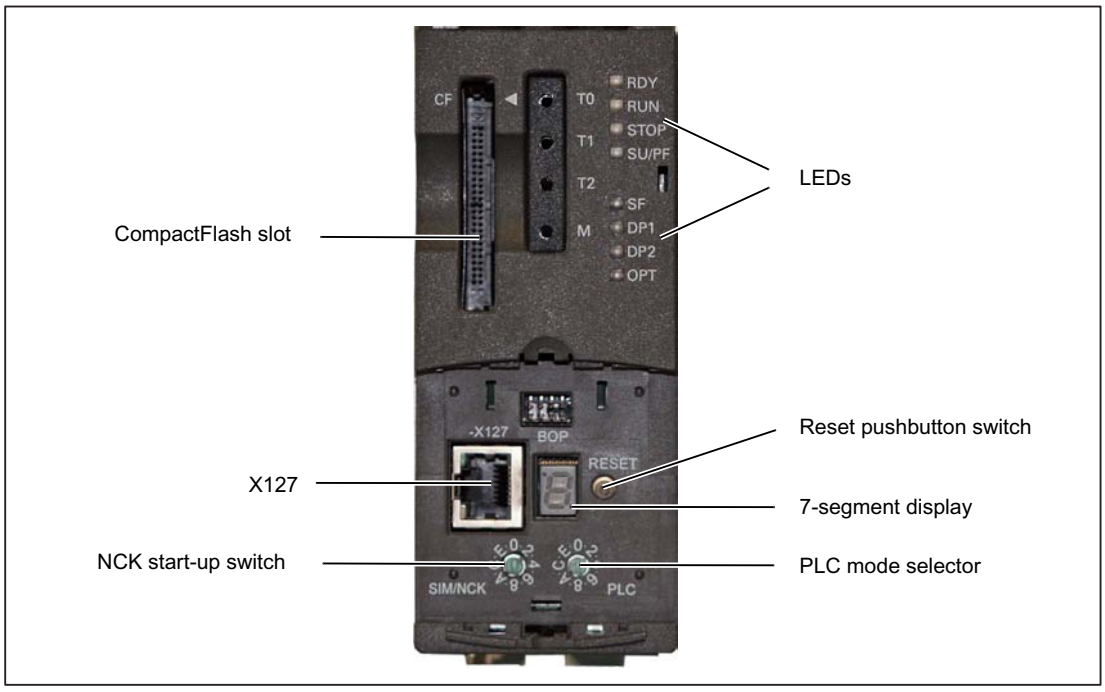


Figure 5-1 Operating and display elements for installation and start-up at the NCU

Note

When you turn the start-up switch or operating mode switch, then the status display indicates the selected number/letters!

LED display

The following LED displays indicate states at the NCU

- RDY (yellow) -> Write/read access to the CompactFlash card,

  RDY (red) -> Watchdog (no NCK ready),

  RDY (green) -> not used with SINUMERIK
- RUN (green) -> PLC running
- STOP (yellow) -> PLC stopped
- SU/PF (yellow) -> Force PLC active
- SF (red) -> general PLC error, see diagnostic buffer
- DP1 (red) -> Error on PROFIBUS (X126)
- DP2 (red) -> Error on PROFIBUS (X136)
- OPT (red) -> Error on option module
- All yellow -> power up not possible (CompactFlash Card not plugged in or empty)

NCK start-up switch

The following switch settings are assigned:

- 0 -> NCK in the operating mode
- 1 -> NCK in the initial clear mode (standard MD)
- 7 -> NCK is not started during run-up
- 8 -> Display IP address for the factory network at X130
  - Turn the NCK start-up switch to "8"
  - Trigger RESET.
  - The individual values of the IP address are displayed as individual digits with points to separate the individual values. The last digit does not have a point. The IP address is displayed again after a short delay. In this state, no NCK operation is possible.

PLC mode selector switch

The following switch settings are assigned:

- 0 -> NC in operating mode
- 1 -> NC in operating mode, protected
- 2 -> NC in operating mode
- 3 -> PLC general reset

5.2 NCK and PLC general reset

Introduction

On initial startup of the PLC, a general reset of the PLC has to be performed after the NCU has been switched on and booted.

To obtain a defined output state of the complete system (NCK and PLC), the NCK must also be deleted.

- PLC general reset

  General reset puts the PLC in a defined initial state by deleting and initializing all system and user data.

- Delete NCK data

  After a request to delete NCKs, all user data is deleted and the system data is reinitialized on the next NCK boot, e.g., after NCK Reset.

Operator input sequence steps NCK and PLC general reset for initial boot

If you want to boot the control for the first time, then the following operator input sequence steps are to be executed for an NCK and PLC general reset:

1. On the NCU, turn the startup switch and mode selector to the following positions:
   - NCK startup switch (SIM/NCK label) to "1"
   - PLC mode selector (PLC label) to "3"
2. Execute a POWER ON (switch on control).
3. Wait until the NCU displays the following continuously:
   - STOP LED flashes
   - SF LED is lit.
4. Turn the PLC-mode selector to the following switch positions in succession:
   - Briefly to "2"
   - Back to "3"

     LED STOP first flashes with about 2Hz and then illuminates.
5. Turn the switch for NCK and PLC back to position "0".
6. On proper completion of startup, the number "6" and a flashing dot is output on the status display of the NCU.
   - LED RUN illuminates GREEN continuously.
7. Re-execute a POWER ON.

   ⇒ PLC and NCK are in cyclic operation.

Notes

Note

If a hardware RESET or POWER ON is triggered in switch position "3" on the PLC mode selector, then the complete SRAM of the PLC is initialized and the diagnostic buffer is not deleted. All user data must be transferred again.

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 winthin three seconds after requesting general reset.

Note

For the first startup, module replacement, battery failure, general reset request via the PLC and PLC upgrade, the PLC general reset is absolutely required.

Note

Since no PLC start is executed after PLC general reset, 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 how to continue.

See also

Separate NCK and PLC general reset (Page 224)

5.3 Boot completed

Introduction

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

- Number "6" and a flashing point
- LED RUN illuminates GREEN continuously

To resume the startup on the user interface of the HMI, the following operator input sequence steps are necessary:

Operator input sequence steps for entry into startup

1. Press <Menu Select> , or the <F10> key on the PG/PC.
2. Press "Commissioning".

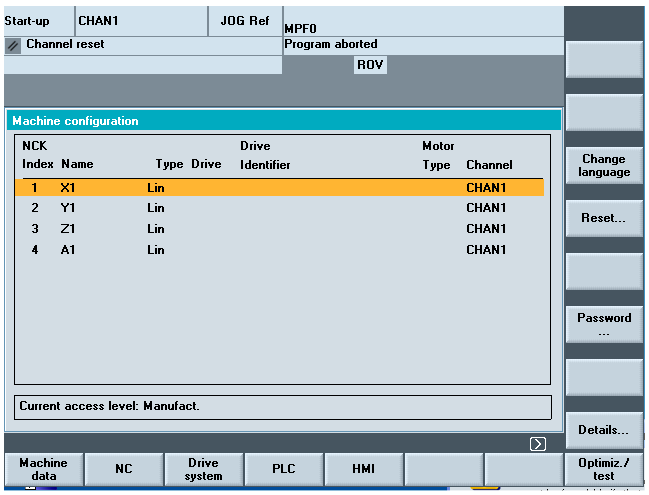


Figure 5-2 "Commissioning" menu

3. Press "Password...".
4. Press "Set password".
5. Enter the manufacturer's password "SUNRISE".
6. Press "OK".

Run-up has been completed.

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

See also

Triggering a reset (warm restart) for NCK and drive system (Page 60)

Connect PG/PC with the PLC

6

6.1 Start SIMATIC Manager

Introduction

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

The SIMATIC Manager lets you

- manage projects and libraries,
- call STEP 7 tools,
- access the PLC online.

Start 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".

1. Run SIMATIC Manager by double-clicking the icon, or from the Start menu (same as with all other Windows applications).

User interface

A corresponding editing tool is started up when you open the relevant objects. Start the program editor by double-clicking the program block you want to edit.

Online help

The online help for the active window is always called by pressing F1.

6.2 Setting up the communication

Introduction

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

Operator input sequence steps for establishing a communications connection to the PLC

The communications connection to the PLC may be set from PG/PC via SIMATIC Manager with the following operator input sequence steps:

1. Select menu command: "Set Extras > PG/PC interface..."
2. On the Access Mode tab look for the interface used, in the selection field "Parameterization of used interface", 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.

PLC commissioning 7

7.1 Creating a SIMATIC S7 project

Introduction

It is necessary to create an 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 you will have to perform the following operations:

- Create a project
- Insert a SIMATIC station 300
- Insert NCU 7x0 in HW Config
- Configure the properties of the network interfaces
- Insert machine control panel and hand wheel

Note

The toolbox must have been installed.

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.

At the present time, the HW config of the CP840 can ONLY be loaded alone via network. Loading the CP840 via PROFIBUS DP2 is not yet possible in the SW version currently described.

Reference

The PLC interface signals are described in "Parameter Manual 2"

7.1.1 Creating a project

Introduction

You have started the SIMATIC Manager.

Operator input sequence steps

1. To create a new project select menu command "File > New" in the SIMATIC Manager.
2. Enter the following project data in the dialog box:
   - Name (for example: PLC-Erst-IBN 840D sl)
   - Storage location (path)
   - Type
3. Confirm the dialog with "OK".

   The SIMATIC Manager opens and displays the project window with an empty structure of the S7 project.

7.1.2 Inserting a SIMATIC station 300

Introduction

Before you introduce required hardware to the S7 project, the following steps are needed:

- Insert a SIMATIC station 300 in the project
- Starting HW-Config

Operating steps

1. Select <right mouse button> menu "Insert new object > SIMATIC 300-Station".

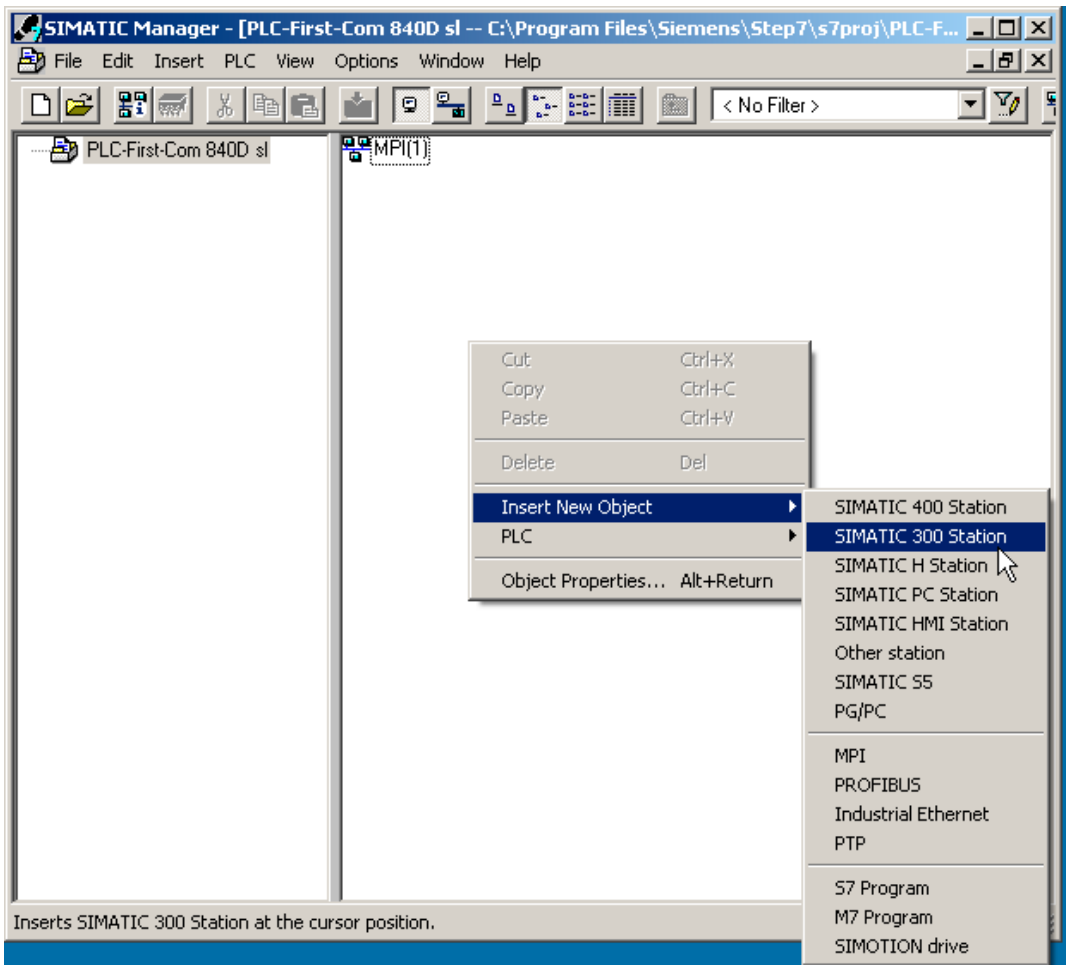


Figure 7-1 Inserting a SIMATIC station 300

2. Double-click on the symbol <SIMATIC 300 (1)>.
3. Double-click on the symbol <Hardware>.

   The HW config for introducing required hardware is started.

4. Select in the menu "View > Catalog". The catalog with the modules is displayed (see following picture).

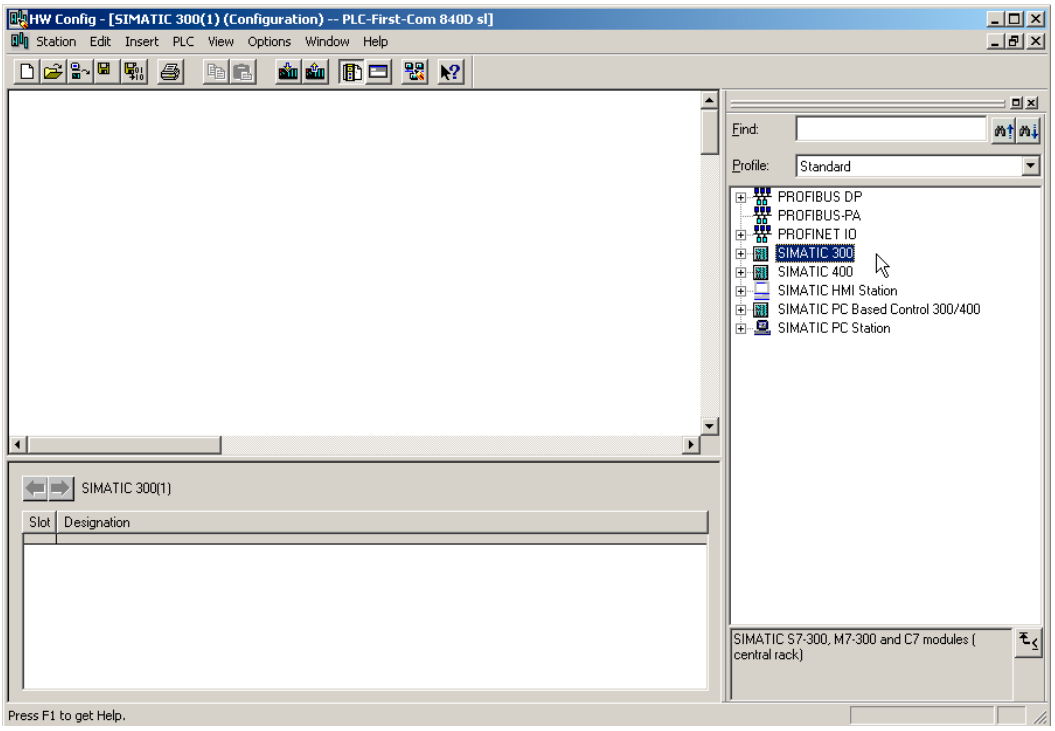


Figure 7-2 HW-Config

7.1.3 Insert NCU 7x0 in HW config

Introduction

The user interface of "HW config" mostly displays (see the following figure):

- 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

  In this catalog, the NCU 7X0 that you need for configuring the hardware is also included.

Use the operator input sequence steps described below to insert an NCU 720.1 as example.

Operating steps

1. Select "View > Catalog".
2. Search for the module in the catalog under "SIMATIC 300 > SINUMERIK > 840D sl > NCU 720.1" (see following figure).

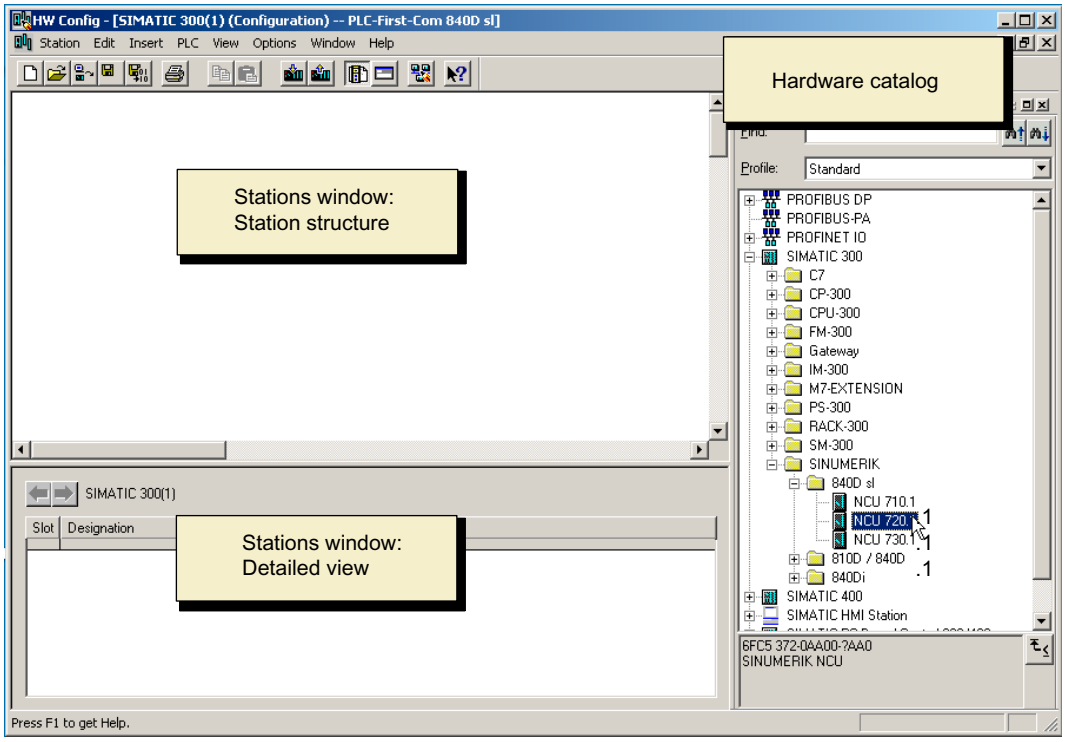


Figure 7-3 NCU 720.1 in the catalog

3. Select NCU 720.1 with the left mouse button, hold the mouse button down and drag to the "Station design" station window.

   After you release the mouse button, configure in the dialog box the interface properties of processor CP 840D sl located on NCU 720.1 (see next chapter).

7.1.4 Configuring the properties of the network interfaces

Introduction

In the STEP7 project, configure the following network interfaces you want to use to reach the NCU 7X0:

- PROFIBUS DP, only with machine control panel for PROFIBUS (see PROFIBUS machine control panel on the HMI (Page 265))
- Ethernet
- integrated PROFIBUS

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

Steps for PROFIBUS DP

1. You used the left mouse button to select NCU 720.1 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 PROFIBUS DP interface for socket X126 (machine control panel) in the dialog box (see figure below).

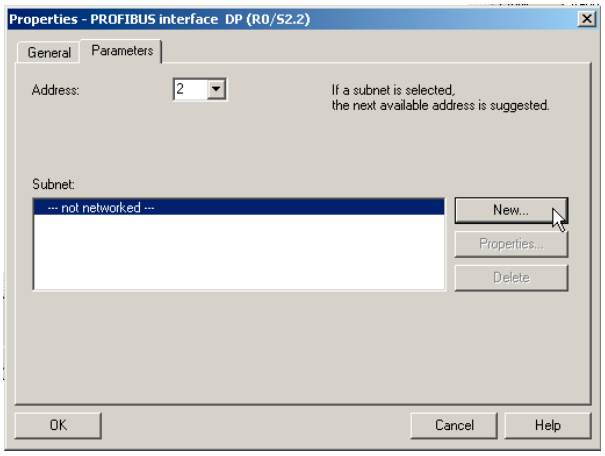


Figure 7-4 Properties of PROFIBUS DP

3. This is an Ethernet machine control panel, which does not require configuration. Select "Cancel".

4. Module NCU 720.1 with SINAMICS S120 is inserted into the HW config (see figure below).

Note

With the <F4> key and confirmation of the question regarding "Reorganize", you can reorganize the display in the station window.

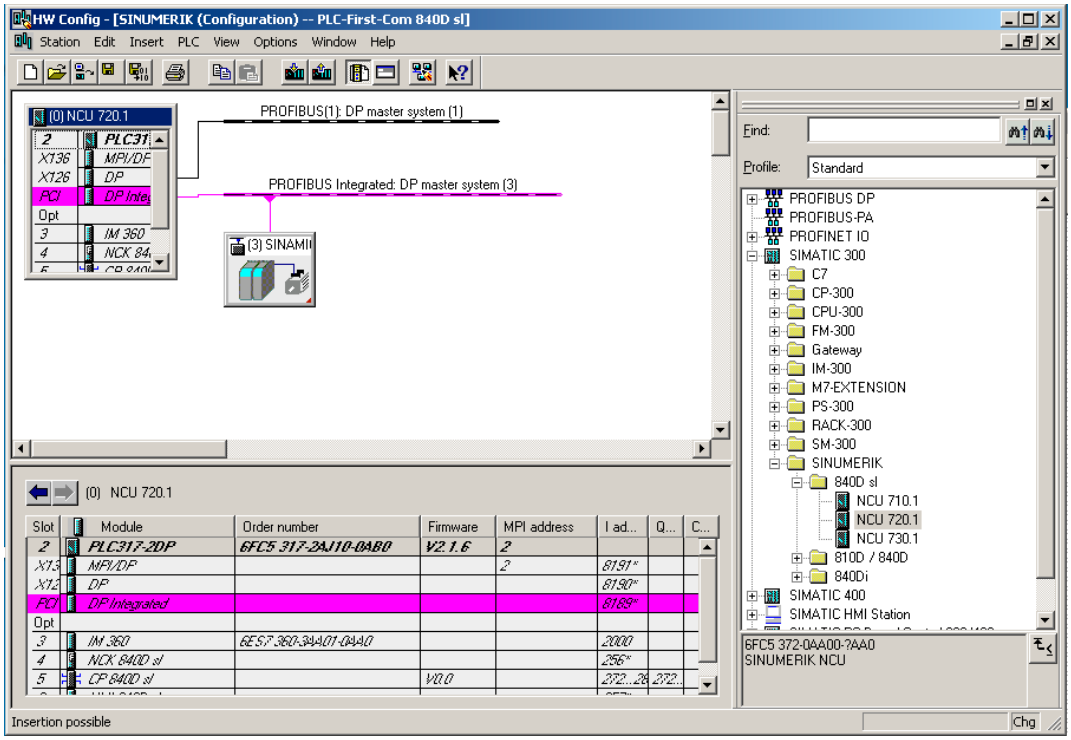


Figure 7-5 HW config with NCU 720.1

Next, specify the properties for the Ethernet interface.

Operating steps for the Ethernet interface

Note

Use socket X127 for commissioning of the PLC for the external HMI. No configuration of the Ethernet interface is required for this. This interface is set with IP address 192.168.215.1 as a default.

For the first commissioning of a HMI 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 on "CP 840D sl" in the basic rack of the NCU 720.1. The dialog "Properties - Ethernet Interface CP 840D sl" is opened (see figure below).

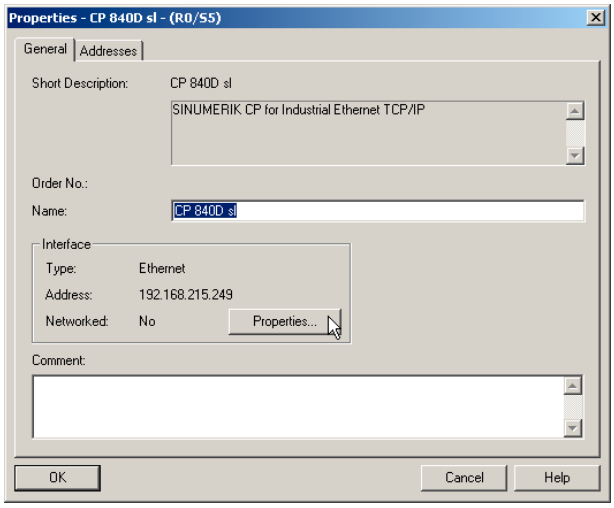


Figure 7-6 General properties of the CP 840D sl

2. After clicking on the "Properties" button, a new Ethernet interface can be created.

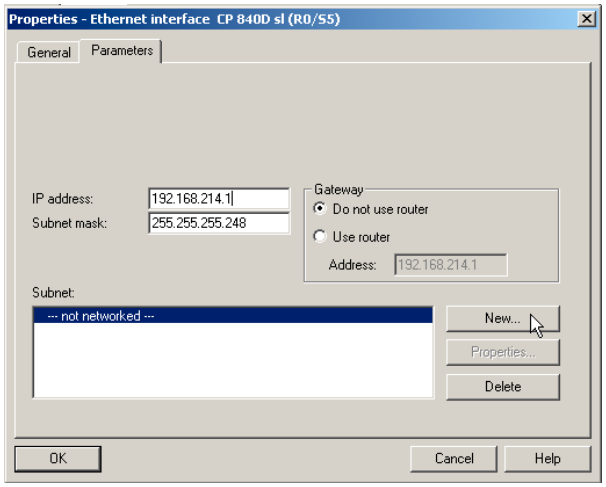


Figure 7-7 Properties of the Ethernet interface

The interface of socket X120 is used for the current commissioning of the internal HMI. The IP address must be changed.

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 on "OK" twice.

Next, specify the properties for the integrated PROFIBUS.

Steps for the integrated PROFIBUS

The integrated PROFIBUS for communication with the SINAMICS S120 requires a common Subnet ID. This Subnet ID has to be introduced to the external HMI in the MMC.ini.

1. In the station window, click on the bus of the integrated "PROFIBUS PROFIBUS Integrated: DP Master System" and use the right mouse button to select the menu item "Object properties".
2. Click on "Properties" on the "General" tab.

   Enter the ID "0046-0010" in field "S7 Sub-network ID".

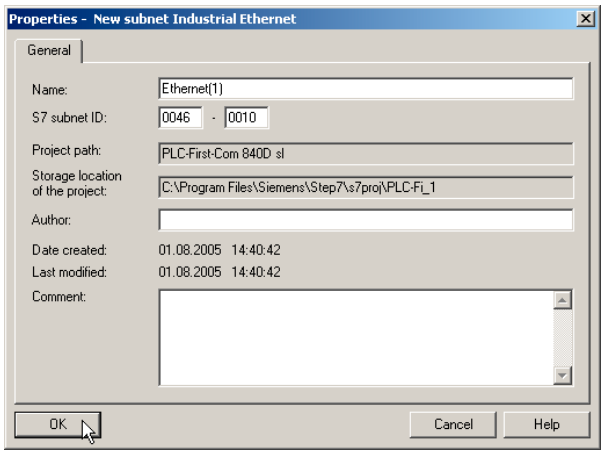


Figure 7-8 Integrated PROFIBUS subnet ID

3. Click on "OK" twice.

Telegram lengths and I/O addresses

The telegram lengths and input/output addresses for communication between the PLC and the drive (can be viewed via the object properties of the integrated SINAMICS) are pre-assigned by default and do not require any configuration.

As the next step insert a NX component.

See also

Configuring the communication between the PLC and the drive (Page 226)

7.1.5 Insert NX in HW Config

Introduction

A NX component is contained in the example configuration, for the axis to control the spindle. This component must also be inserted in the HW Config when creating the SIMATIC-S7 project.

Operating steps

1. Look for the NX module (NX10, NX15) in the hardware catalog under "PROFIBUS DP > SINAMICS > SINUMERIK NX…".
2. Click with the left mouse button 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.

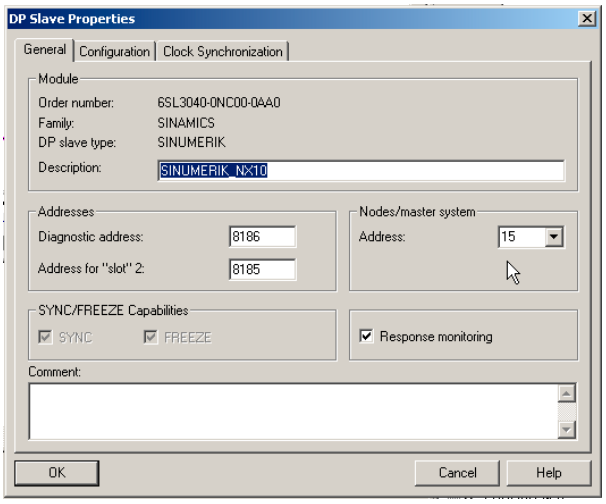


Figure 7-9 DP Slave Properties for NX15

Enter the address for the integrated PROFIBUS in this dialog.

The default value for the first NX15 is "15".

Note

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:

Integrated PROFIBUS address	DRIVE-CLiQ Socket NCU720	DRIVE-CLiQ Socket NCU710
10	X100	X100
11	X101	X101
12	X102	X102

Integrated PROFIBUS address	DRIVE-CLiQ Socket NCU720	DRIVE-CLiQ Socket NCU710
13	X103	X103
14	X104	-
15	X105	-

1. Enter the address and press "OK".

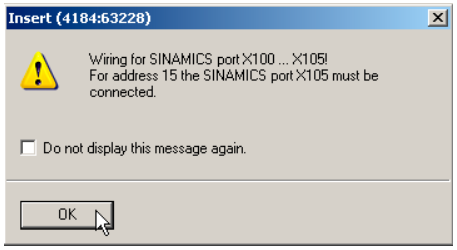


Figure 7-10 Insert NX

2. Confirm the wiring notification with "OK".
3. After releasing the mouse button, the NX module is added (see figure below).

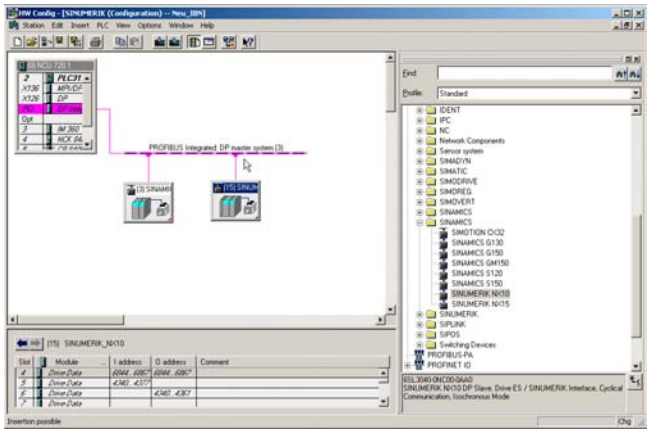


Figure 7-11 NX in HW Config

Note

When deleting and re-inserting NX modules in the hardware config., new slot addresses are issued during addressing. In order to create a unique, and always the same configuration, we would recommend arranging addressing as shown in the following table:

Integrated PROFIBUS address	DRIVE-CLiQ socket, e.g.: NCU720	Start address of first control slot	Start address of last control slot
15	X105	4340	4540
14	X104	4580	4780
13	X103	4820	5020
12	X102	5060	5260

Integrated PROFIBUS address	DRIVE-CLiQ socket, e.g.: NCU720	Start address of first control slot	Start address of last control slot
11	X101	5300	5500
10	X100	5540	5740

See also

Commissioning NX <-> Drive (Page 262)

7.1.6 End hardware configuration and load to the PLC

End hardware configuration and load 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 menu "Station > Save and compile".
2. Click on the button "Load in module", to load the configuration to the PLC.

   The "Select target module" dialog mask automatically displays both configured communication partners (see figure below).

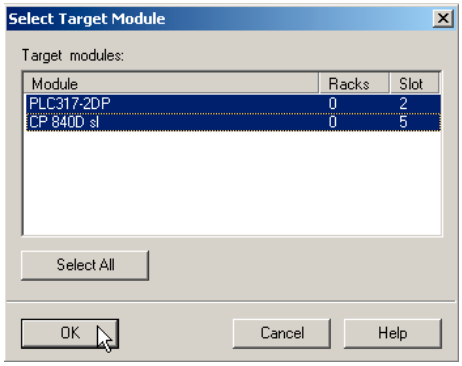


Figure 7-12 Selecting target module

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.

7.2 Creating a PLC program

Introduction

The operator input sequence steps below for the creation of a PLC program describe how to create a basic program.

The SIMATIC STEP7 documentation describes how to modify and extend an application program.

7.2.1 Insert PLC basic program

Introduction

You have performed hardware configuration, have saved and compiled the project ad have created the system data for the PLC.

You have installed the toolbox software, which also contains the libraries for the PLC basic program of an NCU 7x0.

The following operator input sequence steps describe how to open a library and copy the sources, the symbols and the individual blocks into your project.

You are on the main screen of the SIMATIC Manager.

Operator input sequence steps to open library and copy sources, symbols and blocks

1. Select the "File > Open" menu and then click on the "Libraries" tab (see figure below).

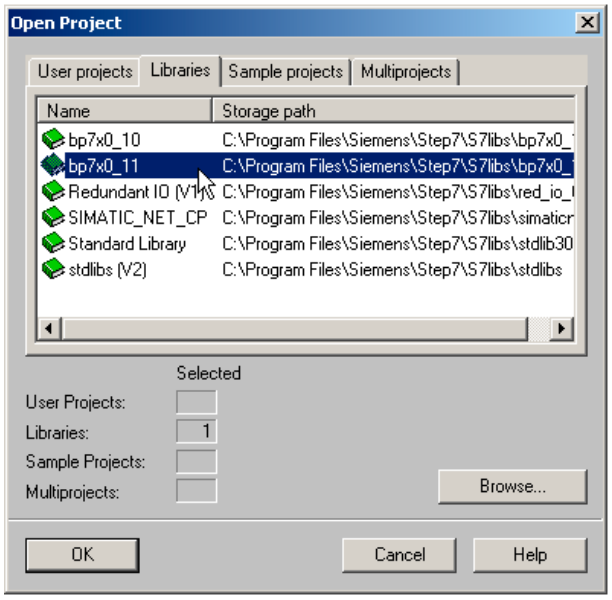


Figure 7-13 Opening the library

2. Select the library for the PLC basic program, e.g. "bp7x0_11" and confirm the dialog with "OK".

   You have inserted the library and selected the PLC program under "PLC-Erst-IBN 840D sl > SINUMERIK > PLC 317 2DP > S7 Program" (see figure below).

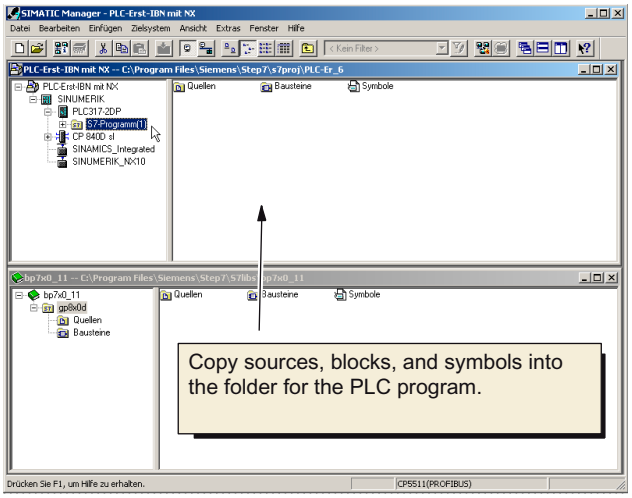


Figure 7-14 Copy the PLC program

3. Copy the sources, modules and symbols to the PLC program

Overwriting OB 1

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.

7.2.2 Modifying Ethernet 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 steps

- 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#55

You have completed the configuration of the PLC basic program.

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

7.3 Loading the project to the PLC

Introduction

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

Requirement

- An Ethernet network connection exists between STEP7 and the PLC.
- The configuration to be loaded corresponds to the actual station configuration.
- NCU 7x0 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 when loading the configuration 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 chapter "End hardware configuration and load to the PLC".

- SIMATIC Manager

  When loading the configuration via the SIMATIC manager all the system data blocks are loaded into the module. The following operator input sequence steps describe how to load the system blocks to the module (PLC).

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.

Operator input sequence steps for loading system blocks into the module

1. To load the configuration of the system blocks change to the SIMATIC Manager.
2. Choose in the SIMATIC Manager in the PLC directory, the directory "Blocks > right mouse button> Target system > Load" (see figure below), or the symbol "Load".

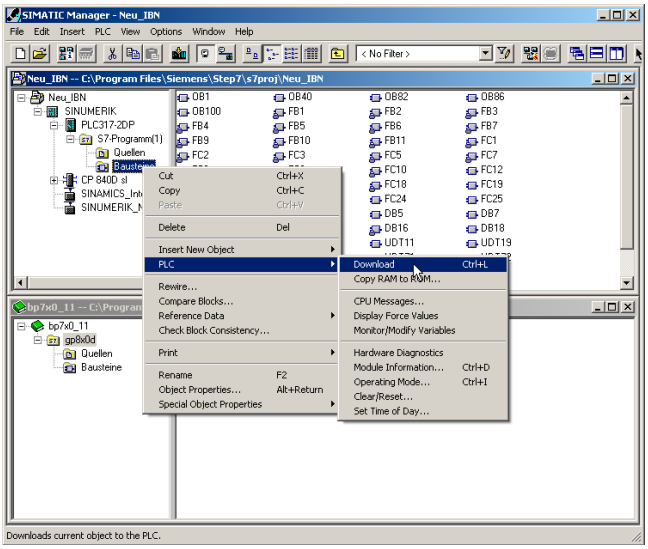


Figure 7-15 Loading system blocks

3. If there is no connection to the destination 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.

NOTICE
A reset (warm restart) of the NCK is required for the PLC-NCK synchronization.

7.4 Configuring an Ethernet machine control panel

Note

If you have an Etrhernet 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] HAND WHEEL_SEGMENT.

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

Introduction

On the HMI the "Commissioning" menu contains:

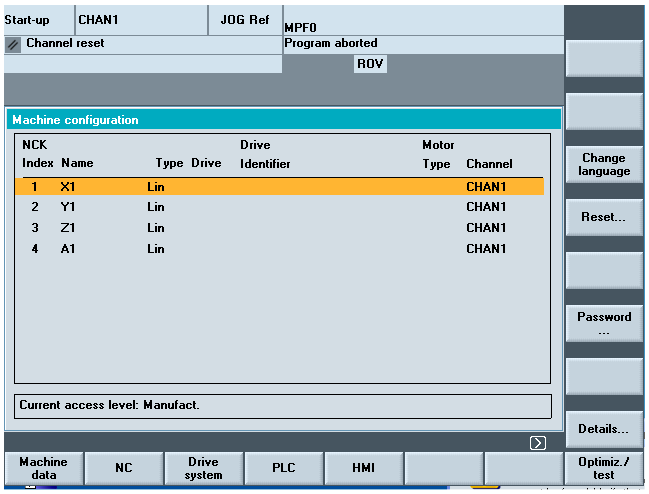


Figure 7-16 "Commissioning" menu

The STOP condition of the PLC which is taken by the PLC for a short time on loading is interpreted by the NC as a PLC failure with an appropriate alarm response.

Alarm response

- Press the button

and select the "Diagnostics > Alarms" menu.

  The system may display the following alarms on the HMI (see figure below):

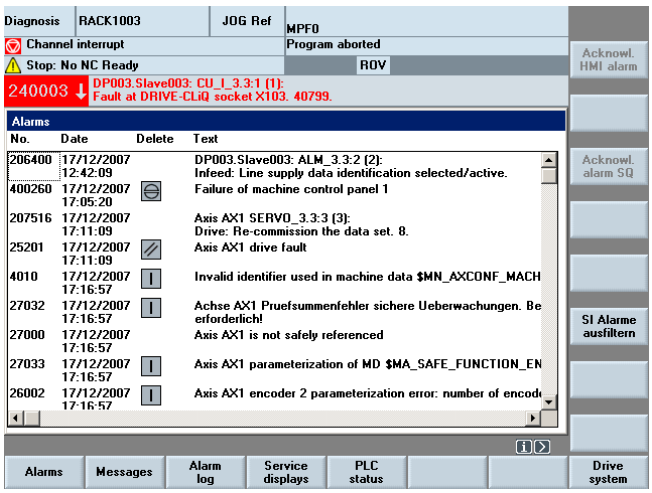


Figure 7-17 Alarm responses

A "reset" (warm restart) is required for the PLC-NCK synchronization.

Triggering the NCK reset operator input steps

1. Press the key

and select the "Commissioning" menu.
2. Press the "Reset..." softkey.
3. Answer the question "Do you want to trigger a reset (warm restart) for the NCK and the entire drive system (all drive units)?" with the "Yes" softkey.

   The PLC goes to RUN mode.

See also

Drive diagnostics (Page 239)

7.6 First commissioning of the PLC completed

First commissioning of the PLC completed

You have completed the first commissioning of the PLC.

The PLC and NCK are in the following state:

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

  ⇒ PLC and NCK are in cyclic operation.

Continue with the steps for commissioning the SINAMICS drives.

You can access the HMI as follows:

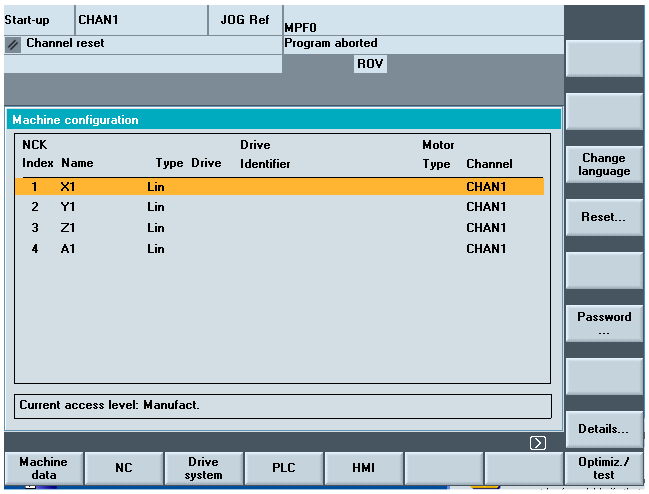


Figure 7-18 PLC commissioning complete

Commissioning SINAMICS drives

8

Introduction

You have completed commissioning of the PLC.

Startup sequence

The basic commissioning of the SINAMICS drives should be carried out in the following sequence:

1. Creating factory settings (if commissioning has been completed)
2. Configure the drive unit (including transfer of the DRIVE-CLiQ topology to the drive unit)
3. Update the component firmware (if necessary)
4. Parameterization of the infeed (if available)
5. Parameterization of the drives (SERVOs)
6. Optimize the drives

Note

Prior to starting commissioning, switch off all drive enables.

8.1 Introduction to commissioning of SINAMICS drives

Introduction

Commissioning of the SINAMICS drives is done in the operating area "Commissioning".

Introduction to commissioning of SINAMICS drives

1. After having completed commissioning of the PLC, you proceed from the following operating interface.

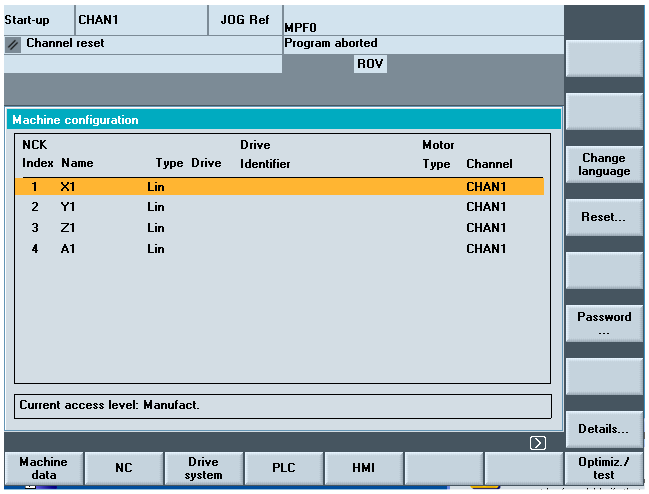


Figure 8-1 "Commissioning" menu

2. Press the "Drive system" softkey.

   There are two different ways to start in the "Commissioning" > "Drive system" menu:

   – The drive system has not yet been commissioned (see following figure).

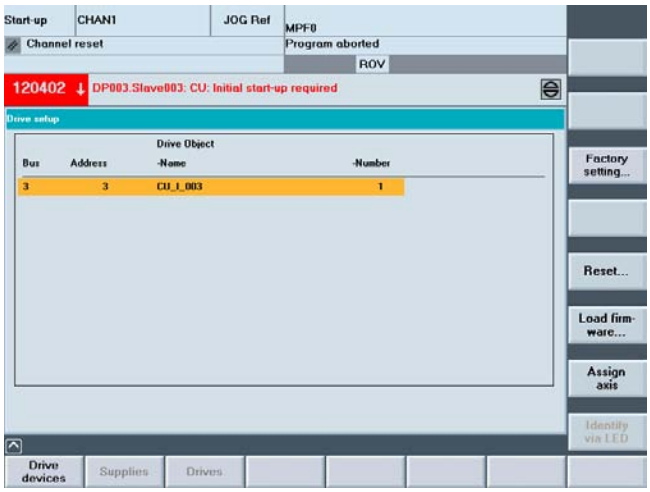


Figure 8-2 "Drive system" menu

This shows an NCU with factory settings that is ready for the first commissioning.

A message appears that a first commissioning is required.

Note

Perform the first commissioning. Start with the operator input steps described in Section "First commissioning of the drive units (Page 69)".

– The drive system has already been commissioned.

  Then start, for example, with the following user interface:

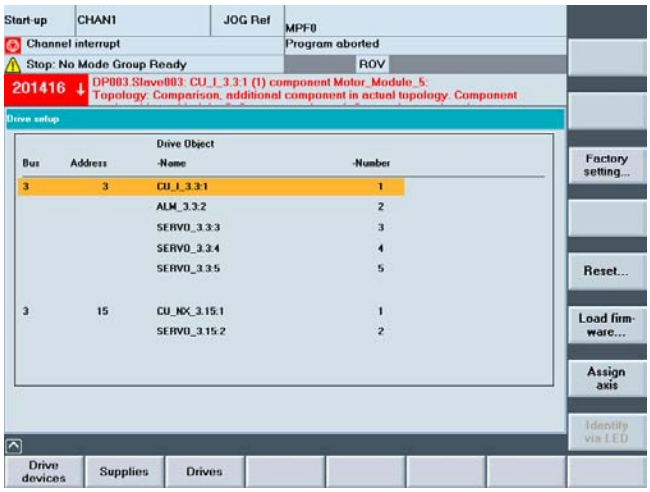


Figure 8-3 Drive system has already been commissioned

Infeed and drives (SERVOs) can be commissioned with the drive wizard (Page 77).

The factory settings can be restored for the drive system with the vertical softkey "Factory settings...". A first commissioning must then be performed again for the drive units.

Note

If commissioning is to be performed using the factory settings, then start with the operator input steps described in the following Section "Restoring factory settings".

8.2 Activate the factory settings

Introduction

If a commissioning has already been performed, then the drive system can be reset to the factory settings with the "Factory settings..." function.

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

Procedure for activating factory settings

1. You are in the "Commissioning > Drive system" menu.

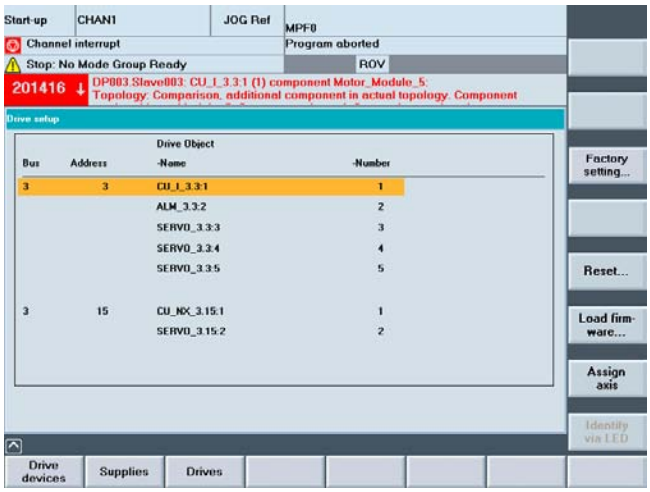


Figure 8-4 "Commissioning > Drive system" menu

2. Press the "Factory settings..." softkey.

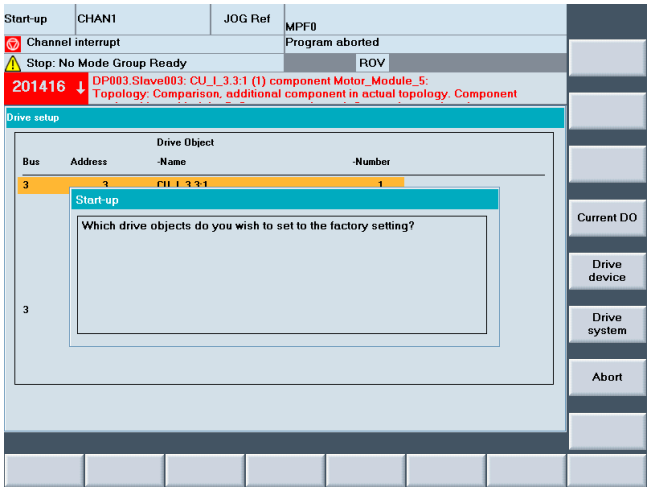


Figure 8-5 Question

3. Press "Drive system" to restore the factory settings for all drive units used in the system (the NCU and NX modules).

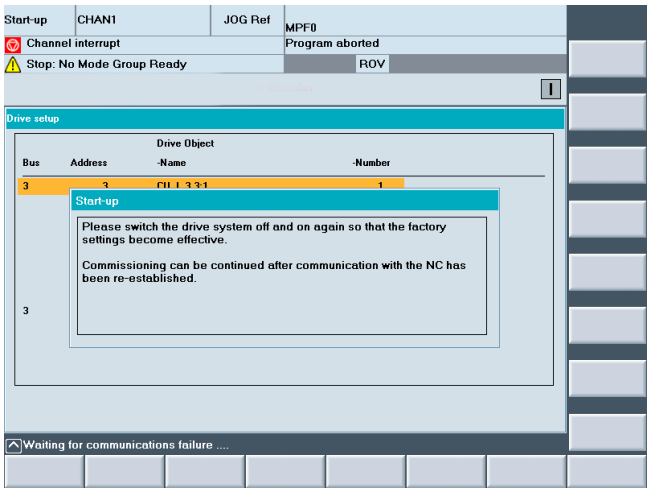


Figure 8-6 Switch factory settings off/on

4. Switch the control (NCU and NX) off (de-energized drive system) and then on again.

   Wait until communication has been established again with the NC.

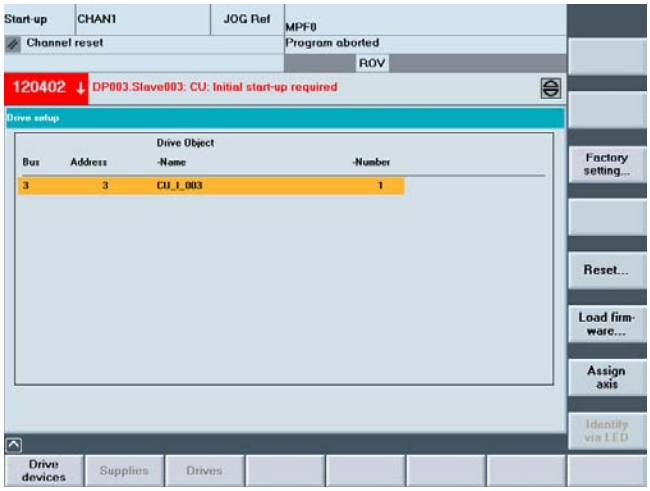


Figure 8-7 Communication re-established

A message appears that a first commissioning is required.

Start the first commissioning with the operator input steps described in the following section.

8.3 First commissioning of the drive units

Introduction

The following unit configuration is performed during the first 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 message frames has been specified with the configuration in the HW Config.

Requirement

- The drive unit is in the first commissioning state.

  Note the following:

NOTICE
It must be ensured that compatible firmware has been loaded on all components. If necessary, stop the operation and first load the firmware from the CF card to all components of the drive unit(s).

The operator input steps for loading the firmware are described in Section "Update of the component firmware".

Note

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

Steps

1. Press the "Drive units" softkey in the "Commissioning" > "Drive system" menu.

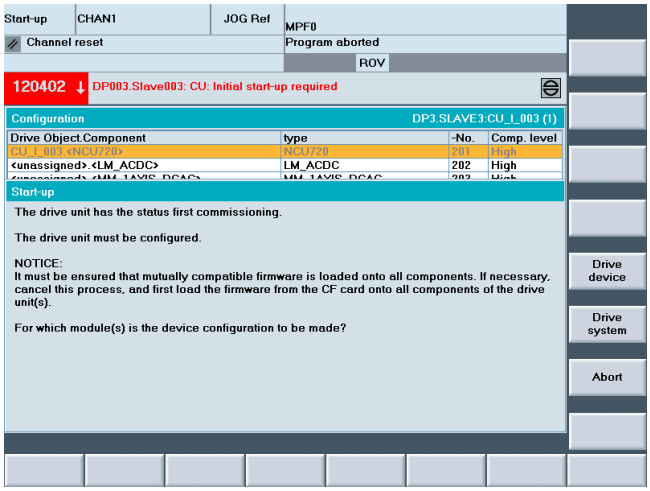


Figure 8-8 "Commissioning > Drive system > Drive units" menu

You are reminded once again that the drive unit is in the first commissioning state and that a unit configuration must be performed for the drive system.

In the example for first commissioning it is assumed that compatible firmware has been loaded on all components.

2. Press the "Drive system" vertical softkey.

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

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

   Before the configuration is completed, the HMI displays the following query:

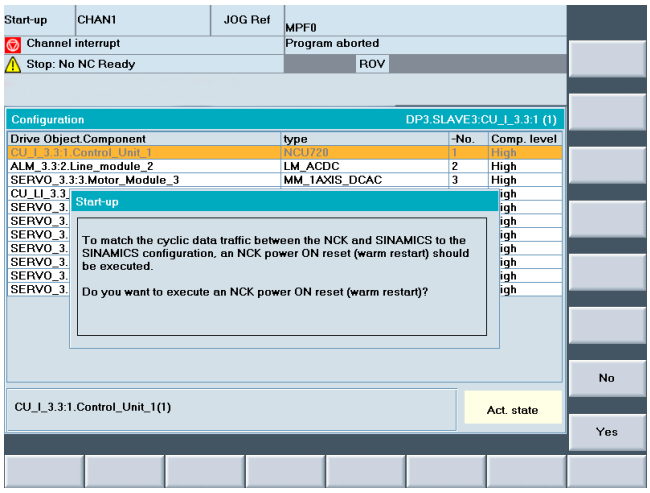


Figure 8-9 Unit configuration, warm restart

3. Press "OK" to perform an NCK power on restart (warm restart).

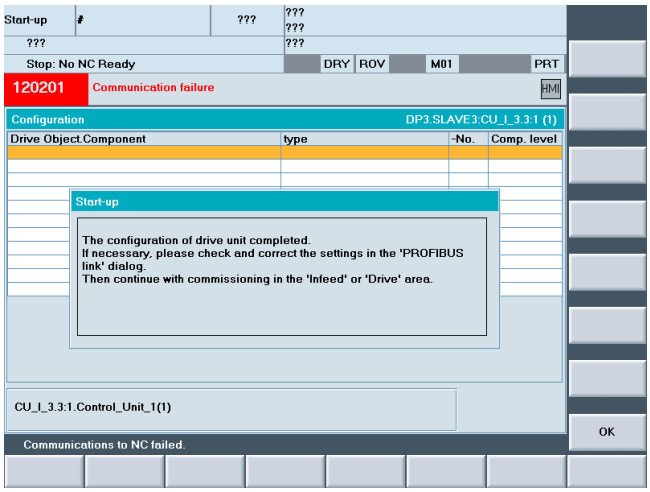


Figure 8-10 Message after the unit configuration has been completed

The unit configuration for the drive units and drive components of the NCU has been completed.

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

4. Press "OK".

If you have selected the NCU, then the drive components of the NCU are displayed.

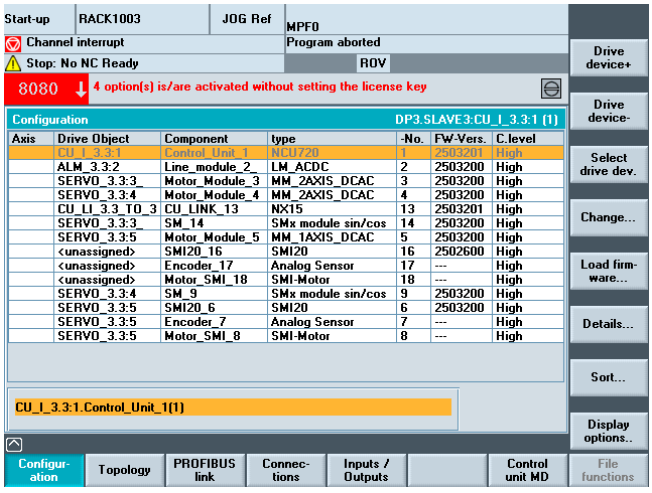


Figure 8-11 Unit configuration completed, NCU unit configuration

5. Press "Drive unit +".

   If you have selected the NX, then the drive components of the NX are displayed.

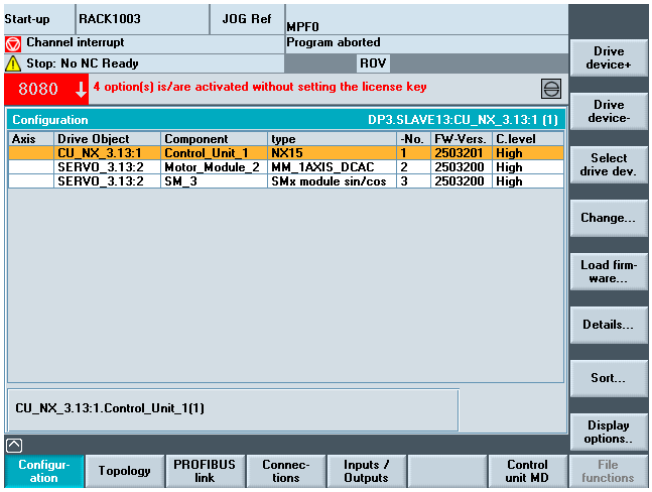


Figure 8-12 NX unit configuration

If necessary you can correct and/or modify the settings in the "PROFIBUS connection" dialog.

6. Press "PROFIBUS connection > Change...".

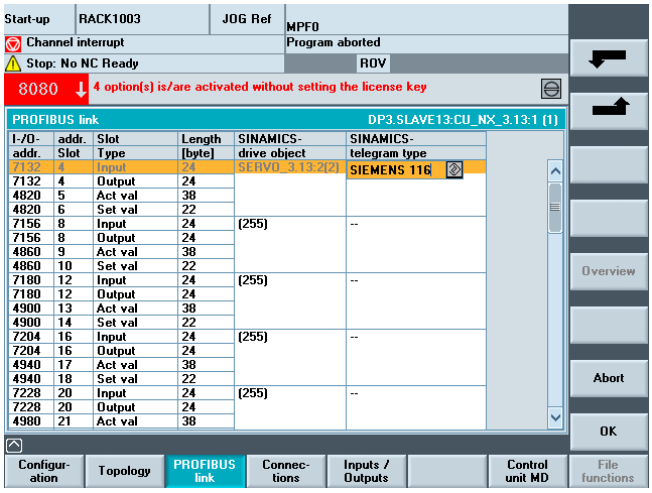


Figure 8-13 PROFIBUS NX connection

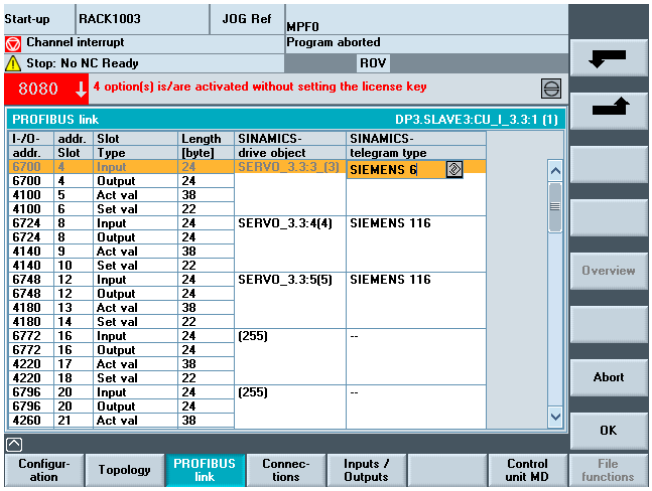


Figure 8-14 PROFIBUS NCU connection

Check and, if required, correct the settings.

7. Press <RECALL>.

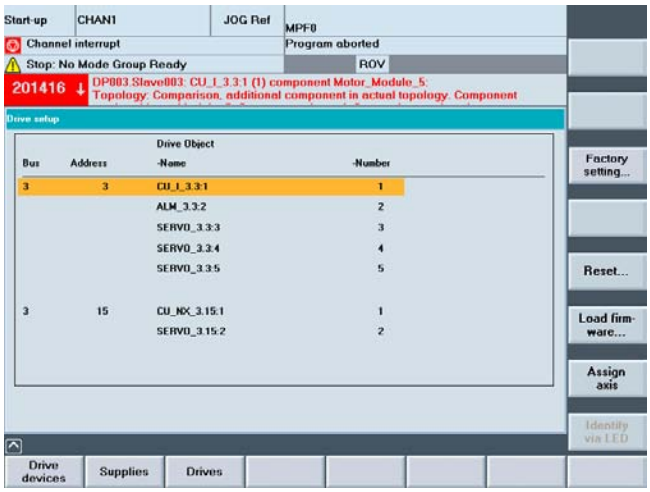


Figure 8-15 Overview of drive system

The following section describes how you can perform an update of the component firmware using the "Load firmware..." function.

In the example for first commissioning it is assumed that compatible firmware has been loaded on all components.

In our example, skip this step and continue with the operator input steps for the Commissioning of the drive components (Page 77) (infeed, drive, encoder).

See also

Updating the component firmware (Page 74)

8.4 Updating the component firmware

Loading firmware update for SINAMICS V2.5 and higher

Note

SINAMICS V2.5 and higher

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

Manual updates for the individual components are not needed in such cases.

After powering up and when operating the control, the drive firmware can however always be loaded from the CompactFlash card.

You activate the "Load firmware ..." function from the "Commissioning > Drive system" menu.

Loading firmware update for up to SINAMICS V2.4

Prior to initial startup, all SINAMICS components should have the same firmware version. The software required for this forms part of the SINAMICS software and is stored on the CompactFlash card. An update of individual components may become necessary, after component replacement for example, and is required if the drive-specific alarm A01006 "Firmware update required for DRIVE-CLiQ component <No.>“ appears.

Note

If a firmware update is run before configuring the device, once this is complete continue with the "First commissioning of drive units (Page 69)" operator input steps.

Requirement

All components of the NCU/NX accessible (connected via DRIVE-CLiQ).

Operating sequences

1. These can be found in the "Commissioning > Drive system > Drive units > Configuration" menu.

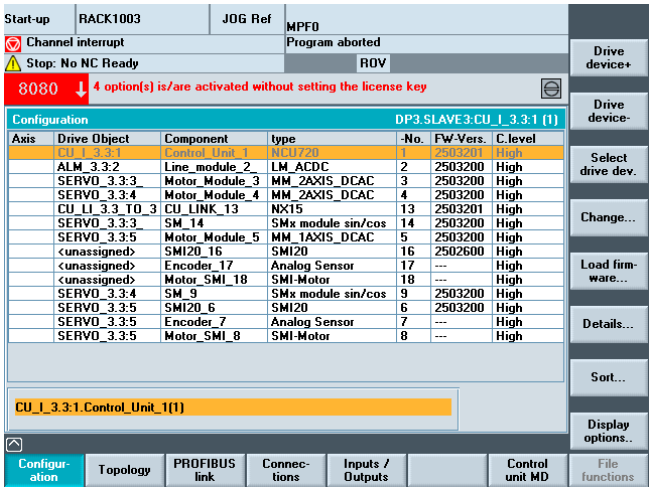


Figure 8-16 Loading firmware

2. Select the next drive module, the NCU or NX with the vertical softkey "Drive unit+/Drive unit-".
3. Press the vertical sotfkey "Load firmware ...".
4. The "Load all" softkey loads the firmware from the CF card to all DRIVE-CLiQ components of the drive unit (NCU or NX).

   Note

   Depending on the design of the SINAMICS drive group, a complete update of component firmware can take about 30 minutes.

   The component, on which a firmware update is performed, is indicated by a flashing LED.

5. Answer the query "Must firmware from the CompactFlash card be loaded to the component?" with "Yes".
6. After the firmware update has been completed, the entire control (NCU, all NX and all DRIVE-CLiQ components (motor modules, encoder interfaces, etc.)) must be switched off (de-energized) and then switched on again so that the firmware update can take effect.

   Follow the instructions displayed on the HMI after the firmware update has been completed.

You can now continue with the commissioning of the drive components (infeed, motor modules, encoders).

Loading firmware for the entire drive system

The "Commissioning > Drive system" menu contains the option for activating a complete component firmware update for the entire drive system.

Note

Depending on the design of the SINAMICS drive group, a complete update of component firmware can take about 30 minutes.

The component, on which a firmware update is performed, is indicated by a flashing LED.

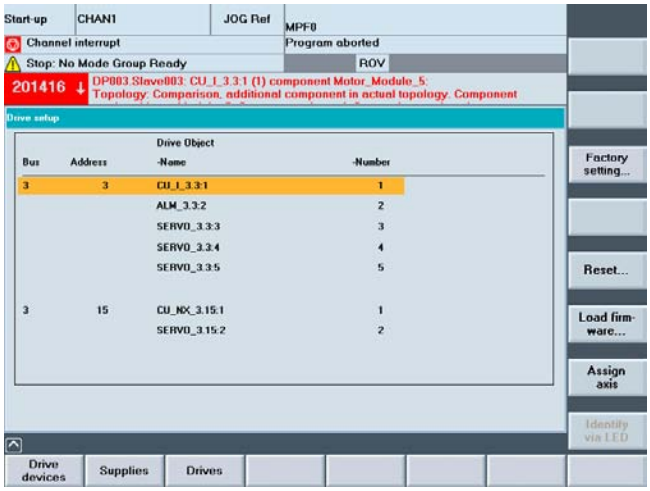


Figure 8-17 Load firmware using the "Commissioning > Drive system" menu

8.5 Commissioning using a drive wizard

Introduction

Drive configuration is done with a drive wizard on the HMI. The following drive components are to be configured:

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

Drive configuration

The drive configuration can be opened by selecting "Commissioning > Drive systems" in the menu.

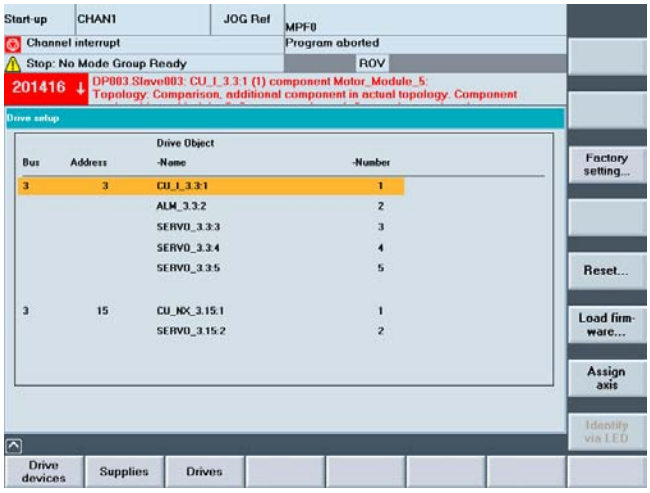


Figure 8-18 Overview of first commissioning

1. Press the corresponding softkey for the drive object to be configured.
   - "Infeeds"
   - "Drives" for drive controls (SERVO)
2. Configuration is performed in the following sequence:
   - You select the component with the vertical softkey "Infeed+/Infeed-" or "Drive+/Drive-"
   - Press the vertical softkey "Change" and follow the drive wizard with the horizontal softkey "Next >".
   - Parameterize the appropriate configuration in the dialog box that appears.

   The following chapters "Parameterization of infeed" and "Parameterization of drive components" list the dialog in detail.

8.5.1 Parameterization of infeed

Introduction

You want to configure/parameterize the Active Line Module of your SINAMICS> You have selected the menu "Commissioning > Drive systems > Infeed". You are in the following menu:

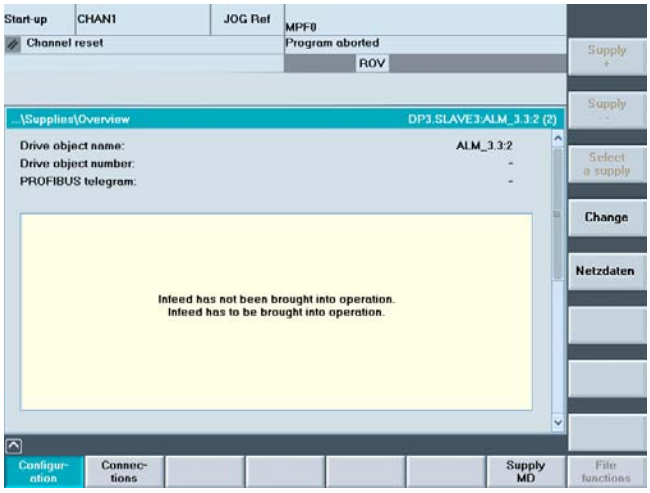


Figure 8-19 Menu "Infeed > Configuration"

Operator input sequence steps

1. If multiple infeeds are present, select the infeed with "Infeed+/Infeed-".

   The system detects that the infeed has not been commissioned and that a commissioning is required (see above figure).

   Note

   If necessary, check the network data using the "Network data" vertical softkey function (see section "Checking/setting network data settings for power supply (Page 244)").

   The commissioning is performed with the "Change" vertical softkey.

2. Press the vertical softkey "Change".

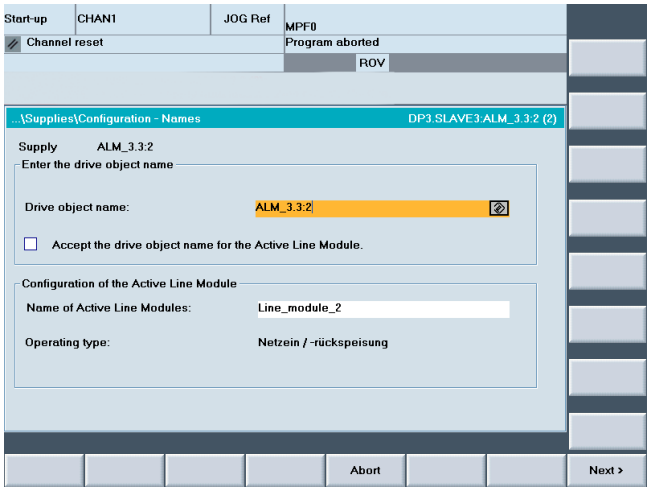


Figure 8-20 Menu "Infeeds > Configuration" "Names" (Change)

3. If required, assign a drive object name or accept the default settings.
4. Follow the drive wizard with the horizontal softkey "Next >".
5. The default values in the following dialogs are standard values and can be taken over with "Next >".

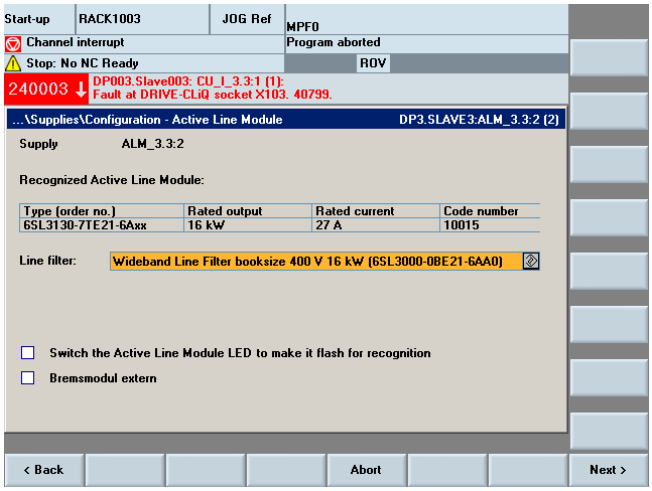


Figure 8-21 Menu "Infeed > Configuration" with recognized ALM (Next 1)

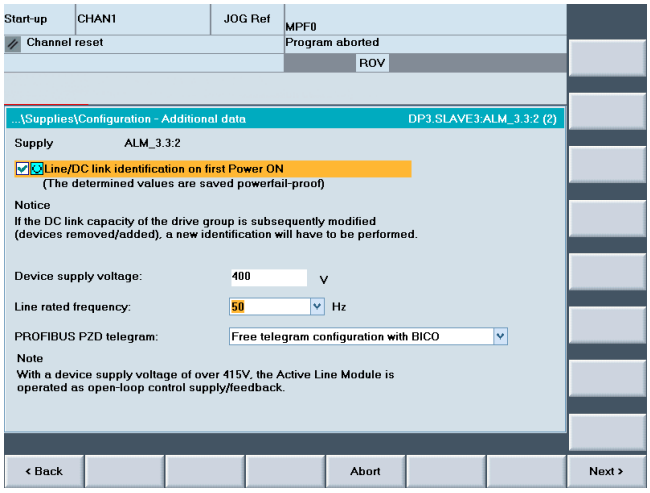


Figure 8-22 Menu "Infeed > Configuration" "Additional data" (Next 2)

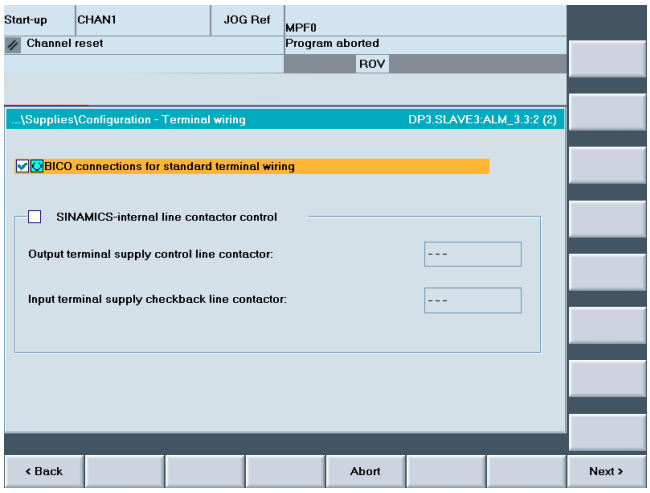


Figure 8-23 Menu "Infeed > Configuration" "BICO terminal wiring" (Next 3)

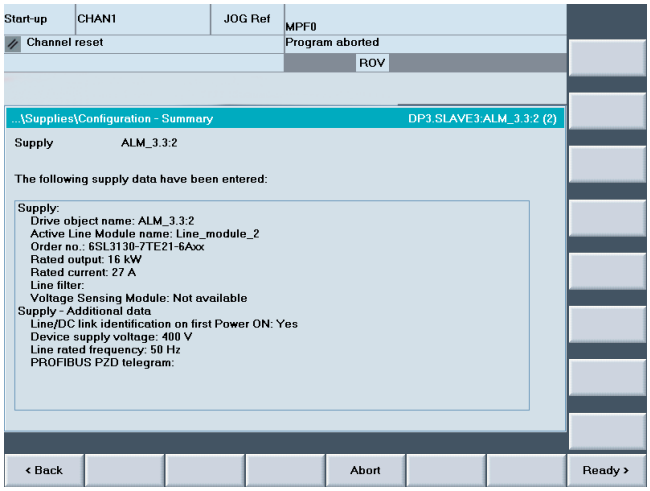


Figure 8-24 Menu "Infeed > Configuration" "Summary" (Next 4)

6. This completes the configuration for the infeed. You can check the configuration in the summary.
7. Press the "Finish >" softkey.

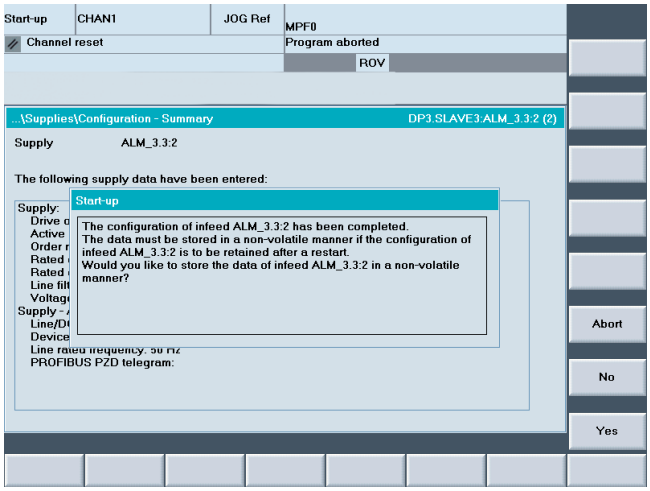


Figure 8-25 Saving the configuration

8. Press "Yes".

   The data is saved as non-volatile data.

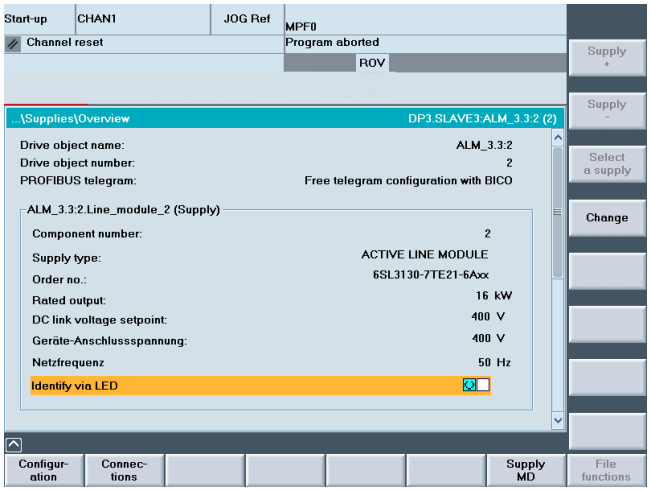


Figure 8-26 Menu "Infeed > Configuration" "Finish"

9. Press the <RECALL> key in order to parameterize/configure the drives in the next step.

8.5.2 Parameterization of the drives

Introduction

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

- Motor
- encoder
- Interface signals

Parameterizing/configuring

You are in the "Commissioning > Drive system" menu.

ALL drives (SERVOs) are configured via the "Drives" softkey.

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/encoder data set (DDS/MDS/EDS) or a second (direct) measuring system is required.

If a motor module (power section) is connected to a motor of which the encoder is controlled via the SMC (Sensor Module Cabinet), i.e. not with a SMI (Sensor Module Integrated), then you have various configuration options at your disposal.

- Standard motors, listed with corresponding motor data.
- Third-party motors where the motor data can be freely configured.

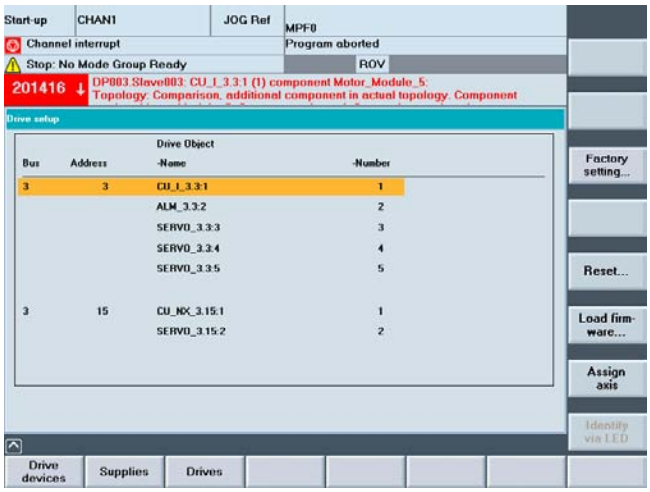


Figure 8-27 Overview of first commissioning

1. Press the "Drives" softkey in order to configure the following drives (SERVOs):
   - Drive with listed motor and encoder via SMC (without DRIVE-CLiQ)
   - Drive with third-party motor and additional second encoder via SMC (without DRIVE-CLiQ)

The drive wizard identifies the relevant design of the drives and guides you through the configuration in the dialog.

8.5.2.1 Commissioning of listed motor and encoder via SMC

Introduction

In our example a power section is to be configured with a listed motor and encoder. You have selected the menu "Commissioning > Drive systems > Drives". You are in the following menu:

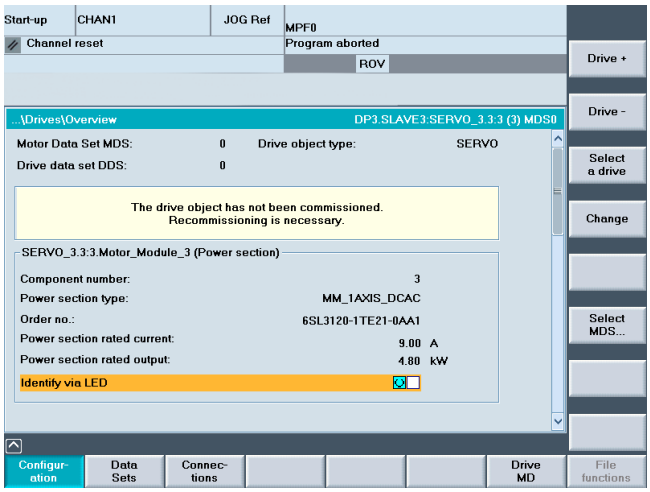


Figure 8-28 Menu "Drives > Configuration"

Operator input sequence steps

1. Select the drive with the vertical softkey "Drive+/Drive-".

   The system detects that the drive object has not been commissioned and that a new commissioning is required (see above figure).

   The new commissioning is performed with the "Change" vertical softkey.

2. Press the vertical softkey "Change".

Note

If commissioning has already been performed, press "New commissioning" and "OK".

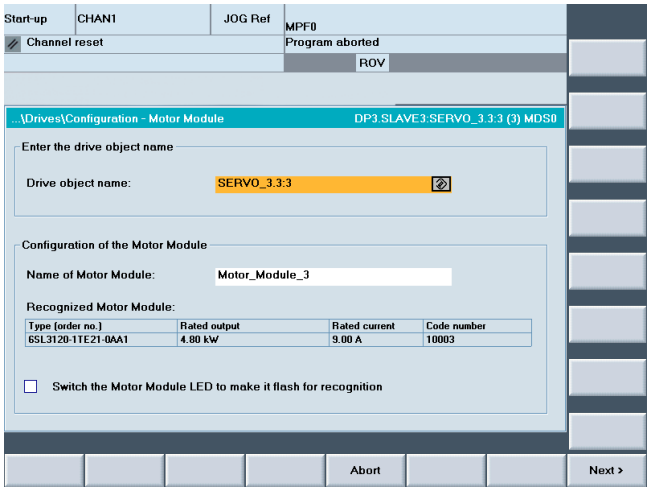


Figure 8-29 Menu "Drives > Configuration" "Motor module" (Change)

3. The drive wizard identifies the power section (Motor module). You can assign a new drive object name or accept the default setting.
4. Follow the drive wizard with the horizontal softkey "Next >".
5. The following dialog boxes are displayed in succession for the configuration:

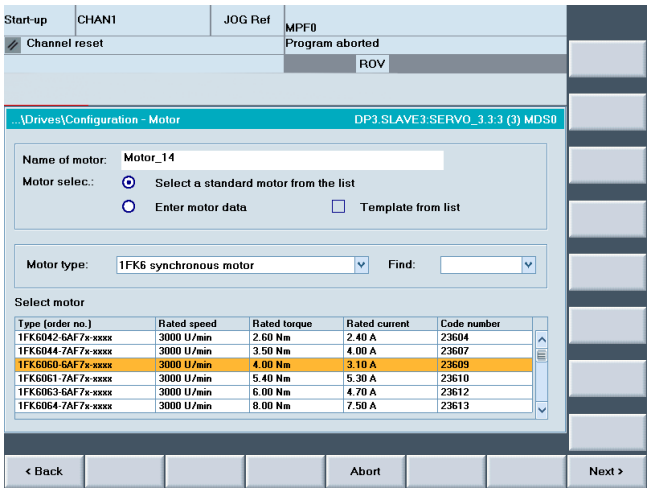


Figure 8-30 Menu "Drives > Configuration" "Select standard motor from list" (Next 1)

6. In this dialog box, select the "Select standard motor from list" button.
7. Select the motor with the "Cursor up / Cursor down" keys.
8. Press "Next >".

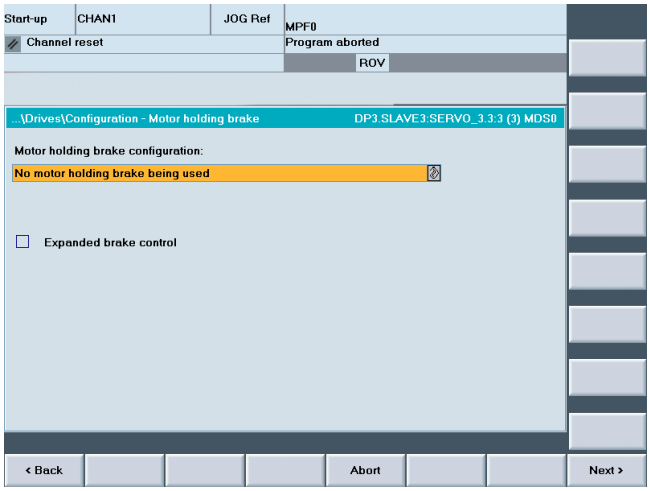


Figure 8-31 Menu "Drives > Configuration" "Motor holding brake" (Next 2)

9. You can select brake control in the dialog "Configuration motor holding brake".

   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.

10. Press "Next >".

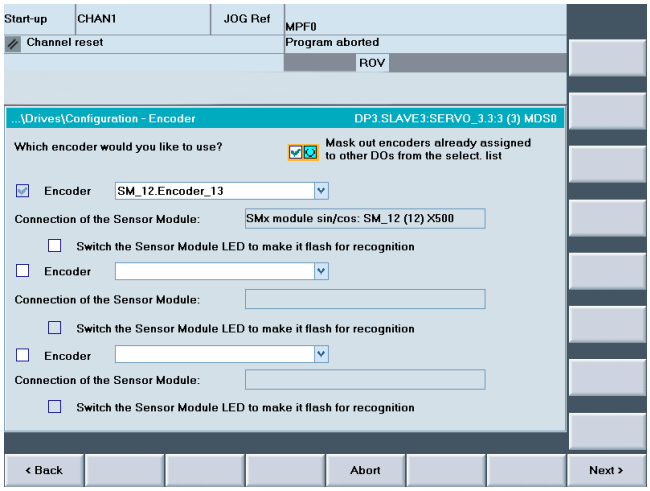


Figure 8-32 Menu "Drives > Configuration" "Encoder" (Next 3)

11. Press "Next >".

    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.

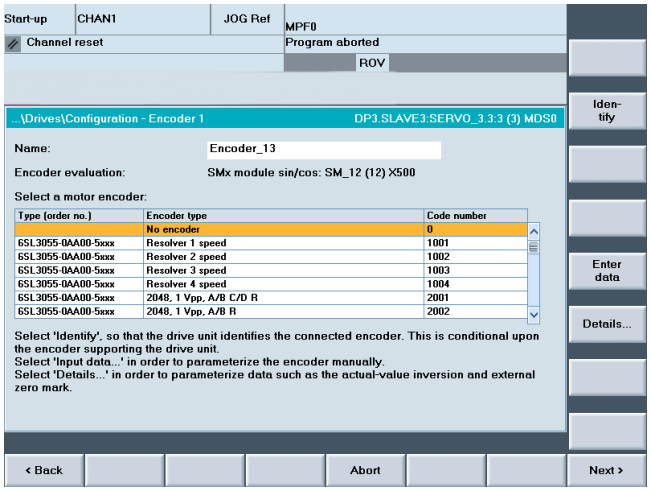


Figure 8-33 Selecting an encoder (Next 4)

The encoder connected via SMC20 must be configured.

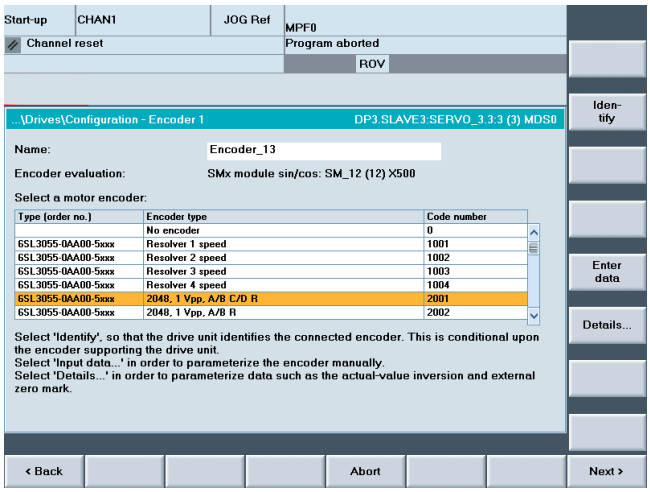


Figure 8-34 Selecting an encoder from the list

12. Select the motor encoder from the list: Select the encoder with the "Cursor up / Cursor down" keys.

Note

You can specify the following data using the "Details..." function:

- Inversion of the actual speed value
- Inversion of the actual position value
- External zero mark

Alternatively, the encoder system can be parameterized manually using the "Enter data" softkey.

13. Press "Enter data".

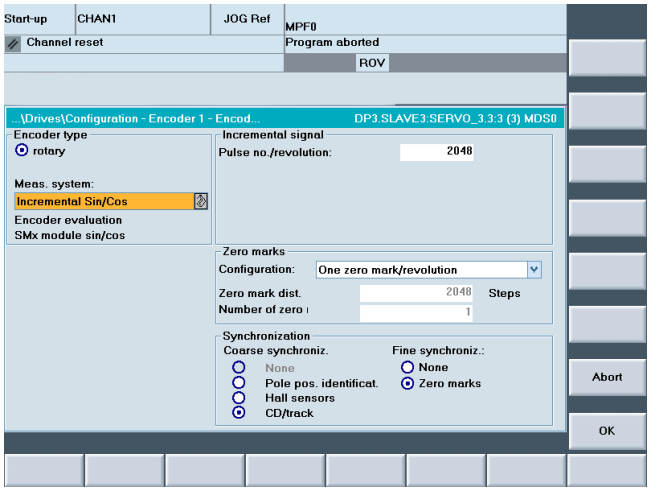


Figure 8-35 Enter data

Configure the encoder in the following fields:

- Encoder type
- Incremental tracks
- Zero marks
- Synchronization

14. Press "OK".
15. Press "Next >".

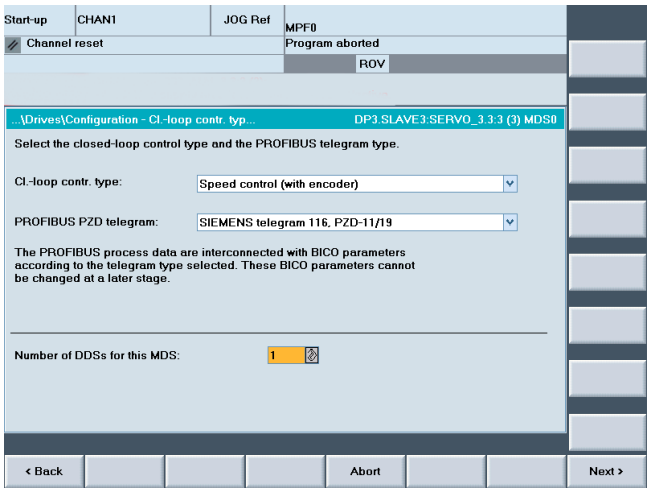


Figure 8-36 Menu "Drives > Configuration" "Control type/setpoints" (Next 5)

16. Set the number of required drive data sets (DDS). The default setting is the maximum possible number (8) of drive data sets. For optimal utilization of the drive unit, the number of drive data sets should be reduced to the number actually required.
17. Select the control type and the PROFIBUS message frame type.

    The default setting is the PROFIBUS message frame 116 for solution line / SINAMICS.
18. Press "Next >".

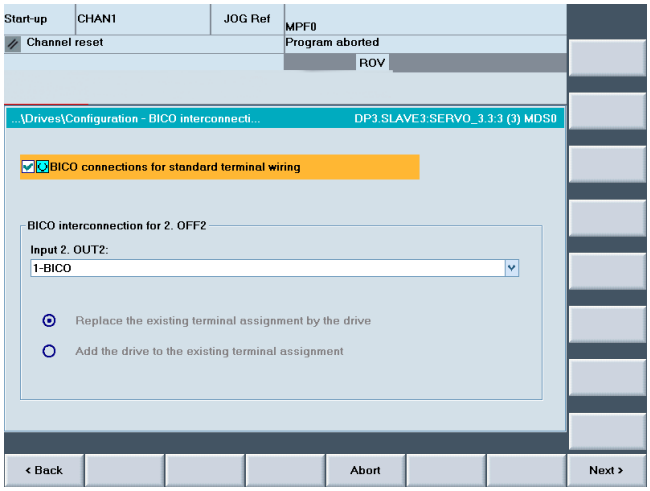


Figure 8-37 Menu "Drives > Configuration" "BICO interconnection" (Next 6)

19. Select the assignment for the terminal for Input 2. OFF2 (Page 246).
20. Press "Next >".

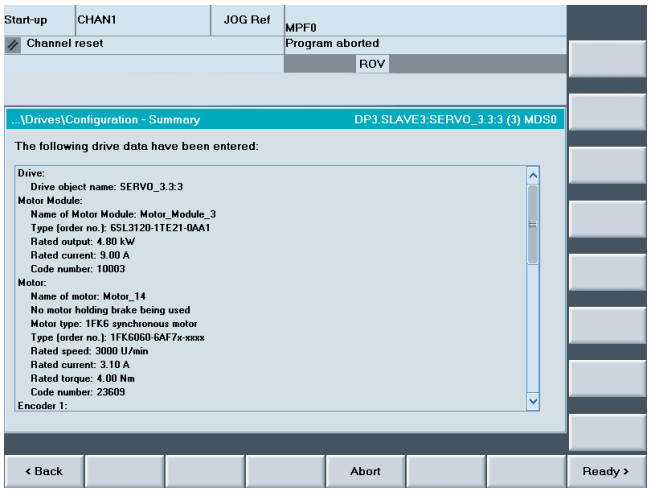


Figure 8-38 Menu "Drives > Configuration" "Summary" (Next 7)

21. The configuration of the drive (SERVO) with listed motor is completed. You can check the configuration in the summary.
22. Press the "Finish >" softkey.

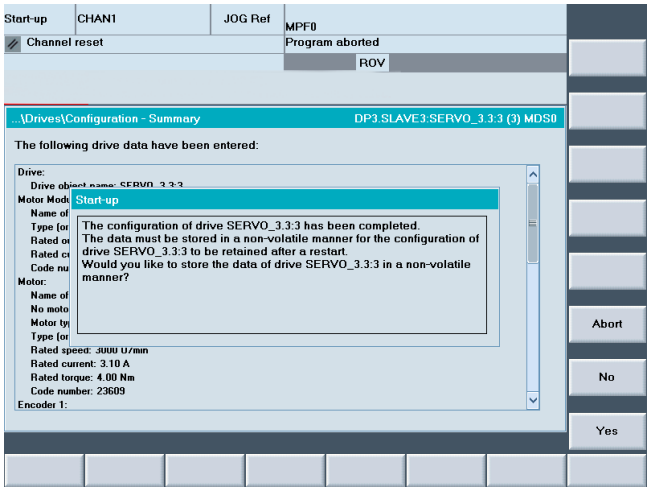


Figure 8-39 Menu "Drives > Configuration" "...save permanently..." (Finish)

23. Confirm the query with "Yes".
24. The next section describes how you can configure a drive (SERVO) with a third-party motor and a second encoder.

8.5.2.2 Commissioning of third-party motor and additional second encoder via SMC

Introduction

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

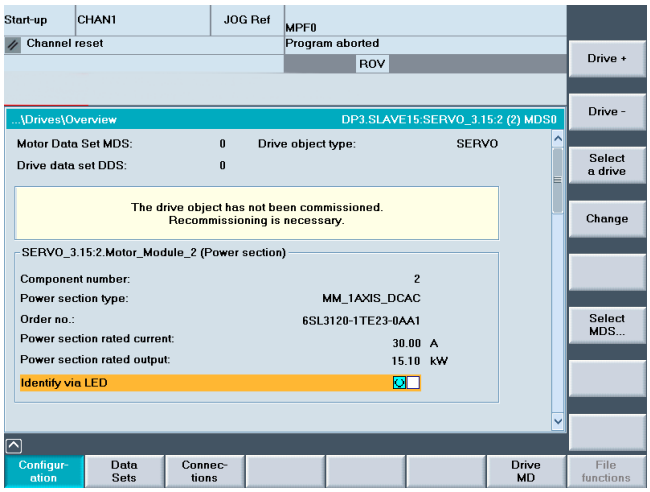


Figure 8-40 Menu "Drives > Configuration" (external motor)

Operator input sequence steps

1. Select the drive with the vertical softkey "Drive+/Drive-".

   The system detects that the drive object has not been commissioned and that a new commissioning is required (see above figure).

   The new commissioning is performed with the "Change" vertical softkey.

2. Press the vertical softkey "Change".

Note

If commissioning has already been performed, press "New commissioning" and "OK".

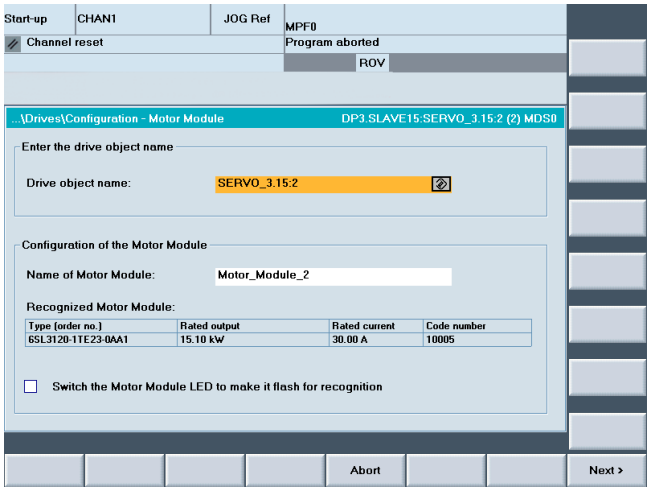


Figure 8-41 Menu "Drives > Configuration" "Motor module" (Change)

3. The drive wizard identifies the power section (Motor module). You can assign a new drive object name or accept the default setting.
4. Follow the drive wizard with the horizontal softkey "Next >".
5. The following dialog boxes are displayed in succession for the configuration:

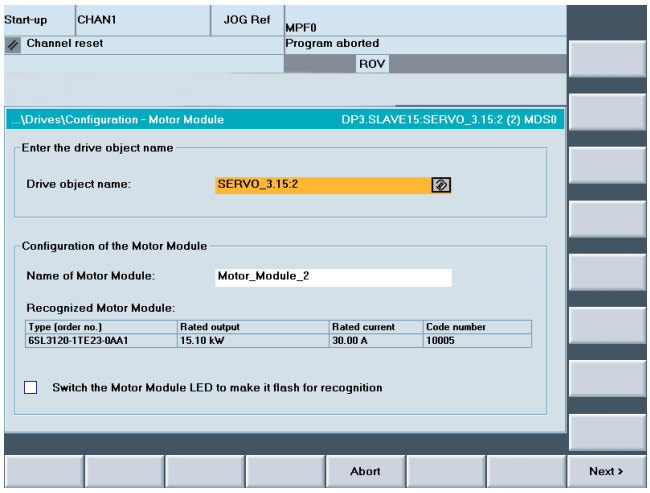


Figure 8-42 Menu "Drives > Configuration" "Motor with externally supplied motor) (Next 1)

6. Select "Enter motor data" and the motor type.
7. Press "Next >".

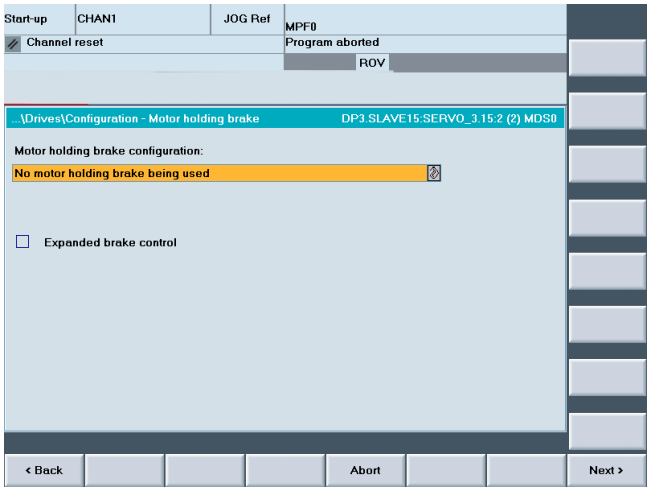


Figure 8-43 Menu "Drives > Configuration" "Motor holding brake" (Next 2)

8. You can select brake control in the dialog "Configuration motor holding brake".

   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.

9. Press "Next >".

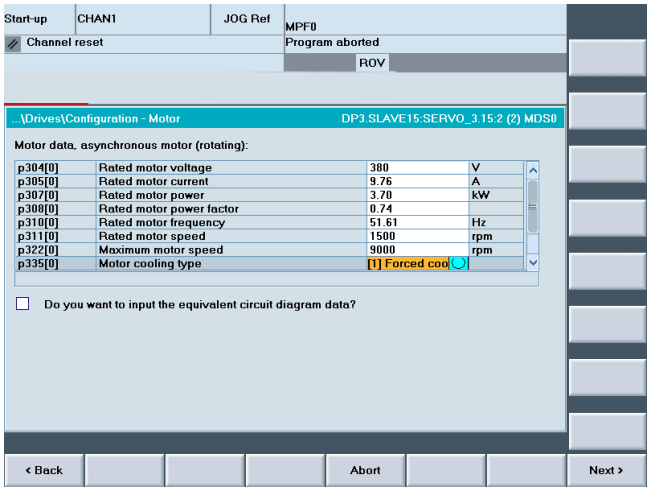


Figure 8-44 Menu "Drives > Configuration" "Motor data 2" (Next 3)

10. Use the "Cursor Up/Cursor Down" keys to select the parameters that need to be changed from the list of motor data.
11. Enter the motor data.
12. Press "Next >". If you have selected "Replacement circuit diagrams" and you select "Next >", then you get to the following dialog:

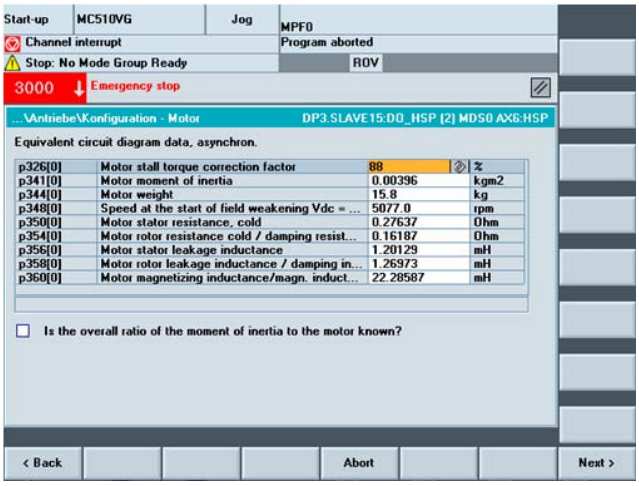


Figure 8-45 Menu "Drives > Configuration" "Replacement circuit diagrams" (Next 4)

13. You can enter additional motor data.
14. Press "Next >".

    If more than one encoder has been selected (see following figure), then the parameterization is run through for each individual encoder in succession with "Next > ".

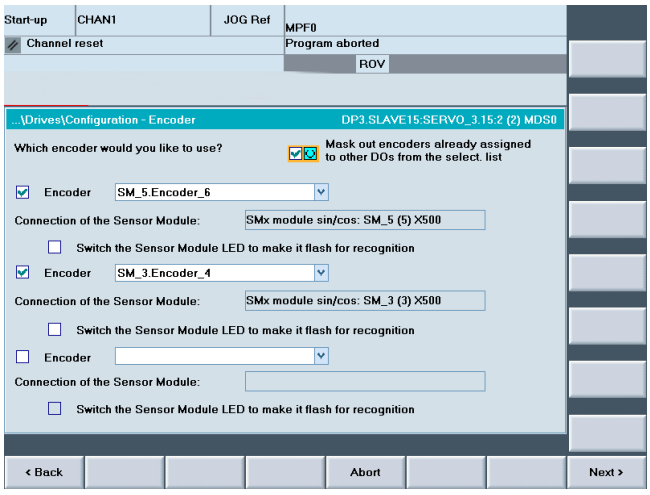


Figure 8-46 Menu "Drives > Configuration" "Encoder" (Next 5)

15. Press "Next >".

    An identification of the selected encoders is triggered (Encoder 1/2).

    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" menu).

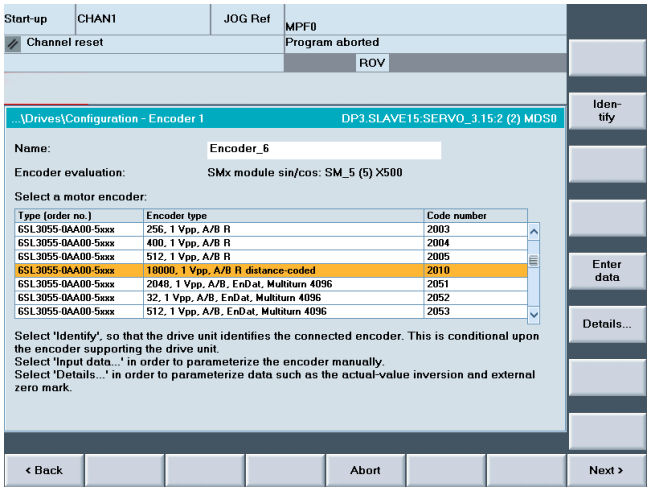


Figure 8-47 Menu "Drives > Configuration" "Encoder 1" (Next 6)

The encoder has been identified.

Note

You can specify the following data using the "Details..." function:

- Inversion of the actual speed value
- Inversion of the actual position value
- External zero mark

Alternatively, the encoder system can be parameterized manually using the "Enter data" softkey.

16. Press "Next >".

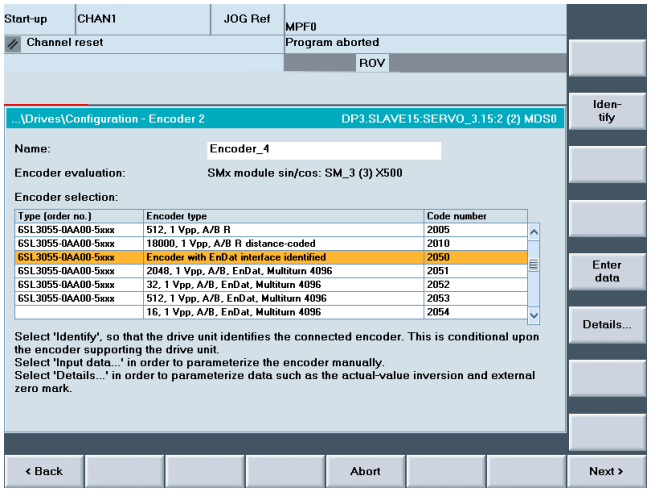


Figure 8-48 Menu "Drives > Configuration" "Encoder 2" (Next 7)

The second encoder has been identified.

Note

If EnDat encoders are detected, no further encoder parameterization need be performed. Parameterizations for the pole position ID/synchronization can be found at "Enter data".

17. Press "Next >".

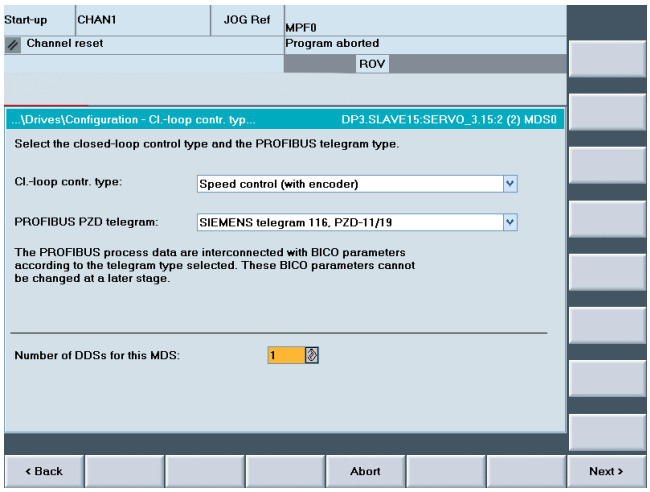


Figure 8-49 Menu "Drives > Configuration" "Control type..." (Next 8)

18. Set the number of required drive data sets (DDS). The default setting is the maximum possible number (8) of drive data sets. For optimal utilization of the drive unit, the number of drive data sets should be reduced to the number actually required.
19. Select the control type and the PROFIBUS message frame type.

    The default setting is the PROFIBUS message frame 116 for solution line / SINAMICS.
20. Press "Next >".

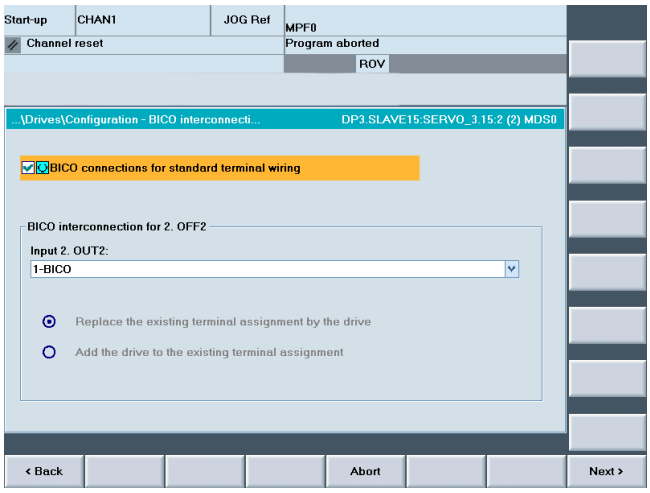


Figure 8-50 Menu "Drives > Configuration" "BICO interconnection" (Next 9)

21. Select the assignment for the terminal for Input 2. OFF2 (Page 246).
22. Press "Next >".

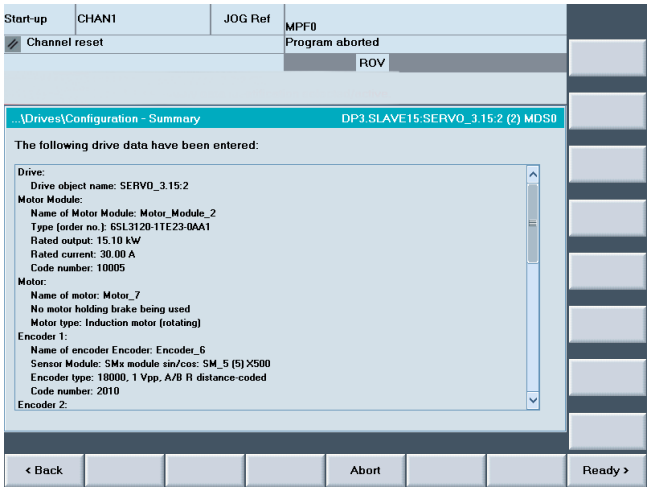


Figure 8-51 Menu "Drives > Configuration" "Summary" (Next 9)

23. The configuration of the drive (SERVO) with third-party motor is completed. You can check the configuration in the summary.
24. Press the "Finish >" softkey.

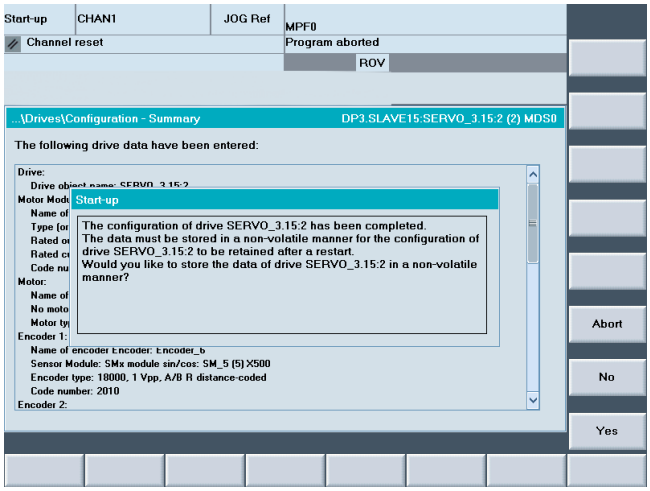


Figure 8-52 Menu "Drives > Configuration" "...save permanently..." (Finish)

25. Confirm the query with "Yes".

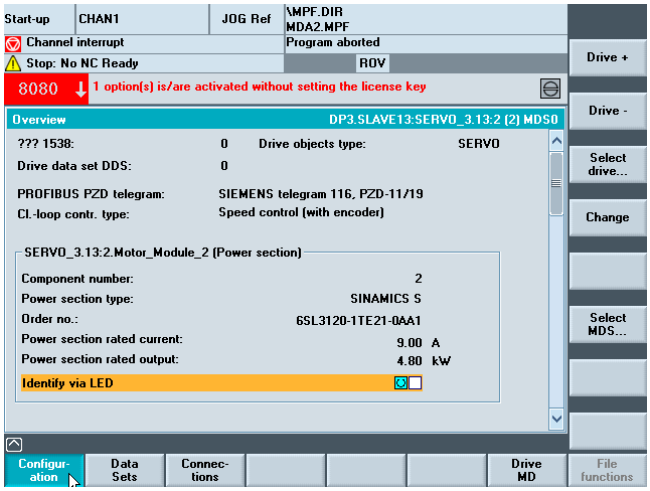


Figure 8-53 Menu "Drives > Configuration"

26. Select the drive with the vertical softkeys "Drive+ / Drive-" in order to configure additional drives (SERVOs).

    The configuration is again started with the vertical softkey "Change".

8.6 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. You have chosen the "Commissioning" operating area.

Commissioning communication NCK<->Drive

9

Introduction

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

What will be configured next?

You will configure the NCK machine data, which communicates with the drive. These are:

- General machine data

  General machine data required for communication with the drive via PROFIBUS, which have been preset with default values. These values may be taken over during first commissioning. These are:

  – The message frame type for transfer

  – The logical addresses for the PLC

  Note

  For an NX module, a logical address for the PLC must be entered in the general machine data MD13120[1] CONTROL_UNIT_LOGIC_ADDRESS.

  See: Commissioning NX <-> Drive (Page 262)

- 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 (CU), one ALM, three motor modules (MM)) the assignment of the NCK machine data for input/output address/telegram/message frame/actual value:

SINAMICS S120	STEP7 (HW-config) DP slave properties		NCK machine data General MD			NCK machine data Axis MD[2)]	
Component	Message frame type/length[1)]	I/O address[1)]	MD13120[0] Control Unit I/O address	MD13050 [0-5] Axis I/O address [1)]	MD13060 [0-5] Message frame type [1)]	MD30110/30220 setpoint/actual value assignment	MD30130 Type of output Setpoint
MM1	116. PZD-11/19	4100		4100	116	1	1
MM2	116. PZD-11/19	4140		4140	116	2	1
MM3	116. PZD-11/19	4180		4180	116	3	1
X (not available)	116. PZD-11/19	4220		4220	116	-	0
X (not available)	116. PZD-11/19	4260		4260	116	-	0
X (not available)	116. PZD-11/19	4300		4300	116	-	0
CU	391. PZD-3/7	6500	6500				
ALM	370. PZD-1/1	6514					

[1)]Default value, do not change

[2)] The axis-specific machine data for configuring setpoints and actual values are pre-assigned using the "Assign axis" function (see section "Configuration of setpoint and actual value" (Page 104))

9.1 Configuration input/output address and telegram

Introduction

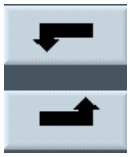
The following general machine data are pre-assigned with a standard value for the PROFIBUS connection between the axes and drive (also see previous table).

- MD13050 DRIVE_LOGIC_ADDRESS (axis address))
- MD13060 DRIVE_TELEGRAM_TYPE (telegram type)
- MD13120 CONTROL_UNIT_LOGIC_ADDRESS (address CU)

Note

No adjustment is necessary here since these values correspond to those preassigned values in HW Config.

PROFIBUS connection



The connection between the relevant axes and drive via PROFIBUS can be viewed and sorted on the HMI in the "Commissioning > Drive system > Drive units > PROFIBUS connections" menu.

The following diagram shows an example of the connection between the relevant axes and drive for an NCU.

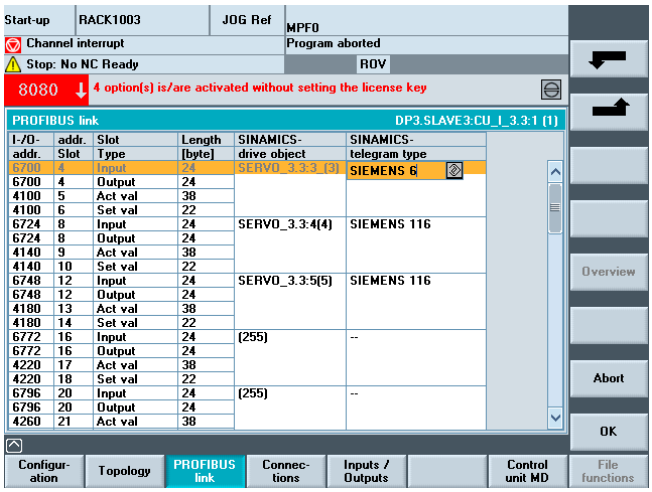


Figure 9-1 PROFIBUS NCU connection

9.2 Configuration 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 is to be adjusted for each axis (also see previous table):

- MD30110 CTRLOUT_MODULE_NR (setpoint channel)
- MD30220 ENC_MODUL_NR (actual-value channel)
- MD30130 CTRLOUT_TYPE (Type of output Setpoint)
- MD30240 ENC_TYPE (actual-value sensing)

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

Operator input steps in the "Assign axis" menu

1. Select the "Commissioning > Drive system > Drives" menu.

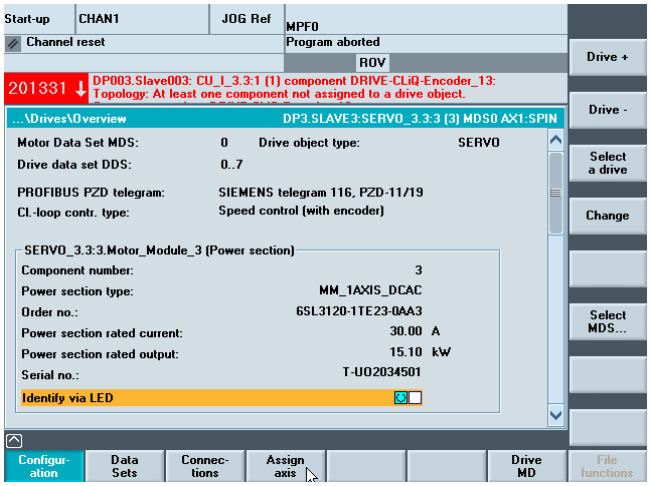


Figure 9-2 "Commissioning > Drive system > Drives" menu

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

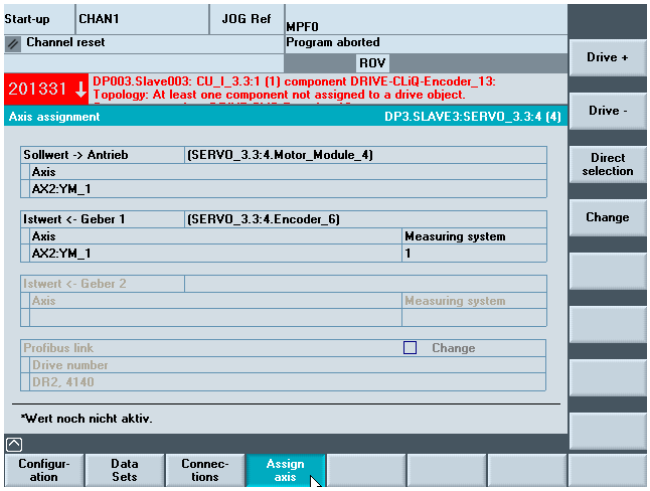


Figure 9-3 Assignment of setpoints and actual values for axes to drive

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

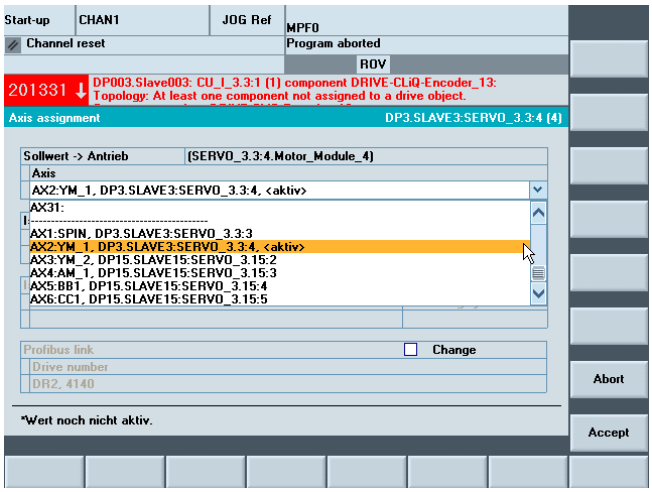


Figure 9-4 "Assign axis > Change" menu

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".

Operator input steps in the "Commissioning > Machine data > Axis MD" menu

1. Select the "Axis MD" softkey in the "Commissioning > Machine data" in the operating range.
2. Select the corresponding axis using "Axis+".
3. For the setpoint channel, search for MD30110 CTRLOUT_MODULE_NR.
4. Enter the drive number.
5. For the actual value channel, search for MD30220 ENC_MODUL_NR.
6. Enter the drive number.
7. For the setpoint type of output, search for MD30130 CTRLOUT_TYPE.
8. Enter "1".
9. For the actual-value sensing, search for MD30240 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.

9.3 Commissioning communication NCK<->Drive completed

Commissioning communication NCK<->PLC completed

You have placed 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

10

10.1 Overview Commissioning NCK

Introduction

The parameterization of NCK regarding the connected machine occurs by setting system variables.

These system variables are called:

- Machine data (MD)
- Setting data (SD).

See also

Machine and setting data (Page 318)

10.2 System data

10.2.1 Resolutions

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 parts 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 parts program.

Input and display resolution

The input and display resolution is specified via the control panel being used, whereby the display resolution of position values can be changed with machine data:MD9004 DISPLAY_RESOLUTION.

MD9011 DISPLAY_RESOLUTION_INCH (INCH unit 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 parts 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 INT_INCR_PER_MM (computational resolution for linear positions)
- MD10210 INT_INCR_PER_DEG (computational resolution for angle 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 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 ≥ 10^4 incr./mm.

MD10200 INT_INCR_PER_MM = 10000 [incr./mm]:

Example of related parts program:

N20 G0 X 10000 Y 10000
;Axes move to position X=10000 mm, Y=10000 mm

N25 G0 X 50002 Y 20003
;Axes move to position X=50002 mm, Y=20003 mm

Machine data

Table 10-1 Resolutions: Machine data

Number	Name of identifier	Name / remarks	Reference
General ($MN_ ...)			
9004	DISPLAY_RESOLUTION	Display resolution	G2
9011	DISPLAY_RESOLUTION_INCH	Display resolution for INCH system of measurement	G2
10200	INT_INCR_PER_MM	Computational resolution for linear positions	G2
10210	INT_INCR_PER_DEG	Computational resolution for angular positions	G2

Literature

Function Manual Basic Functions; Velocities, traversing ranges, accuracy: Input/display resolution, computational resolution

10.2.2 Normalization of phys. units of machine data and setting data

Standard

Machine and setting data having 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.

Table 10-2 Normalization of phys. units of machine data and setting data

Physical unit	Input/output units for the standard 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

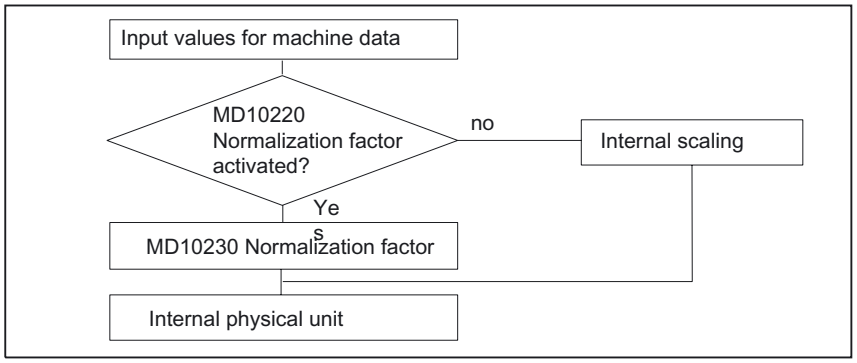
User-defined

The user can define different input/output units for machine and setting data.

For this purpose,

- MD10220 SCALING_USER_DEF_MASK (activation of scaling factors) and
- MD10230 SCALING_FACTORS_USER_DEF[n] (scaling factors of the physical quantities)

allow you to set the adaptation between the newly selected input/output units and the internal units.



The following applies:

Input/output unit selected=

*MD: SCALING_FACTORS_USER_DEF[n] * internal unit*

In MD10230 SCALING_FACTORS_USER_DEF[n], the selected I/O device must be entered expressed in the internal units mm, 1 degree and 1 sec.

Table 10-3 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:

Machine data input/output of the linear velocities is to be in m/min instead of mm/min (initial state). The internal unit is mm/s.

MD10220 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:

$$MD: SCALING_FACTORS_USER_DEF\ [n] = \frac{Selected\ \ / I/O\ unit}{internal\ unit}$$

$$MD:SCALING_FACTORS_USER_DEF[n] = \frac{1\frac{m}{min}}{1\frac{mm}{s}} = \frac{\frac{1000mm}{60s}}{1\frac{mm}{s}} = \frac{1000}{60} = 16{,}667;$$

$$\Rightarrow\ MD:SCALING_FACTORS_USER_DEF[2] = 16{,}667$$

Index 2 specifies the "linear velocity" (see above).

Example 2:

In addition to the change in example 1, the machine data input/output of linear accelerations is to be performed in ft/s², instead of m/s² (initial state). (the internal unit is mm/s²).

$$MD: SCALING_USER_DEF_MASK = 'H14'; (Bit-No.4\ and\ Bit-No.2\ from\ example\ 4\ as\ hexadecimal\ value)$$

$$MD:SCALING_FACTORS_USER_DEF[n] = \frac{1\frac{ft}{s^2}}{1\frac{mm}{s^2}} = \frac{12*25{,}4\ \frac{mm}{s^2}}{1\frac{mm}{s^2}} = 304{,}8;$$

$$\Rightarrow\ MD:SCALING_FACTORS_USER_DEF[4] = 304{,}8$$

Index 4 specifies the "linear acceleration" (see above).

Machine data

Table 10-4 Normalization of phys. units of machine data and setting data: Machine data

Number	Name of identifier	Name / remarks	Reference
General ($MN_ ...)			
10220	SCALING_USER_DEF_MASK	Activation of scaling factors	
10230	SCALING_FACTORS_USER_DEF[n]	Scaling factors of physical quantities	
10240	SCALING_SYSTEM_IS_METRIC	Basic system metric	
10250	SCALING_VALUE_INCH	Conversion factor for switchover to inch system	
10260	CONVERT_SCALING_SYSTEM	Basic system switchover active	
10270	POS_TAB_SCALING_SYSTEM	System of measurement of position tables	T1
10290	CC_TDA_PARAM_UNIT	Physical units of the tool data for CC	
10292	CC_TOA_PARAM_UNIT	Physical units of the tool edge data for CC	

10.2.3 Modifying scaling machine data

The scaling of machine data having physical units is defined by the following machine data:

- MD10220 SCALING_USER_DEF_MASK (activation of scaling factors)
- MD10230 SCALING_FACTORS_USER_DEF (scaling factors of physical quantities)
- MD10240 SCALING_SYSTEM_IS_METRIC (basic system metric)
- MD10250 SCALING_VALUE_INCH (conversion factor for switchover to INCH system)
- MD30300 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 IS_ROT_AX[A1] = 0 (no rotary axis)
- MD3200 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 IS_ROT_AX[A1] = 1 (rotary axis)
- MD3200 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 rescales MD32000 MAX_AX_VELO to [rev/min] relative to a rotary axis.

- MD30300 IS_ROT_AX[A1] = 1 (rotary axis)
- MD32000 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.

10.2.4 Loading default machine data

The default machine data can be loaded in different ways.

HMI startup

HMI startup via the HMI standard user interface: Menu command **Window > Diagnosis > 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 INIT_MD

Using the entry values listed below in MD11200 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 INIT_MD is reset to value "0".

Input values

MD11200 INIT_MD = **1**
On the next NC power-up, all machine data (with the exception of the memory configuring data) are overwritten with default values.

MD11200 INIT_MD = **2**
On the next NC boot, all memory-configuring machine data are overwritten with default values.

10.2.5 Switching over the measuring system

The unit system is switched over for the entire machine using a softkey in the HMI Advanced operating area "MACHINE". The switchover is only accepted if:

- MD10260 CONVERT_SCALING_SYSTEM=1
- Bit 0 of MD20110 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 parts 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.

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.

MD10240 SCALING_SYSTEM_IS_METRIC and the corresponding G70/G71/G700/G710 settings in MD20150 GCODE_RESET_VALUES are switched over automatically and consistently for all configured channels.

The value of machine data: MD20150 GCODE_RESET_VALUES[12] varies between G700 and G710.

This process takes place independently of the protection level currently set.

System data

When changing 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
- Feed rates
- Acceleration rates
- Jerk
- Tool offsets
- Programmable, settable and work offsets external and DRF offsets
- Compensation values
- Protection zones
- Machine data
- Jog and hand wheel factors

After switching, all above mentioned data is available in the physical units according to Chapter "Standardizing of physical units of machine and setting data".

Data for which no unique physical units are defined, such as:

- 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

are not converted automatically. The user is prompted to take the current valid measuring system MD10240 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

Table 10-5 Switching over the unit system: Machine data

Number	Name of identifier	Name / remarks	Reference
General ($MN_ ...)			
10240	SCALING_SYSTEM_IS_METRIC	Basic system metric	
10250	SCALING_VALUE_INCH	Conversion factor for switch-over to inch system	
10260	CONVERT_SCALING_SYSTEM	Basic system switch-over active	

axis spec. ($MA_ ...)			
32711	CEC_SCALING_SYSTEM_METRIC	System of measurement of sag compensation	G2

Literature

Function Manual; speed, setpoint/actual-value systems, control: Metric/inch measuring system

10.2.6 traversing ranges

Computational resolution and traversing ranges

The range of values of the traversing ranges directly depends on the selected computational resolution (see Subsection "Resolution").

With the default assignment of the machine data for the computational resolution

- 1000 inc./mm
- 1000 inc./deg.

the following traversing ranges result:

Table 10-6 traversing ranges

	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.]

10.2.7 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 rougher 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

Table 10-7 Positioning accuracy: Machine data

Number	Name of identifier	Name / remarks	Reference
General ($MN_ ...)			
10200	INT_INCR_PER_MM	Computational resolution for linear positions	G2
10210	INT_INCR_PER_DEG	Computational resolution for angular positions	G2
Axisspecific ($MA_ ...)			
31020	ENC_RESOL[n]	Encoder pulses per revolution	

10.2.8 Cycle times

On the SINUMERIK 840D sl the system clock cycle, the position controller cycle, and the interpolation cycle of the NC are based on the DP cycle time configured in STEP 7 HW config. See Chapter "SIMATIC create S7 project".

System basic 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 SYSCLOCK_CYCLE_TIME (system cycle). It cannot be changed.

Position controller cycle

The position controller cycle (MD 10061 POSTCTRL_CYCLE_TIME) is set to the fixed ratio 1:1 with respect 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 POSCTRL_CYCLE_DELAY=0).

The effective position controller offset is displayed in the MD10063[1].

The following values can be read out via the MD10063 POSCTRL_CYCLE_DIGNOSIS:

- MD10063[0]= T_{DX}
- MD10063[1]= T_M
- MD10063[2]= $T_M + T_{Lag\ max}$

The following conditions must be met for explicit specification of the position controller cycle offset (MD10062 POSCTRL_CYCLE_DELAY!=0):

- The 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 clock is completed.
  Condition: $T_M + T_{Position\ control\ max} < T_{DP}$

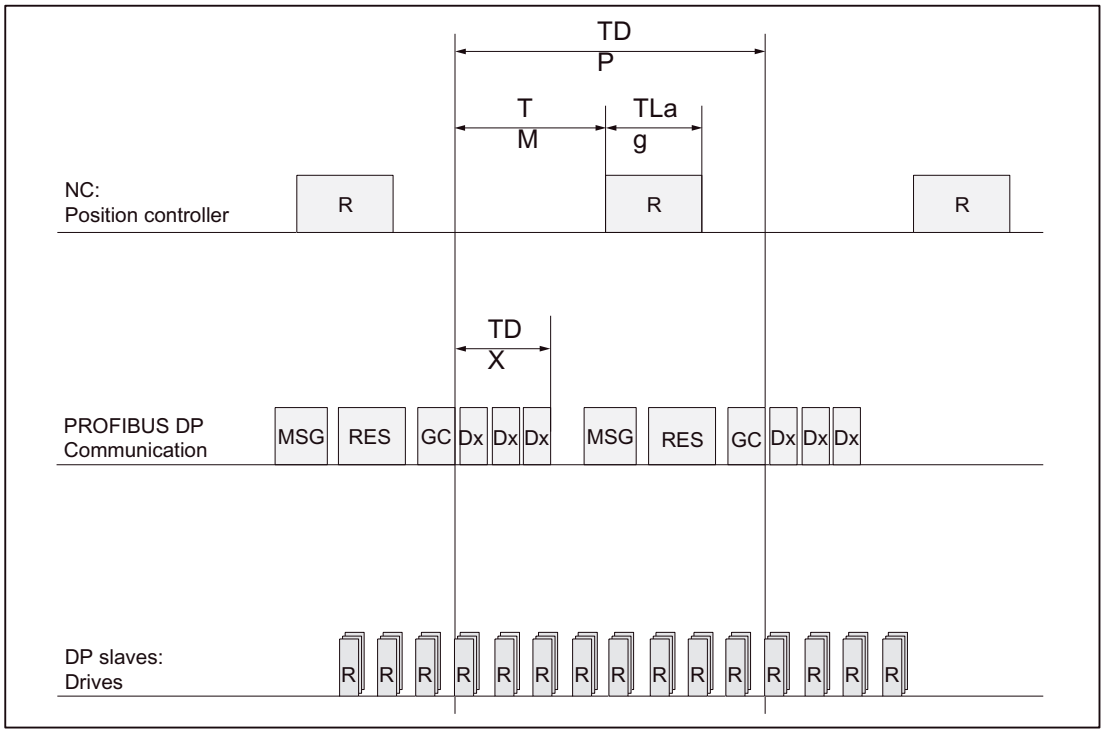


Figure 10-1 Position control cycle offset compared to PROFIBUS DP cycle

Key to Fig. above:

T_{Lag}:CPU time required by position controller

T_{DP}: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 controller

GC: Global Control: Broadcast message for cyclic convergence of the equidistance between DP master and DP slaves

R: CPU time

Dx: Useful data exchange between the DP master and DP slaves

MSG: Acyclic services (e.g. DP/V1, pass token)

RES: Reserve: "Active pause" until the isochronous (equidistant) cycle has expired

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

  – Remedy: Increase the DP cycle time.

    The DP cycle time is set using STEP7 "HW-Config". See Chapter "SIMATIC create S7 project".

Interpolation cycle

The interpolator cycle may be chosen freely as a whole multiple of the position control cycle.

- MD10070 IPO_SYSCLOCK_TIME_RATIO (factor for the interpolation cycle)

Error response

- Alarm: "4240 CPU time overflow on the IPO or position controller level"

Cause of errors/error handling

The DP cycle time/position controller 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).

Remedial action:
Calculate the maximum values for $T_{pos\ max}$ and $T_{IPO\ max}$ (see above) and adapt the following machine data:

- MD10185 NCK_PCOS_TIME_RATIO (CPU time component NCK)
- MD10070 IPO_SYSCLOCK_TIME_RATIO (factor for the interpolation cycle)
- MD10050 SYSCLOCK_CYCLE_TIME (system clock cycle)

Note

You must adjust the **system clock cycle** by changing the DP cycle time using STEP7 "HW-Config".

Literature

Function Manual special functions; cycly times

Machine data

Table 10-8 Cycle times: Machine data

Number	Identifier	Name / remarks	Reference
General ($MN_ ...)			
10050	SYSCLOCK_CYCLE_TIME	System clock cycle/only display data; is always equal to the equidistant PROFIBUS DP cycle. Note: **For SINUMERIK solution line for display only!**	
10060	POSCTRL_SYSCLOCK_TIME_RATIO	Factor for the position control cycle/is set fixed to the factor 1.	
10061	POSCTRL_CYCLE__TIME	Position Controller cycle	
10062	POSCTRL_CYCLE_DELAY	Position control cycle offset	
10063	POSCTRL_CYCLE_DIAGNOSIS	[0] = DP cycle time [1] = Position controller cycle offset [2] = Position controller cycle offset + max. computation time needed by the position controller	
10070	IPO_SYSCLOCK_TIME_RATIO	Factor for the interpolator cycle/can be freely selected in integer multiples.	
10185	NCK_PCOS_TIME_RATIO	Computation time ratio NCK	

⚠ CAUTION

If you change the cycle times, check the behavior of the controller in all operating modes before you finish commissioning.

Note

The smaller the cycle times (PROFIBUS DP cycle) chosen, the greater the control quality for the drive and the better the surface quality on the workpiece.

10.2.9 NCK utilization

Introduction

You can view utilization of system resources for the NCK on the HMI under the menu "Diagnostics > Service displays > System resources".

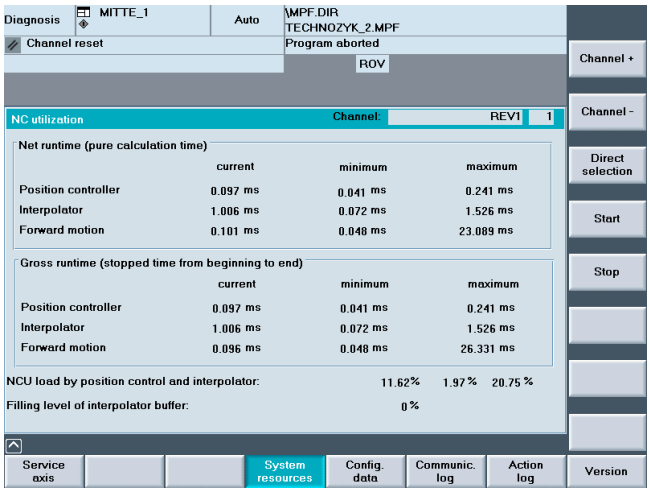


Figure 10-2 NC utilization

The following machine data is taken into consideration for displayed runtimes (see Chapter Cycle times (Page 119)):

- MD1061 POSCTRL_CYCLE_TIME = MD10050 SYSCLOCK_CYCLE_TIME (System basic cycle)
- MD1070 IPO_SYSCLOCK_TIME_RATIO (factor for interpolation cycle)
- MD1071 IPO_CYCLE_TIME (interpolation cycle)

What will be displayed?

In the display of the "System resources" menu, the values have the following meaning:

- Area "Nett runtime (purely CPU time)":

  Active times (current, minimum and maximum) are displayed in the nett values.

  The relation to the machine data can be seen from the displayed values.

- Area "Gross runtime (time from start to end)":

  The corresponding total utilization of the system (position controller + interpolator) is displayed, based on the net values.

- Line "NCU load by position controller and interpolator":

  Note

  The current, minimum and maximum utilization of the NCK is displayed.

  In order to have sufficient reserves for program processing, maximum utilization in reset condition when pressing the <Reset> key should be in the range of 60-65%.

- Line "Capacity of interpolator buffer":

  The capacity indicator MD28060 NUM_IPO_Buffer_SIZE is indicated in %.

  This display indicates whether batch preparation for batch processing can commence.

  A jerky processing in track control, if for instance a number of short traversing sets have been programmed in succession, is a typical indicator of the IPO buffers becoming full.

  Capacity indication is channel-specific.

10.2.10 Velocities

Max. axis velocity or spindle speed

The maximum possible axis velocities and spindle speeds depend on the machine design, drive dynamics and the encoder limit frequency of the individual drives.

Max. progr. 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 parts 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 parts program blocks are executed continuously (control margin), the NC limits the tool path velocity within a parts 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 parts programs generated by means of 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 parts program blocks.

The function "Online compressor" can help to avoid such sudden velocity dips.

Literature

Programming Manual Work Preparation: Compressor COMPON/COMPCURVE

Voltage limit

The minimum tool path or axis velocity at which traversing is possible results from:

$$V_{min} \geq \frac{10^{-9}}{\text{comput. resolution } [\frac{\text{incr.}}{\text{mm or degrees}}] * \text{IPO cycle [s]}}$$

(for the computational resolution, see Chapter "Resolutions"

If V_{min} is not reached, no traversing movement is carried out.

Literature

Function Manual Basic Functions; Velocities, traversing ranges, accuracy: Velocities

10.3 Memory configuration

Introduction

On the SINUMERIK 840D sl, the persistent data are divided into various independent areas:

- SIEMENS
- Vendor
- Users

SRAM

For historical reasons, SRAM is still named as the memory medium at various points in relation to persistent data. For SINUMERIK solution line, this only applies insofar as SRAM is also sometimes used in the context of persistent data management. However, when a SINUMERIK solution line control system is in continuous operation, the data are physically stored in the much more powerful DRAM. Only when the control system is switched off are the data saved to a persistent data storage area. SRAM is also used for specific control systems.

Memory division

The figure below shows how NCK persistent data is divided:

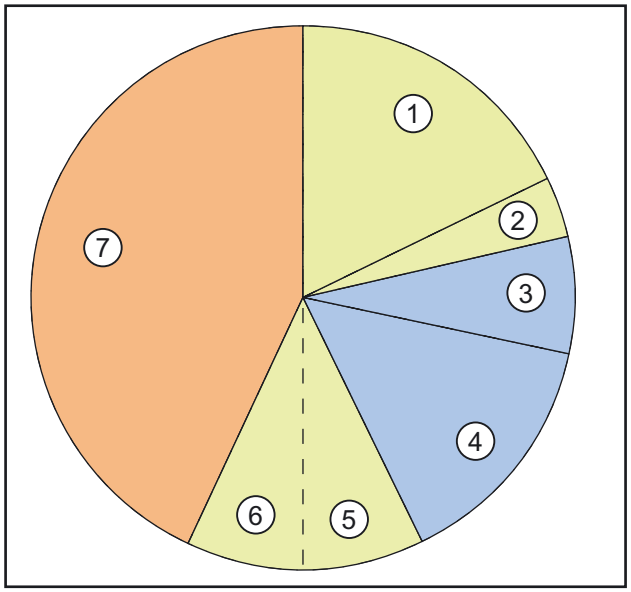


Figure 10-3 Memory division

Legend	Description	User
1	Part programs and OEM cycles can be set via MD 18352: $MM_U_FILE_MEM_SIZE.	User

Legend	Description	User
2	In addition to part programs and OEM cycles, can be set via MD 18353: $MM_M_FILE_MEM_SIZE.	User
3	SIEMENS cycles	Siemens AG
4	Reserved	Siemens AG
5	RAM in NCK	User
6	RAM in NCK, contains the system and user data accessed by the NCK during program execution. Numbers for tools, frames, etc., are set by default.	User
7	Additional memory (optional)	Available to users as an option and can be used for RAM in NCK or for part programs and cycles.

Memory display

The memory available in the NCK is displayed on the user interface, e.g., HMI Advanced, under: **Commissioning > NC > NC memory**.

See also

Import licensing terms (Page 273)

10.4 Parameter sets of axis/spindle

Per machine axis, six parameter sets are available. They are used as follows

- on an axis:

  for accommodation of the own dynamic response to another machine axis, e.g. when tapping or thread cutting on the relevant spindle.

- on a spindle:

  for accommodation of the position controller to modified properties of the machine during operation, e.g. when switching the gearbox.

Tapping, thread cutting

The following applies to axes:

- For a machine axis that is not involved in tapping or thread cutting, the 1st set of parameters (index=0) is active in all cases.

  The further parameter sets need not be considered.

- 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 instance Gearbox step 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.

For example, in HMI Advanced, the active parameter set of a machine axis is displayed in the control area "DIAGNOSIS" in the screen form "Service Axis".

The active parameter set can be read in the PLC via the signals DB31, ... DBX69.0-2 (Controller parameter set)."

Parameter set no.	Axis	Spindle	Gear stage The spindle
0	Standard	Axis mode	as specified by manufacturer input
1	Axis interpolated with spindle (G33)	Spindle mode	1.
2	Axis interpolated with spindle (G33)	Spindle mode	2.
3	Axis interpolated with spindle (G33)	Spindle mode	3.
4	Axis interpolated with spindle (G33)	Spindle mode	4.
5	Axis interpolated with spindle (G33)	Spindle mode	5.

Figure 10-4 Validity of parameter sets for axis and spindle modes

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

Machine data

The following machine data of a machine axis depend on the parameter set:

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

Table 10-9 Parameter-set-dependent machine data

Number	Identifier	Name	Reference
Axis/spindlespecific ($MA_ ...)			
31050	DRIVE_AX_RATIO_DENOM[n]	Denominator load gearbox	
31060	DRIVE_AX_RATIO_NUMERA[n]	Numerator load gearbox	
32200	POSCTRL_GAIN [n]	K_V factor	
32810	EQUIV_SPEEDCTRL_TIME [n]	Equivalent time constant, of speed control loop for feed forward control	
32910	DYN_MATCH_TIME [n]	Time constant for dynamic matching	
35110	GEAR_STEP_MAX_VELO[n]	Maximum speed for gear change	
35120	GEAR_STEP_MIN_VELO[n]	Minimum speed for gear change	
35130	GEAR_STEP_MAX_VELO_LIMIT[n]	Maximum speed of gear stage	
35140	GEAR_STEP_MIN_VELO_LIMIT[n]	Minimum speed of gear stage	
35200	GEAR_STEP_SPEEDCTRL_ACCEL[n]	Acceleration in speed control mode	
35210	GEAR_STEP_POSCTRL_ACCEL[n]	Acceleration in position control mode	
36200	AX_VELO_LIMIT [n]	Threshold value for velocity monitoring	

10.5 Parameterize axis data

Reference

See also

Axis data (Page 326)

Axis assignment (Page 330)

Axis names (Page 333)

10.5.1 Incremental measuring system settings

Rotary measuring system

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

Figures equally apply to rotary axes, modulo axis and spindles.

Linear axis with encoder on the machine

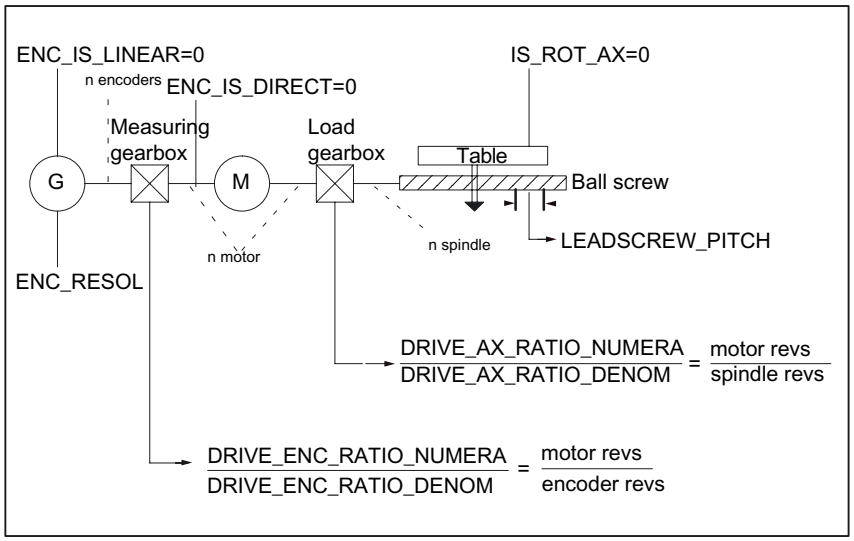


Figure 10-5 Linear axis with encoder on motor

Linear axis with sensor on load

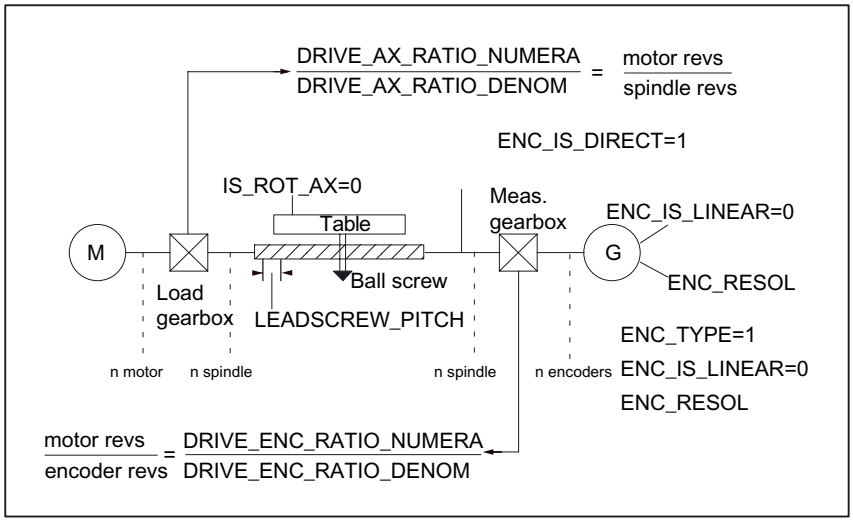


Figure 10-6 Linear axis with sensor on load

Rotary axis with encoder on motor

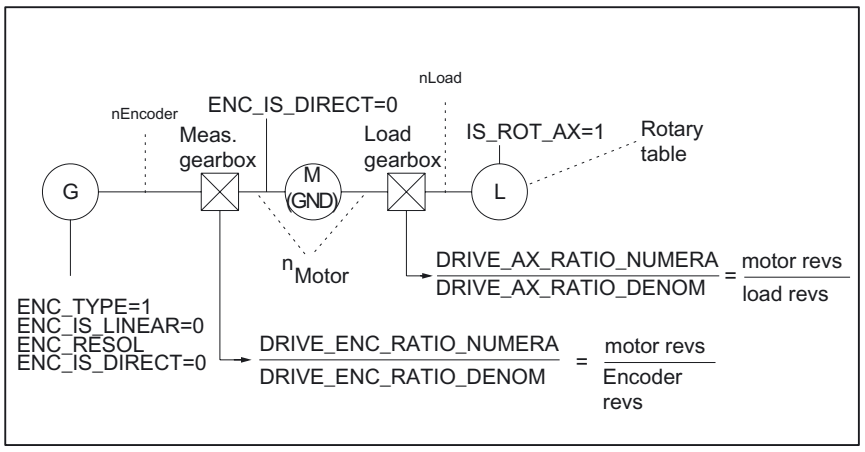


Figure 10-7 Rotary axis with encoder on motor

Linear axis with encoder on the machine

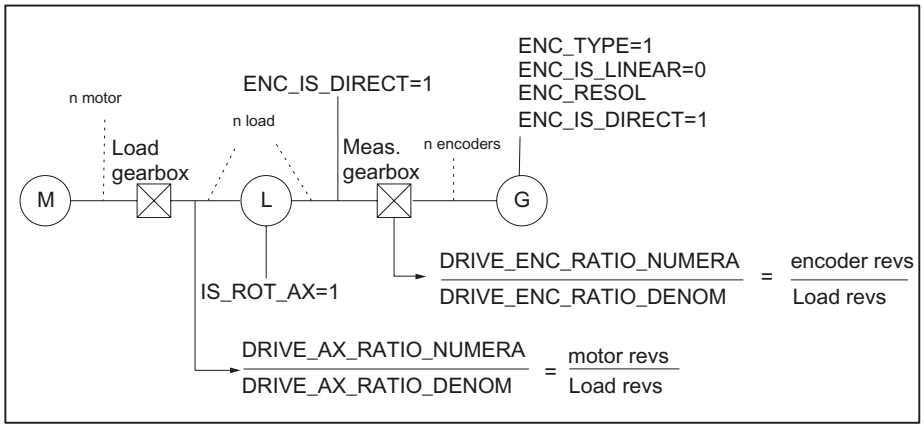


Figure 10-8 Linear axis with encoder on the machine

Machine data

Table 10-10 Incremental measuring systems: Machine data

Number	Identifier	Name / remarks	Reference
Axisspecific ($MA_ ...)			
30240	ENC_TYPE[n]	Actual value acquisition modes 1=incremental raw signal encoder	
30242	ENC_IS_INDEPENDENT[n]	Encoder is independent	
30300	IS_ROT_AX	Rotary axis	R2
31000	ENC_IS_LINEAR[n]	Direct measuring system (linear scale)	
31020	ENC_RESOL[n]	Encoder pulses per revolution	
31030	LEADSCREW_PITCH	Leadscrew pitch	
31040	ENC_IS_DIRECT[n]	Encoder is connected directly to the machine	
31050	DRIVE_AX_RATIO_DENOM[n]	Denominator load gearbox	
31060	DRIVE_AX_RATIO_NUMERA[n]	Numerator load gearbox	
31070	DRIVE_ENC_RATIO_DENOM[n]	Denominator of resolver gearbox	
31080	DRIVE_ENC_RATIO_NUMERA[n]	Numerator of resolver gearbox	

Linear measuring system

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

Linear axis with linear scale

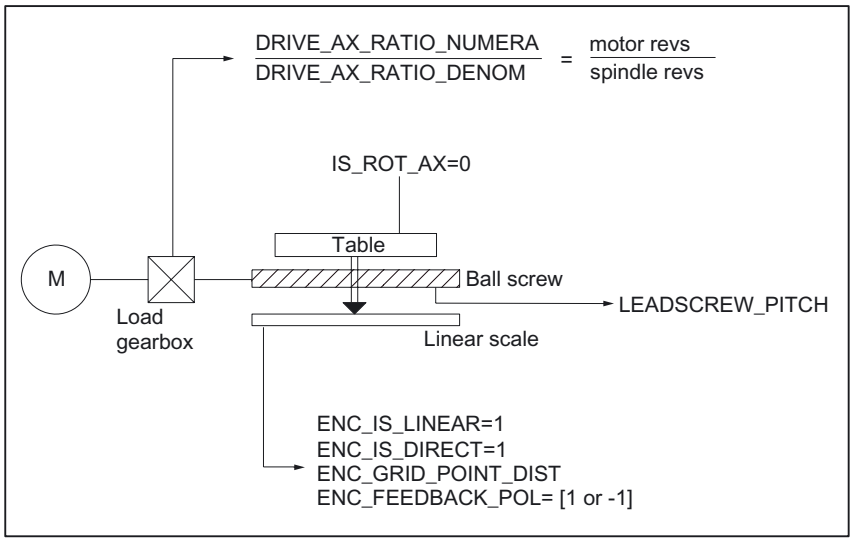


Figure 10-9 Linear axis with linear scale

Machine data

Table 10-11 Linear measuring systems: Machine data

Number	Identifier	Name / remarks	Reference
axisspecific ($MA_ ...)			
30240	ENC_TYPE[n]	Actual value acquisition modes 1=incremental raw signal encoder	
30242	ENC_IS_INDEPENDENT[n]	Encoder is independent	
30300	IS_ROT_AX	Rotary axis	R2
31000	ENC_IS_LINEAR[n]	Direct measuring system (linear scale)	
31010	ENC_GRID_POINT_DIST[n]	Distance between reference marks on linear scales	
31030	LEADSCREW_PITCH	Leadscrew pitch	
31040	ENC_IS_DIRECT[n]	Encoder is connected directly to the machine	
31050	DRIVE_AX_RATIO_DENOM[n]	Denominator load gearbox	
31060	DRIVE_AX_RATIO_NUMERA[n]	Numerator load gearbox	
32110	ENC_FEEDBACK_POL[n]	Sign actual value (feedback polarity)	

10.5.2 Parameterization of absolute measuring systems

Encoder types

The following encoder types are currently supported:

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

with EnDat protocol and incremental sinusoidal encoder signals A and B, e.g. Haidenhain EQN 1325.

EQN 1325

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. For calibration of the absolute value encoder, see Chapter "Axis Homing".

Rotary measuring systems

An absolute encoder can currently exclusively be used as a motor encoder (indirect measuring system).

Linear axis with absolute value encoder on motor

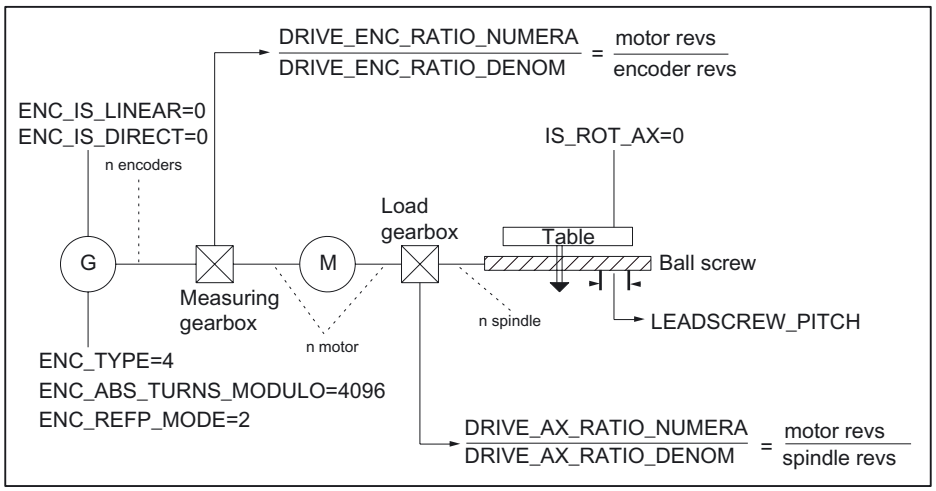


Figure 10-10 Linear axis with absolute value encoder on motor

Rotary axis, modulo axis and spindle with absolute value sensor on motor

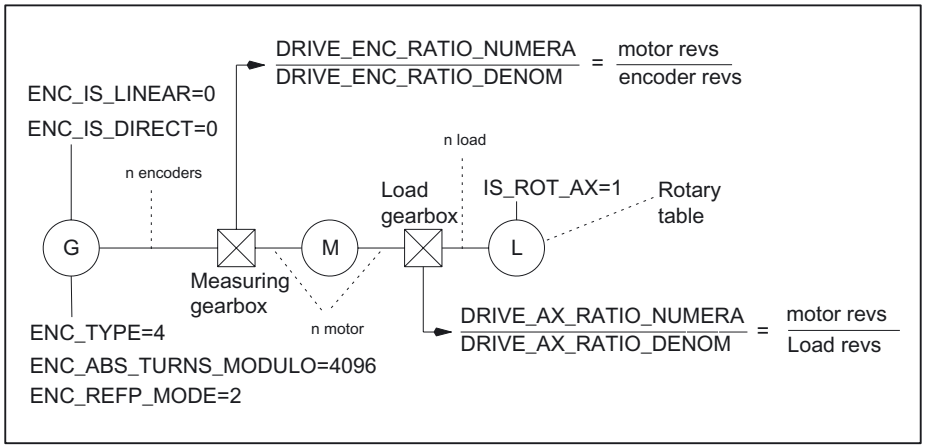


Figure 10-11 Rotary axis, modulo axis and spindle with absolute value sensor on motor

Machine data

Table 10-12 Measuring systems: Machine data

Number	Identifier	Name / remarks	Reference
axisspecific ($MA_ ...)			
30240	ENC_TYPE[n]	Actual-value acquisition modes	
30242	ENC_IS_INDEPENDENT[n]	Encoder is independent	
30260	ABS_INC_RATION[n]	Encoder fine resolution (absolute value encoder)	
30300	IS_ROT_AX[n]	Rotary axis	R2
31000	ENC_IS_LINEAR[n]	Direct measuring system (linear scale)	
31030	LEADSCREW_PITCH[n]	Leadscrew pitch	
31040	ENC_IS_DIRECT[n]	Encoder is connected directly to the machine	
31050	DRIVE_AX_RATIO_DENOM[n]	Denominator load gearbox	
31060	DRIVE_AX_RATIO_NUMERA[n]	Numerator load gearbox	
31070	DRIVE_ENC_RATIO_DENOM[n]	Measuring gearbox denominator	
31080	DRIVE_ENC_RATIO_NUMERA[n]	Measuring gearbox numerator	
34200	ENC_REFP_MODE[n]	Referencing mode	
34210	ENC_REFP_STATE[n]	Status of absolute value encoder	
34220	ENC_ABS_TURNS_MODULO[n]	Absolute value encoder range for rotary encoders (multi-turn resolution)	R2

10.5.3 DSC (Dynamic Servo Control)

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.

That 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.

Requirements

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

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

Switch ON/OFF

The DSC function is switched ON/OFF via the axis-specific NCK machine data

- MD32640 STIFFNESS_CONTROL_ENABLE (dyn. stiffness control).

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

- MD32200 POSCRTL_GAIN (K_V factor)
- MD32610 VELO_FFW_WEIGHT (feedforward control factor)
- MD32810 EQUIV_SPEEDCTRL_TIME (substitute time const. 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.

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

Table 10-13 DSC: Machine data

Number	Identifier	Name	Reference
Axisspecific ($MA_ ...)			
32640	STIFFNESS_CONTROL_ENABLE	Dyn. stiffness control	DD2
32200	POSCRTL_GAIN	K_V factor	G2
32642	STIFFNESS_CONTROL_CONFIG	The dynamic stiffness control is configured. 0->standard case: DSC in drive operates with indirect measuring system 1->DSC in the drive operates using direct measuring system	DD2

10.5.4 Rotary axes

Rotary axes

A machine axis is parameterized as a rotary axis in

- MD30300 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 Subsection "Modifying Scaling Machine Data" .

Modulo display

Machine data

- MD30320 DISPLAY_IS_MODULO (modulo 360 degrees display for rotary axes)

is used to display the rotary axis position modulo 360 degrees.

Endlessly rotating rotary axis/modulo axis

The machine data

- MD30310 ROT_IS_MODULO (modulo conversion for rotary axis)

is used to traverse the rotary axis modulo 360 degrees. 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

Table 10-14 Rotary axes: Machine data

Number	Identifier	Name	Reference
general ($MN_ ...)			
10210	INT_INCR_PER_DEG	Computational resolution for angular positions	G2
axisspecific ($MA_ ...)			
30300	IS_ROT_AX	Axis is rotary axis	
30310	ROT_IS_MODULO	Modulo conversion for rotary axis	
30320	DISPLAY_IS_MODULO	Actual value display modulo	
36100	POS_LIMIT_MINUS	Minus software limit switch	A3
36110	POS_LIMIT_PLUS	Plus software limit switch	A3

Setting data

Table 10-15 Rotary axes: Setting data

Number	Identifier	Name	Reference
General ($SN_ ...)			
41130	JOG_ROT_AX_SET_VELO	JOG speed for rotary axes	H1
Axisspecific ($SA_ ...)			
43430	WORKAREA_LIMIT_MINUS	Working area limitation minus	A3
43420	WORKAREA_LIMIT_PLUS	Working area limitation plus	A3

Literature

Function Manual Expanded Functions; Rotary axes

10.5.5 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 parts program or from the PLC.

Concurrent machine axes

The machine data

- MD30450 IS_CONCURRENT_POS_AX (concurr. positioning axis) = 1

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

Positioning axis feedrate

If a positioning axis is programmed in the parts program without specifying an axis-specific feedrate, the feedrate entered in

- MD32060 POS_AX_VELO (initial setting for positioning axis velocity)

entered feed rate.

This feedrate will apply until an axis-specific feedrate is programmed in the parts program for this axis.

Machine data

Table 10-16 Positioning axes: Machine data

Number	Identifier	Name	Reference
Channelspecific ($MC_ ...)			
22240	AUXFU_F_SYNC_TYPE	Output timing of F functions	H2
axisspecific ($MA_ ...)			
30450	IS_CONCURRENT_POS_AX	Concurrent positioning axis	
32060	POS_AX_VELO	Feedrate for positioning axis	

Interface signals

Table 10-17 Positioning axes: Interface signals

DB number	Bit, byte	Name	Reference
Axis/spindle-specific		Signals from PLC to axis/spindle	
31,...	0	Feedrate override, axis-specific	
31,...	2.2	Delete distance-to-go, axis-specific	
		Signals from axis/spindle to PLC	
31,...	74.5	Positioning axis	
31,...	78-81	F function (feedrate) for positioning axis	

Literature

Function Manual Expanded Functions; Positioning axes

10.5.6 Indexed axes/"Hirth" axes

Indexed axes are rotary or linear axes, which can be traversed to indexed positions by index program instructions.

These indexed positions are approached in JOG mode.

In "normal" positioning, every position can be approached.

Note

Traversing to indexing positions using the parts 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 HIRTH_IS_ACTIVE).

The indexing positions are stored in tables.

Indexing axis

Machine data

- MD30500 INDEX_AX_ASSIGN_POS_TAB[n] (axis is indexing axis)

assigns the machine axis the relevant table of indexing positions and also defines the machine axis as an indexing axis.

Indexing position tables

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

- MD10900 INDEX_AX_LENGTH_POS_TAB_1 (number of positions of indexing table 1)
- MD10910 INDEX_AX_POS_TAB_1[n] (indexing position table 1)
- MD10920 INDEX_AX_LENGTH_POS_TAB_2 (number of positions of indexing table 2)
- MD10930 INDEX_AX_POS_TAB_2[n] (indexing position table 2)

Machine data

Table 10-18 Indexing axes: Machine data

Number	Identifier	Name	Reference
general ($MN_ ...)			
10260	CONVERT_SCALING_SYSTEM	Basic system switch-over active	G2
10270	POS_TAB_SCALING_SYSTEM	Measuring system of position tables	
10900	INDEX_AX_LENGTH_POS_TAB_1	Number of indexing positions used in Table 1	
10910	INDEX_AX_POS_TAB_1[n]	Indexing position table 1	
10920	INDEX_AX_LENGTH_POS_TAB_2	Number of indexing positions used in Table 2	
10930	INDEX_AX_POS_TAB_2[n]	Indexing position table 2	
Axis/spindlespecific ($MA_ ...)			
30300	IS_ROT_AX	Rotary axis	R2
30310	ROT_IS_MODULO	Modulo conversion for rotary axis	R2
30320	DISPLAY_IS_MODULO	Position display is modulo 360 degrees	R2
30500	INDEX_AX_ASSIGN_POS_TAB	Axis is indexing axis	
30501	INDEX_AX_NUMERATOR	Numerator for indexing axes with equidistant positions	
30505	HIRTH_IS_ACTIVE	Axis is an indexing axis with Hirth toothing	

Interface signals

Table 10-19 Indexing axes: Interface signals

DB number	Bit, byte	Name	Reference
Axis/spindle-specific		**Signals from axis/spindle to PLC**	
31,...	60.4, 60.5	Referenced/synchronized 1, referenced/synchronized 2	R1
31,...	76.6	Indexing axis in position	

Literature

Function Manual Expanded Functions; Indexing axes

10.5.7 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.

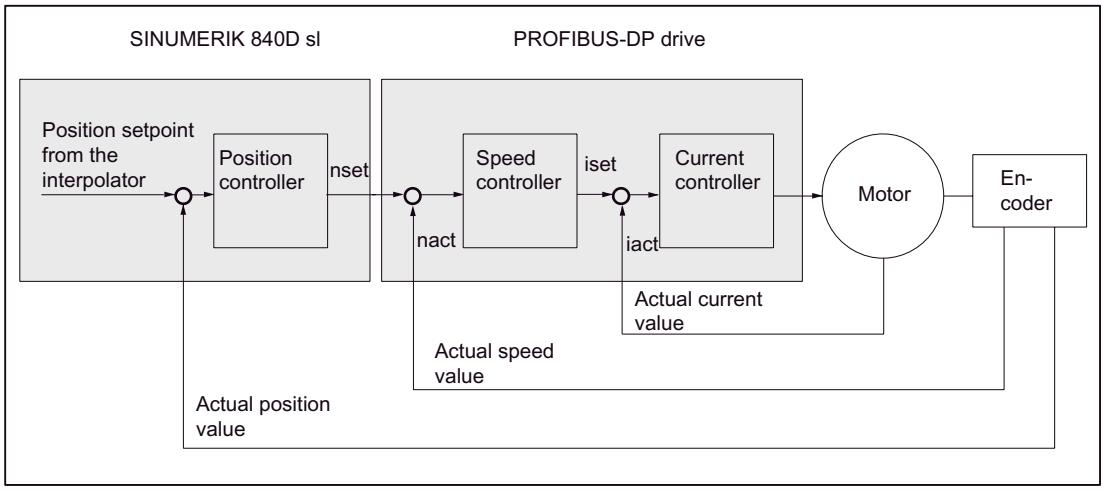


Figure 10-12 Control loops

Traversing direction

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

- MD32100 AX_MOTION_DIR (traversing 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 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 first commissioning is performed without feedforward control.

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

Definition of the KV 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 POSCTRL_GAIN (K_V 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 assigned pre-assigned:
  - MD10230 SCALING_FACTORS_USER_DEF[9] = 16.666667
  - MD10220 SCALING_USER_DEF_MASK = 'H200'; (bit no. 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 RATED_VELO
- MD32250 RATED_OUTVAL
- Automatic interface alignment (SINAMICS parameter "Reference speed" p2000)

For drive optimization see Further optimization options (Page 214)

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 DYN_MATCH_ENABLE • MD32910 DYN_MATCH_TIME The real K_V factor can be checked with the following error in the service display. • e.g., HMI Advanced: Operating area "DIAGNOSIS" > Service displays > 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 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.

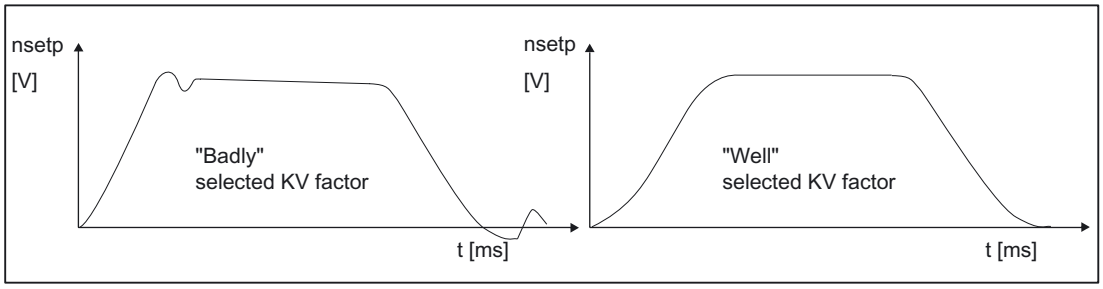


Figure 10-13 Speed setpoint characteristic

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 DYN_MATCH_ENABLE[n]
- MD32910 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 (MD 36400 CONTROL_TOL).

Acceleration

In the following machine data machine axes are accelerated and decelerated with the values entered.

- MD32300 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 MAX_AX_JERK (maximum jerk)
- For JOG and positioning axes the following machine data should be supplemented:
  - MD 32420 JOG_AND_POS_JERK_ENABLE
  - MD 32430 JOG_AND_POS_MAX_JERK

Machine data

Table 10-20 Position control: Machine data

Number	Identifier	Name/remarks	Reference
axis spec. ($MA_ ...)			
32100	AX_MOTION_DIR[n]	Traversing direction	
32110	ENC_FEEDBACK_POL[n]	Actual value sign	
32200	POSCTRL_GAIN [n]	KV factor	
32300	MAX_AX_ACCEL[n]	Axis acceleration	
32420	JOG_AND_POS_JERK_ENABLE	Enabling jerk limitation	
32430	JOG_AND_POS_MAX_JERK	Axial jerk	
32431	MAX_AX_JERK	Maximum axial jerk when traversing along the path	
32900	DYN_MATCH_ENABLE[n]	Dynamic response adaptation	
32910	DYN_MATCH_TIME [n]	Time constant for dynamic matching	
36400	CONTROL_TOL	Contour monitoring	

Literature

Function Manual; speed, setpoint/actual-value systems, control: Closed-loop control

Function Manual Extended Functions; Compensation, Section "Dynamic feedforward control (following error compensation)"

10.5.8 Speed setpoint matching

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 in the following machine data the value "0" is entered:

- MD32250 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 SINAMICS parameter "Reference speed" p2000 may not be changed during operation of the control with the drive.

Note

If automatic speed setpoint matching fails for one axis, the following message is output on a traverse request for this axis:

- Message: "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 RATED_OUTVAL (rated output voltage) [%]
- MD32260 RATED_VELO (rated motor speed)

If a non-zero value is entered into the following machine data, the NCK assumes that speed setpoint matching will be performed manually.

- MD32250 RATED_OUTVAL (rated output voltage) [%]

  Note

  The maximum upper limit for the speed setpoint is set in machine data

  - MD36210 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

$$n_{motor} = \frac{Vaxis * \frac{MD31060\ DRIVE_RATIO_NUMERA}{MD31050\ DRIVE_RATIO_DENOM}}{MD31030:\ LEADSCREW_PITCH}$$

Motor speed for rotary axis/spindle

$$n_{motor} = n_{load} * \frac{MD31050\ DRIVE_RATIO_NUMERA}{MD31050\ DRIVE_RATIO_DENOM}$$

- v_{Axis} [mm/min]
- MD31060 DRIVE_RATIO_NUMERA (numerator load gearbox)
- MD31050 DRIVE_RATIO_DENOM (denominator load gearbox)
- MD31030 LEADSCREW_PITCH (leadscrew pitch) [mm/rev]
- n_{Motor} [rpm]
- n_{Load} [rpm]

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.

$$\text{Desired following error} = \frac{\text{Traversing velocity}}{MD32200\ POSCTRL_GAIN}$$

- Desired following error [mm]
- Traversing velocity [m/min]
- MD32200 POSCTRL_GAIN (K_V factor) [(m/min)/mm]

The actual following error is shown in the axis-specific service data:

HMI:
Operating area "Diagnostics" > Service displays > Service axis/spindle

Machine data

Table 10-21 Speed setpoint matching: Machine data

Number	Identifier	Name/remarks	Reference
Axis-spec. ($MA_ ...)			
32250	RATED_OUTVAL	Rated output voltage [%]	G2
32260	RATED_VELO	Rated motor speed	G2

Literature

Function Manual Basic Functions;
Speeds, setpoint/actual value systems, control, Chapter "Speeds, traversing ranges, accuracy"

10.5.9 Drift compensation

Digital drives

Digital drives are not subject to drift or compensate for it automatically.

Machine data

Table 10-22 Drift compensation: Machine data

Number	Identifier	Name/remarks	Reference
axis spec. ($MA_ ...)			
36720	DRIFT_VALUE	Basic drift value, always = 0 Note: 0 recommended for digital drive.	G2

10.5.10 Velocity matching (axis)

Max. axis velocity

The value entered in machine data

- MD32000 MAX_AX_VELO[n] (max. axis velocity)

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.

The max. axis velocity is used for traversing in the parts program when rapid traverse (G00) is programmed.

The maximum linear or rotary axis velocity should be entered in the machine data in accordance with MD 30300: IS_ROT_AX[n].

Rapid traverse in JOG mode

The value entered in machine data

- MD32010 JOG_VELO_RAPID[n] (rapid traverse in JOG mode) or
- MD32040 JOG_REV_VELO_RAPID[n] (revolutional feedrate in JOG mode with rapid traverse override)

is the velocity at which the machine axis traverses in JOG mode with the rapid traverse override key actuated and with an axial feedrate override of 100%.

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 machine data

- MD32020 JOG_VELO[n] (axis velocity in JOG mode) or
- MD32050 JOG_REV_VELO[n] (revolutional feedrate in JOG mode)

is the velocity at which the machine axis traverses in JOG mode with an axial feedrate override of 100%.

The velocity from MD32020 JOG_VELO[n] or MD32050 JOG_REV_VELO[n] is used only if

- for linear axes: SD41110 JOG_SET_VELO = 0
- for rotary axes: SD41130 JOG_ROT_AX_SET_VELO = 0

or

- for reverse feed: SD41120 JOG_REV_SET_VELO = 0.

If the above mentioned setting data are unequal to 0, the JOG velocity results as follows:

1. SD: JOG_REV_IS_ACTIVE (revolutional feedrate in JOG mode) = 0

   => Linear feedrate (G94)

   – Linear axes:

   JOG velocity = SD41110 JOG_SET_VELO (JOG velocity for G94)

   – Rotary axes:

   JOG velocity = SD41130 JOG_ROT_AX_SET_VELO (JOG velocity for rotary axes)

2. SD: JOG_REV_IS_ACTIVE (revolutional feedrate in JOG mode) = 1

   – JOG velocity = SD41120 JOG_REV_SET_VELO (JOG velocity for G95)

The entered value may not exceed the max. permissible axis velocity.

NOTICE
Depending on MD30300 IS_ROT_AX[n], the velocities have to be entered in mm/min, inch/min, or rpm. If the velocities are changed, MD36200 AX_VELO_LIMIT[n] (threshold value for velocity monitoring) must be adapted accordingly.

Machine data

Table 10-23 Velocities: Machine data

Number	Identifier	Name / remarks	Reference
axis-spec. ($MA_ ...)			
30300	IS_ROT_AX[n]	Rotary axis	
32000	MAX_AX_VELO[n]	Maximum axis velocity	G2
32010	JOG_VELO_RAPID[n]	Rapid traverse in JOG mode	
32020	JOG_VELO[n]	JOG axis velocity	
32040	JOG_REV_VELO_RAPID[n]	Revolutions feedrate in JOG mode with rapid traverse override	
32050	JOG_REV_VELO[n]	Revolutional feedrate in JOG mode	
32060	POS_AX_VELO[n]	Initial setting for positioning axis velocity	P2
32250	RATED_OUTVAL	Rated output voltage	
32260	RATED_VELO[n]	Rated motor speed	

Setting data

Table 10-24 Velocities: Setting data

Number	Identifier	Name / remarks	Reference
General ($SN_ ...)			
41100	JOG_REV_IS_ACTIVE	Revolutional feedrate in JOG mode active	
41110	JOG_SET_VELO	JOG velocity for linear axes (for G94)	
41120	JOG_REV_SET_VELO	JOG velocity (for G95)	
41130	JOG_ROT_AX_SET_VELO	JOG speed for rotary axes	
41200	JOG_SPIND_SET_VELO	JOG velocity for the spindle	

Literature

Function Manual Basic Functions;
Speeds, setpoint/actual value systems, control, Chapter "Speeds, traversing ranges, accuracy"

Function Manual, Expanded Functions; Manual and Hand Wheel Travel

10.5.11 Axis monitoring

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 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 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 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 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 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 CLAMP_POS_TOL (clamping tolerance)
- IS: DB31,... DBX2.3 (clamping active)
- Alarm: "26000 Clamping monitoring"

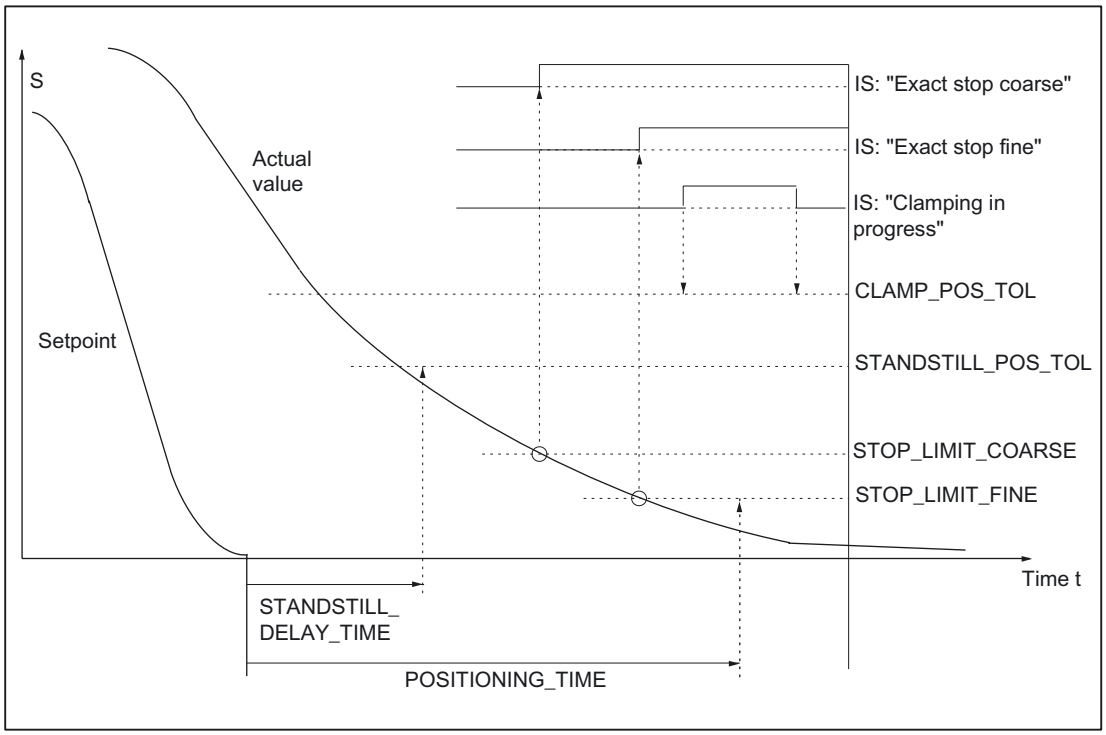


Figure 10-14 Static monitoring functions

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 WORKAREA_PLUS_ENABLE (working area limitation active in the positive direction)
- SD43410 WORKAREA_MINUS_ENABLE (working area limitation active in the negative direction)
- SD43420 WORKAREA_LIMIT_PLUS (working area limitation plus)
- SD43430 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 switches

Two software limit switch pairs are provided per machine axis. The active software limit switch pair is selected in the PLC.

- MD36100 POS_LIMIT_MINUS (1st software limit switch minus)
- MD36110 POS_LIMIT_PLUS (1st software limit switch plus)
- MD36120 POS_LIMIT_MINUS2 (2nd software limit switch minus)
- MD36130 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 +/-"

NOTICE
All position monitoring functions are only active with valid reference point of the corresponding reference point of the machine axis.

Hardware limit switches

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 BRAKE_MODE_CHOICE (deceleration behavior on hardware limit switch)

  0 = Brake characteristic is complied with

  1 = Rapid deceleration with setpoint "0"
- Alarm: "21614 Hardware limit switch [+/-]"

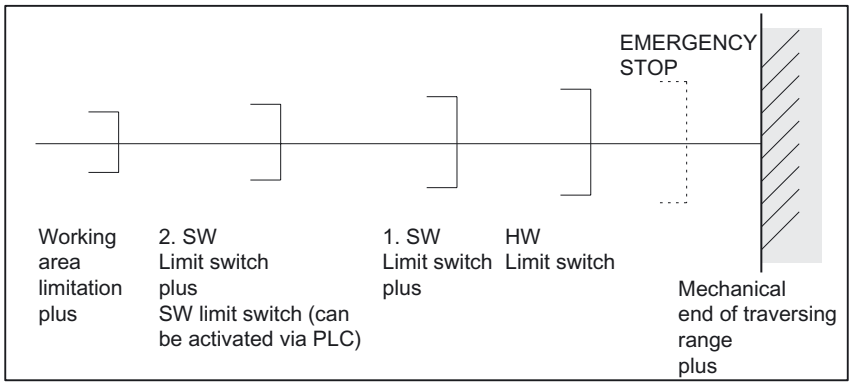


Figure 10-15 Overview of end limitations

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 CTRLOUT_LIMIT[n] (maximum speed setpoint in %)

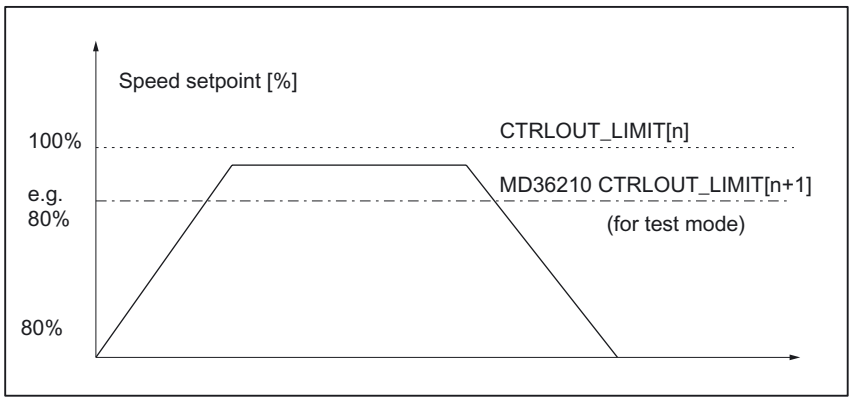


Figure 10-16 Speed setpoint limitation

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 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 AX_EMERGENCY_STOP_TIME (time for braking ramp when an error occurs)

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).

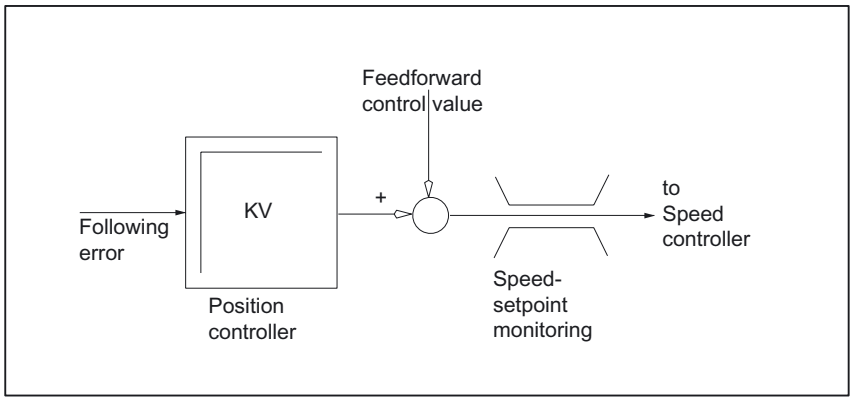


Figure 10-17 Speed setpoint calculation

NOTICE
The limitation of the speed setpoint will turn the control loop into a nonlinear 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 AX_VELO_LIMIT (velocity for 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 AX_EMERGENCY_STOP_TIME (time for braking ramp when an error occurs)

Remedy

- 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 AX_EMERGENCY_STOP_TIME (time for braking ramp when an error occurs)

Remedy

Contour errors are caused by signal distortions in the position control loop.

Remedy:

- Increase the tolerance band
- Checking the K_V factor:

  The real K_V factor must correspond to the desired K_V factor, set via MD32200 POSCTRL_GAIN[n] (K_V factor).

  HMI Advanced
  Operating area DIAGNOSTICS > Service displays > Service axis
- Check optimization of the speed controller
- Check smooth running of the axes
- Check machine data for traversing motions

  (Feedrate override, acceleration, max. velocities, ...)
- For operation with feedforward control:

  MD32810 EQUIV_SPEEDCTRL_TIME (equivalent time constant speed control loop for feedforward control) or if the machine data is imprecisely set, the MD36400 CONTOUR_TOL must be enlarged.

Encoder limit frequency monitoring

Monitoring of the limit frequency of the encoder of a machine axis.

- MD36300 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 AX_EMERGENCY_STOP_TIME (time for braking ramp when an error occurs)

Remedy

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 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 situation:
A value of 100 will additionally disable 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 AX_EMERGENCY_STOP_TIME (time for braking ramp when an error occurs)

Error causes

- MD36300 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 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.

Transmission Monitoring the encoder position tolerance

The position difference between the two encoders or position measuring systems of a machine axis is monitored with

- MD36510 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 AX_EMERGENCY_STOP_TIME (time for braking ramp when an error occurs)

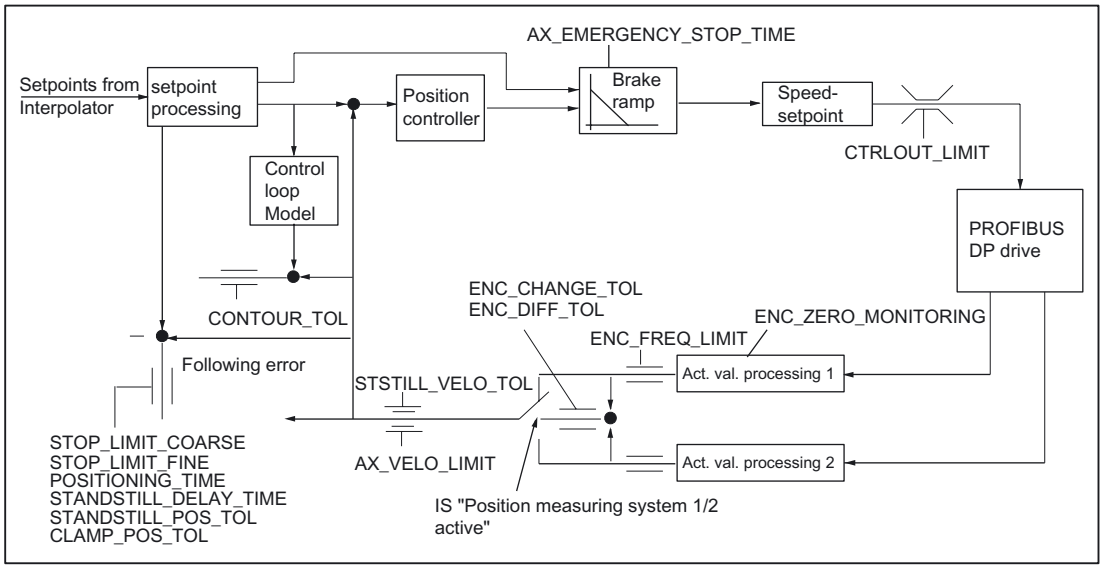


Figure 10-18 Monitoring for SINUMERIK 840D sl:

NOTICE
MD36620 SERVO_DISABLE_DELAY_TIME (switchoff delay servo enable) must always be selected greater than MD36610 AX_EMERGENCY_STOP_TIME (time for braking ramp when an error occurs) If this is not the case, the braking ramp cannot be kept.

Literature

Function Manual Basic Functions; Axis monitoring: Protection zones

10.5.12 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).

10.5.12.1 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 marker
3. Approach reference point

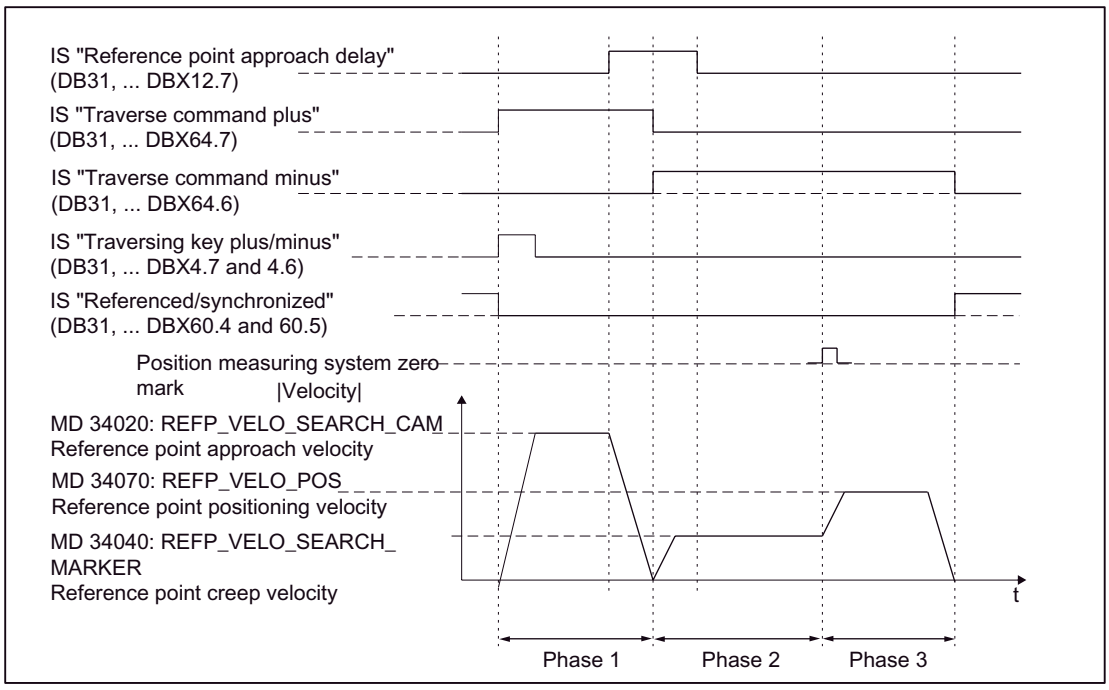


Figure 10-19 Signal chart: Referencing with an incremental measuring system (principle)

Phase-independent data

The following **machine data** and **interface signals** are relevant in each of the individual phases of the reference point approach:

- MD11300 JOG_INC_MODE_LEVELTRIGGRD (INC/REF in jog mode)
- MD34000 REFP_CAM_IS_ACTIVE (axis with reference cam)
- MD34110 REFP_CYCLE_NR (axis sequence for channel-specific reference point approach)
- MD30240 ENC_TYPE (encoder type)
- MD34200 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 REFP_CAM_DIR_IS_MINUS (approach reference cam in negative direction)
- MD34020 REFP_VELO_SEARCH_CAM (reference cam approach velocity)
- MD34030 REFP_MAX_CAM_DIST (maximum distance to the reference cam)
- MD34092 REFP_CAM_SHIFT (electr. cam offset, incremental measuring systems with equidistant zero markers)
- 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 feedrate 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 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 REFP_VELO_SEARCH_MARKER (creep velocity)
- MD34050 REFP_SEARCH_MARKER_REVERSE (direction reversal to reference cam)
- MD34060 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 movement is stopped.
- Feed stop (channel-specific and axis-specific) is active.

  On a feed stop, the traverse movement is stopped and the alarm displayed:
- Alarm 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 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:

    Alarm 20002 "Zero mark missing"

Phase 3: Approach reference point

The following **machine data** and **interface signals** are relevant:

- MD34070 REFP_VELO_POS (reference point positioning velocity)
- MD34080 REFP_MOVE_DIST (reference point distance to zero mark)
- MD34090 REFP_MOVE_DIST_CORR (reference point offset, additive)
- MD34100 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

Function Manual Basic Functions; Reference point approach: Referencing with incremental measurement systems

10.5.12.2 Distancecoded reference marks

Distancecoded reference marks

When clearance-coded reference marks are used, referencing is divided into 2 phases:

1. Synchronize by overriding 2 reference marks
2. Traverse to target point

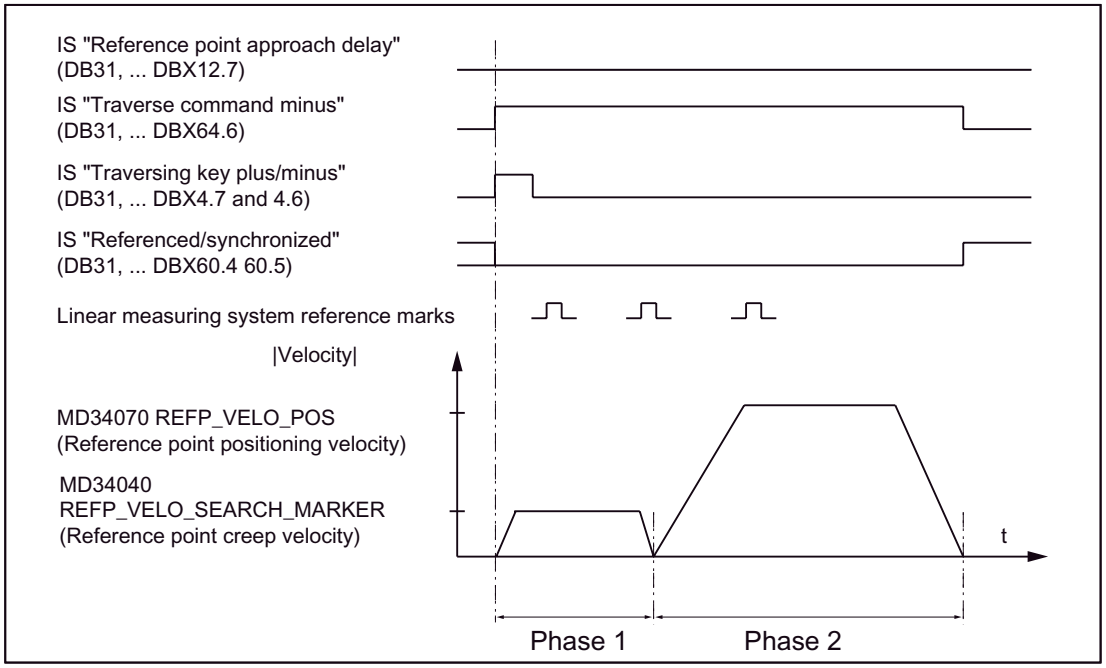


Figure 10-20 Signal chart: Distance-coded reference marks (principle)

Phase-independent data

The following **machine data** and **interface signals** are independent with respect to the individual phases of reference point approach:

- MD11300 JOG_INC_MODE_LEVELTRIGGRD (INC/REF in jog mode)
- MD34000 REFP_CAM_IS_ACTIVE (axis with reference cam)
- MD34110 REFP_CYCLE_NR (Axis sequence for channel-specific reference point approach)
- MD30240 ENC_TYPE (encoder type)
- MD34200 ENC_REFP_MODE (Referencing mode)
- MD34310 ENC_MARKER_INC (interval between two reference marks)
- MD34320 ENC_INVERS (inverse measuring system)
- IS: DB21, ... DBX1.0 ("Activate referencing")
- IS: DB21, ... DBX33.0 ("Referencing active")

Phase 1: Synchronize by overriding 2 reference marks

The following **machine data** and **interface signals** are relevant:

- MD34010 REFP_CAM_DIR_IS_MINUS (approach reference cam in negative direction)
- MD34040 REFP_VELO_SEARCH_MARKER (referencing velocity)
- MD34060 REFP_MAX_MARKER_DIST (maximum distance between 2 reference marks)
- MD34300 ENC_REFP_MARKER_DIST (reference marker 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 REFP_MARKER_DIST (max. distance to the reference mark) without two reference marks being overtraveled, 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 REFP_VELO_POS (target point positioning velocity)
- MD34090 REFP_MOVE_DIST_CORR (absolute offset)
- MD34100 REFP_SET_POS (target point)
- MD34330 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 rate override (feed rate 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. Determining 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 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. Calculating the absolute offset

   Linear measurement system non-inverse to machine system:

   Absolute offset = machine actual position + actual position of the measuring system

   Linear measuring system inverse to machine system:

   Absolute offset = machine actual position - actual position of the measuring system

- MD34090 REFP_MOVE_DIST_CORR (reference point/absolute offset)

⚠ WARNING

After you have determined the absolute offset and made an entry in
- MD34090 REFP_MOVE_DIST_CORR (absolute offset)

the position measuring system must be re-referenced.

Literature

Function Manual Basic Functions; Reference point approach: Referencing with length measuring systems with distancecoded reference marks

10.5.12.3 Absolute encoders

Absolute encoder

Initial referencing of the measuring system of a machine axis with absolute encoder is performed by calibrating the encoder.

Follow-up referencing

Follow-up referencing of a machine axis is performed automatically while the NC starts up without axis movement. 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 ENC_REFP_STATE[n] = **2** (absolute encoder is calibrated)

Calibration

To calibrate the absolute encoder, the actual value of the encoder is matched with the machine zero once and then enabled.

The SINUMERIK 840D sl supports the following types of calibration:

- Operator-assisted calibration
- Automatic calibration using probe
- Calibration using BERO

The calibration using the probe and BERO is described in:

Literature

Function Manual Basic Functions; Reference point approach: Automatic adjustment with measuring probe, adjustment with 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. Parameterization of referencing mode
   - MD34200 $MA_ENC_REFP_MODE[n] = 0
2. Approaching referencing position

   Traversing 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 minus direction) (0 = positive, 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. Assumption of 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. Enabling encoder calibration

   Encoder calibration is performed in the machine data:
   - MD34210 $MA_ENC_REFP_STATE[n] = **1**
5. Activate changed machine data by NCK reset.
6. Completing encoder calibration

   When the NC has started up, encoder calibration is completed in mode: JOG > REF for the machine axis by once more pressing the direction key as described in point 2:
   - Select JOG > REF mode
   - Select machine axis
   - Press 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 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 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

Recalibration of the absolute encoder is required after:

- 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, battery power failure. In this case, it is necessary to load a series startup file.
- PRESET

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 recalibration of the absolute encoder is also required when machine data MD34210 $MA_ENC_REFP_STATE[n] is set to zero under the following conditions:

- Alarm 25020 "Zero mark monitoring of the active encoder" has been issued.
- The control has been switched off during the consistency check.
- The encoder number has changed.

Literature

Function Manual Basic Functions; Reference point approach: Referencing with absolute encoders

10.5.12.4 Interface signals and machine data

Interface signals

Table 10-25 Referencing: Interface signals

DB number	Bit, byte	Name	Reference
Mode-groupspecific		Signals from PLC to mode group	
11, ...	0.7	Mode group reset	K1
11, ...	1.2	Machine function REF	K1
Mode-groupspecific		Signals from mode group to PLC	
11, ...	5.2	Active machine function REF	K1
Channel-specific		Signals from PLC to channel	
21, ...	1.0	Activate referencing	
Channel-specific		Signals from channel to PLC	
21, ...	28.7	(MMC -> PLC) REF	K1
21, ...	33.0	Referencing active	
21, ...	35.7	Reset	K1
21, ...	36.2	All axes that must have a reference point are referenced	
Axis-specific		Signals from PLC to axis/spindle	
31, ...	1.5/1.6	Position measuring system 1/position measuring system 2	A2
31, ...	2.4-2.7	Reference point value 1 to 4	
31, ...	4.6/4.7	Traversing keys minus/plus	H1
31, ...	12.7	Reference point approach delay	
Axis-specific		Signals from axis/spindle to PLC	
31, ...	60.4/60.5	Referenced, synchronized 1/Referenced, synchronized 2	
31, ...	64.6/64.7	Traverse command minus/plus	H1

Machine data

Table 10-26 Referencing: Machine data

Number	Name of Identifier	Name	Reference
General ($MN_ ...)			
11300	JOG_INC_MODE_LEVELTRIGGRD	INC/REF in jog/continuous mode	H1
Channelspecific ($MC_ ...)			
20700	REFP_NC_START_LOCK	NC start disable without reference point	
axisspecific ($MA_ ...)			
30200	NUM_ENCS	Number of encoders	G2
30240	ENC_TYP	Actual value encoder type	
30242	ENC_IS_INDEPENDENT	Encoder is independent	G2
31122	BERO_DELAY_TIME_PLUS	BERO delay time in plus direction	S1
31123	BERO_DELAY_TIME_MINUS	BERO delay time in minus direction	S1
34000	REFP_CAM_IS_ACTIVE	Axis with reference cam	
34010	REFP_CAM_DIR_IS_MINUS	Reference point approach in minus direction	
34020	REFP_VELO_SEARCH_CAM	Reference point approach velocity	
34030	REFP_MAX_CAM_DIST	Maximum distance to reference cam	
34040	REFP_VELO_SEARCH_MARKER[n]	Reference point creep speed [encoder number]	
34050	REFP_SEARCH_MARKER_REVERSE[n]	Change of direction on reference cam [encoder number]	
34060	REFP_MAX_MARKER_DIST[n]	Maximum distance to reference mark; Maximum distance to 2 reference marks with distance-coded scales [encoder number]	
34070	REFP_VELO_POS	Reference point positioning velocity	
34080	REFP_MOVE_DIST[n]	Reference point distance/target point with distance-coded system [encoder number]	
34090	REFP_MOVE_DIST_CORR[n]	Reference point/absolute offset, distance-coded [encoder number]	
34092	REFP_CAM_SHIFT	Electronic reference cam shift for incremental measurement systems with equidistant zero marks.	
34100	REFP_SET_POS[n]	Reference point value [reference point number]	
34102	REFP_SYNC_ENCS	Actual value adjustment to the referencing measurement system	
34110	REFP_CYCLE_NR	Axis sequence for channel-specific referencing	
34120	REFP_BERO_LOW_ACTIVE	Polarity change of BERO	
34200	ENC_REFP_MODE[n]	Referencing mode [encoder number]	
34210	ENC_REFP_STATE[n]	Status of absolute value encoder [encoder number]	
34220	ENC_ABS_TURNS_MODULO	Absolute value encoder range for rotary encoders	R2

Number	Name of Identifier	Name	Reference
34300	ENC_REFP_MARKER_DIST[n]	Reference marker distance with distance-coded scales [encoder number]	
34310	ENC_MARKER_INC[n]	Interval between two reference marks with distance-coded scales [encoder no.]	
34320	ENC_INVERS[encoder]	Linear measuring system inverse to machine system [encoder number]	
34330	REFP_STOP_AT_ABS_MARKER[n]	Distancecoded linear measurement system without destination point [encoder number]	
35150	SPIND_DES_VELO_TOL	Spindle speed tolerance	S1
36302	ENC_FREQ_LIMIT_LOW	Encoder limit frequency resynchronization	
36310	ENC_ZERO_MONITORING	Zero mark monitoring	
30250	ACT_POS_ABS	Absolute encoder position at time of deactivation.	

Literature

Function Manual Basic Functions; Reference point approach:

10.6 Parameterization of spindle data

Reference

See also

Spindle data (Page 338)
Spindle modes (Page 339)
Initial spindle state (Page 339)
Axis mode (Page 340)
Axis mode (Page 340)

10.6.1 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. Also refer to the section: Setpoint/actual-value channels

10.6.2 Gear stages

Enabling of

The gear stage change is generally carried out in

- MD35010 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 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 GEAR_STEP_MAX_VELO[n] (n_{max} for gear stage change)
- MD35120 GEAR_STEP_MIN_VELO[n] (n_{min} for gear stage change)
- MD35130 GEAR_STEP_MAX_VELO_LIMIT[n] (n_{max} for gear stage)
- MD35135 GEAR_STEP_PC_MAX_VELO_LIMIT (n_{max} for gearbox step with position control)
- MD35140 GEAR_STEP_MIN_VELO_LIMIT[n] (n_{min} for gear stage)
- MD35200 GEAR_STEP_SPEEDCTRL_ACCEL[n] (acceleration in speed-control mode)
- MD35210 GEAR_STEP_POSCTRL_ACCEL[n] (acceleration in position control mode)

For further information on parameter sets, see above, Subsection: Parameter blocks for axis/spindle.

Literature

Function Manual Basic Functions; Spindles: Gear stage change

10.6.3 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 Chapter "Parameterization of incremental measuring systems".

For absolute measuring systems see Chapter "Parameterization of absolute measuring systems".

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 INT_INC_PER_DEG (computational resolution) = 1,000 [incr./degree]
- MD31020 ENC_RESOL (encoder resolution) = 500 [pulses/revolution]
- MD31050 DRIVE_AX_RATION_DENOM (load rev. denominator) = 1
- MD31060 DRIVE_AX_RATION_NUMERA (load rev. numerator) = 1
- MD31070 DRIVE_ENC_RATION_DENOM (sensor speed denominator) = 1
- MD31080 DRIVE_ENC_RATION_NUMERA (sensor speed numerator) = 1

$$\text{Internal Resolution} = \frac{360\ \text{degree}}{\text{MD31020} * \text{pulse rev.}} * \frac{\text{MD31080}}{\text{MD31070}} * \frac{\text{MD31050}}{\text{MD31060}} * \text{MD10210}$$

$$\text{Internal Resolution} = \frac{360}{500 * 128} * \frac{1}{1} * \frac{1}{1} * 1000 = 5{,}625\ \frac{\text{int. increments}}{\text{encoder pulse}}$$

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

$$\text{Internal Resolution} = \frac{360\ \text{degree}}{\text{MD31020} * \text{pulse rev.}} * \frac{\text{MD31080}}{\text{MD31070}} * \frac{\text{MD31050}}{\text{MD31060}} * \text{MD10210}$$

$$\text{Internal Resolution} = \frac{360}{2048 * 128} * \frac{1}{1} * \frac{1}{2{,}5} * 1000 = 0{,}54932\ \frac{\text{int. increments}}{\text{encoder pulse}}$$

One encoder increment corresponds to 0.54932 internal increments.

One encoder increment corresponds to 0.00054932 degrees (highest possible positioning resolution).

Gear stage 2

$$\text{Internal Resolution} = \frac{360}{2048 * 128} * \frac{1}{1} * \frac{1}{1} * 1000 = 1{,}3733\ \frac{\text{int. increments}}{\text{encoder pulse}}$$

One encoder increment corresponds to 1.3733 internal increments.

One encoder increment corresponds to 0.0013733 degrees (highest possible positioning resolution).

10.6.4 Speeds and setpoint adjustment for spindle

Speeds, gear stages

In SINUMERIK solution line, data for five gear stages are implemented. 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 changeover.

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 changeovers 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.

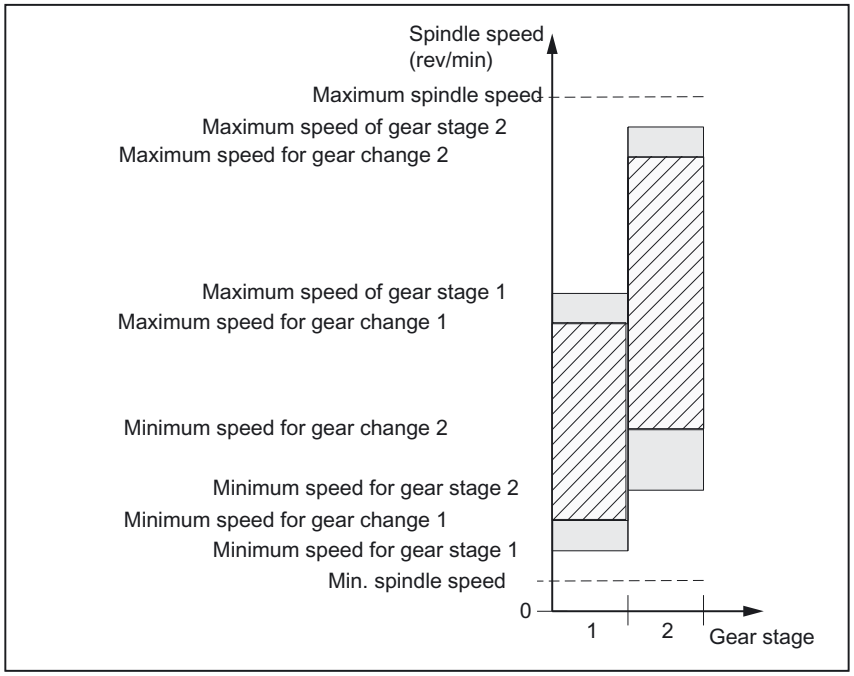


Figure 10-21 Example for speed ranges for automatic gear stage selection (M40)

Speeds for conventional operation

The speeds of the spindle in conventional mode are entered in the machine data:

- MD32010 JOG_VELO_RAPID (rapid traverse in jog mode)
- MD32020 JOG_VELO (JOG axis velocity)

The direction of rotation is specified via the appropriate directional keys for the spindle on the MCP.

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

Table 10-27 Speeds and setpoint adjustment for spindle: Machine data

Axisspecific ($MA_ ...)			
31050	DRIVE_AX_RATIO_DENOM	Load gearbox denominator	G2
31060	DRIVE_AX_RATIO_NUMERA	Numerator load gearbox	G2
32010	JOG_VELO_RAPID	Rapid traverse in the JOG mode	
32020	JOG_VELO	JOG axis velocity	
35010	GEAR_STEP_CHANGE_ENABLE	Gear stage change possible	
35020	SPIND_DEFAULT_MODE	Basic spindle setting	
35030	SPIND_DEFAULT_ACT_MASK	Activate initial spindle setting	
35040	SPIND_ACTIVE_AFTER_RESET	Spindle active after reset	
35200	GEAR_STEP_SPEEDCTRL_ACCEL[n]	Acceleration in speed control mode	
35220	ACCEL_REDUCTION_SPEED_POINT	Speed limit for reduced acceleration	
35230	ACCEL_REDUCTION_FACTOR	Reduced acceleration	
35400	SPIND_OSCILL_DES_VELO	Oscillation speed	
35410	SPIND_OSCILL_ACCEL	Acceleration during oscillation	
35430	SPIND_OSCILL_START_DIR	Starting direction during oscillation	
35440	SPIND_OSCILL_TIME_CW	Oscillation time for M3 direction	
35450	SPIND_OSCILL_TIME_CCW	Oscillation time for M4 direction	

Interface signals

Table 10-28 Speeds and setpoint adjustment for spindle: Interface signals

DB number	Bit, byte	Name	Reference
Axis-specific		Signals from PLC to axis/spindle	
31, ...	4.6	Traversing keys minus	
31, ...	4.7	Traversing keys plus	
31, ...	16.2-16.0	Actual gear stage	
31, ...	16.3	Gear changed	
31, ...	16.6	No speed monitoring when changing the gear	
31, ...	18.4	Oscillation via PLC	
31, ...	18.5	Reciprocating speed	
Axis-specific		Signals from axis/spindle to PLC	
31, ...	82.2-82.0	Set gear stage	
31, ...	82.3	Change gear stage	
31, ...	84.7	Active spindle control mode	
31, ...	84.6	Active spindle mode oscillation mode	

10.6.5 Position spindle

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.

Literature

Function Manual Basic Functions; Spindles

Functionality

- 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 control brakes the spindle down to position control speed at the acceleration rate for speed operation.

If position control speed has been reached, the control 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 on hand the direction of movement is as in MD35350 SPIND_POSITIONING_DIR. When position control mode is switched on, contour monitoring is activated.

Machine data

Table 10-29 Spindle positioning: Machine data

axisspecific ($MA_ ...)			
35300	SPIND_POSCTRL_VELO	position control activation speed	
35350	SPIND_POSITIONING_DIR	Direction of rotation when positioning from the standstill	
35210	GEAR_STEP_POSCTRL_ACCEL	Acceleration in position control mode	
36000	STOP_LIMIT_COARSE	Exact stop coarse	
36010	STOP_LIMIT_FINE	Exact stop fine	
32200	POSCTRL_GAIN	K_V factor	
36400	CONTOUR_TOL	Contour monitoring	

Interface signals

Table 10-30 Spindle positioning: Interface signals

DB number	Bit, byte	Name	Reference
Axis-specific		Signals from axis/spindle to PLC	
31, ...	60.6	Position reached with exact stop "fine"	
31, ...	60.7	Position reached with exact stop "coarse"	
31, ...	84.5	Positioning mode	

10.6.6 Synchronizing spindle

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.

Machine data

- MD34100 REFP_SET_POS (reference point value)

defines the actual position of the spindle at the zero mark position.

The machine data

- MD34090 REFP_MOVE_DIST_CORR (reference-point offset)

is used to enter the zero mark offset.

Machine data

- MD34200 ENC_REFP_MODE (referencing mode)

specifies via which signal the synchronization takes place:
1 = encoder zero mark
2 = reference cam

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 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 reference cam hysteresis reduce the accuracy achievable during synchronization.

Machine data

Table 10-31 Synchronizing spindle: Machine data

Axisspecific ($MA_ ...)			
34100	REFP_SET_POS	Reference point value	
34090	REFP_MOVE_DIST_CORR	Reference point offset	
34200	REFP_MODE	Referencing mode	

Interface signals

Table 10-32 Synchronizing spindle: Interface signals

DB number	**Bit, byte**	**Name**	**Reference**
Axis-specific		**Signals from PLC to axis/spindle**	
31, ...	16.4	Synchronize spindle 1	
31, ...	16.5	Synchronize spindle 2	
Axis-specific		**Signals from axis/spindle to PLC**	
31, ...	60.4	Referenced/synchronized 1	
31, ...	60.5	Referenced/synchronized 2	

10.6.7 Spindle monitoring

Axis/spindle stops

If the speed drops below the speed set in machine data MD36060 STANDSTILL_VELO_TOL (max. speed "Axis/Spindle stopped"), the interface signal NST DB31,... DBX61.4 (Axis/Spindle stopped) is set.

With MD35510 SPIND_STOPPED_AT_IPO_START set (Traverse enabled with "Spindle stopped"), track traverse is enabled.

Spindle in setpoint range

If the spindle reaches the tolerance area specified in machine data MD35150 SPIND_DES_VELO_TOL (Spindle speed tolerance), the interface signal NST DB31,... DBX83.5 (Spindle in setpoint range) is set.

Maximum spindle speed

The maximum spindle speed is entered in the following machine data:

- MD35100 SPIND_VELO_LIMIT (max. spindle speed)

The NC limits the spindle speed to this value.

Error response

If the speed is nevertheless exceeded by the speed tolerance (drive error), the following signal is output:

- IS DB31,... DBX83.0 (speed limit exceeded) = 1
- Alarm "22150 Maximum number of chucks exceeded"

The following machine data monitors the speed of the spindle. When the speed is exceeded, an alarm (25030) is generated.

- MD36200 AX_VELO_LIMIT (threshold value for velocity monitoring)

In position-controlled mode (e.g. SPCON), the NC limits the specified maximum speed specified in machine or setting data to 90% of the maximum value (control reserve).

A different maximum speed for position control can be set with MD35135 GEAR_STEP_PC_MAX_VELO_LIMIT.

Gear stage speed min./max.

The max./min. gear stage speed is entered in:

- MD35130 GEAR_STEP_MAX_VELO_LIMIT (maximum speed for gear stage)
- MD35140 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 following function LIMS=... can be used to specify a spindle speed limit for G96 (constant cutting rate):

- LIMS=... (speed limitation (G96))

This limitation is only active when G96, G961 and G97 are active.

Encoder limit frequency

If the sensor frequency in the following machine data is exceeded, synchronization of the spindle is lost and spindle functionality is reduced (thread, rotational feed, constant cutting speed).

- MD36300 ENC_FREQ_LIMIT (encoder limit frequency)

The spindle will be re-synchronized automatically once the sensor frequency falls below the value defined in the following machine data:

- MD36302 ENC_FREQ_LIMIT_LOW (encoder limit frequency at which the encoder is turned on again).

Sensor frequency must be entered such that the sensor will not be destroyed mechanically (e.g. by too high speed).

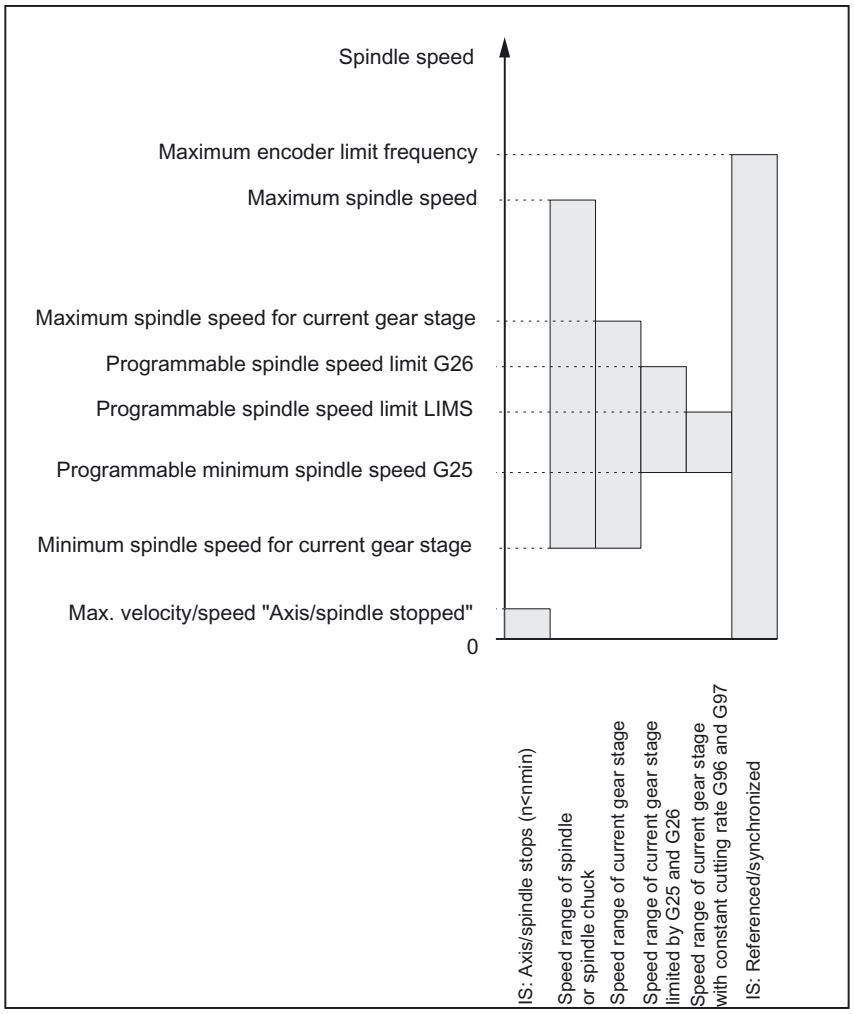


Figure 10-22 Ranges of spindle monitoring functions/speeds

Literature

Function Manual Basic Functions; Spindles: Spindle monitoring

10.6.8 Spindle data

Machine data

Table 10-33 Spindle: Machine data

Number	Name of identifier	Name	Reference
General ($MN_ ...)			
12060	OVR_SPIND_IS_GRAY_CODE	Spindle override with Gray coding	V1
12070	OVR_FACTOR_SPIND_SPEED	Evaluation of spindle speed override switch	V1
12080	OVR_REFERENCE_IS_PROG_FEED	Override reference velocity	V1
Channelspecific ($MC_ ...)			
20090	SPIND_DEF_MASTER_SPIND	Initial setting for master spindle on channel	
20092	SPIND_ASSIGN_TAB_ENABLE	Enabling/disabling of spindle converter	
20118	GEOAX_CHANGE_RESET	Allow automatic geometry axis change	
22400	S_VALUES_ACTIVE_AFTER_RESET	S function active after RESET	
Axisspecific ($MA_ ...)			
30300	IS_ROT_AX	Rotary axis	R2
30310	ROT_IS_MODULO	Modulo conversion	R2
30320	DISPLAY_IS_MODULO	Position display	R2
31050	DRIVE_AX_RATIO_DENOM	Denominator load gearbox	G2
31060	DRIVE_AX_RATIO_NUMERA	Numerator load gearbox	G2
31122	BERO_DELAY_TIME_PLUS	BERO delay time in plus direction	
31123	BERO_DELAY_TIME_MINUS	BERO delay time in minus direction	
32200	POSCTRL_GAIN	K_V factor	G2
32810	EQUIV_SPEEDCTRL_TIME	Equivalent time constant speed control loop for feedforward control	K3
32910	DYN_MATCH_TIME	Time constant for dynamic matching	G2
34040	REFP_VELO_SEARCH_MARKER	Reference point creep speed	R1
34060	REFP_MAX_MARKER_DIST	Monitoring of zero mark distance	R1
34080	REFP_MOVE_DIST	Reference point distance/destination point for distancecoded system	R1
34090	REFP_MOVE_DIST_CORR	Reference point offset/absolute offset, distance-coded	R1
34100	REFP_SET_POS	Reference point value	R1
34200	ENC_REFP_MODE	Homing mode	R1
35000	SPIND_ASSIGN_TO_MACHAX	Assignment of spindle to machine axis	
35010	GEAR_STEP_CHANGE_ENABLE	Gear stage change possible	
35012	GEAR_STEP_CHANGE_POSITION	Gear stage change position	
35020	SPIND_DEFAULT_MODE	Basic spindle setting	
35030	SPIND_DEFAULT_ACT_MASK	Activate initial spindle setting	
35040	SPIND_ACTIVE_AFTER_RESET	Spindle active after reset	
35100	SPIND_VELO_LIMIT	Maximum spindle speed	
35110	GEAR_STEP_MAX_VELO[n]	Maximum speed for gear change	

Number	Name of identifier	Name	Reference
35120	GEAR_STEP_MIN_VELO[n]	Minimum speed for gear change	
35130	GEAR_STEP_MAX_VELO_LIMIT[n]	Maximum speed of gear stage	
35140	GEAR_STEP_MIN_VELO_LIMIT[n]	Minimum speed of gear stage	
35150	SPIND_DES_VELO_TOL	Spindle speed tolerance	
35160	SPIND_EXTERN_VELO_LIMIT	Spindle speed limitation via PLC	
35200	GEAR_STEP_SPEEDCTRL_ACCEL[n]	Acceleration in speed control mode	
35210	GEAR_STEP_POSCTRL_ACCEL[n]	Acceleration in position control mode	
35220	ACCEL_REDUCTION_SPEED_POINT	Speed limit for reduced acceleration	
35230	ACCEL_REDUCTION_FACTOR	Reduced acceleration	
35300	SPIND_POSCTRL_VELO	position control activation speed	
35350	SPIND_POSITIONING_DIR	Positioning direction of rotation for a non-synchronized spindle	
35400	SPIND_OSCILL_DES_VELO	Oscillation speed	
35410	SPIND_OSCILL_ACCEL	Oscillation acceleration	
35430	SPIND_OSCILL_START_DIR	Oscillation start direction	
35440	SPIND_OSCILL_TIME_CW	Oscillation time for M3 direction	
35450	SPIND_OSCILL_TIME_CCW	Oscillation time for M4 direction	
35500	SPIND_ON_SPEED_AT_IPO_START	Feed enable with spindle in setpoint range	
35510	SPIND_STOPPED_AT_IPO_START	Feed enable with stationary spindle	
35590	PARAMSET_CHANGE_ENABLE	Parameter set definition possible from PLC	A2
36060	STANDSTILL_VELO_TOL	Threshold velocity "Axis/spindle stationary"	A3
36200	AX_VELO_LIMIT	Threshold value for velocity monitoring	A3

Setting data

Table 10-34 Spindle: Setting data

Number	Name of identifier	Name	Reference
Spindlespecific ($SA_ ...)			
42600	JOG_FEED_PER_REF_SOURCE	Revolutional feedrate control in JOG mode	V1
42800	SPIND_ASSIGN_TAB	Spindle number converter	
42900	MIRROR_TOOL_LENGTH	Mirror tool length offset	W1
42910	MIRROR_TOOL_WEAR	Mirror wear values of tool length compensation	W1
42920	WEAR_SIGN_CUTPOS	Mirror wear values of machining plane	W1
42930	WEAR_SIGN	Invert sign of all wear values	W1
42940	TOOL_LENGTH_CONST	Retain the assignment of tool length components when changing the machining plane (G17 to G19)	W1
43210	SPIND_MIN_VELO_G25	Progr. Spindle speed limiting G25	
43220	SPIND_MAX_VELO_G26	Progr. Spindle speed limiting G26	
43230	SPIND_MAX_VELO_LIMS	Progr. spindle speed limitation with G96	
43300	ASSIGN_FEED_PER_REF_SOURCE	Rotational feedrate for positioning axes/spindles	V1, P2

Interface signals

Table 10-35 Spindle: Interface signals

DB number	Bit, byte	Name	Reference
Axis-specific		**Signals from PLC to axis/spindle**	
31, ...	0	Feed override	V1
31, ...	1.7	Override active	V1
31, ...	1.6	Position measuring system 2	A2
31, ...	1.5	Position measuring system 1	A2
31, ...	1.4	Followup mode	A2
31, ...	1.3	Axis/spindle disable	A2
31, ...	2.2	Spindle reset/delete distancetogo	A2
31, ...	2.1	Servo enable	A2
31, ...	3.6	Velocity/spindle speed limitation	A3
31, ...	16.7	Delete S value	
31, ...	16.5	Resynchronize spindle 2	
31, ...	16.4	Resynchronize spindle 1	
31, ...	16.3	Gear changed	
31, ...	16.2-16.0	Actual gear stage A to C	
31, ...	17.6	Invert M3/M4	
31, ...	17.5	Resynchronize spindle during positioning 2	
31, ...	17.4	Resynchronize spindle during positioning 1	
31, ...	18.7	Direction of rotation setpoint left	
31, ...	18.6	Direction of rotation setpoint right	
31, ...	18.5	Oscillation speed	
31, ...	18.4	Oscillation via PLC	
31, ...	19.7 - 19.0	Spindle offset H - A	V1
Axis-specific		**Signals from axis/spindle to PLC**	
31, ...	60.7	Position reached with exact stop fine	B1
31, ...	60.6	Position reached with exact stop coarse	B1
31, ...	60.5	Referenced/synchronized 2	R1
31, ...	60.4	Referenced/synchronized 1	R1
31, ...	60.3	Encoder limit frequency exceeded 2	A3
31, ...	60.2	Encoder limit frequency exceeded 1	A3
31, ...	60.0	Axis/no spindle	
31, ...	61.7	Current controller active	A2
31, ...	61.6	Speed control loop active	A2
31, ...	61.5	Position controller active	A2
31, ...	61.4	Axis/spindle stationary (n < nmin)	A2
31, ...	82.3	Change gear	
31, ...	82.2-82.0	Set gear stage AC	
31, ...	83.7	Actual direction of rotation clockwise	
31, ...	83.5	Spindle in setpoint range	

DB number	Bit, byte	Name	Reference
31, ...	83.2	Setpoint speed increased	
31, ...	83.1	Setpoint speed limited	
31, ...	83.0	Speed limit exceeded	
31, ...	84.7	Active spindle control mode	
31, ...	84.6	Active spindle mode oscillation mode	
31, ...	84.5	Active spindle positioning mode	
31, ...	84.3	Rigid tapping active	
31, ...	86 and 87	M function for spindle	
31, ...	88-91	S function for spindle	

Optimize the drive. 11

You can optimize the drives in the "Commissioning" > "Optimization/Test" operating area. 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
- Servo 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 or to analyze the contour accuracy on the quadrant transitions (circular contours) achieved by means of friction compensation (conventional or neural quadrant error compensation).

Reference

Function Manual Extended Functions, K3 Compensation, Section "Circularity test"

Servo trace

The servo trace provides a graphically assisted analysis of the time response of position controller and drive data.

11.1 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 11-1 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

11.2 Frequency response measurements

11.2.1 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"

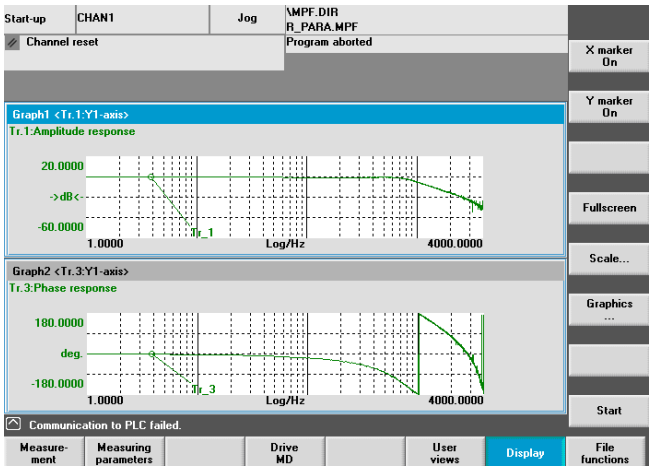


Figure 11-1 Current controller

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

11.2.2 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 11-2 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).

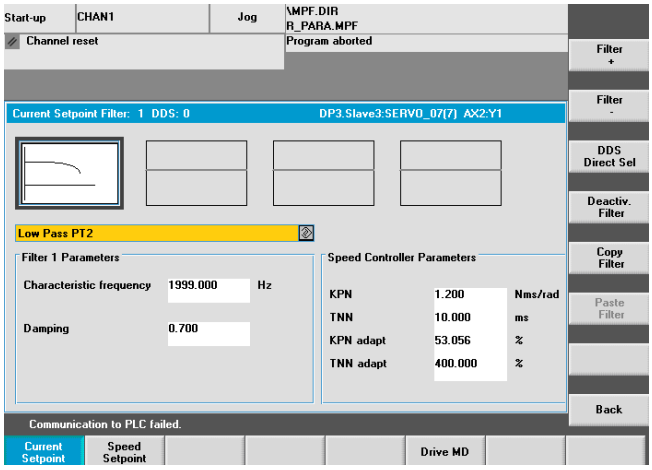


Figure 11-3 Standard settings of the speed control loop filter

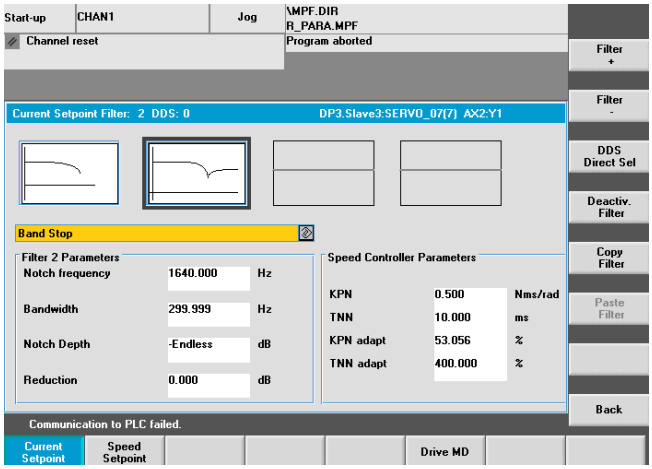


Figure 11-4 Speed control loop filter with rejection band 1190 Hz

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 11-5 Optimized speed control loop

11.2.3 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 POSCTRL_GAIN.

Figure 11-6 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.

  A jerk-controlled motion can be set for a specific axis with:

- MD32400 AX_JERK_ENABLE (axial jerk limitation) = **1**
- MD32410 AX_JERK_TIME (time constant for the axial jerk filter).

  The position setpoint and the actual value of the active measuring system are recorded in each case.

- 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.

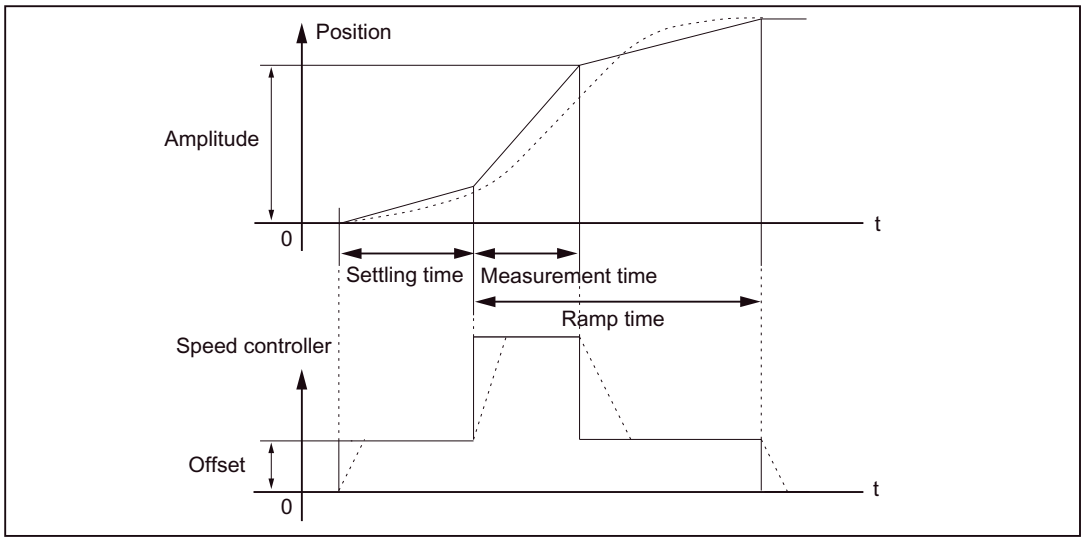


Figure 11-7 Signal chart for position setpoint/ramp measuring function

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 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 MAX_AX_VELO (max. axis velocity)

  The maximum axis velocity limits the ramp gradient (velocity limitation). The drive does not reach the programmed end position (amplitude).

- MD32300 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 MAX_AX_VELO (maximum axis velocity) • MD32300 MAX_AX_ACCEL (maximum axis acceleration)

11.3 Circularity test measurement

Functionality

The circularity test serves to set and assess the dynamic response for interpolating axes or to analyze the contour accuracy on the quadrant transitions (circular contours) achieved by means of friction compensation (conventional or neural quadrant error compensation).

Operating path

Operating path for the 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 measuring time calculated exceeds the time range that can be displayed from the trace buffers (maximum measuring time = position controller cycle frequency * 2048), a coarser sampling rate is used for recording (n * position controller cycle frequency), so that a complete circle can be displayed.

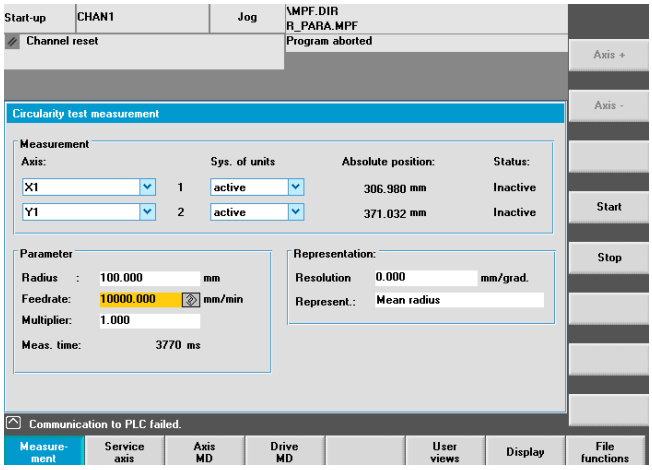


Figure 11-8 Circularity test measurement parameters

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 POSCTRL_GAIN for the K_V factor optimization.

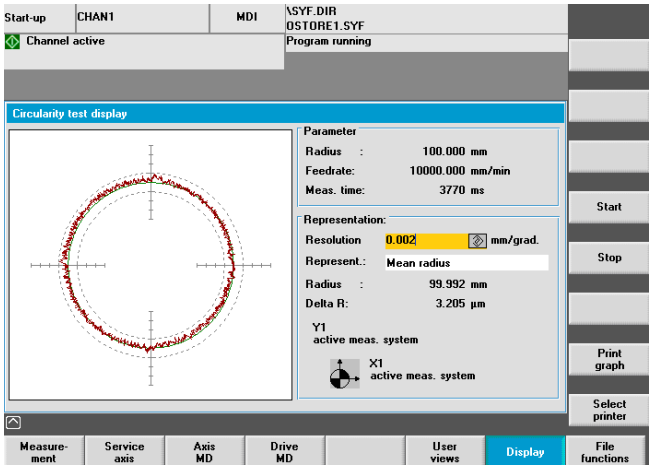


Figure 11-9 Circularity test measurement

11.4 Servo trace

Introduction

A trace represents monitored values and signals over a period of time. Servo trace provides functions with a graphical user interface for controlling and monitoring drive/servo signals and states.

Basic display of servo trace

The basic display of the trace is reached via the operating area "Commissioning" > "Optimization/Test" > " Servo trace".

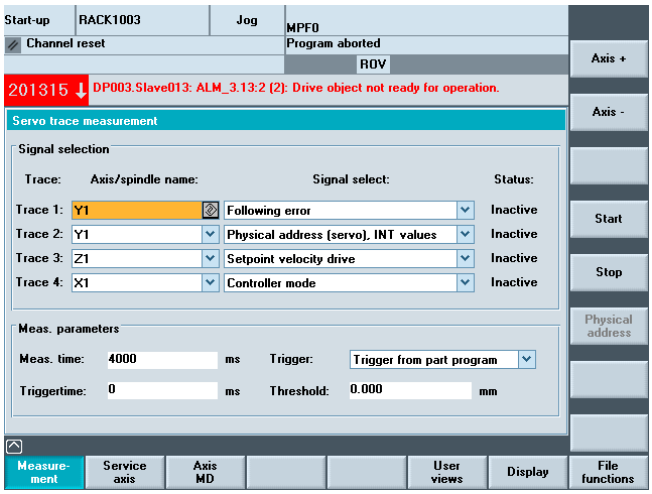


Figure 11-10 "Servo trace measurement" basic display

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 when you press the softkey "Start" (all traces are started synchronously)
- "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"

With the "Start" softkey, trace function recording is started.

With the "Stop" softkey or RESET, you can cancel a running measurement.

11.5 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

Data backup and standard commissioning 12

Introduction

Once commissioning of the NCK, PLC and drive has been completed, you can manage the modified data using the functions below:

- Save/Archive user data
- Series commissioning
- Upgrading, as series commissioning

User data

The following user data can be managed:

Table 12-1 User data

NCK/HMI	PLC
Machine data	OB (organization blocks)
Setting data	FB (function blocks)
Option data	SFB (system function blocks)
Global (GUD) and local (LUD) user data	FC (functions)
Tool and magazine data	SFC (system functions)
Protection zone data	DB (data blocks)
R parameters	SDB (system data blocks).
Work offsets	
Compensation data	
Display machine data	
Workpieces, global part programs and subroutines	
Standard and user cycles	
Definitions and macros	

12.1 Data backup

Introduction

Data is backed up by means of the HMI. SINUMERIK solution line components can either be backed up individually or jointly. You can select from:

- NCK (NC)
- PLC
- HMI
- Drives

Operator input sequence steps

1. Selection of Data backup menu

   Operating range "Services > ETC key ">" > "Standard commissioning".
2. You can choose which data you want to back up:
   - HMI
   - NC with compensation data
   - PLC
   - PROFIBUS drives
3. Archive name: The suggested archive name depends on the selected area and can be changed if necessary.
4. Create the data backup file by selecting the component to which you wish the file to be output:
   - NC card (CompactFlash card)
   - Archive

Data backup DRIVE-CLiQ motors

Note

We would recommend backing up the DRIVE-CLiQ motor data onto a CompactFlash card (NC card).

The p4692 parameter must be set to "1" in the "Commissioning" > "Machine data" > "Control unit MD" operating range.

12.2 User data backup/Series commissioning

Introduction

Data can be saved and archived in the following ways:

- Reading out the data completely: Series commissioning
- Files are exported/imported area by area.

  The following user data can be selected as individual files:

  – Machine data
  – Setting data
  – Tool data
  – R parameters
  – Zero point offset
  – Compensation data (LEC)
  – Part programs
  – Standard cycles
  – User cycles
  – PLC programs (binary file)

In the case of a data backup, e.g., following commissioning of the control system, the user data selected via the user interface are written to what is known as a series-commissioning file. Once a series-commissioning file has been imported, the control system returns to its original state, as it was at the time of the data backup.

Time of data backup

Experience has shown that the following times can be recommended for carrying out data backups:

- Following commissioning
- After changing machine-specific settings
- After service, e.g., after replacement of a hardware component, software upgrade, etc.
- Before activation of memory-configuring machine data. A warning prompting you to back up is displayed automatically.

Note

References: Operator's Guides for:

- HMI Advanced
- HMI-Embedded
- ShopMill/ShopTurn

12.3 Preassignments when saving PLC data

Introduction

When creating a series-commissioning file that contains PLC data, the PLC image that is saved during this process is dependent on the status of the PLC at the time of creation.

Depending on the status of the PLC, the following PLC images result:

- Original image
- Instantaneous image
- Inconsistent image

Operator input steps 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 operating status STOP.
2. Load the appropriate S7 project into the PLC using SIMATIC Manager STEP 7.
3. Create a series-commissioning file with PLC data.
4. Set the PLC to the RUN operating status.

Operator input steps 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 operating status STOP.
2. Archive PLC data.
3. Set the PLC to the RUN operating status.

Operator input steps for inconsistent image

An inconsistent image results if a series-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 under certain circumstances may meanwhile have changed. 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 series-commissioning file with PLC data while the PLC is in RUN status (cyclic operation) may result in an inconsistent PLC image in the series commissioning archive. After this series-commissioning file has been copied back, this data inconsistency in the PLC user program may under certain circumstances result in a PLC stop.

Changing the PLC operating status

The PLC operating status can be changed using:

- SIMATIC STEP7 Manager
- PLC mode selector on the NCU (position "2" -> STOP, position "0" -> RUN)

12.4 Series commissioning

Introduction

Series commissioning means bringing a series of control systems to the same initial state as regards their data.

You can archive/read in your choice of PLC, NC and HMI data for series commissioning. Compensation data can be saved at the same time if necessary. The drive data are saved as binary data which cannot be modified.

Requirement

The password, e.g., with access level 3 (user) is set.

Note

In order to prevent a topology error, Control Unit parameter p9906 (topology comparison stage of all components) should be set to "Medium" to load Control Unit series commissioning.

Operator input sequence steps

1. Open the menu to create a series-commissioning file:

   Operating range "Services > ETC key ">" > "Standard commissioning".
2. Create an archive for the series-commissioning file: You can select which data you wish to save as the archive contents:
   - HMI
   - NC with compensation data
   - PLC
   - PROFIBUS drives
3. Archive name: The suggested archive name depends on the selected area and can be changed if necessary.
4. Create the series-commissioning file by selecting the component to which you wish the file to be output:
   - NC-Card
   - Archive

Tips

13

13.1 Configuration of the properties of the 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:

Steps for PROFIBUS DP

1. You used the left mouse button to select NCU 720.1 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 PROFIBUS DP interface for socket X126 (machine control panel) in the dialog box (see figure below).

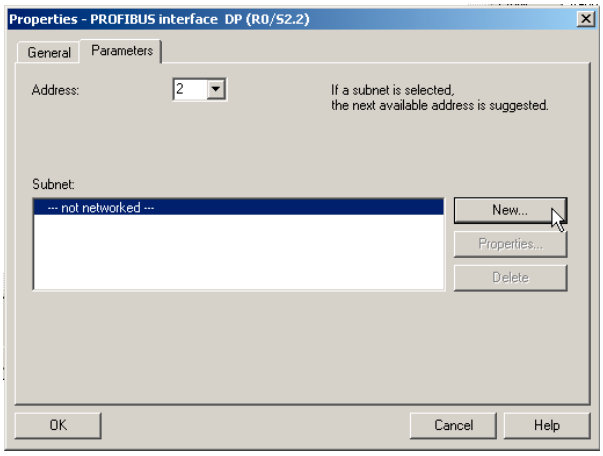


Figure 13-1 Properties of PROFIBUS DP

3. Click the following menu items one after the other:
   - the "New..." button,
   - the "Network settings" tab in the "Properties new subnet PROFIBUS Subnet" dialog box.
4. Select the transmission rate "12 Mbps" for the "DP" profile (see figure below).

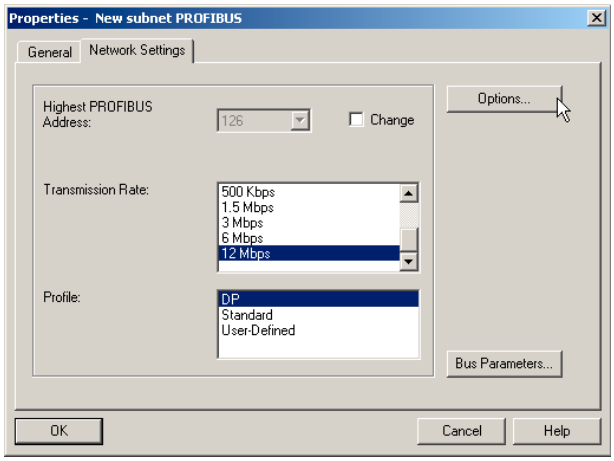


Figure 13-2 Properties of the PROFIBUS interface

5. Click on "Options" and then on the "Equidistance" tab (see figure below).

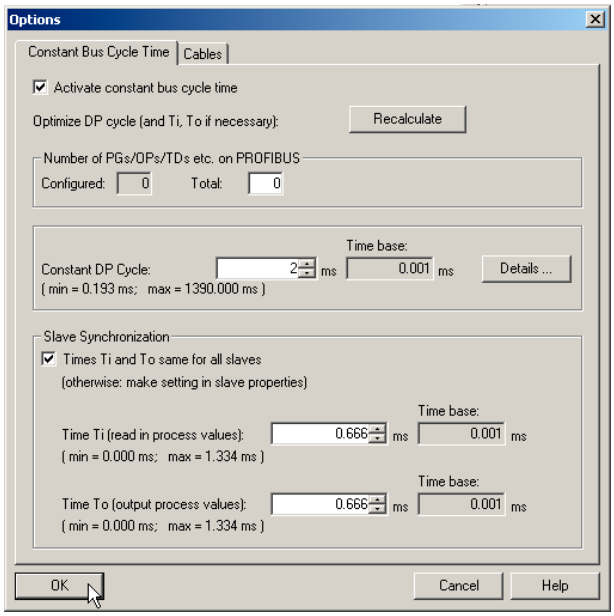


Figure 13-3 Equidistance

6. To enable reproducible access to peripherals (for hand wheel mode), the PROFIBUS DP must have 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 Syscock_Cycle_Time).
   - Click on the "Times Ti and To equal for all slaves" field
   - The fields "Time Ti" and "Time To" must contain a value "< 2ms".
7. Click on "OK" three times.

8. Module NCU 720.1 with SINAMICS S120 is inserted into the HW config (see figure below).

Note

With the <F4> key and confirmation of the question regarding "Reorganize", you can reorganize the display in the station window.

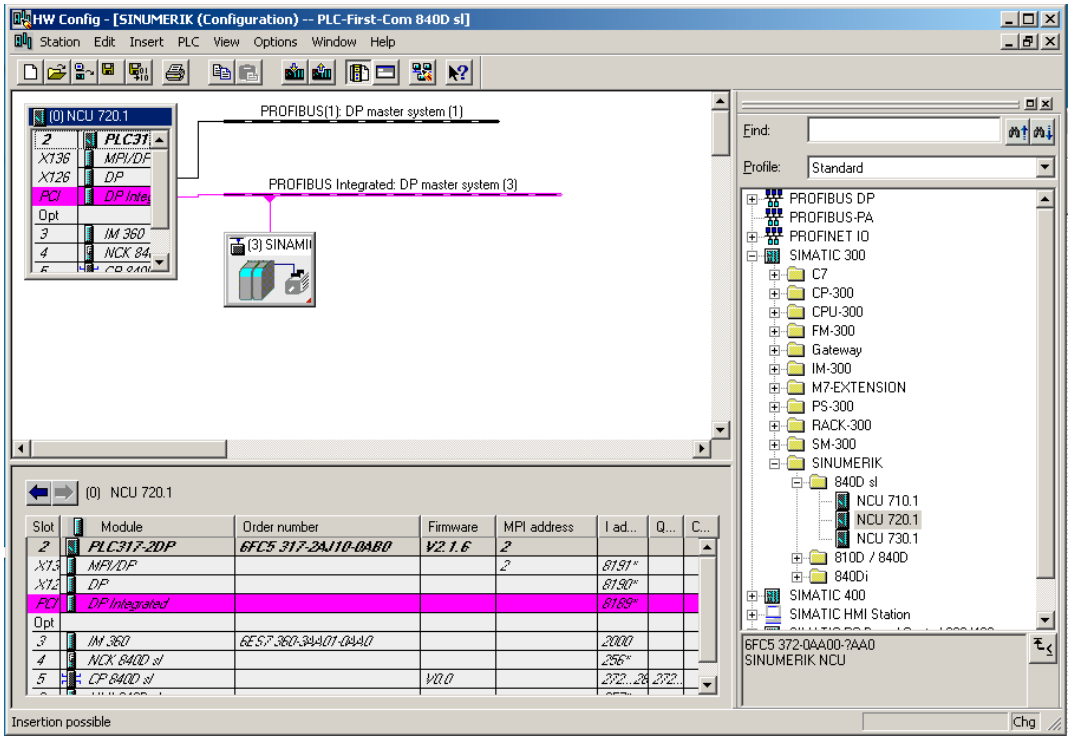


Figure 13-4 HW config with NCU 7x0

As the next step configure a machine control panel with hand wheel.

13.2 Separate NCK and PLC general reset

Introduction

If necessary, you can execute NCK or PLC general reset separately. To do so, proceed as follows:

Operator input sequence steps - NCK general reset

1. Turn the NCK startup switch (SIM/NCK label) on the NCU to position ”1”.
2. Execute POWER ON or Hardware RESET.
3. NCK general reset is requested.
   - The control system boots up,
   - The SRAM is deleted and
   - the machine data is preassigned with standard values.
4. After an error-free boot, the system generates the number ”6” and a flashing point on the status display of the NCU.
   - The LED RUN illuminates GREEN continuously.
   - The NCK is in cyclic transmission.
5. Turn the NCK startup switch back to the ”0” position.

Note

It is also possible to trigger an NCK boot (corresponds to position "0" on the NCK commissioning switch) via the **NCK RESET** softkey under **Commissioning** on the HMI. In the status bar, the system displays the message "startup successful".

Operator input sequence steps for PLC general reset with hardware RESET or POWER ON

Using the following operator input sequence steps, you can request a PLC general reset in the boot (via hardware RESET or POWER ON):

1. PLC mode selector at position "3".
2. Carry out POWER ON or Hardware RESET.
3. PLC general reset is requested.
   - LED STOP flashes
   - LED SF illuminates
4. Turn the PLC-mode selector in succession to the following switch positions:
   - Briefly to "2"
   - Back to "3"

     LED STOP first flashes with about 2Hz and then illuminates.
5. After LED STOP lights up, place the PLC mode selector at position "0".
   - LED STOP goes out and LED RUN (GREEN) lights up.
   - PLC has had a general reset and is in cyclic transmission.

Operator input sequence steps for PLC general reset without hardware RESET or POWER ON

By using the following operator input sequence steps you can generate a PLC general reset without RESET/POWER ON:

1. Turn to position ”2” (operating state STOP).
   – LED STOP illuminates
2. Turn to position ”3” (operating state MRES, request general reset) and hold in this position (about 3 seconds) until STOP-LED PS lights up again.
   – LED STOP goes off then comes back on
3. Within 3 seconds, turn to the positions
   STOP-MRES-STOP (”2”-”3”-”2”).
   – LED STOP first flashes with about 2Hz and then illuminates again.
4. After LED STOP lights up, place the PLC mode selector at position "0".
   – LED STOP goes out and LED PR (GREEN) lights up.
   – PLC has had a general reset and is in cyclic transmission.
5. After LED RUN (green) is illuminated, place the PLC mode selector in position”0”.
   ⇒ PLC has had a general reset and is now in cyclic transmission.

13.3 Configuring the communication between the PLC and the drive

Telegram lengths and I/O addresses

Note

In the HW Config, a telegram length and the associated I/O addresses is preassigned per default.

The pre-assignment for SINAMICS Integrated corresponds to telegram 116 for the axes and 391 for the NCU and 370 for the ALM with the max. possible telegram length.

This default can be used to supply all known telegrams; no modification is necessary.

Operating steps

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 the select the "Overview" tab.

   As shown in the figure below, you can view the lengths of the preassigned telegrams.

   The figure shows user-defined telegrams for 6 axes.

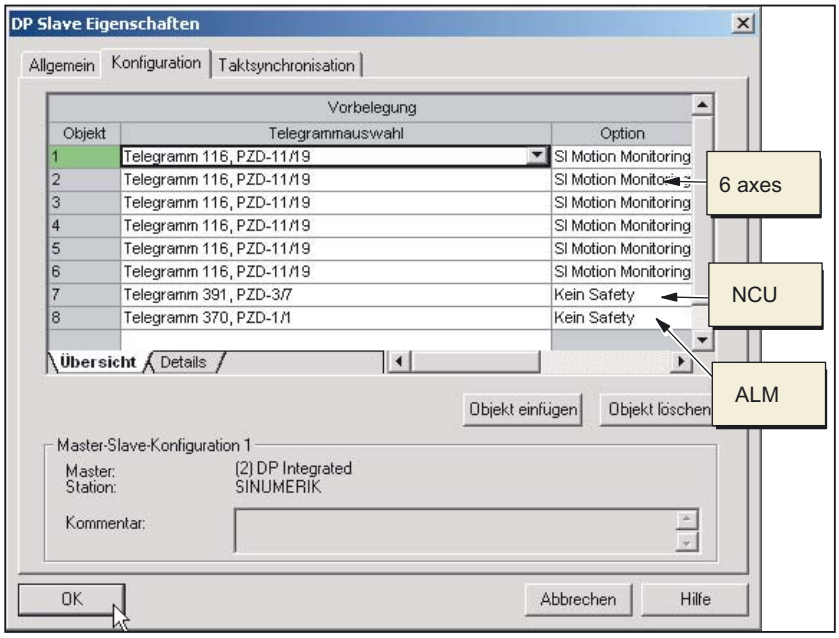


Figure 13-5 Message length

3. Click "OK" to close the dialog.
4. You can view the address areas in the station window in the detail view by clicking on "SINAMICS Integrated". Here, for example, address 4100 corresponds to the address entered in MD13050 DRIVE-LOGIC_ADRESS[0]. The addresses have a gap of 40 bytes. The following figure shows how the default values MD13050 DRIVE-

LOGIC_ADRESS[0…5] correspond to the input/output addresses for standard configuration of the PLC.

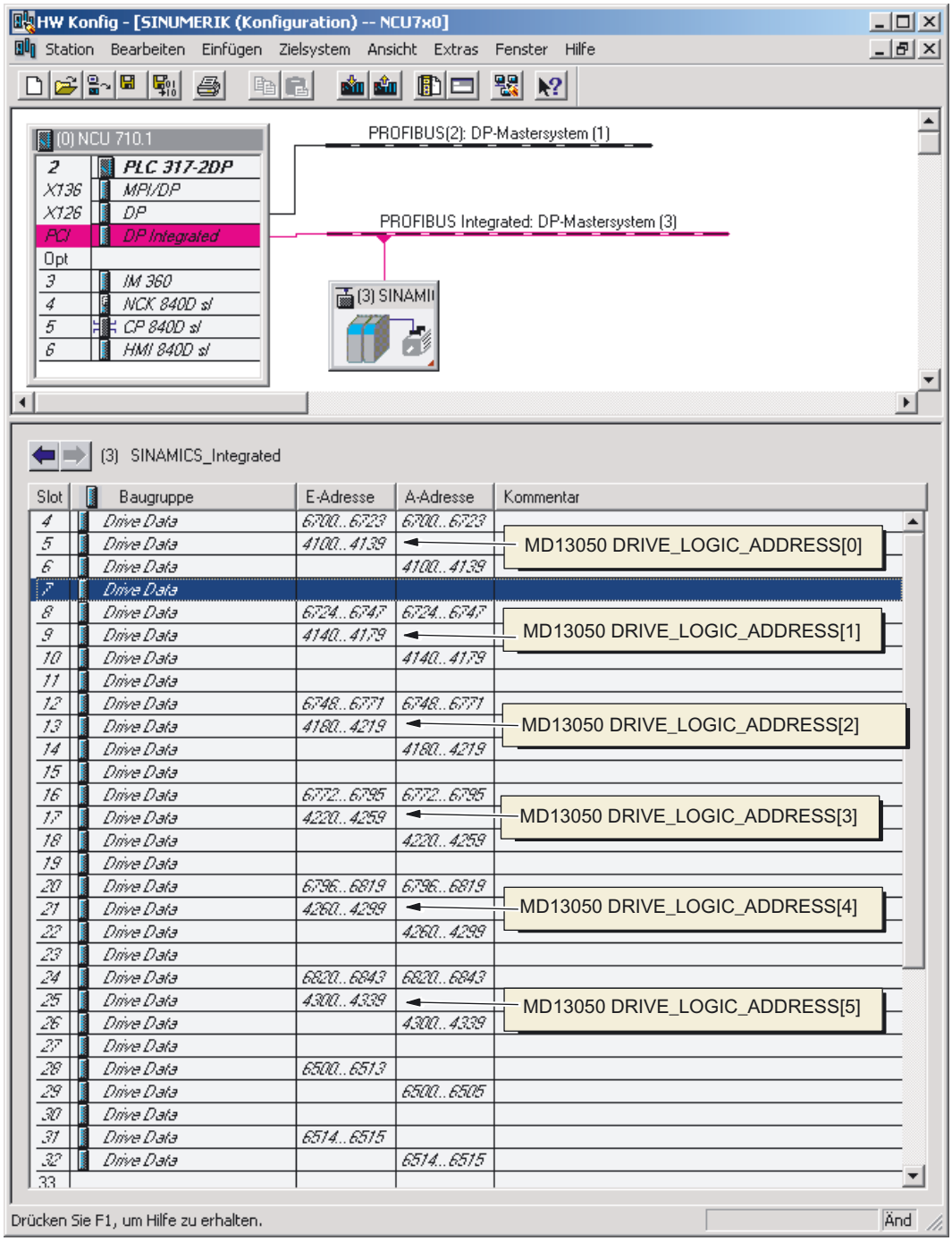


Figure 13-6 SINAMICS Integrated addresses

13.4 Integrating PG/PC into the network (NetPro)

Introduction

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

Requirements

You have to have carried out the following as laid out in the previous chapters:

- inserted NCU 720.1 into the HW config,
- configured the properties of the network interfaces,
- configured the PLC to drive communication,
- inserted the machine control panel (MCP),
- saved and compiled the configuration,
- created a PLC program.

See also

Insert NCU 7x0 in HW config (Page 45)
Configuring the properties of the network interfaces (Page 46)
Adding a machine control panel and handwheel in HW Config (Page 269)
End hardware configuration and load to the PLC (Page 53)
Creating a PLC program (Page 54)

13.4.1 Integrating PG/PC into NetPro

Introduction

To enable the communication between PG/PC <-> HMI via Ethernet, the PC/PG is to be included in the network configuration of the system.

To integrate the PG/PC, proceed from the following starting situation in the SIMATIC Manager.

You are in the HW config in the created project "PLC-Erst-IBN 840D sl" (see figure below).

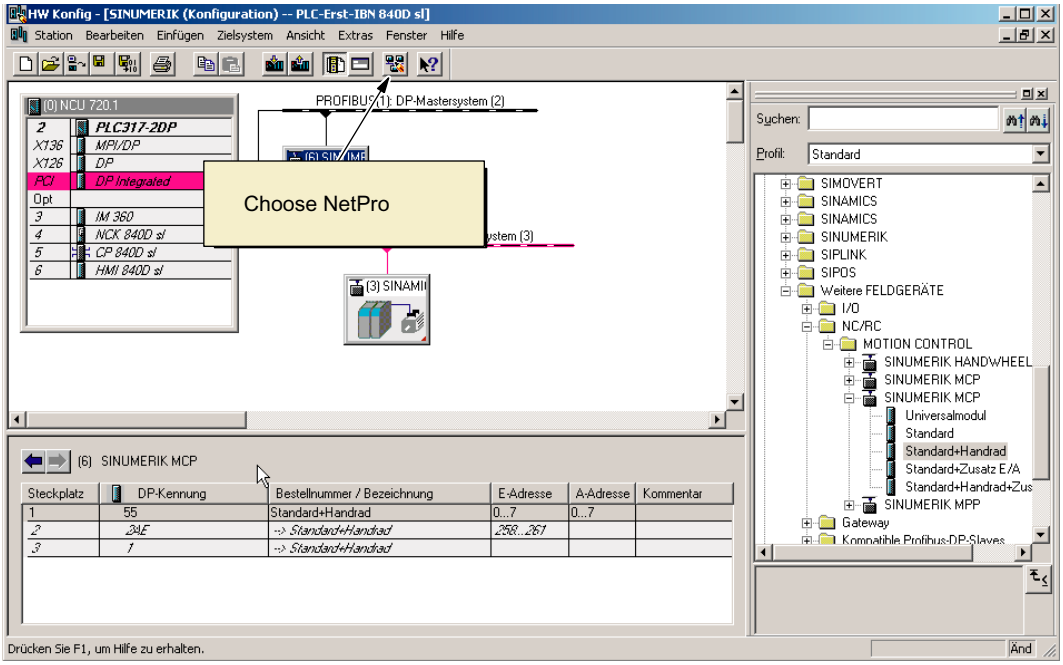


Figure 13-7 HW config project "PLC-Erst-IBN 840D sl"

Operator input sequence steps - Integrating PG/PC into NetPro

Using the following operator input sequence steps, you can integrate a PC/PG into NetPro:

1. Click on the "NetPro" button (see figure above).
2. From the catalog under "Stations", insert the PG/PC via Drag&Drop into the network configuration (see figure below).

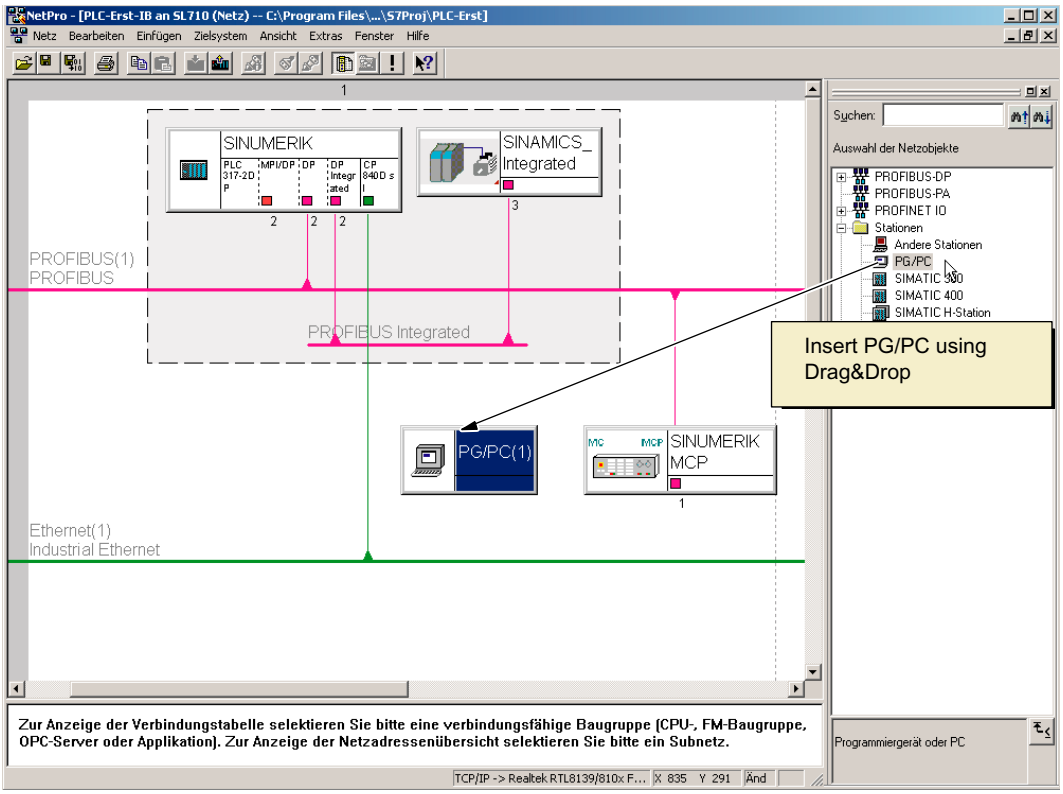


Figure 13-8 Insert PG/PC

The newly inserted symbol PG/PC does not yet contain any interfaces. Next, configure the interfaces.

13.4.2 PG/PC interface configuration

Introduction

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

- Ethernet for the communication for NCU socket X127
- PROFIBUS

Operator input sequence steps for configuring interfaces

1. Highlight the symbol "PG/PC" under NetPro.
2. Select "Object properties" <right mouse button >.
3. In the "Properties - PG/PC" dialog box displayed, select the "Interfaces" tab in the dialog (see figure below).

   Under this tab, define/configure all the required interfaces.

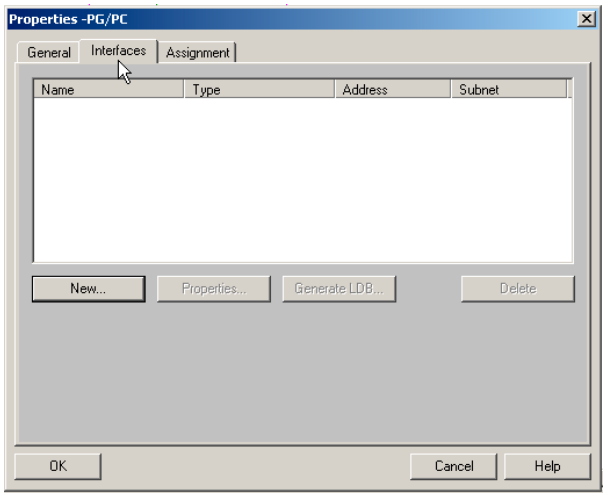


Figure 13-9 Properties - PG/PC

Operator input sequence steps - Configuring interfaces at PG/PC

1. Click on "New…" to configure the Ethernet interface first.
2. In the type selection field, select "Industrial Ethernet" (see figure below).

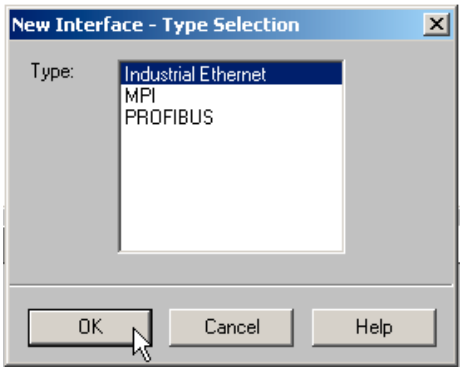


Figure 13-10 Type Industrial Ethernet

3. Click "OK".
4. In the subsequent dialog box, select the subnet "Ethernet(1)" and enter the IP address and the subnet screen mask of your PG/PC (see figure below). E.g.:
   - IP address, such as, 192.168.0.3
   - Subnet screen form = 255.255.255.0

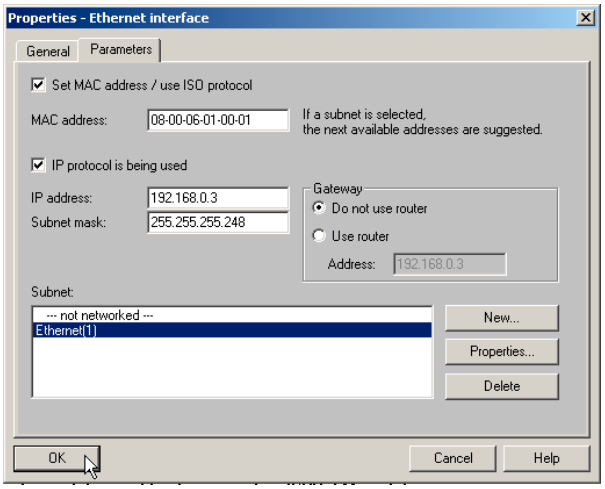


Figure 13-11 Properties of the Ethernet Interface

5. Click "OK".
6. You can configure additional interfaces via "New".

7. When you have configured the interfaces, all the configured interfaces are visible under the "Interface" tab (see figure below).

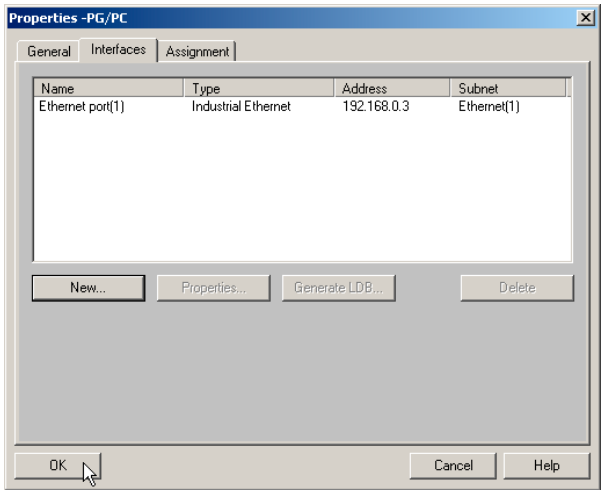


Figure 13-12 Configured interfaces

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

The operator input sequence steps are laid out in the following chapter.

13.4.3 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.

The following operator input sequence steps detail the assignment of the Ethernet interface.

Operator input sequence steps for assigning an Ethernet interface

1. Select the "Assign" tab.
2. Select "Ethernet interface(1)" in the selection field "Configured interfaces".
3. Select the installed network card "TCP/IP -> Realtek RTL8139/810xF…" in the selection field "Interface parameterizations in PG/PC" (see figure below).

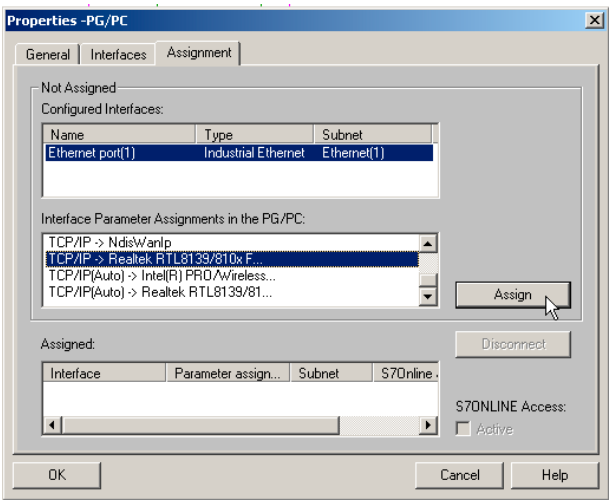


Figure 13-13 Selecting

4. Click on "Assign" and confirm the subsequent message on processing object properties with "OK".

   The assigned interfaces are deleted from the field "Configured interfaces" and these assigned interfaces are displayed in the field "Assigned" (see figure below).

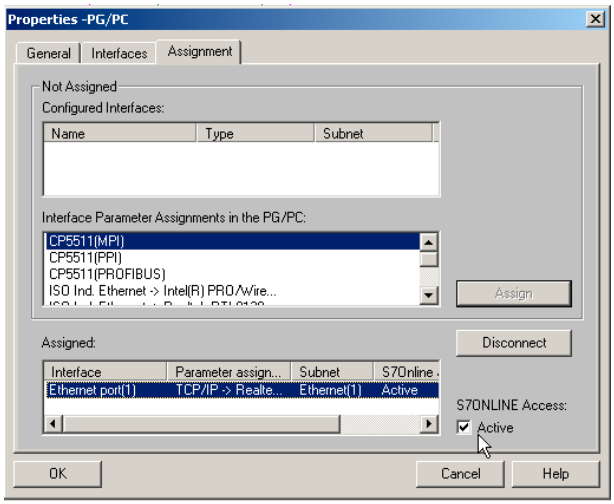


Figure 13-14 Assigning Ethernet interface

5. Now assign the remaining configured interfaces (PROFIBUS).

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

6. Select "Ethernet interface" in the field "Assigned" and mark the field next to it as "active".
7. Click on "OK" to end the dialog "Properties - PG/PC".

   In NetPro, the PG/PC interface declared as "active" is highlighted in YELLOW (see figure below).

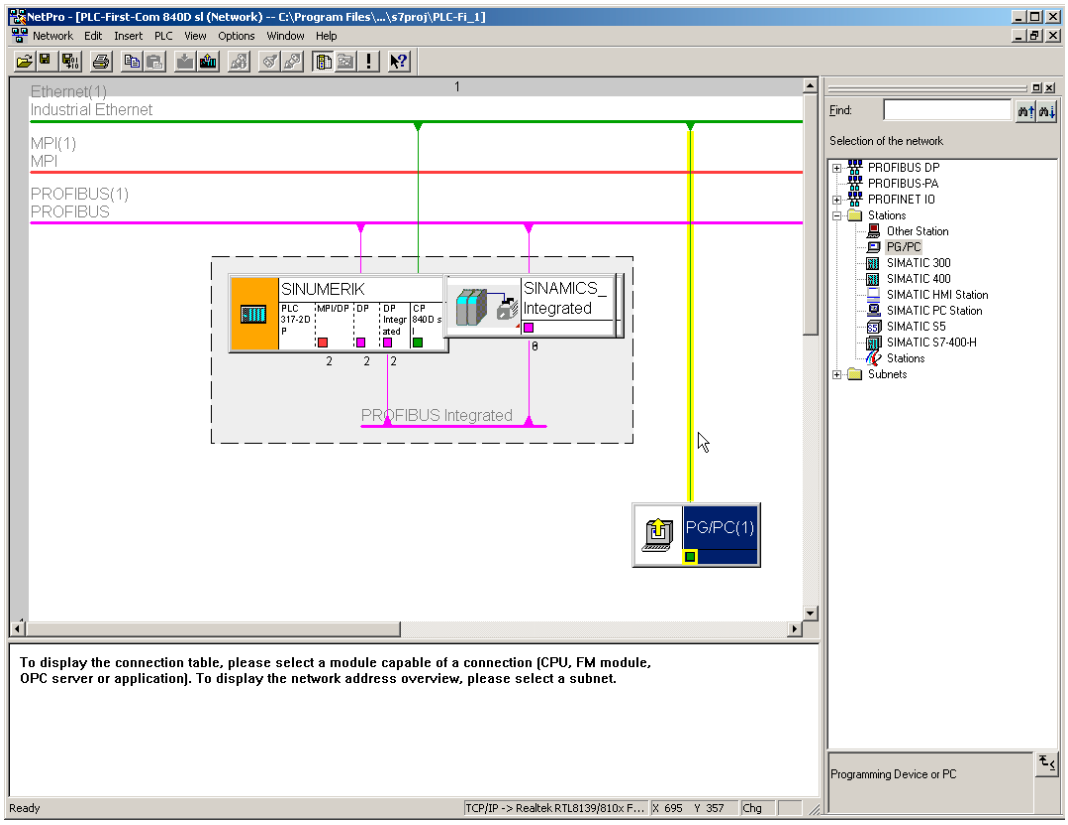


Figure 13-15 Configured PG/PC in the network configuration

8. Select "Save and compile > Save and check all" and confirm the process with "OK".

   The subsequent operator input sequence steps describe loading this hardware configuration to NCU.

13.4.4 Loading the HW config to NCU

Introduction

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

You have established a connection to the Ethernet interface (X120 or X127) and you load this configuration from the PG/PC to the NCU using the operator-input sequence steps laid out below.

Operator input sequence steps for loading HW config to NCU

1. Change from "NetPRO" to "HW Config".
2. Press the "Download to module" button.

   The target module interactive screenform 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 NCU is only possible via Ethernet interface.

13.5 Tips for commissioning SINAMICS drives

Introduction

This chapter describes instructions and tips on:

- Component exchange SINAMICS S120
- Drive states
- Diagnostics for pending alarms
- Drive (SERVO) parameter RESET, individual
- Version display of the drives (SERVOs)
- Checking/setting power supply data settings
- Identification/Optimization "ALM > Infeed/Configuration"

13.5.1 Component exchange SINAMICS S120

Introduction

When exchanging several SINAMICS components (modules), for example, if you exchange Motor Module 1 with Motor Module 2, this exchange must be made known to the Control Unit.

Operating steps

After exchanging several SINAMICS components, then proceed as follows:

1. Set the **CONFIGURATION** parameter on the Control Unit: p0009 = 1
2. Accept the new component: Control Unit: p9905 = 1
3. Wait until p9905 = 0 is automatically set.
4. Reset the **CONFIGURATION** parameter on the Control Unit: p0009 = 0
5. Save "All": set p977 = 1.
6. It is imperative you wait until p977 is automatically written back to "0" this takes about 40 seconds.

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

13.5.2 Drive diagnostics

Introduction

You can view the alarms and faults of the drive in the operating area "Diagnostics > Drive system" on the HMI.

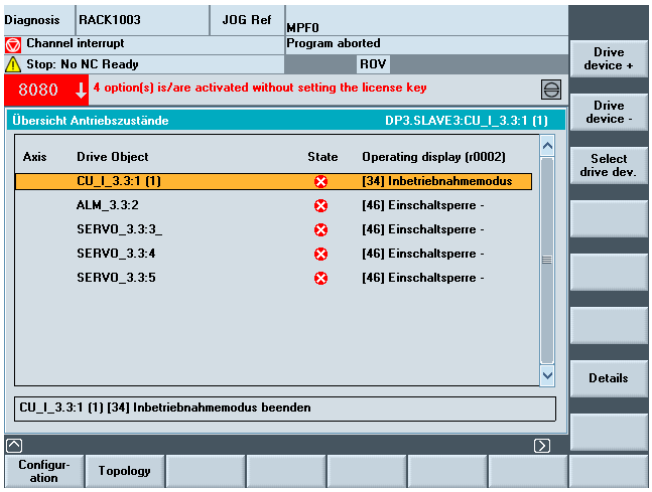


Figure 13-16 Overview of drive states, "Diagnostics > Drive system" menu

Operator input sequence steps

1. Select the relevant drive component with the cursor in the overview of the drive states.
2. Press "Details".

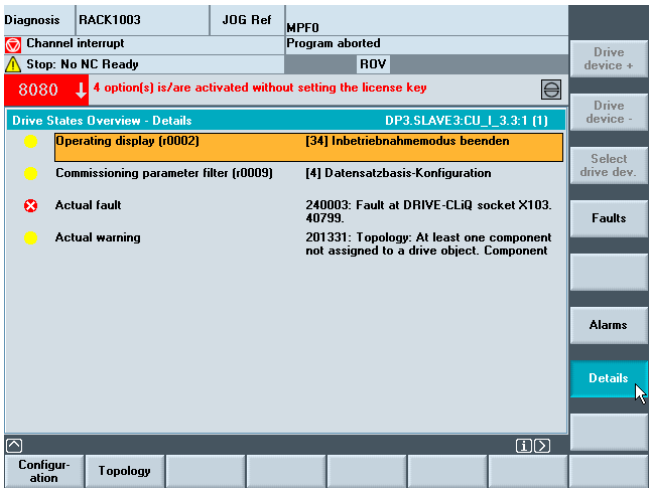


Figure 13-17 "Diagnostics > Drive system > Details" menu

3. Press "Alarms".

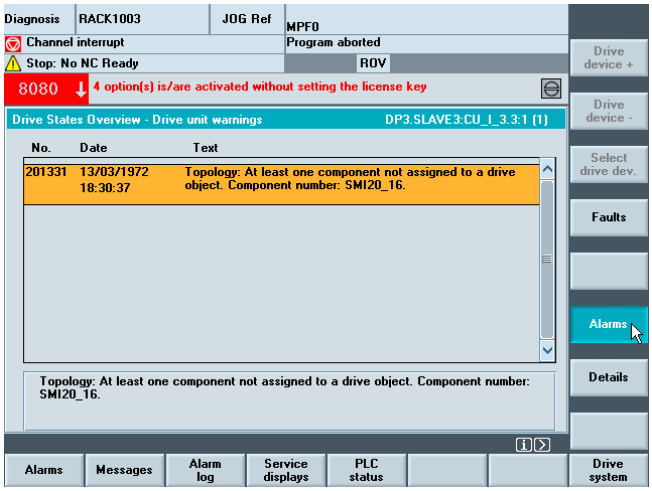


Figure 13-18 "Diagnostics > Drive system > Details > Alarms" menu

4. Press "Faults".

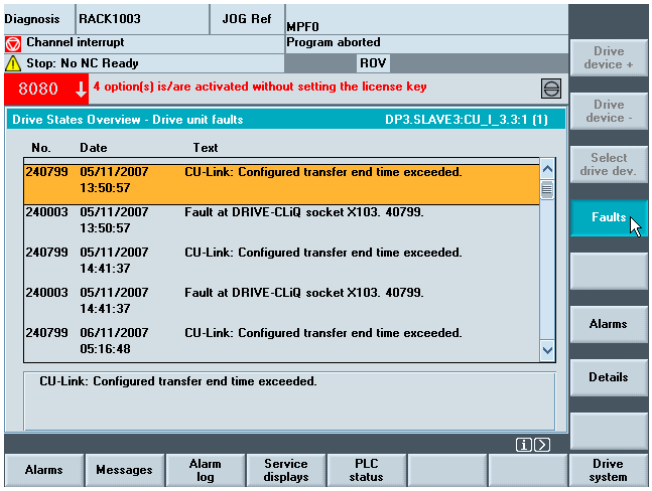


Figure 13-19 "Diagnostics > Drive system > Details > Faults" menu

See also

Adding components to the topology (Page 250)

Check topology (Page 256)

13.5.3 Diagnostics for pending alarms

Introduction

Alarms - these are warnings and faults - can be viewed in SINAMICS S120 via parameters.

Warnings

Pending warnings are indicated by parameter r2122 of the relevant drive components in question.

Deleting the warning buffer may be carried out manually:

- Write r2111 of the drive component with "0".

  This results in the deletion of all existing warnings of this component and updates the current warnings still pending.

Faults

Fault messages are indicated by parameter r945.

Display on HMI

If you set the MD13150 SINAMICS_ALARM_MASK to the hexadecimal value "D0D" on the HMI, then the HMI automatically displays the pending warnings/faults from SINAMICS S120.

13.5.4 Drive (SERVO) parameter RESET, individual

Introduction

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

Note

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

Operator input sequence steps

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 p971 = 1
   or
   save "All": set p977 = 1
5. It is imperative you wait until p977/p971 is automatically written back to "0"; this takes about 40 seconds.

13.5.5 Version display of the drives (SERVOs)

Introduction

Using certain parameters from individual drives (SERVOs), it is possible to view the relevant firmware version for:

- System software SINAMICS S120
- Firmware from:
  - Drive components
  - SMC or SMI modules

System software SINAMICS S120

The version of the SINAMICS S120-SW available in the system is readable in parameter r18 on the TCU/PCU.

Example:

r18 = 2300700, -> firmware version is 02.30.07.00

Firmware version of drive components

The firmware version of all individual components is read out individually in parameters r975[2] and r975[10] for each drive component (NCU, ALM, power unit).

Example:

r975[2] = 230, r975[10] = 700 -> "230" & "700" -> firmware version is 02.30.07.00

Firmware version of all SMC or SMI modules

The firmware version of all SMC or SMI modules is read out in parameter r148[0…2] on the relevant motor module.

Example:

r148[0] = 2300700, -> firmware version of the connected encoder module 1 is 02.30.07.00

13.5.6 Checking/setting power supply data settings

Introduction

The power supply data settings must be checked/set in the SINAMICS during commissioning.

Procedure for checking/setting power supply data.

Proceed as follows to check/set power supply data in the SINAMICS:

1. Select machine data for the infeed (ALM) in the "Commissioning > Machine data > Infeed MD" operating area.
2. ALM: Set p10=1
3. ALM: Enter p210=current power supply frequency at the site
4. ALM: Enter p211=current power supply voltage at the site
5. ALM: Set p3900=3 (implicit version p340=1)
6. ALM: Set p3410=5 perform power supply identification (see section "Identification ALM > Infeed"; Section "Procedure for manual power supply identification of ALM")

Saving of changed parameters p210/p211 will be done within the framework of power supply identification and need not be initiated manually.

Checking/setting network data when commissioning the infeed

You can use the "Commissioning > Drive units > Infeed > Configuration > Network data" menu to view and modify the network data.

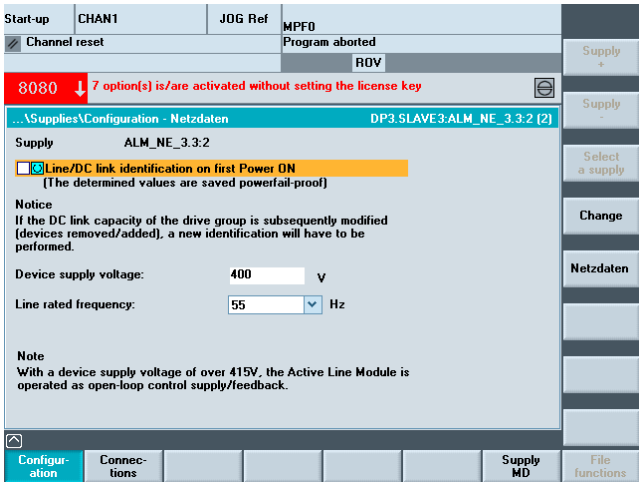


Figure 13-20 Network data

13.5.7 Identification/Optimization "ALM > Infeed/Configuration"

Introduction

On identification of the ALM, control optimization in the ALM is also carried out. 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 automatic identification of the ALM

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 enable terminal X122.1 activated. An internal optimization sequence is started automatically; it takes appox. 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 manual identification of the ALM

Identification of the ALM is carried out as follows:

1. Disconnect release (AUS1) ALM (X122.1) by commissioner.
2. Select machine data for the infeed (ALM) in the menu "Commissioning > Machine data > Infeed MD".
3. Initiate identification on the ALM: p3410 = 5.
4. Connect release ALM (release has to remain pending during the execution of the first step of the identification).
5. ALM controller data are reset automatically and power supply identification starts.
6. After identification has occurred, p3410 is automatically written to 0 and the values are saved automatically for the controller data of the ALM. Check: p3402 = 9 (release has to remain during the execution of this step of the identification!).
7. Disconnect release ALM (X122.1) by commissioner.
8. The optimized ALM data are saved automatically. The data does not need to be saved manually (p977 = 1).

13.6 NCU 7x0 and NX1x Terminal Assignment

Introduction

The following terminals are pre-assigned with the unit configuration:

- NCU 7x0
  - X122
  - X132
- NX1x
  - X122

Terminal assignment X122 (NCU 7x0)

Pin no.	Function	Assignment recommendation	BICO source/sink		Macro number
1	Input[1)]	ON/OFF 1 Infeed Line Module with DRIVE-CLiQ Connection	CU: r0722.0	Infeed p840	1
		"Infeed Ready Signal" of Line Module without DRIVE-CLiQ connection	SLM X21.1	Drive p864	5
2	Input	"OFF3 – rapid stop" Function: Braking with a configurable OFF3 ramp (p1135,1136,1137); thereafter, pulse suppression and starting lockout. The drive stops controlled. The braking response can be set separately for each servo.	CU: r0722.1	Each drive 2. OFF3, p849	1 5
3	Input	SH/SBC - Group 1 SINAMICS Safety Integrated (SH = p9601 release)	CU: r0722.2	p9620 (all drives in the group)	The macro does not perform any BICO interconnection; the use of the function requires parameterization by the user.
4	Input	SH/SBC - Group 2 SINAMICS Safety Integrated (SH = p9601 release)	CU: r0722.3	p9620 (all drives in the group)	
5	Ground for pins 1 ... 4				
6	Ground for pins 7, 8, 10, 11				
7	Output	SH/SBC - Group 1 SINAMICS Safety Integrated	CU: p0738	r9774 Bit 1 BICO from CU after the first drive in the group	The macro does not perform any BICO interconnection; the use of the

Pin no.	Function	Assignment recommendation	BICO source/sink		Macro number
8	Output	SH/SBC - Group 2 SINAMICS Safety Integrated	CU: p0739	p9774 bit 1 BICO from CU after the first drive in the group	function requires parameterization by the user. The pin will be parameterized as output by the macro 1/5.
9	Ground for pins 7, 8, 10, 11				
10	Input	Bero 1 – equivalent zero mark"	CU: r 0722.10	p495 = 2	The macro does not perform any BICO interconnection; the use of the function requires parameterization by the user.
11	Input	Probe 1 Central Measuring (check that MD13210 = 0!)	CU: p0680[0] = 3	Each drive p488 [1,2,3]=0	1/5
		Probe 1 - distributed measurement (control MD13210 = 1)	CU: p0680[0] = 0	Each drive p488 [1,2,3]=3	The macro does not perform any BICO interconnection; the use of the function requires parameterization by the user.
12	Ground for pins 7, 8, 10, 11				

[1)] Low – high edge required!

Terminal assigment X132 (NCU 7x0)

Pin no.	Function	Assignment recommendation	BICO source/sink		Macro number
1	Input	Digital input $A_IN[1]	CU: r0722.4	CU: p2082[0]	1
2	Input	Digital input $A_IN[2]	CU: r0722.5	CU: p2082[1]	5
3	Input	Digital input $A_IN[3]	CU: r0722.6	CU: p2082[2]	
4	Input	Digital input $A_IN[4]	CU: r0722.7	CU: p2082[3]	
		Line contactor, feedback signal		LM : p0860	The macro does not perform any BICO interconnection; the use of the function requires parameterization by the user.
5	Ground for pins 1 ... 4				
6	Ground for pins 7, 8, 10, 11				
7	Output	Infeed Operation (Line Module with DRIVE-CLiQ Connection)	LM :r0863.0	CU: p0742	1

Pin no.	Function	Assignment recommendation	BICO source/sink		Macro number
		Digital output $A_OUT[4]	CU: p2091.3		5
8	Output	Infeed Operational (if Line Module with DRIVE-CLiQ Connection)	LM : r0899.0	CU: p0743	1
		Digital output $A_OUT[3]	CU: p2091.2		5
9	Ground for pins 7, 8, 10, 11				
10	Output	Digital output $A_OUT[2]	CU: p2091.1	CU: p0744	1/5
		Line contactor control	LM : r0863.1		The macro does not perform any BICO interconnection; the use of the function requires parameterization by the user.
	Input	Bero 2 – equivalent zero mark	CU: r 0722.14	Drive: p0495 = 5	The macro does not perform any BICO interconnection; the use of the function requires parameterization by the user.
		2. OFF 2		Drive: p0845	
11	Output	Digital output $A_OUT[4]	CU: p2091.0	CU: p0745	1/5
	Input	Probe 2 Central Measuring (check that MD13210 = 0!)	CU: p0680[1] = 6	Each drive p489 [1,2,3]=0	The macro does not perform any BICO interconnection; the use of the function requires parameterization by the user.
		Probe 2 - distributed measurement (control MD13210 = 1)	CU: p0680[1] = 0	Each drive p489 [1,2,3]=6	
12	Ground for pins 7, 8, 10, 11				

Terminal assignment X122 (NX 10/15)

Pin no.	Function	Assignment recommendation	BICO source/sink		Macro number
1	Input[1)]	ON/OFF 1 Infeed Line Module with DRIVE-CLiQ Connection	NX: r0722.0	Infeed p840	The macro does not perform any BICO interconnection; the use of the function requires parameterization by the user.
		"Infeed Ready Signal" of Line Module without DRIVE-CLiQ connection	SLM X21.1	Drive p864	
2	Input	"OFF3 – rapid stop" Function: Braking with a configurable OFF3 ramp (p1135,1136,1137); thereafter, pulse suppression and starting lockout. The drive stops controlled. The braking response can be set separately for each servo.	NX: r0722.1	Each drive 2. OFF3, p849	
3	Input	SH/SBC 1 - Group 2 SINAMICS Safety Integrated (SH enable = p9601)	NX: r0722.2	p9620 (all drives in the group)	

Pin no.	Function	Assignment recommendation	BICO source/sink		Macro number
4	Input	SH/SBC 1 - Group 1 SINAMICS Safety Integrated (SH enable = p9601)	NX: r0722.3	p9620 (all drives in the group)	
5	Ground for pins 1 ... 4				
6	Ground for pins 7, 8, 10, 11				
7	Output	SH/SBC - Group 1 SINAMICS Safety Integrated	NX: p0738	r9774 bit 1 BICO from CU after the first drive in the group	The macro does not perform any BICO interconnection; the use of the function requires parameterization by the user.
8	Output	SH/SBC - Group 2 SINAMICS Safety Integrated	NX: p0739	p9774 bit 1 BICO from CU after the first drive in the group	
9	Ground for pins 7, 8, 10, 11				
10	Input	Bero 1 – equivalent zero mark"	NX: r0722.10	Drive: p495 = 2	The macro does not perform any BICO interconnection; the use of the function requires parameterization by the user.
11	Input	Bero 2 – equivalent zero mark	NX: r0722.11	Drive: p495 = 3	
		2. OFF 2	NX: r0722.11	Drive: p0845	
12	Ground for pins 7, 8, 10, 11				

[1] Low – high edge required!

Support for terminal assignment at the HMI

In the "Commissioning > Drive system > Drive units > Inputs/outputs" menu you can perform terminal assignment for the drive units (NCU, NX) of the associated SINAMICS drive group.

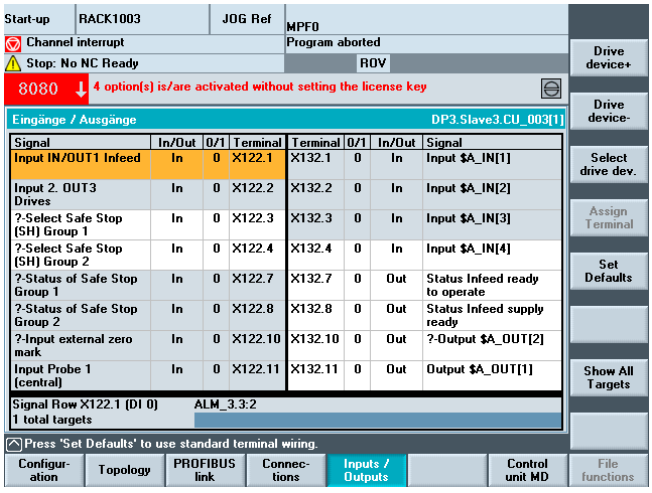


Figure 13-21 Terminal assignment

13.7 Extending/checking the topology

13.7.1 Adding components to the topology

Introduction

If you connect a component (e.g. SMC20) via DRIVE-CLiQ to the drive system for the NCU, SINAMICS detects the change in the actual topology and sends the actual/reference topology difference to the HMI.

The new component must be configured on the HMI and assigned to a drive object (SERVO-DO/Motor Module) via the drive wizard.

Note

A new motor with DRIVE-CLiQ can only be assigned to an existing drive object (SERVO-DO) (see following operator input steps, including "Add component") that has never previously been assigned an encoder interface or another motor with DRIVE-CLiQ and that has not yet ever been commissioned.

Operator input sequence steps

1. Select the menu "Drive system > Configuration".

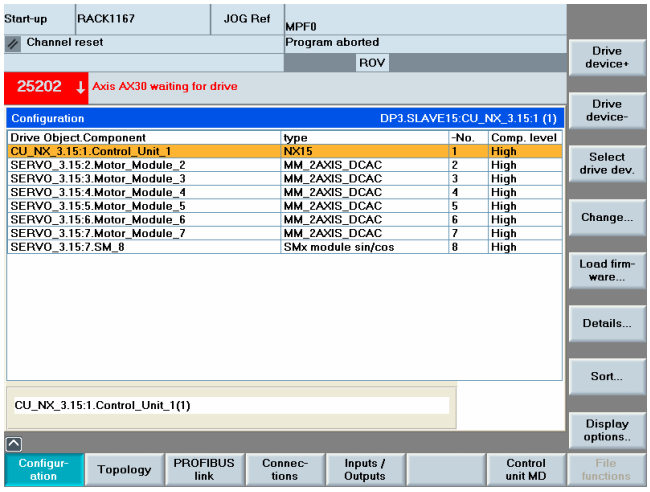


Figure 13-22 Menu "Drive system > Configuration"

2. Press "Topology".

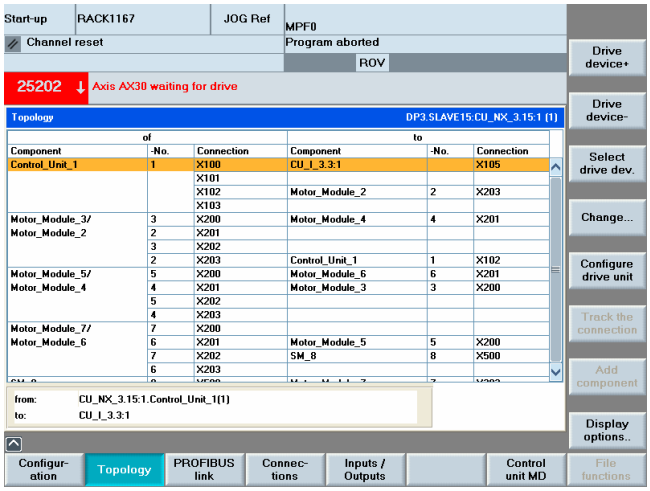


Figure 13-23 Topology without new component

in the "Topology" menu, you start with the actual status (here an example).

The component has not been connected yet.

3. Connect a new DRIVE-CLiQ component (e.g. SMC20) to a Motor Module.

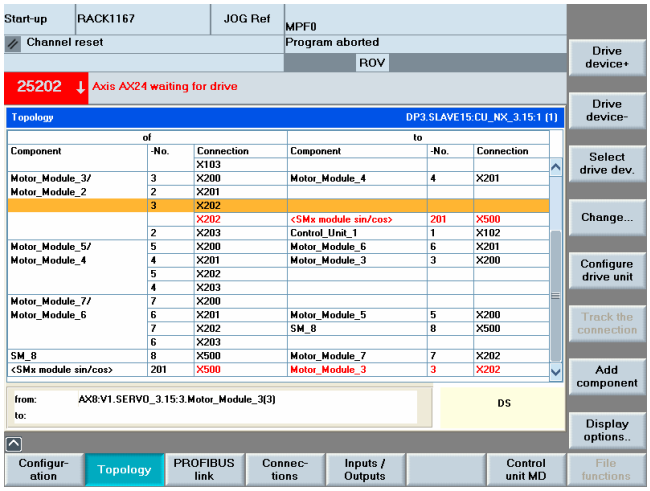


Figure 13-24 Desired state

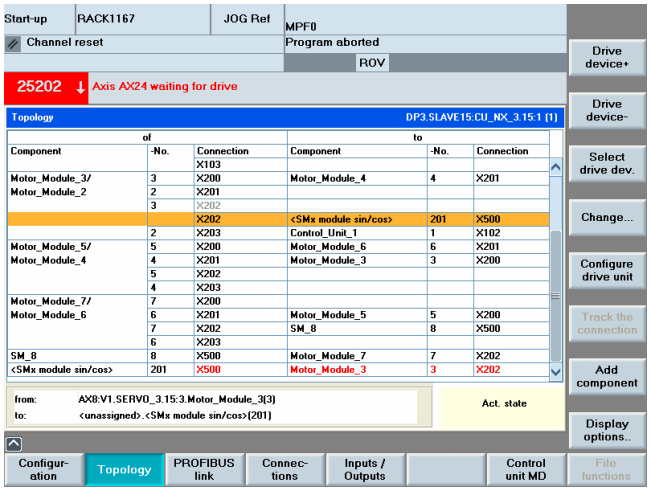


Figure 13-25 Actual state

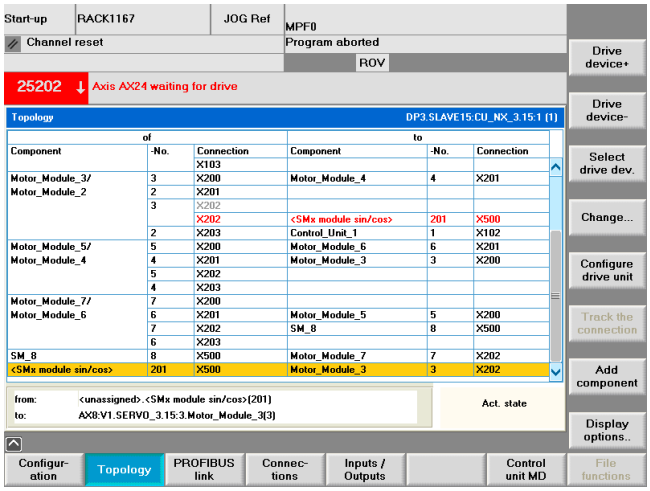


Figure 13-26 Component not commissioned yet (201)

SINAMICS detects the change in the actual topology and sends the actual/reference topology difference to the HMI.

– GRAY -> desired state
– RED -> actual state

The new, not yet commissioned, component has the number "201".

The new component must now be configured in the drive system via the vertical softkey "Add component...".

4. Press "Add component...".

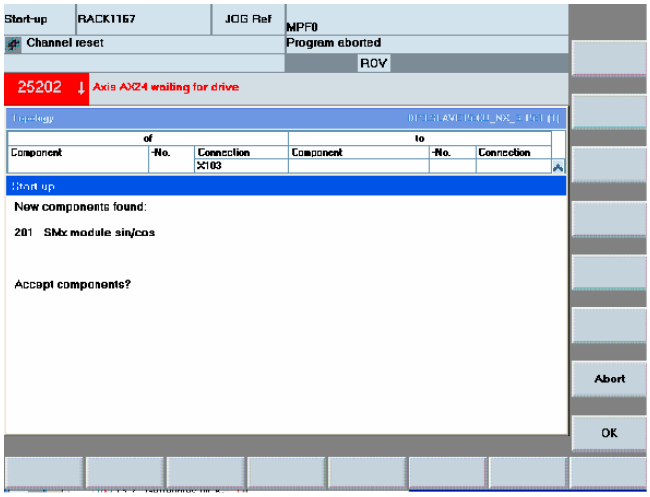


Figure 13-27 Menu "Add component"

A new component has been found.

5. Press "OK" to configure and accept this component.

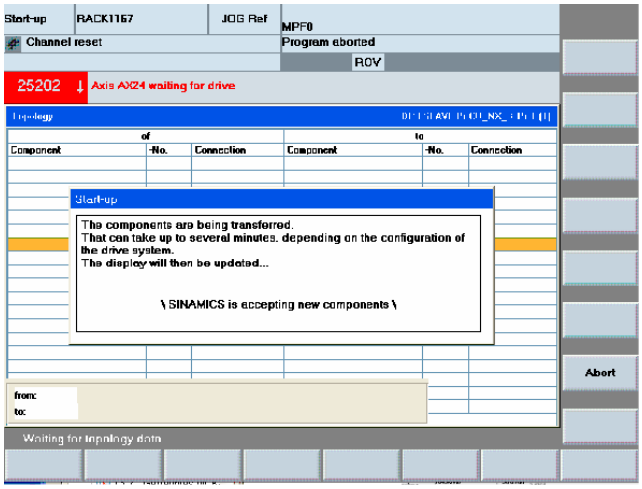


Figure 13-28 Configuration begins

During the unit configuration there are a succession of messages containing information on the configuration.

The unit configuration can take several seconds.

Before the configuration is completed, the HMI displays the following query:

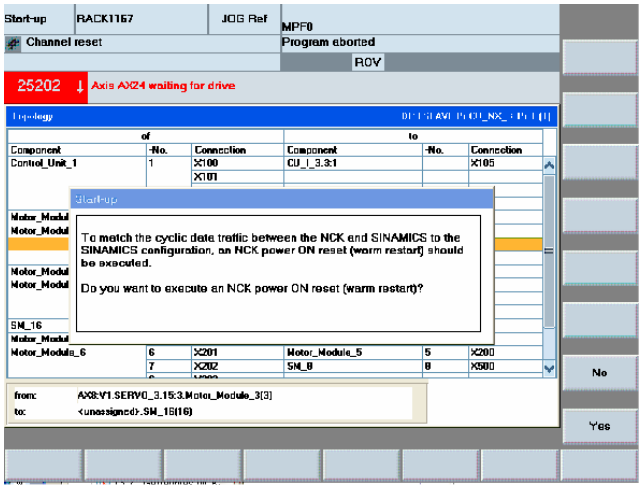


Figure 13-29 Power on reset (warm restart)

6. Press "OK" to perform an NCK power on restart (warm restart).

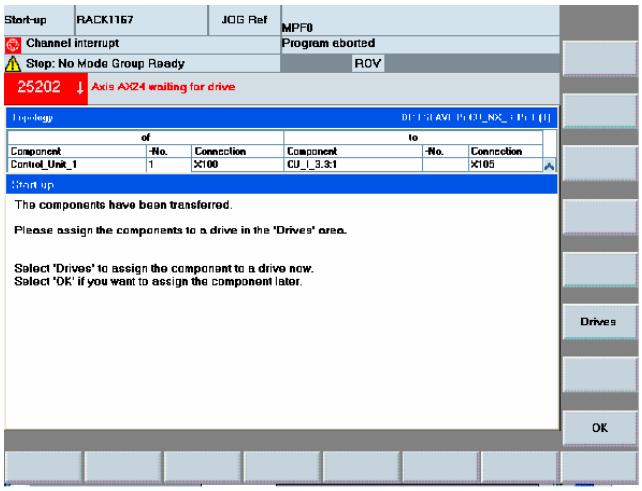


Figure 13-30 Component accepted

The unit configuration is finished. The component has been accepted.

You have the following options to assign this component (e.g. SMC20 with new encoder) to a drive:

– Press "Drives" to open the drive wizard. Select the drive and run through the drive wizard to the encoder configuration (Page 82).

– Press "OK" and assign this component later to a drive.

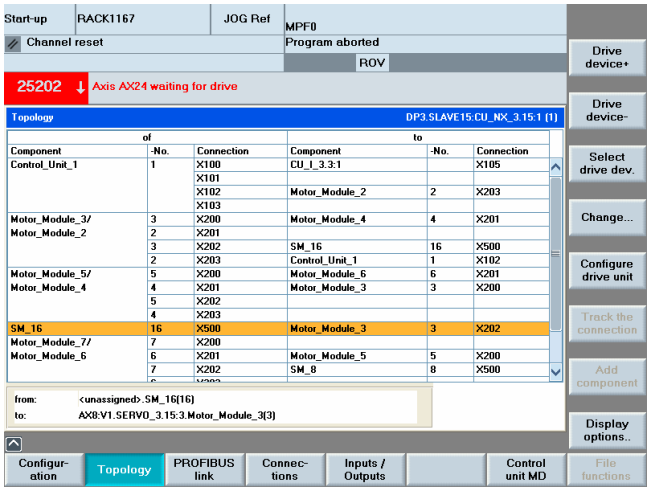


Figure 13-31 "Topology" menu after "OK"

The actual state is displayed in the topology.

If you select the component with the cursor keys, the HMI informs you in the bottom area of the topology table, which components have been connected to this component via DRIVE-CLiQ.

Note

A non-assigned component must be commissioned with the drive wizard.

You can start the drive wizard from the "Topology" menu with the following operator input steps:

1. Press the <RECALL> key.
2. Press "Drive".

See also

Drive diagnostics (Page 239)

13.7.2 Check topology

Introduction

After you have parameterized the drive components, you can view the topology on the HMI.

Topology of individual drive components

1. Under "Commissioning", press the "Drive system > Drive units > Topology" softkeys one after the other.
2. On the HMI, the topology of individual drive components is displayed, including the component number (see figure below).

   You can now check whether the topology displayed conforms with the topology of your system.

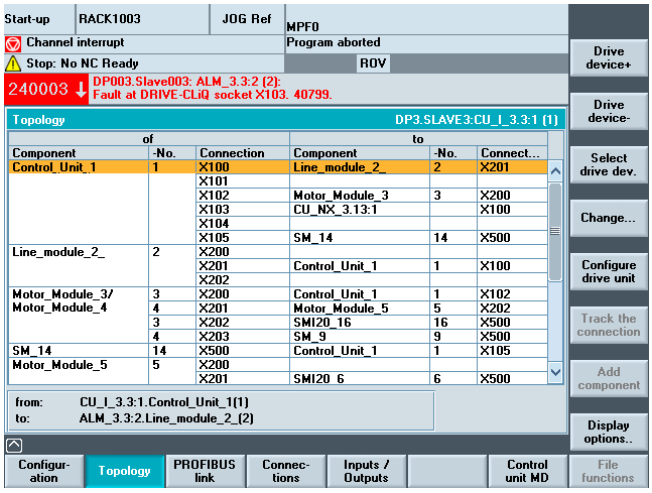


Figure 13-32 Topology

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

See also

Drive diagnostics (Page 239)

13.8 Overview - Assignment of SINAMICS and NCK machine data for communication via PROFIBUS

Assignment of SINAMICS and NCK machine data for communication

The table below uses a sample to SINAMICS S120 component configuration to illustrate the assignment of the communication parameters. The SINAMICS S120 drive group comprises the following:

- an NCU (CU),
- an ALM,
- Three Motor Modules (MM)

Note

In the Control Unit Parameter 978, deactivate the process data exchange with the value "0". Cyclic and acyclic data are separated. Components that do not communicate on PROFIBUS are to be preassigned "255".

SINAMICS S120				STEP7 (HW Config) DP slave properties		NCK machine data General machine data			NCK machine data Axis MD	
HW Module	Control Unit Parameter p978[0-9] List of drive objects	Control Unit Parameter p922 Message frame type	Drive parameter p922 Message frame type	Message frame 1) type length	I/O address 1)	MD13120[0] Control Unit I/O address	MD13050[0-5] Axis I/O address 1)	MD13060[0-5] Message frame type1)	MD30110/30220 Setpoint/Actual value assignment	MD30130 Type of output setpoint
MM1	3		116	116, PZD-11/19	4100		4100	116	1	1
MM2	4		116	116, PZD-11/19	4140		4140	116	2	1
MM3	5		116	116, PZD-11/19	4180		4180	116	3	1
x	255		x	116, PZD-11/19	4220		4220	116	4	0
x	255		x	116, PZD-11/19	4260		4260	116	5	0
x	255		x	116, PZD-11/19	4300		4300	116	6	0
CU	1	391		391, PZD-3/7	6500	6500				
ALM	255			370, PZD-1/1	6514					
x	0									
x	2									

Process data (PZD) exchange configured

X — Does not exist

255 — Not active

1) Standard value, do not change

Figure 13-33 Assignment

13.9 Drive-object assignment for PROFIBUS connection

Introduction

PROFIBUS message frames (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 (DOs). The drive objects have drive-object (DO) numbers and are input in p978[0…9] as a list of drive objects.

You configure the following from parameter p978 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 message frame 370 is not currently available for the Active Line Module (infeed). However, according to the SINAMICS rule, all DOs 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 DOs involved in process-data exchange is completed by entering a value of "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, first 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 "(…)".

Drive-object assignment

The table below uses the example of a SINAMICS S120 component configuration to illustrate the drive-object assignment to be made for the drive parameters.

For example, the drive group could be configured as follows:

- One Control Unit (CU)
- One Active Line Module (ALM)
- Three Motor Modules

Table 13-1 Assignment of p978[0…9] for infeed with DRIVE-CLiQ connection

Component	Index p978	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 p978[0…9] for an infeed without DRIVE-CLiQ connection. This assignment is also done for a drive group with NX module.

Table 13-2 Assignment p978[0…9] for infeed without DRIVE-CLiQ connection

Component	Index p978	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 p978

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

p978 can be written using the following sequence:

1. Set p9 = 1
2. Set p978 [0...9] to the values outlined 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 p9 = 0
4. Save "All": set p977 = 1

   It is imperative you wait until p977 is automatically written back to "0".

See also

Overview - Assignment of SINAMICS and NCK machine data for communication via PROFIBUS (Page 257)

13.10 Commissioning NX <-> Drive

Introduction

The commissioning of a drive group with NX module is done using the steps that are described in the sections on commissioning. In particular the following sections are concerned:

- PLC commissioning
- Commissioning SINAMICS drives
- Commissioning communication NCK<->Drive

During the first commissioning, put the NCU into operation, followed by the NX.

The first commissioning for the entire drive group always begins with "Switch-on power up" and ends with "Commissioning communication NCK <-> Drive".

The following description addresses additional particulars for commissioning an NX.

See also

Initial commissioning procedure (Page 19)

Creating a SIMATIC S7 project (Page 41)

Commissioning SINAMICS drives (Page 63)

Commissioning communication NCK<->Drive (Page 101)

Special features when commissioning NX <-> Drive

The following must also be observed for the respective commissioning steps:

- PLC commissioning

  When creating the SIMATIC S7 project, one or more NX modules must be integrated in the HW Config.

  – Look for the NX module (NX10, NX15) in the hardware catalog under "PROFIBUS DP > SINAMICS > SINUMERIK NX…".

  – Click with the left mouse button to select the "SINUMERIK NX ..." module and drag it to the "PROFIBUS Integrated DP master system" bus in the "Station design" station window.

  – After releasing the mouse key, you have inserted the NX module.

- Commissioning SINAMICS drives

  – You have commissioned the DRIVE-CLiQ topology of the SINAMICS drives belonging to the NCU (configuration macro "1" or "5"). Next comes the commissioning of the SINAMICS drives, which communicate with the NX.

  – Under "Control Unit MD" you select the NX module using the vertical softkeys "Control Unit +/-".

  – You begin with the step "Establishing the factory settings" etc.

– Instead of the drive components macro call-up, you carry out the following work steps in order to match the topology:

  NX p97=1 (actual topology accepted into setpoint topology),

  NX p9=0 (restart of the controller),

  wait until NX p3988>=680.

– For the drive object assignment for the PROFIBUS connection, the list of the drive objects in the parameter p978 for the first motor module begins with "2" (no ALM/infeed without DRIVE-CLiQ).

- Commissioning communication NCK<->Drive

  The following table illustrates, using the example of an SINAMICS S120 component structure (one NX (CU), three motor modules (MM)), the assignment of the NCK machine data for input/output address/message frame/setpoint/actual value.

SINAMICS S120	**STEP7 (HW-config) DP slave properties**		**NCK machine data General MD**			**NCK machine data Axis MD**	
Component	Message frame type/length[1)]	I/O address[1)]	MD13120[1] Control Unit I/O address	MD13050 [0-5] Axis I/O address [1)]	MD13060 [0-5] Message frame type [1)]	MD30110/30220 setpoint/actual value assignment	MD30130 Type of output Setpoint
MM1	116. PZD-11/19	4340		4340	116	7	1
MM2	116. PZD-11/19	4380		4380	116	8	1
MM3	116. PZD-11/19	4420		4420	116	9	1
X (not available)	116. PZD-11/19	4460		4460	116	-	0
X (not available)	116. PZD-11/19	4500		4500	116	-	0
X (not available)	116. PZD-11/19	4540		4540	116	-	0
NX	Standard 1 PZD-2/2	6516	6516				
ALM	370. PZD-1/1	6520					

[1)]Default value, do not change

- You have put the communication NCK <-> Drive into operation. Next comes the commissioning NX <-> Drive
- You begin with step "Configuration input/output address and message frame".
  – Under "General MD" in the "MD13120 [1] CONTROL_UNIT_LOGIC_ADDRESS", you enter the input/output address for the NX (e.g. address "6516").

    You have determined this address in the SIMATIC Manager in the HW Config via "Object properties > Configuration > Details".

  – The following general machine data is preassigned with a default value. No adjustment is necessary here since these values correspond to those preassigned values in the HW Config.

    MD13060 DRIVE_TELEGRAM_TYPE (message frame type)

    MD13050 DRIVE_LOGIC_ADDRESS (axis address)

– In the next step, you enter the axis component number for the setpoint and actual value.
– Under "Axis-MD" with "Axis+", you select the corresponding axis.

  The following axis machine data must be adapted for each axis:

  MD30110 CTRLOUT_MODULE_NR (setpoint channel)

  MD30220 ENC_MODUL_NR (actual-value channel)

  MD30130 CTRLOUT_TYPE (type of output setpoint)

  MD30240 ENC_TYPE (actual value acquisition),"1" for incremental encoder or "4" for absolute encoder.

Note

The commissioning engineer must ensure that the ready signal of the infeed is interconnected with the parameter p864 from each drive.

13.11 PROFIBUS machine control panel on the HMI

Configuration of the PROFIBUS machine control panel

The following is essential 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

13.11.1 Configuration of the properties of the 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:

Steps for PROFIBUS DP

1. You used the left mouse button to select NCU 720.1 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 PROFIBUS DP interface for socket X126 (machine control panel) in the dialog box (see figure below).

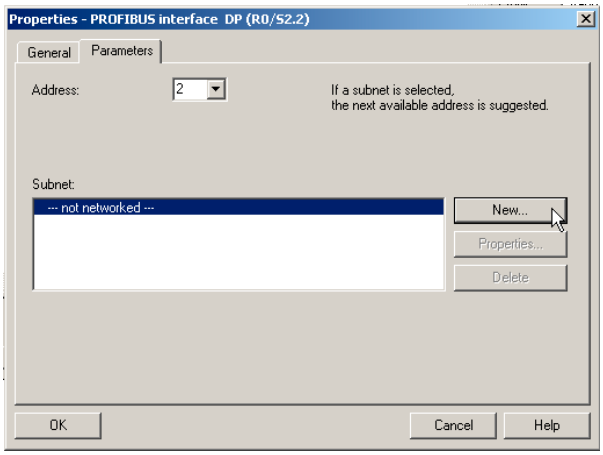


Figure 13-34 Properties of PROFIBUS DP

3. Click the following menu items one after the other:
   - the "New..." button,
   - the "Network settings" tab in the "Properties new subnet PROFIBUS Subnet" dialog box.
4. Select the transmission rate "12 Mbps" for the "DP" profile (see figure below).

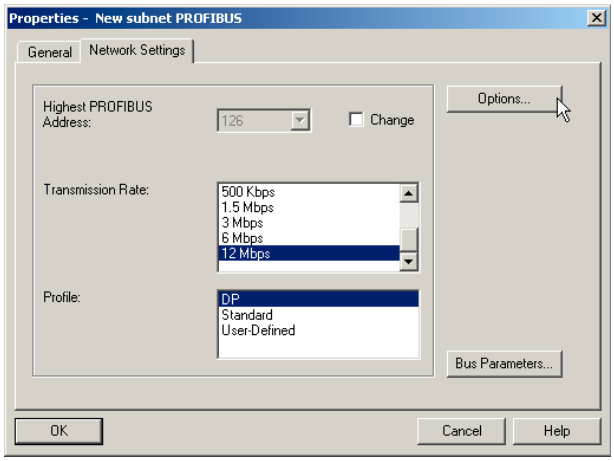


Figure 13-35 Properties of the PROFIBUS interface

5. Click on "Options" and then on the "Equidistance" tab (see figure below).

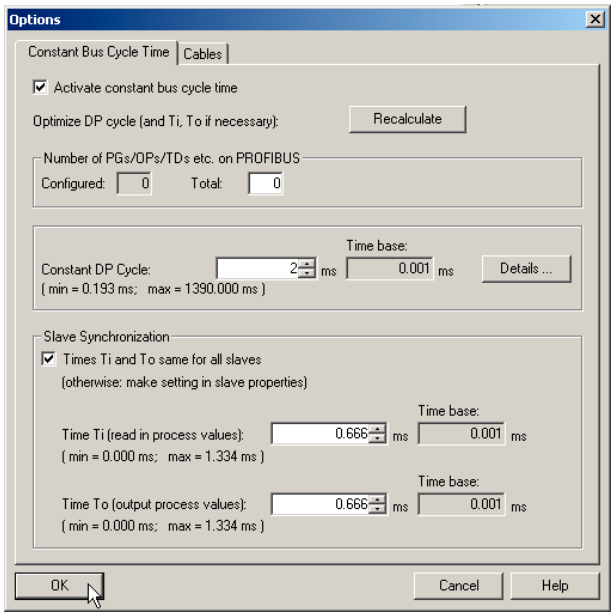


Figure 13-36 Equidistance

6. To enable reproducible access to peripherals (for hand wheel mode), the PROFIBUS DP must have 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 Syscock_Cycle_Time).
   - Click on the "Times Ti and To equal for all slaves" field
   - The fields "Time Ti" and "Time To" must contain a value "< 2ms".
7. Click on "OK" three times.

8. Module NCU 720.1 with SINAMICS S120 is inserted into the HW config (see figure below).

Note

With the <F4> key and confirmation of the question regarding "Reorganize", you can reorganize the display in the station window.

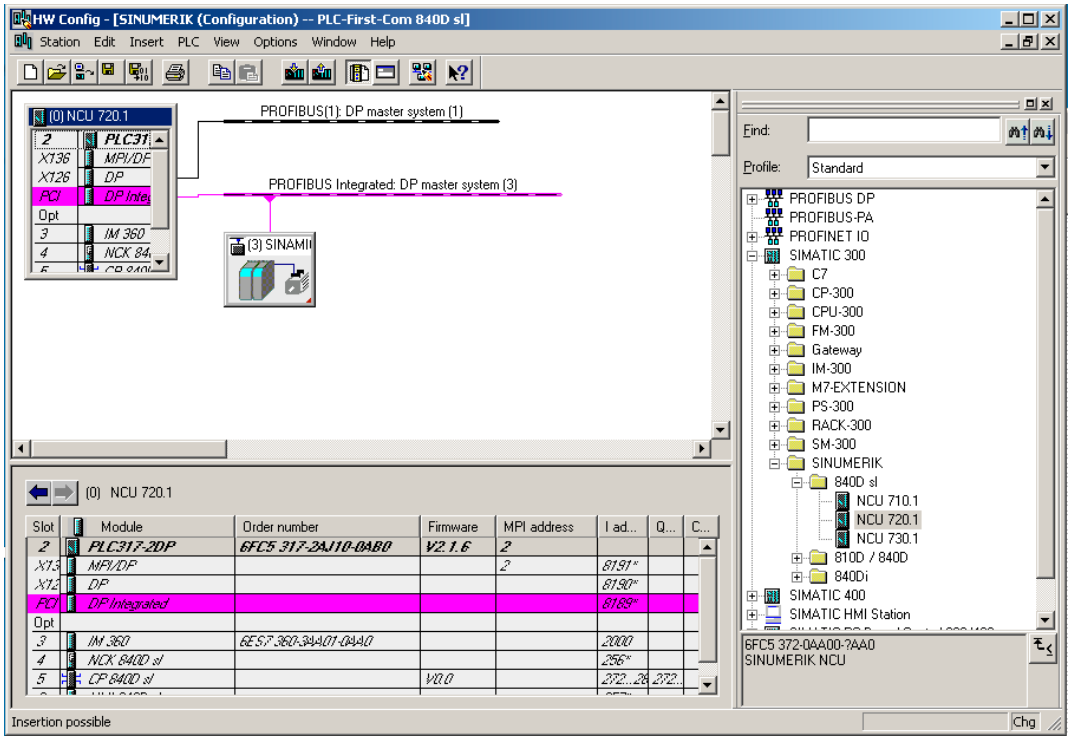


Figure 13-37 HW config with NCU 7x0

As the next step configure a machine control panel with hand wheel.

13.11.2 Load GSD file (contains machine control panel)

Introduction

To expand the machine control panel, you need the device 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.

This file is a component of the STEP7 package for NCU7x0 (tool box).

Operating steps

1. Search in the HW config under "Extras > Install GSD file…" in the installation directory of the tool box under, for example: C:\temp\tb_sl_1.1.0.0\8x0d\GSD\MCP_310_483 to find the corresponding GSD directory.
2. Choose the corresponding language you want to install.
3. Click "Install".
4. Click "Close".

13.11.3 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.

Steps 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. Add the MCP in the following steps:

1. Search under "PROFIBUS DP > Further Field Devices > NC/RC > MOTION CONTROL" for the module "SINUMERIK MCP".
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".

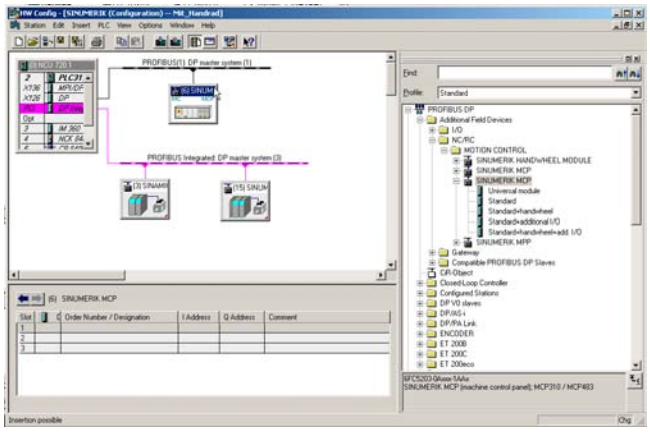


Figure 13-38 Machine control panel in HW Config

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).

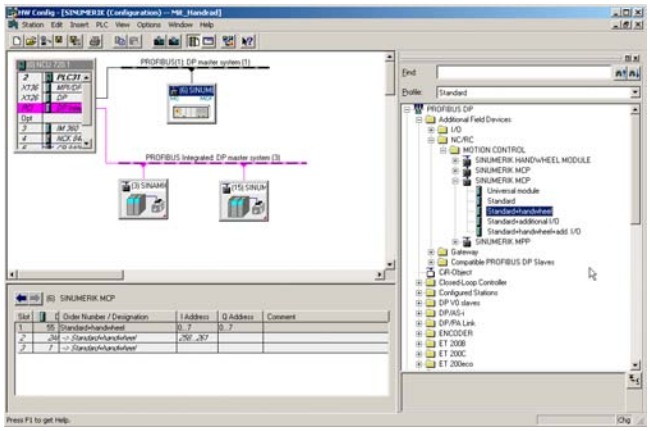


Figure 13-39 Standard+Handwheel for slot

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 operator input sequence step.

13.11.4 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 steps

- 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
```

You have completed the configuration of the PLC basic program.

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

Licensing

14

14.1 Import licensing terms

The terms below are important for understanding the license management of SINUMERIK software products.

Term	Description
Software product	"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.
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. License information is also saved to remanent memory on this component. Example: • SINUMERIK 840D sl: CF card • SINUMERIK 840Di sl: MCI board
License	A license gives the user a legal right to use the software product. Evidence of this right is provided by the following: • CoL (Certificate of License) • License key
CoL (Certificate of License)	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 **Note** 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.
License number	The license number is the feature of a license that is used for its unique identification.
CF Card (Compact Flash Card)	The CF Card represents, as the carrier of all the remanent data of a SINUMERIK solution line control system, the identity of this control system. The CF Card includes the following data relevant for the license management: • Hardware serial number • License information including the License Key

Term	Description
Hardware serial number	The hardware serial number is a permanent part of the CF Card. It is used to identify a control system uniquely. The hardware serial number can be determined by: • CoL (see: Certificate of License > "Note") • HMI user interface • Printing on the CF Card
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.
Product	A product is marked by the data below within the license management of SINUMERIK software products: • Product designation • Order number: • License number

14.2 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, access occurs to a license database administered by Siemens A&D via the Internet. Finally, the license information including the License Key is transferred to the hardware.

There are two ways to access the license database:

- Web License Manager
- Automation License Manager

Note

Using SINUMERIK software products for testing purposes

SINUMERIK software products may be temporarily activated and used for testing purposes on a SINUMERIK control system, even without the corresponding License Key.

The license-information "Overview" dialog box on the SINUMERIK user interface, e.g., HMI Advanced, indicates that the License Key is "Insufficient". Also the control system will repeatedly display a corresponding message.

14.3 Web License Manager

By using the Web License Manager, you can assign licenses to hardware in a standard Web browser. To conclude the assignment, the License Key must be entered manually at the control system via the HMI user interface.

Internet address

The Internet address of the Web License Managers is:
http://www.siemens.com/automation/license

14.4 Automation License Manager

The Automation License Manager can be used to assign all the licenses required for a piece of hardware (license-requirement comparison). The license information, including the License Key, is transferred electronically via an Ethernet link (TCP/IP).

Preconditions:

- The Automation License Manager must be installed on the computer (PC/PG) that is used to assign the licenses to the hardware.
- The computer (PC/PG) must be able to connect to the license database and the SINUMERIK control system via Ethernet link (TCP/IP):
  - License database: Internet connection
  - SINUMERIK control system: Intranet or PTP connection (Ethernet, Peer-To-Peer)

  The individual steps for assigning licenses to hardware (license database) and the transfer of license information from/to the SINUMERIK control system can be performed such that only one connection must be available at any one time.

14.5 License database

The license database contains all the customer-specific license information relevant 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.

License database access

License database access occurs via:

- Direct access

  The direct access occurs with:

  – Delivery note number

  – License 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.

- Customer login

  The customer login occurs with:

  – User name

  – Password

  The customer login enables the assignment of all the licenses available to the user that are delivered at the time of the login and have not yet been assigned to any hardware. 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

Customer login

You can obtain a customer login from Siemens A&D Mall under menu item: "Registration". The Internet address is: http://mall.automation.siemens.com/

Currently, access is not yet possible for all countries.

Various license information

As indicated above, only the license information in the license database represents the current status regarding a piece of hardware. Differences may arise between the license information available for a piece of hardware and that of the license database due to:

- loading older archive data into the NCK (data restoration from a series-commissioning file after a service job)
- assigning licenses to hardware without transferring the modified license information for the hardware control system (online)

As a result, a more limited license requirement (possibly no license requirement) may be displayed than indicated on the HMI user interface of the control system for a license requirement alignment by Automation License Manager.

To align the license information, a transfer should be carried out for the current license information of the license database for the hardware control system (online).

14.6 CF Card and hardware serial numbers

The CF card (Compact Flash card) contains, in addition to the system and user software and the retentive system and user data, that data relevant for the license management of SINUMERIK software products of a control system:

- Hardware serial number
- License information including the License Key

The CF card thus represents the identity of a SINUMERIK control system. For this reason, assigning licenses to a control system always occurs using the hardware serial number.

This has the advantage that the CF card can be slotted into a replacement NCU in the event of failure and all data is retained.

Automation License Manager

Thus, the hardware serial number is always decisive during the transfer of license information to a control system in Automation License Manager and not the set IP address of the control system with which Automation License Manager is currently communicating.

Determining the hardware serial number

The hardware serial number is a permanent part of the CF card. It is used to identify a control system uniquely. The hardware serial number can be determined by:

- CoL (Certificate of License) (see note)
- SINUMERIK user interface, e.g. HMI Advanced
- Printing on the CF card
- Display in the Automation License Manager as supplementary information for the elements below:
  - Control system file
  - Control system (online)
  - Control image (offline)

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.

14.7 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 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 CF card is only valid for this CF card and will be rejected on other CF cards as invalid.
- Total number of assigned licenses
  A SINUMERIK License Key not only refers to one single license, instead it is the "technical representative" of all licenses that are assigned to the hardware at the time of its generation.

Copying SINUMERIK License Keys

By the fixed reference to certain hardware, a SINUMERIK License Key may, for example, be copied to various computers (PC/PG) and/or memory media for security or archiving purposes.

14.8 Assigning via Web License Manager

14.8.1 You can execute an assignment via direct access as follows

Background

For the direct access, log on to a computer connected to the Internet (PC/PG) with the delivery note and license number in the Web License Manager. All licenses of the delivery note numbers entered at the login may then be assigned to a piece of hardware. After completing the assignment process, the new License Key is displayed. This must then be entered in the licensing dialog of the HMI components used.

Requirements

The following prerequisites must be met in order to assign a license to a piece of hardware via direct access and HMI user interface:

- The HMI component is connected with the control system (NCU) on which the license should be assigned. Both components have been booted.
- A computer (PC/PG) with Internet connection and browser is available.
- The login data for the direct access (e.g., per CoL) are available:
  - License number
  - Delivery note number

Assigning a license to a piece of hardware

1. Determine the hardware serial number and the product name (HMI Advanced/HMI Embedded: "Hardware type") via the HMI licensing dialog box.
   HMI Advanced/HMI Embedded:

   Operating-area switchover: Commissioning > Key: etc. (">") > Licenses > Overview

   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:
   http://www.siemens.com/automation/license
3. Login via "Direct access":
   - License number
   - Delivery note number
4. Follow the additional instructions in the Web License Manager.

Note

License Key via e-mail

If you have an e-mail address, you can have the option (checkbox) of receiving the License Key by e-mail. Advantage: the entry of the License Key to the control system is simplified.

5. After completing the assignment process, enter the License Key displayed on the Web License Manager into the licensing dialog of the HMI user interface.
   HMI Advanced/HMI Embedded:

   Operating-area switchover: Commissioning > Key: etc. (">") > Licenses > Overview
6. Confirm the entry of the new License Key by pressing the softkey: "Transfer".

14.8.2 You can execute an assignment via customer login as follows

Background

For the customer login, log on to a computer (PC/PG) connected to the Internet with the user name and password in the Web License Manager. All licenses released for this user name in the framework of the license management may then be assigned to a piece of hardware. After completing the assignment process, the new License Key is displayed. This must then be entered in the licensing dialog of the HMI components used.

Requirements

The following prerequisites must be met in order to assign a license to a piece of hardware via customer login and HMI user interface:

- The HMI component is connected with the control system (NCU) on which the license should be assigned. Both components have been booted.
- A computer (PC/PG) with Internet connection and browser is available.
- The login data for the customer login is available:
  - User name
  - Password

Assigning a license to a piece of hardware

1. Determine the hardware serial number and the product name (HMI Advanced/HMI Embedded: "Hardware type") via the HMI licensing dialog box.
   HMI Advanced/HMI Embedded:

   Operating-area switchover: Commissioning > Key: etc. (">") > Licenses > Overview

   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:
   http://www.siemens.com/automation/license
3. Login via "Customer login":
   – User name
   – Password
4. Follow the additional instructions in the Web License Manager.

   Note

   License Key via e-mail

   If you have an e-mail address, you have the option (checkbox) of receiving the License Key by e-mail. Advantage: the entry of the License Key to the control system is simplified.

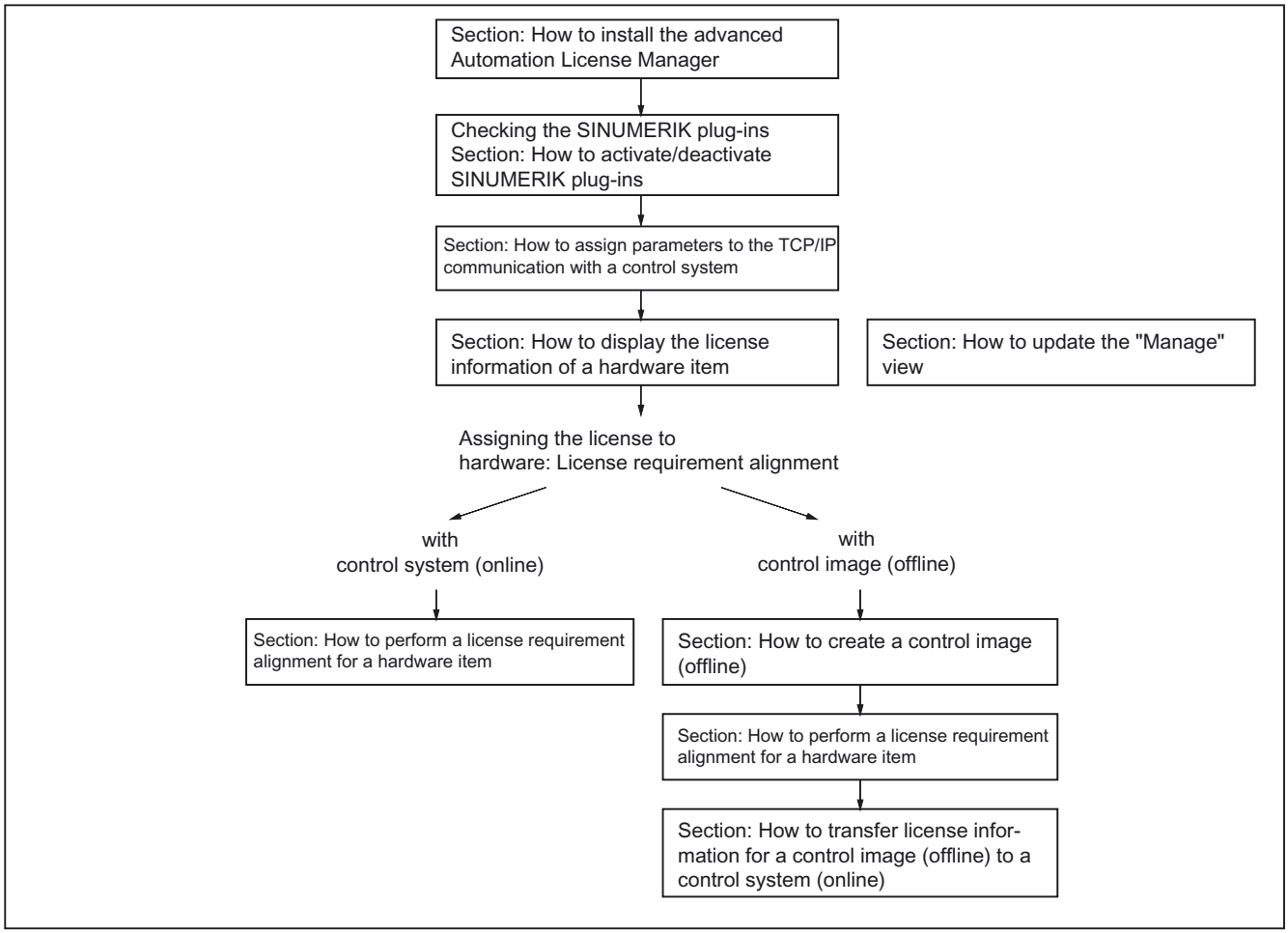
5. After completing the assignment process, enter the License Key displayed on the Web License Manager into the licensing dialog of the HMI user interface.
   HMI Advanced/HMI Embedded:

   Operating-area switchover: Commissioning > Key: etc. (">") > Licenses > Overview
6. Confirm the entry of the new License Key by pressing the softkey: "Transfer".

14.9 Assigning via Automation License Manager

14.9.1 Function Overview

The following figure provides an overview of the functions available and the sequence in which they should be applied.



14.9.2 Installing the Automation License Manager

Background

The following components need to be installed for the license management of SINUMERIK solution line License Keys:

- Automation License Manager
  The Automation License Manager is loaded by the installation routine only if no manager or a manager version with a lower version number is installed on the computer (PC/PG).
- SINUMERIK plug-in
  The SINUMERIK plug-in is loaded by the installation routine only if it finds a version of the Automation License Manager installed on the computer (PC/PG).
- HMI basic software
  The HMI basic software is loaded by the installation routine only if no HMI software or a version with a lower number is installed on the computer (PC/PG).

Note

The Automation License Manager is used for all Siemens A&D products, e.g. SIMATIC STEP7. As versions of the Automation License Manager are upwards compatible, we always recommend using the version with the highest version number, irrespective of the source of supply (e.g. SINUMERIK or SIMATIC product CD, download via A&D Mall, etc.).

System requirements

Hardware

- Computer: Industrial PC, programming device, etc.
- Work memory: >= 128 MB
- Free hard-disk storage:
  5 MB (SINUMERIK plug-in)
  + 32 MB (Automation License Manager)
  + 300 MB (HMI basic software)
- Operating system: Windows XP

Execution

1. Launch the installation program for the Automation License Manager from "SETUP.EXE" and follow the instructions for the installation.
2. Launch the installation program for the SINUMERIK plug-in from "SETUP.EXE" and follow the instructions for the installation.
   The HMI basic software can be installed as part of this process.

14.9.3 Enabling/disabling SINUMERIK plug-ins

Background

All of the plug-ins enabled for the Automation License Manager scan the relevant communication interfaces when booting and after specific operator inputs. If there is a large number of enabled plug-ins, this can result in a significantly longer boot and refresh time for the user interface. To prevent this delay, you can disable the plug-in installed for handling the SINUMERIK License Keys in dialog: "Connect to target system".

Procedure

Perform the following actions to enable/disable the SINUMERIK plug-ins:

1. Start the Automation License Manager
2. Open the "Connect to target system" dialog via menu command: **Edit > Connect to target system > SINUMERIK . . .**
3. In the dialog, open tab: **Settings**
4. Enable/disable the plug-in by selecting/deselecting the appropriate checkbox.
5. Close the dialog by pressing the button: **OK**

Result

The Automation License Manager shows the SINUMERIK-specific license information in accordance with the current status of the SINUMERIK plug-in. See Section:

Note

How to refresh the view manually

If the view is not automatically refreshed, you can refresh the view manually. See Section: "How to refresh the view: Manage"

14.9.4 Assigning parameters to the TCP/IP communication with a control system

Background

To be able to read or transfer license information from or to the CF card of a control system, the Automation License Manager must communicate with the control system via TCP/IP.

Requirements:

- The HMI basic software is installed
- The SINUMERIK plug-in is enabled

Note

HMI Advanced

If the SINUMERIK user interface "HMI Advanced" is installed on the same computer (PC/PG) as the Automation License Manager you can set the IP address using the user interface. The IP address for the control system with which both HMI Advanced as well as the Automation License Manager communicate is set via the following dialog:
Operating area switchover > Start-up > HMI > NCU link

This requires at least the password of protection level 2 (manufacturer) to be set.

General communication parameters
The default general communication parameters for the HMI basic software are stored in the following initialization file:
<installation drive>:\Siemens\Sinumerik\HMI-Advanced\mmc2\MMC.INI

User-specific communication parameters
The user-specific communication parameters for the HMI basic software are stored in the following initialization file:
<installation drive>:\Siemens\Sinumerik\HMI-Advanced\user\MMC.INI

During evaluation of the initialization data when booting the HMI basic software, user-specific communication parameters have priority over general communication parameters.

Sections of the initialization file**: MMC.INI**
The parameters relevant to TCP/IP communication with SINUMERIK control systems are stored in the following sections:

- [GLOBAL]
  Section: [GLOBAL] specifies the section (e.g. *AddressParameter*) that contains the communication parameters for the current SINUMERIK control system.
- [*AddressParameter*]
  The name of this section can be any unique ASCII string within the file. The specified IP address is crucial for communication with the current SINUMERIK control system: *IP address*.

Table 14-1 User-specific file: MMC.INI

Statements
[GLOBAL]
NcddeMachineName = *AddressParameter*
NcddeDefaultMachineName = *AddressParameter*
NcddeMachineNames = *AddressParameter*

Statements

```
[ AddressParameter ]
ADDRESS0 = IP address, LINE=10,NAME=/NC, SAP=030d, PROFILE=CLT1__CP_L4_INT
ADDRESS1 = IP address, LINE=10,NAME=/PLC, SAP=0201, PROFILE=CLT1__CP_L4_INT
ADDRESS2 = IP address, LINE=10, NAME=/DRIVE0, SAP=0900, PROFILE=CLT1__CP_L4_INT
ADDRESS3 = IP address, LINE=10, NAME=/DRIVE1, SAP=0a00, PROFILE=CLT1__CP_L4_INT
ADDRESS4 = IP address, LINE=10, NAME=/DRIVE2, SAP=0b00, PROFILE=CLT1__CP_L4_INT
ADDRESS5 = IP address, LINE=10, NAME=/DRIVE3, SAP=0c00, PROFILE=CLT1__CP_L4_INT
ADDRESS6 = IP address, LINE=10, NAME=/DRIVE4, SAP=0d00, PROFILE=CLT1__CP_L4_INT
ADDRESS7 = IP address, LINE=10, NAME=/DRIVE5, SAP=0e00, PROFILE=CLT1__CP_L4_INT
```

Multiple SINUMERIK control systems

If you require communication with multiple SINUMERIK control systems you must create a section
[*AddressParameter*] with a unique name e.g. [840D_001], [840D_002], etc. for each control system with the relevant IP address.

In the [GLOBAL] section, you must specify the section name for the SINUMERIK control system, e.g. [840D_001], with which communication should occur once the Automation License Manager has booted.

NOTICE

Editing the IP address

The IP address specified in the user-specific initialization file MMC.INI influences not only the Automation License Manager but also all other applications installed on the same computer (PC/PG) that use HMI basic software (e.g. HMI Advanced).

To apply the change to the active IP address, you must close all active applications using HMI basic software (e.g. HMI Advanced). Once you have closed all applications, restart the computer to activate the new IP address.

Requirements

The following conditions must be fulfilled:

- The HMI basic software is installed on the computer (PC/PG) on which the Automation License Manager is running.
- The IP addresses of the SINUMERIK control systems with which the Automation License Manager must communicate are known.

Procedure: Creating parameters for the first time

Perform the following actions when creating user-specific communication parameters for the first time:

1. Create the text file:
   <installation drive>:\Siemens\Sinumerik\HMI-Advanced\user\MMC.INI if it does not already exist.
2. Open the file MMC.INI with a text editor.
3. Copy the [GLOBAL] section from the table given above: "User-specific file: MMC.INI" to the open file MMC.INI.
4. Copy the [*AddressParameter*] section from the table given above: "User-specific file: MMC.INI" to the open file MMC.INI according to the number of available SINUMERIK control systems.
5. For all [*AddressParameter*] sections replace the string: "AddressParameter" with a unique name.
6. In all [*AddressParameter*] sections replace the string: "IP-Address" with the relevant IP address for the corresponding SINUMERIK control system.
7. In the [GLOBAL] section replace the string: "*AddressParameter* " with the section name for the SINUMERIK control system with which the Automation License Manager must communicate after booting. (See note "Changing the IP address" above.)

Procedure: Changing the active control system (online)

Perform the following actions to change the active control system (online), i.e. the SINUMERIK control system with which the Automation License Manager communicates:

1. Close the Automation License Manager.
   (See note "Changing the IP address" above.)
2. Open the file: <installation drive>:\Siemens\Sinumerik\HMI-Advanced\user\MMC.INI with a text editor.
3. In the [GLOBAL] section, replace the current address string with the section name for the SINUMERIK control system with which the Automation License Manager should communicate after booting.
4. Start the Automation License Manager.

Result

After booting the Automation License Manager communicates with the SINUMERIK control system defined in the user-specific communication parameters.

The control system to which you have switched is represented by an "online" control system file in the navigation area of the Automation License Manager.

The control system to which the Automation License Manager was connected before switching is represented by an "offline" control system file, if a control image (offline) exists.

14.9.5 How to refresh the navigation view: "Manage"

Background

After actions which add or remove elements in the navigation area of the navigation view: "Manage" of the Automation License Manager (e.g. deletion of a control image (offline), enabling/disabling of plug-ins), the view is normally refreshed automatically. If the view does not refresh automatically after an operation, you can refresh the view manually.

Execution

Perform the following actions to refresh the navigation view: "Manage" manually:

1. Select the following nodes in the navigation area of the Automation License Manager: **My Computer**
2. Refresh the view using one of the following options:
   - Menu command: **View > Refresh**
   - Key **F5**
   - Toolbar:

Result

The navigation view of the Automation License Manager is refreshed. All sub-nodes under the node: **My Computer** are closed.

The object view of the Automation License Manager shows the current nodes and drives of the navigation area.

Note

All directories are closed when the view is refreshed. When you select key: ' * ' on the numeric keypad, you can open all directories with a single key.

14.9.6 Displaying the license information of a piece of hardware

Background

To perform one of the following tasks with the Automation License Manager:

- Check the license information for the hardware
- Ascertain the license requirement for the hardware and align if necessary
- Assign new licenses to hardware and transfer updated license information including License Keys to the hardware

you must display the license information for a hardware item.

Requirements

The license information can only be displayed if the Automation License Manager is communicating with the relevant SINUMERIK control system.

Procedure with current control system (online)

Perform the following actions to display the license information for the control system currently connected to the Automation License Manager:

1. In the navigation area of the Automation License Manager, open: Technology folder: "SINUMERIK online" > Control folder and choose the control system (online) by clicking with the left mouse button.
2. Enable the default object view: "SINUMERIK".

Procedure with control system change over (online)

Perform the following actions to display the license information for a control system not connected to the Automation License Manager:

1. Exit the Automation License Manager and all other applications using HMI basic software (e.g. HMI Advanced).
2. Switch the active communication parameters to the required control system. See Section:
3. Start the Automation License Manager
4. In the navigation area of the Automation License Manager, open: Technology folder: "SINUMERIK online" > Control folder and choose the control system (online) by clicking with the left mouse button.

Result

The license information for the control system (online) is displayed in the object area of the Automation License Manager.

14.9.7 Creating a control image (offline)

Background

It is essential to create a control image (offline) in the following situations:

- The license information must later be transferred to the control system (online).
- The computer (PC/PG) on which the Automation License Manager is installed is not simultaneously connected to the Internet and the control system. This means the license information must be transferred to the control system (online) in three separate steps.
  - Intranet or PTP link to control system: Creating a control image (offline) in the Automation License Manager
  - Internet connection: Transferring license information to the control image (offline) by license requirement alignment
  - Intranet or PTP link to control system: Transferring license information from the control image (offline) to the control system (online) in the Automation License Manager
- The license information for a control system should be saved as an archive file for the purpose of archiving or customer support.

Requirements

A control image (offline) can only be created if the Automation License Manager is communicating with the control system.

Note

A PTP link (Peer-To-Peer) via Ethernet and TCP/IP requires a crossed Ethernet cable (twisted pair crossed 10baseT/100baseTX Ethernet cable).

Procedure using drag-and-drop

Perform the following steps to create a control image (offline) of the control system (online) by drag-and-drop:

1. In the navigation area of the Automation License Manager, open:
   Technology folder: "SINUMERIK online" > Control folder and choose the control system (online) by clicking with the left mouse button.
2. Select any line from the license information displayed in the object area by clicking with the left mouse button.
3. Drag the selected line to the desired target and release the mouse button.

The following objects can be selected as the target:

- Computer
- Drive
- Storage folder
- Control folder "offline"
- Control image (offline)

Result

A control image (offline) has been created from the license information of the control system (online) in the selected target:

- <computer> → drive C:\<default storage folder>
- <drive>:\SINUMERIK\<storage folder>\<control folder "offline">
- <storage folder>\<control folder "offline">
- <control folder "offline">
- Control image (offline): The control image (offline) was overwritten with the license information of the control system (online)

Procedure using menu command: "Upload from target system"

Perform the following actions to create a control image (offline) of the control system (online) using menu command: "Upload from target system":

1. In the navigation area of the Automation License Manager, open: Technology folder: "SINUMERIK online" > Control folder and choose the control system (online) by clicking with the left mouse button.
2. Create the control image (offline) using menu command: **License Key > Upload from target system**

Result

A control image (offline) has been created from the license information of the control system (online) in the default storage folder:

14.9.8 Performing a license requirement alignment for a piece of hardware

Background

If one or more options are active on a SINUMERIK control system, you must assign each license to the hardware. Next, the updated license information including the new license key is transferred to the hardware.

Via the function: "Align requirement" you can perform the alignment automatically for all required licenses based on the control system (online) or a control image (offline). The following actions are performed:

- Determining the hardware serial number for the control system
- Determining the license requirement for the control system
- Taking the required licenses from the customer-specific licenses and assigning these to the hardware
- Transferring the updated license information including License Key to the control system (online) or the control image (offline)

Requirements

The following requirements must be met for the license requirement alignment:

- The address data for the customer login (personalized login) is available:
  - User name
  - Password
- Control (online) or control image (offline)

  An "online" control system file or an "offline" control system file with the relevant control image (offline) is available.

Procedure

Perform the following actions for license requirement alignment with a control system (online) or a control image (offline):

1. In the navigation area of the Automation License Manager, open:
   - For control system (online)
     Technology folder: SINUMERIK online > Control folder "online"
   - For control image (offline)
     Technology folder: SINUMERIK offline > storage folder > control folder "offline" or

   and choose the control system (online) or the control image (offline) or by clicking with the left mouse button.
2. Select the menu command: **License Key > Align requirement**
3. Login via your customer login.
4. Start the Automation License Manager and perform the following actions: "Align requirement", "Confirm requirement list" and "Transfer licenses". Follow the instructions displayed on the screen.

NOTICE
Suggested license assignment Carefully check the suggested license assignment. An adjustment may be required if: • you wish to use a license number that differs from the number suggested • you wish to use a license package rather than single licenses • you wish to assign greater or fewer licenses than suggested for any reason You can **no** longer undo the assignment independently.

The procedure for transferring the updated license information from a control image (offline) to a control system (online) is described in Subsection:

Result

A new License Key has been generated and loaded to the control (online) or the control image (offline).

14.9.9 Transferring license information for a control image (offline) to a control system (online)

Background

It is essential to transfer the license information for a control image (offline) to a control system (online), i.e. the hardware for a SINUMERIK control, in the following situations:

- The computer (PC/PG) on which the Automation License Manager is installed is not simultaneously connected to the Internet and the control system. License information is initially only updated based on a control image (offline). The computer on which the Automation License Manager is running is then disconnected from the Internet and connected to the relevant SINUMERIK control system to transfer the license information.
- After a service call, the license information should be transferred from an archive file to a SINUMERIK control system.

Requirements

The following conditions must met for transmission of a control image (offline) to the control system (online):

- The Automation License Manager must be communicating with the control system.
- The hardware serial number of the control image (offline) and the control system (online) must be identical.

Procedure using drag and drop

Perform the following steps to transfer a control image (offline) to the control system (online) by drag-and-drop:

1. In the navigation area of the Automation License Manager, open:
   Technology folder: "SINUMERIK online" > Control folder and choose the control system (online) by clicking with the left mouse button.
2. In the navigation area of the Automation License Manager, open:
   Technology folder: "SINUMERIK offline" > storage folder: > control folder .
   Choose the control image (offline) by clicking with the left mouse button.
3. Select any line from the license information displayed in the object area by clicking with the left mouse button.
4. Drag the selected line to the control system (online) release the mouse button.

Procedure using menu commands

Perform the following actions to transfer a control image (offline) to the control system (online) using menu command: "Download to target system":

1. In the navigation area of the Automation License Manager, open:
   Technology folder SINUMERIK offline > storage folder: > control folder: and choose the control image (offline) by clicking with the left mouse button.
2. Select the menu command: **License Key > Download to target system**

Result

The license information of the control system (online) is now identical to the information for the control image (offline), including the license key.

14.10 Internet links

Overview of Internet links used:

No.	Topic	Address
1	Web License Manager	http://www.siemens.com/automation/license
2	Siemens A&D Mall: Customer login	http://mall.automation.siemens.com/
3	Download server	http://software-download.automation.siemens.com

Fundamentals 15

15.1 Basic information on SINAMICS S120

Reference

See also

Small SINAMICS Glossary (Page 347)

15.1.1 Rules for wiring the DRIVE-CLiQ interface

Introduction

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:

If you follow the optional rules for wiring DRIVE-CLiQ, the components associated with the encoder are automatically assigned to the drives (see figure below) if commissioning is performed via macro 150xxx.

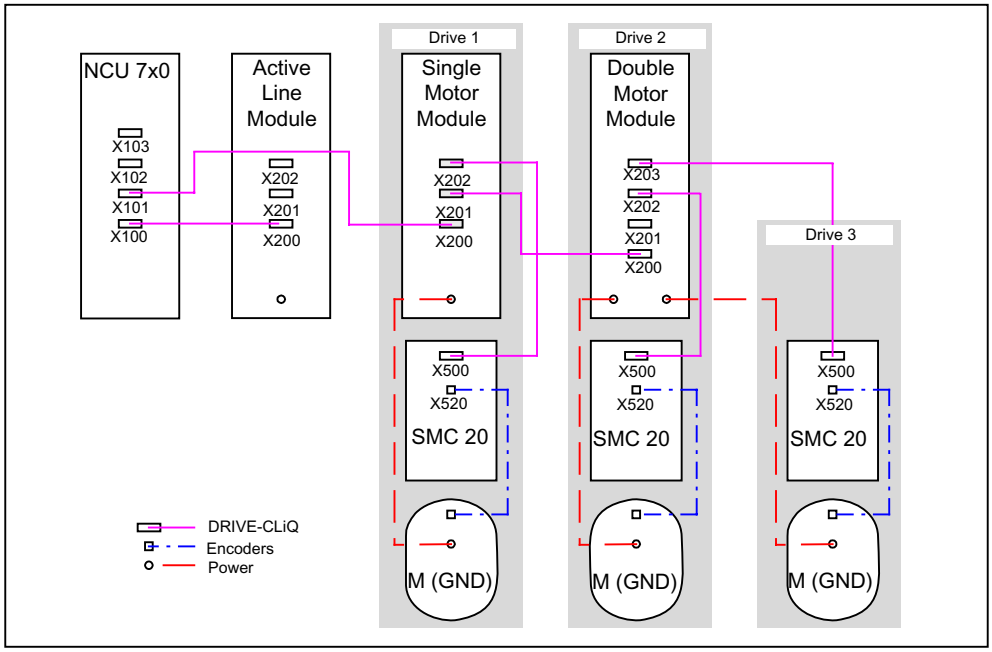


Figure 15-1 Optional rules

- 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.

15.1.2 Drive Objects (DO's) and Drive components

Introduction

The components that belong to the drive group are refelcted in the parameterization in a drive object.

Each drive object has its own parameter list.

General procedure

The figure below uses the example of a SINAMICS S120 drive group to illustrate the meaning of the drive components and drive objects.

Example

Drive object 3 is made up of the components Single Motor Module (No. 3), Motor (No. 10), Encoder (No. 9) and SMC (No. 8).

The component number is assigned by the drive after DRIVE-CLiQ topology recognition.

The component number in each case can be viewed in the parameter list for the relevant drive object. E.g.: under operating area "Commissioning > Machine data > Drive MD > Axis +".

Table 15-1 Component numbers in the DO 3

Parameter	Name of the parameter
p121	Component number of power module
p131	Component number of motor
p141	Component number of encoder interface
P142	Component number of encoder

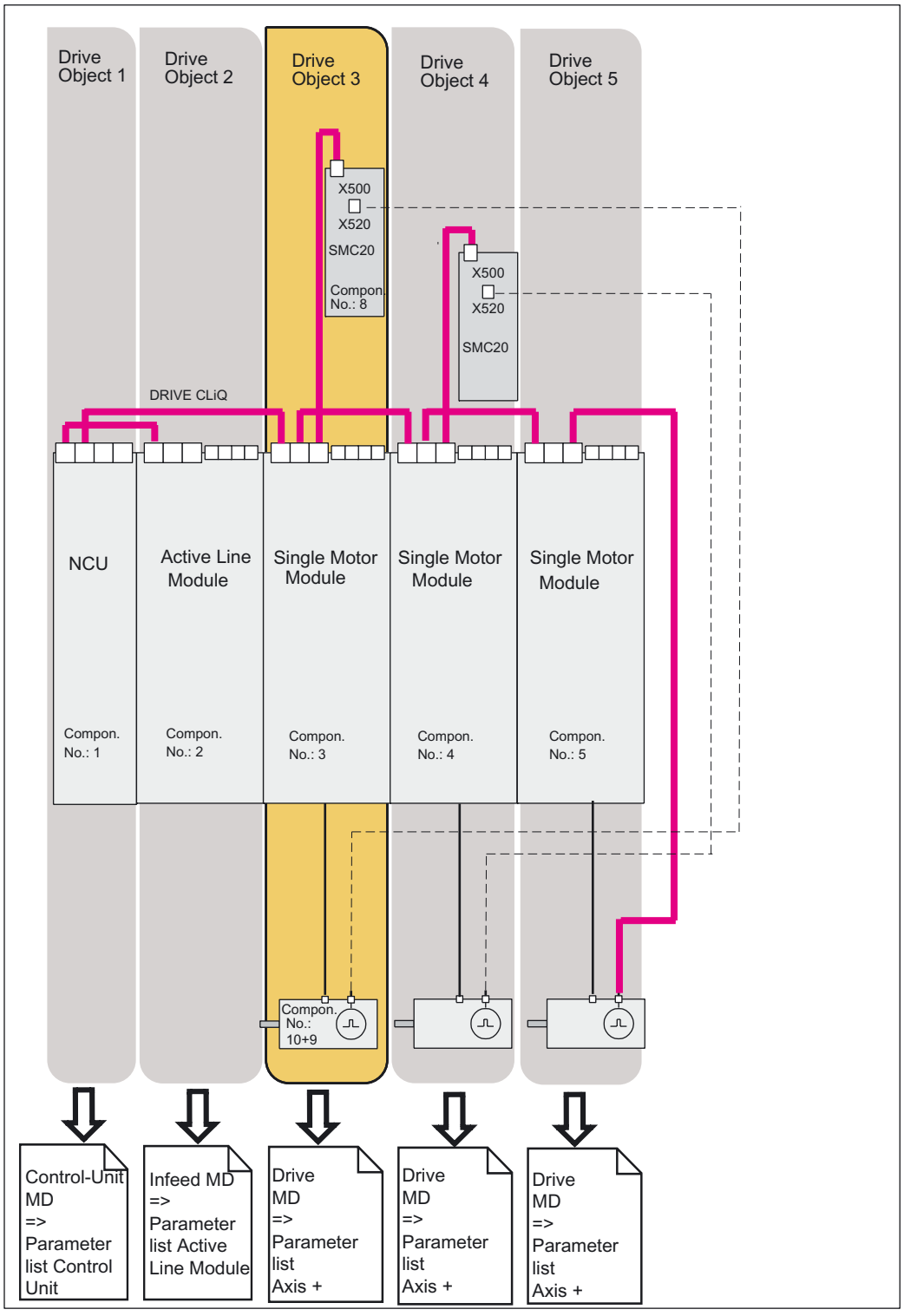


Figure 15-2 Drive group

15.1.3 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).

Note

See also the Commissioning Manual /IH1/ or the Parameter Manual /LH1/ of the SINAMICS S120 documentation.

Visualization of BICO connections on the HMI

In the "Commissioning > Drive systems > Drives/Drive units > Connections" menu you can perform a BICO connection of the SINAMICS drive group associated components.

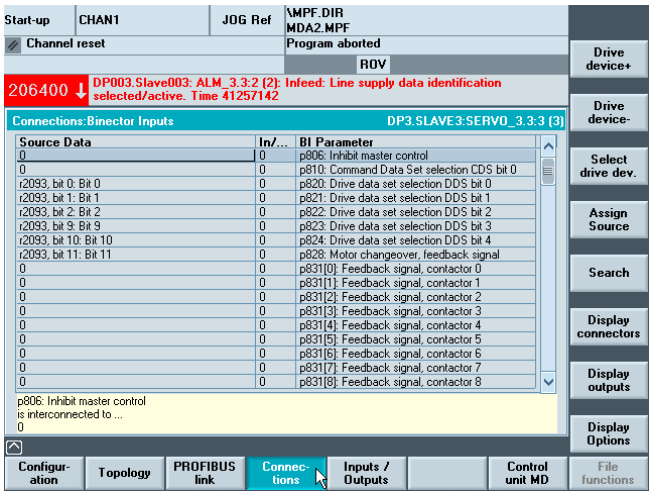


Figure 15-3 "Connections" menu

15.2 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 operating area **Commissioning > Machine data > Control Unit MD** 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

Message frame types

The message frame length for communication with the drive must be defined in the hardware configuration. The message frame length to be chosen depends on the axis functions required, e.g., the number of encoders or DSC, or the functions in the drive used.

Note

If you change the message frame length of a drive component in HW config, you also must adjust the selection of the message frame type in the configuration of the interface in the NCK.

What types of message frames 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 message frame 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 message frame number setting.

  The following vendor-specific telegrams can be set via p0922:

  – For axes (SERVO)

    116 DSC with torque reduction, 2 position encoders, supplementary data (also parameterization)

  – For Control Unit

    390 telegram without probe (for NX)

    391 message frame for up to 2 probes (for NCU)

15.2.1 Structure of the telegram with the process data for SINUMERIK 840D sl

Introduction

SINUMERIK 840D sl uses the following preferred message frame types:

- For axes

  116 DSC with torque reduction, 2 position encoders, supplementary data (also parameterization)

- For NX

  390 message frame without probe (NX)

- For NCU

  391 message frame for up to 2 probes (only valid for NCU)

Note

The telegram types 116, 390 and 391 are preset by default via HW Config. It is recommended not to change these.

Telegrams for receiving

The following table contains the structure of the telegrams with the process data for receiving the control words and setpoints (NCK->drive).

Table 15-2 Telegrams with the process data for receiving (NCK->drive)

PZD receive word	Message frame 116	Message frame 390	Message frame 391
PZD 1	STW1	STW1	STW1
PZD2	NSET_B	Digital outputs	Digital outputs
PZD 3			STW_PROBES
PZD 4	STW2		
PZD 5	MOMRED		
PZD 6	G1_STW		
PZD 7	G2_STW		
PZD 8	XERR		
PZD 9			
PZD 10	KPC		
PZD 11			

Telegrams for sending

The following table contains the structure of the telegrams with the process data for sending the status words and actual values (drive->NCK).

Table 15-3 Telegrams with the process data for sending (drive->NCK)

PZD sending word	Message frame 116	Message frame 390	Message frame 391
PZD 1	ZSW1	ZSW1	ZSW1
PZD2	NACT_B	Digital inputs	Digital inputs
PZD 3			ZSW_PROBES
PZD 4	ZSW2		TIMESTAMP_PROBE_1N
PZD 5	MELDW		TIMESTAMP_PROBE_1P
PZD 6	G1_ZSW		TIMESTAMP_PROBE_2N
PZD 7	G1_XIST1		TIMESTAMP_PROBE_2P
PZD 8			
PZD 9	G1_XACT2		
PZD 10			
PZD 11	G2_ZSW		
PZD 12	G2_XIST1		
PZD 13			
PZD 14	G2_XACT2		
PZD 15			
PZD 16	LOAD		
PZD 17	TORQUE		
PZD 18	POWER		
PZD 19	CURR		

15.2.2 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.

Literature

SINAMICS S120 Commissioning Manual

Abbreviation	Name
STW1	Control word 1
STW2	Control word 2
NSET_A	Speed setpoint A (16-bit)
NSET_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	Positon controller gain factor
MOMRED	Torque reduction
A_CSW1	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 p922).

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.

Literature

SINAMICS S120 Commissioning Manual

Abbreviation	Name
ZSW1	Status word 1
ZSW2	Status word 2
NACT_A	Speed setpoint A (16 bit)
NACT_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
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

15.3 Control- and status-word bits for NCK<->drive communication

15.3.1 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
RFGIS	DB(AX).DBX20.1		4	Ramp-function generator enable
RFGIS	DB(AX).DBX20.1		5	Ramp-function generator Start
		NCK controlled parallel to STW1 bit0	6	Setpoint enable
(DriveReset) is generated by: • "RESET signal" or CANCEL KEY, if a simultaneous drive fault is 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
Is "1", "TRUE", if the NC can control the associated drive AND the drive itself requests that control (ZSW1.bit9)	No signal		10	Control from the PLC
Always "0", "FALSE"	No signal	Signal not used	11	Reserved

Signal provided by NCK	VDI interface (PLC)	Remarks	Bit in STW1	Meaning
"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	Signal not used in conjunction with SINUMERIK, no PROFIDRIVE 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"
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 selection in progress	DB(AX).DBX21.5		11	Motor selection in progress
Master sign-of-life	No signal		12	Master sign-of-life

Signal provided by NCK	VDI interface (PLC)	Remarks	Bit in STW2	Meaning
			13	
			14	
			15	

15.3.2 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	Remarks	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 Bit2 from ZSW1 = 0 and simultaneously Bit11 from the MedW = 1, the drive is in autonomous drive status.	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
nset = nact	8		No signal	No evaluation
Control from the PLC	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

Meaning	Bit in ZSW1	Remarks	VDI interface (PLC)	Signal processing in the NCK
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 ZSW21

Meaning	Bit in ZSW21	Remarks	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 operated	DB(AX).DBX92.3	As signal from SINAMICS not operated: 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	
Motor being changed over	11		No signal	
Slave sign-of-life	12		No signal	Drive sign-of-life
	13			
	14			
	15			

PLC interface for signalW

Meaning	Bit in signal W	Remarks	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		No 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

15.4 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 tool box 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 basic PLC program has been added to or extended.

PLC basic program

For a complete description of the basic PLC program, its structure and all modules including their call parameters, please refer to:

Literature

Function Manual Basic Functions; Basic PLC Program

PLC user program

The organization blocks of the basic machine contain the entry points for the appropriate parts of the PLC user program.

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

The following diagram shows the structure of the PLC program:

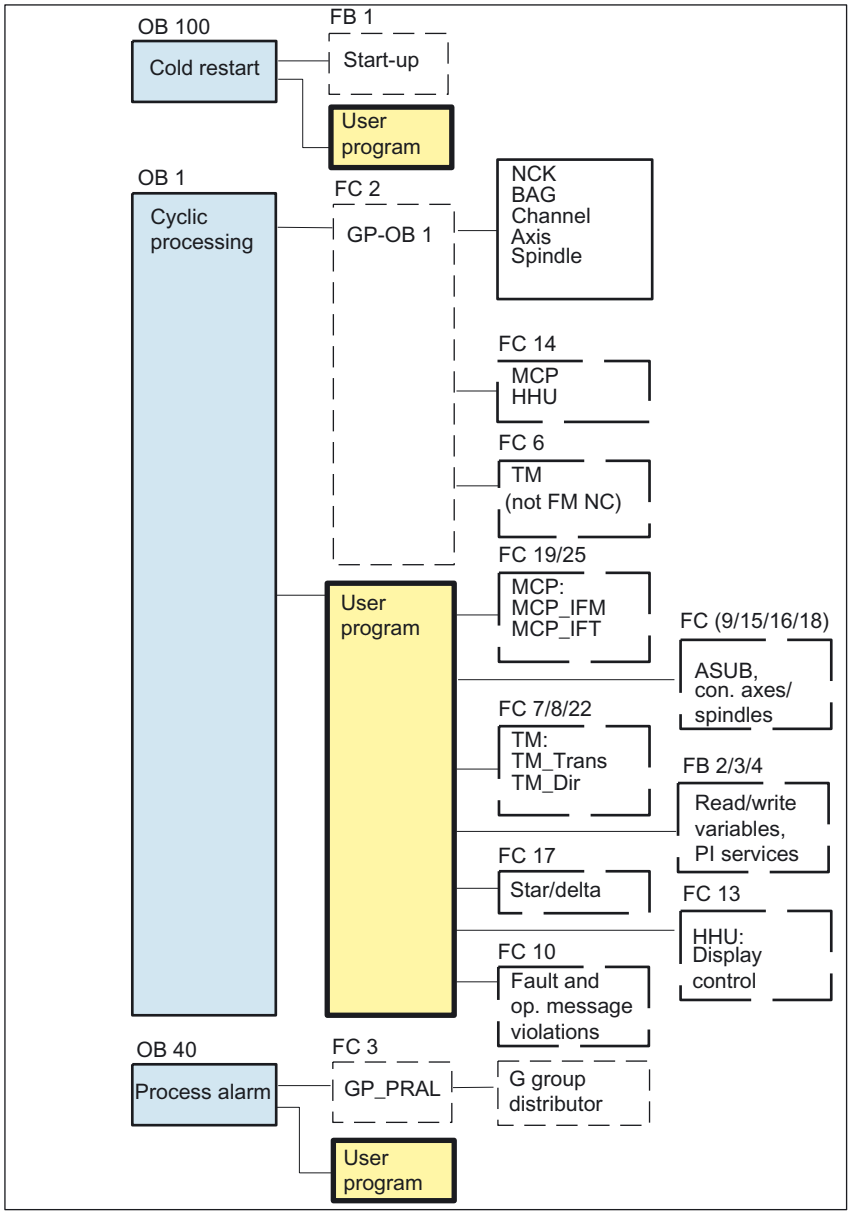


Figure 15-4 PLC program structure

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. There is no re-entry at the point of interruption (e.g. on power failure).

Start-up behavior of the PLC

There are both remanent and non-remanent areas for the markers, times and counter. 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 cancelled
- 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)

Basic program, start-up part (FB1)

FB 1 (start-up block of the PLC program) must be assigned variables.

Parameter FB 1

A precise description of the variables and options for modifying their parameterization is given in:

Literature

Function Manual Basic Functions; Basic PLC Program

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 power-up and the first OB1 cycle have been completed. A PLC failure produces alarm ”2000 Sign-of-life monitoring PLC”.

See also

Creating a PLC program (Page 54)

15.4.1 Fundamentals of creating a PLC user program

Introduction

The following points must be observed when creating a PLC user program:

- Software and hardware prerequisites
- Installing the toolbox (PLC basic program, slave OEM, GSD files)
- Editing the blocks in the PLC basic program

Software and hardware prerequisites

- SIMATIC STEP 7 as from Version 5.3, Service Pack 2
- SIMATIC STEP 7 is installed on the PG/PC

Installing the PLC basic program library

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

Editing the blocks in the PLC basic program

The individual blocks in the basic PLC 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 menu command **Edit > Open Object** 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 menu command **View > LAD** or STL or CSF

See also

Creating a PLC program (Page 54)

15.5 Machine and setting data

Introduction

Adaption of the control at the machine is carried out using the machine and setting data.

Parameter assignment

- Machine data

  The machine data (MD) are 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

- Setting data

  The setting data (SD) are divided into the following areas:

  – General setting data
  – Channel-specific setting data
  – Axis-specific setting data

- Option data

  For enabling options. The option data are included in the scope of delivery.

Overview of machine and setting data

The table below lists the areas for machine and setting data. The List Manual contains a detailed description.

Table 15-4 Overview of machine and setting data

Range	Name
from 2 to 9977	Machine data for drives
from 9000 to 9999	Operator panel machine data
from 10000 to 18999	General machine data
from 19000 to 19999	Reserved
from 20000 to 28999	Channelspecific machine data
from 29000 to 29999	Reserved
from 30000 to 38999	Axisspecific machine data
from 39000 to 39999	Reserved
from 41000 to 41999	General setting data
from 42000 to 42999	Channelspecific setting data
from 43000 to 43999	Axisspecific setting data
from 51000 to 61999	General machine data for compile cycles
from 62000 to 62999	Channel-specific machine data for compile cycles
from 63000 to 63999	Axis-specific machine data for compile cycles

See also

Overview Commissioning NCK (Page 107)

15.5.1 Machine data fundamentals

Introduction

Machine and setting data are parameterized via:

- Number and identifier
- Activation
- Protection levels
- Unit
- Default value
- Value range (minimum and maximum)

Number and identifier

Machine data and setting data are identified using the number or the name (identifier). The number and name are displayed at the HMI.

The identifier of a machine data is subject to the scheme:

- **$ M k** _IdentifierString

  where the following applies:

  – **$**System variable
  – **M**Machine data
  – **k**Component

    k identifies the components of the NC parameterizing the appropriate machine data:

  – **N**NC
  – **C**Channel
  – **A**Axis

The identifier of a setting data is subject to the scheme:

- **$ S k** _IdentifierString

  where the following applies:

  – **$**System variable
  – **S**Setting data
  – **k**Component

    k identifies the components of the NC parameterizing the appropriate machine data:

  – **N**NC
  – **C**Channel
  – **A**Axis

Activation

Activation when referring to a machine data indicates the NC status in which a change to a machine data becomes active.

The levels of effectiveness have been listed below in order of priority. Modification of the machine data takes effect after:

- POWER ON (po) NCK RESET
- NEWCONF (cf)
  - Softkey **Activate MD** at MMC
  - **RESET** key on MCP
  - It is possible to modify block limits during program operation
- RESET (re)
  - at end of program M2/M30 or
  - **RESET** key on MCP
- IMMEDIATE (so)
  - After entry of value

Note

Unlike machine data, changes to setting data always become effective **immediately**.

Protection levels

Access level 4 (keyswitch position 3) or more is required to display machine data.

To start up the system the appropriate access level must generally be enabled by entering the password "EVENING".

Unit

The unit refers to the standard setting of the machine data:

SCALING_FACTOR_USER_DEF_MASK,

SCALING_FACTOR_USER_DEF and

SCALING_SYSTEM IS METRIC = 1.

If the machine data is not based on an engineering unit, then the field is marked with ”-”.

Default value

The machine data/setting data is preset to this value.

Note

Inputs via HMI are limited to ten digits plus comma and sign.

Value range (minimum and maximum)

Specifies the input limits. If no range of values is specified, the data type determines the input limits and the field is marked with "***".

15.5.2 Handling the machine data

Introduction

To display and input machine data, appropriate screen forms are provided.

Example

Selection of displays:

When yóu press the **Area Switchover** key on the HMI, the menu bar appears with the following areas: **Machine**, **Parameter**, **Program**, **Services**, **Diagnostics** and **Installation and Start-Up**. Press **Installation and Start-Up** and then **Machine data**.

Note

For the input of machine data, the protection level 2 password "EVENING" has to be set at the least.

Screen editor for HEX machine data

A bit editor has been implemented to simplify the matter of setting certain machine data bits. If the input cursor is on a machine data in HEX format in the MD list, you can call up the editor by pressing the toggle key (in the middle of the cursor keys).

You can set or reset single bits by clicking them with the mouse or by selecting them with the cursor keys and then pressing the toggle key.

- With the soft key **OK**, you can terminate the bit editor and accept the value set.
- With the soft key **Abort**, you can quit the bit editor and discard the value set. The previous setting is then valid again.

15.6 Protection levels

Introduction

Access to programs, data and functions is useroriented and controlled via eight hierarchical protection levels. These are divided into

- 4 password levels for Siemens, machine manufacturer, start-up personnel, and end user
- 4 key switch positions for end user

Protection levels

There are protection levels 0 to 7 (see table below), where

- 0 is the highest and
- 7 is the lowest level.

Table 15-5 Protection level concept

Protection level	Locked by	Range
0	Password	Siemens
1	Password: SUNRISE (default)	Machine manufacturer
2	Password: EVENING (default)	Installation engineer, service
3	Password: CUSTOMER (default)	End user
4	Key switch position 3	Programmer, machine setter
5	Key switch position 2	Qualified operator
6	Key switch position 1	Trained operator
7	Key switch position 0	Semi-skilled operator

Interlock

Protection levels

- 0 to 3 are locked by means of a password and
- 4 to 7 by means of keyswitch positions (see table below).

Table 15-6 Keyswitch settings

Keyswitch setting	Retraction pos.	NC password level	User group
	0 or 1 or 2 or 3 Red key	4 (highest access level)	Programmer, machine setter
	0 or 1 or 2 Green key	5 (increasing access rights)	Qualified operator
	0 or 1 Black key	6 (increasing access rights)	Trained operator
	-	7 (lowest access level)	Semi-skilled operator

Protection levels for machine data

The machine data is assigned different protection levels by default.

Access level 4 (keyswitch position 3) or more is required to display machine data.

Note

To start up the system the appropriate access level must generally be enabled by entering the password "EVENING".

You can find additional change options of protection levels at:

Literature

Function Manual Basic Functions; Diverse Interface Signals

15.6.1 Protection level fundamentals

Introduction

You can influence the protection levels used with passwords via softkeys.

Press the "HMI" -> "Password" softkey in the “Startup” operating area. The following softkeys are available:

- Setting the password
- Change password
- Delete password

Set password

1. Press the softkey "Set password." The "Please enter password:" input window appears.
2. Enter one of the possible default passwords (see table "Protection levels concept") and confirm the entry with the softkey "OK." A permissible password is set and the valid access level is displayed. Invalid passwords will be rejected.

Change password

For secure access protection, you should change the default passwords

1. Press the "Change password" softkey. The current access level is displayed in the window that opens.
2. Mark the area for which you would like to assign the new password. You can select the following areas here:
   - System
   - Vendor
   - Service
   - User
3. Enter the new password in the input fields "New password" and "Repeat password."
4. Confirm the entry with the softkey "OK." Both entered passwords must match for the modified password to become valid.

Delete password

1. Press the softkey "Delete password" in order to reset the access authorization.

Access authorization is not automatically deleted at POWER ON!

NOTICE
For a system boot in which standard machine data is loaded, the passwords are set to the default values.

15.7 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

15.7.1 Axis configuration

Introduction

The figure below shows the assignment between the geometry axes, special axes, channel axes and machine axes as well as the names of the individual axis types. MD are used for assignment.

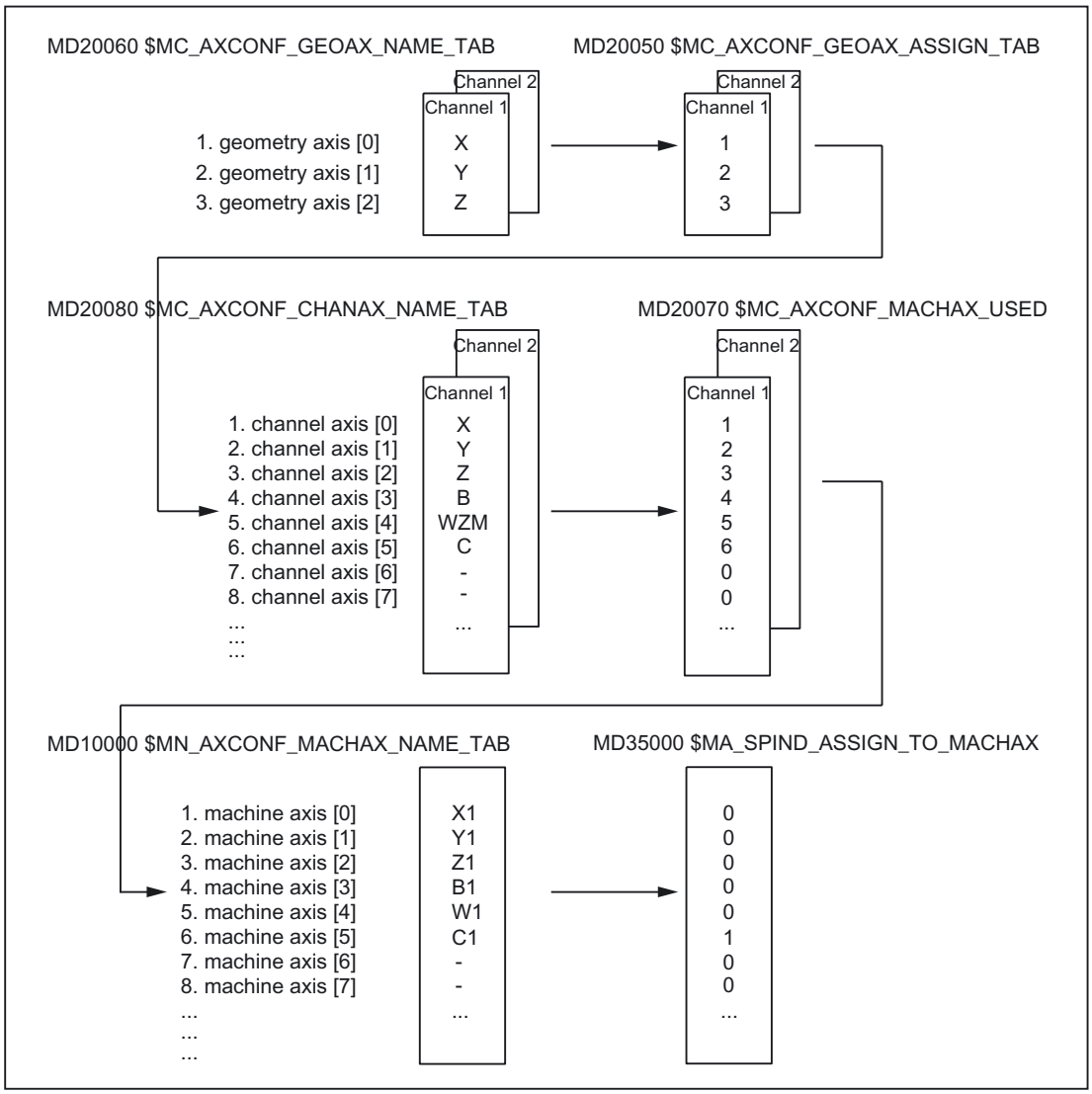


Figure 15-5 Axis configuration

Note

Leading zeroes in user-defined axis identifiers are ignored.

Example:

MD10000 AXCONF_MACHAX_NAME_TAB[0] = X01 is equivalent to X1

The geometry axes must be assigned to the channel axes in ascending order leaving no gaps.

Special features

- Three geometry axes are assigned to the channel axes in the MD.
- All channel axes that are not assigned to the three geometry axes are special axes.
- The channel axes are assigned to machine axes.
- The spindles are also assigned to machine axes.

Channel axis gaps

Channel axes need not be defined contiguously in ascending order, in other words, not each channel axis needs to have a machine axis assigned to it (local or link axis). The assignment occurs as follows:

- MD20080 AXCONF_CHANAX_NAME_TAB
  via:
- MD20070 AXCONF_MACHAX_USED

Application:

Consistent, semidefined channel axes for various machine versions of a manufacturer's machine series.

Advantages:

- Uniform basic configuration of various machines
- Simple reconfiguration on removal of a machine
- Portability of programs

Reliability of channel axis gaps

Channel axis gaps must be disconnected via the machine data:

- MD11640 ENABLE_CHAN_AX_GAP = 1 (Channel axis gap allowed).

If this is not carried out, an entry of 0 in the machine data
MD20070 AXCONF_MACHAX_USED
prevents other machine axes being assigned to channel axes.

Literature

Function Manual, Expanded Functions; Several Control Panels on Multiple NCUs, Decentralized Systems

Example

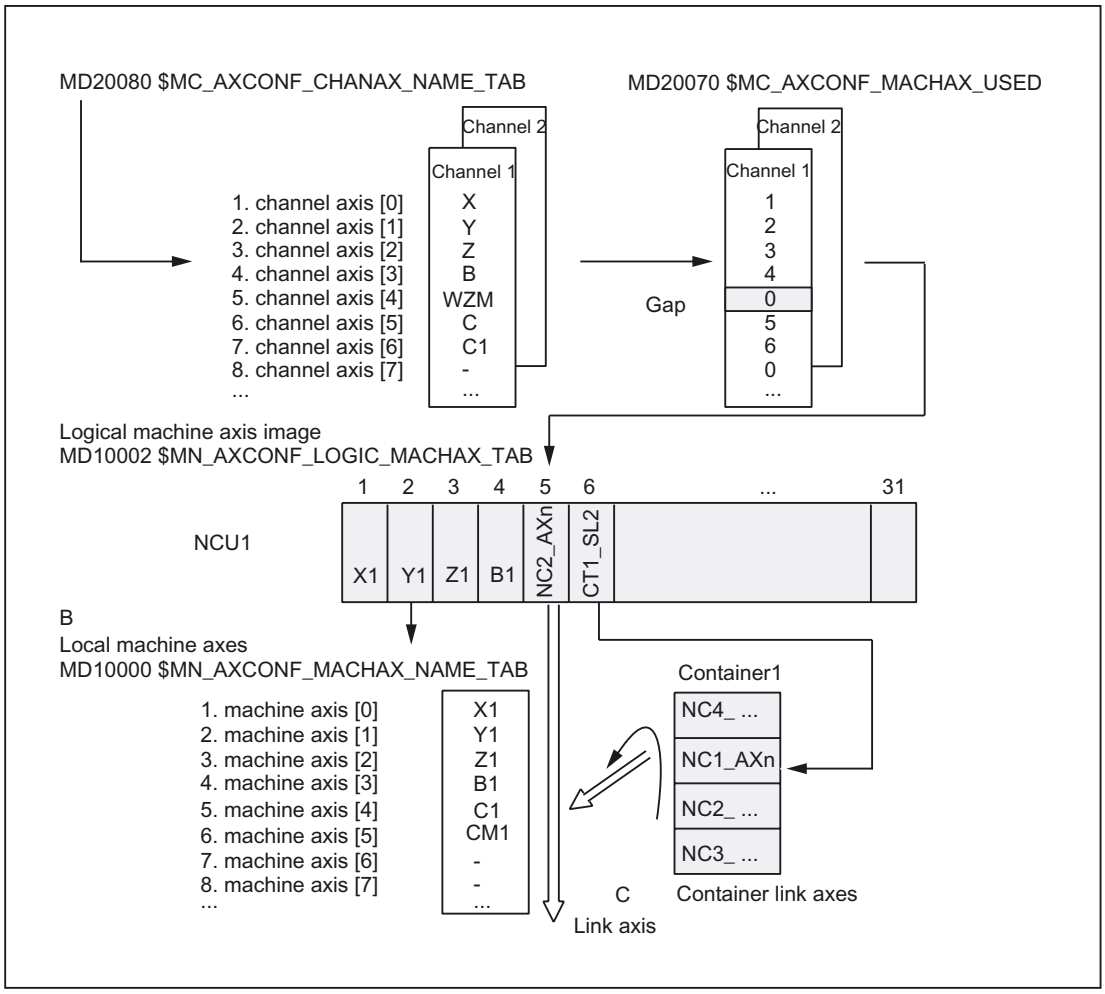


Figure 15-6 Axis configuration with channel axis gap

Note

The gaps count as axes with reference to the number of channel axes and their indices.

If an attempt is made to define a channel axis gap on the geo axis via the machine data MD20050 AXCONF_GEOAX_ASSIGN_TAB
, the attempt is
rejected without an alarm.

Using channel axes in
MD24120ff. TRAFO_GEOAX_ASSIGN_TAB1...8
and
MD24110ff. TRAFO_AXES_IN1...8
, to which no machine axes are defined using
MD20070 AXCONF_MACHAX_USED
(gap),
triggers alarms 4346 or 4347.

15.7.2 Axis assignment

Introduction

The assignment of machine, channel and geometry axes is carried out using the relevant machine data.

Axis assignment

The following diagram illustrates the assignment of the relevant machine data:

- Machine axes of the NC
- Channel axes of the channel
- Geometry axes of the channel

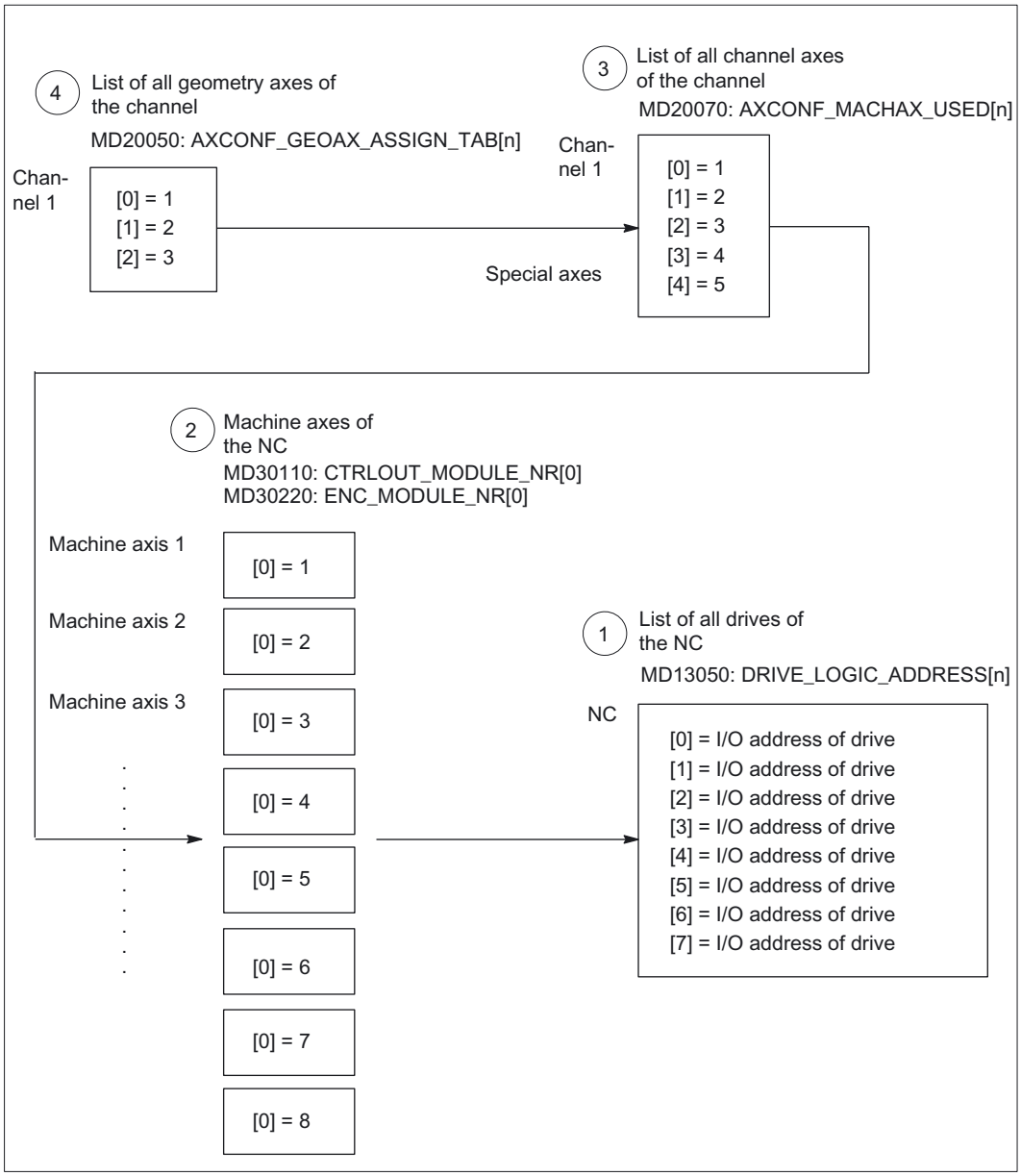


Figure 15-7 Axis assignment

(1) The I/O addresses of the drives defined in the S7 project using "HW Config" are contained in the following machine data.

MD13050: DRIVE_LOGIC_ADDRESS[n] (I/O address of the drive)

The machine data index (n+1) is the logical drive number for the NC.

(2) Te following machine data are used to assign each individual machine axis to a drive.

MD30110: MODULE_NR[0] (setpoint assignment)

MD30220: ENC_MODULE_NR[0] (actual-value assignment)

The logical drive number m to be entered in the two machine data refers to the entry with the index n=(m-1) in the list described under Point 1 MD13050: DRIVE_LOGIC_ADDRESS[n].

(3) Which channel axis uses which machine axis (explicite) and how many channel axes are present in the channel (implicite) is detemined through the following machine date:

MD20070: AXCONF_MACHAX_USED[n] (machine axis number valid in channel)

The machine axis number m to be entered in the machine data (with m=1,2,3...) is referred to the appropriate machine axis m.

(4) Which channel axis uses which machine axis (explicitly) and how many channel axes can be implicitly available in a channel is defined by the following machine data:

MD20050: AXCONF_GEOAX_ASSIGN_TAB[n] (assignment geometry axis - channel axis) (n = 0...2)

The channel axis number k to be entered in the machine data (k=1,2,3...) is referred to the entry with the index n (n=(k-1)=0,1,2...) in the list of the channel axes MD20070: AXCONFIG_MACHAX_USED[n] (see Point 3).

Machine data

The following machine data are relevant for the axis configuration:

Table 15-7 Axis configuration: Machine data

Number	Name of identifier	Name / remarks
General ($MN_ ...)		
13050	DRIVE_LOGIC_ADDRESS	I/O address of drive
Channelspecific ($MC_ ...)		
20050	AXCONF_GEOAX_ASSIGN_TAB	Assignment of geometry axis to channel axis
20070	AXCONF_MACHAX_USED	Machine axis number valid in channel
Axisspecific ($MA_ ...)		
30110	CTRLOUT_MODULE_NR	Setpoint assignment
30220	ENC_MODULE_NR	Actual-value assignment

15.7.3 Axis names

Introduction

Each machine, channel and geometry axis can/must be assigned an individual name unambiguously identifying it in its name range.

Machine axes

The name of the machine axes are defined via the following machine date:

MD10000: 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: 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: AXCONF_GEOAX_NAME_TAB[n] (name of the 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:

Table 15-8 Axis names: Machine data

Number	Name of identifier	Name / remarks
General ($MN_ ...)		
10000	AXCONF_MACHAX_NAME_TAB	Machine axis name
Channelspecific ($MC_ ...)		
20060	AXCONF_GEOAX_NAME_TAB	Geometry axis name in channel
20080	AXCONF_CHANAX_NAME_TAB	Channel axis name/special axis name in channel

15.7.4 Setpoint/actual value channels

Introduction

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

Note

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

- MD30130 CTRLOUT_TYPE (output type of setpoint value) = 0
- MD30240 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.

Machine data

- MD30350 SIMU_AX_VDI_OUTPUT (output of axis signals with simulation axes)

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

Assignment of the setpoint/actual value channels

For each machine axis to which a drive is assigned,

- a setpoint channel and
- at least one actual-value channel

must be parameterized.

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 two axis-specific machine data:

- MD30110 CTRLOUT_MODULE_NR[0] (setpoint assignment: logical drive number)
- MD30220 ENC_MODUL_NR[n] (actual value assignment: logical drive number)

the index m for the DRIVE_LOGC_ADRESS of the drive is entered, which represents the machine axis.

The entered value m refers to the drive whose I/O address is defined under the index n = (m-1) in MD13050 DRIVE_LOGIC_ADDRESS[n] (see Chapter "Drive Configuration").

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 interface signals

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

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

Literature

Function Manual Basic Functions; Diverse Interface Signals

Machine data

Table 15-9 Setpoint/actual value channels: Machine data

Number	Name of identifier	Name/remarks	Reference
Axisspecific ($MA_ ...)			
30110	CTRLOUT_MODULE_NR	Setpoint assignment: Logical drive number	
30130	CTRLOUT_TYPE	Output of setpoint value 0 = Simulation 1 = Output of speed setpoint	
30200	NUM_ENCS	Number of measuring channels 1 = One position measuring system present 2 = Two position measuring systems present	
30220	ENC_MODULE_NR[0]	Actual value assignment: Logical drive number for position measuring system 1	
30220	ENC_MODULE_NR[1]	Actual value assignment: Logical drive number for position measuring system **2**	
30230	ENC_INPUT_NR[0]	Actual value assignment: Position measuring system 1 1 = G1_XIST encoder 1 actual position value 1 2 = G2_XIST encoder 1 actual position value 2	
30230	ENC_INPUT_NR[1]	Actual value assignment: Position measuring system **2** 1 = G1_XIST encoder 2 actual position value 1 2 = G2_XIST encoder 2 actual position value 2	
30240	ENC_TYPE[0]	Type of actual value recording 0 = Simulation 1 = Incremental encoder 4 = Absolute encoder with EnDat interface	

Interface signals

Table 15-10 Switchover of position measuring system: Interface signals

DB number	Bit, byte	Name	Reference
Axis/spindle-specific		**Signals from PLC to axis/spindle**	
31, ...	1.5	Position measuring system 1	
31, ...	1.6	Position measuring system 2	

Literature

Function Manual Basic Functions;
Speeds, Setpoint/actual-value systems, Control: Setpoint/actual-value system

Function Manual Basic Functions;
Diverse Interface Signals: Interface signals to axis/spindle

15.8 Spindle data

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 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: IS_ROT_AX (rotary axis/spindle)
- MD30310: ROT_IS_MODULO (modulo conversion for rotary axis/spindle)
- MD30320: DISPLAY_IS_MODULO (modulo 360 degrees display 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: 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.

15.8.1 Spindle modes

Spindle modes

The spindle can have the following modes:

- Control mode
- Oscillation mode
- Positioning mode
- Synchronous mode, synchronous spindle
- Rigid tapping

References:
/FB2/ Function Manual Extended Functions; Synchronous Spindle (S3)
/PG/ Programming Manual, Fundamentals
/PGZ/ Programming Manual, Cycles

Axis mode

The spindle can be switched from spindle mode to axis mode (rotary axis) if the same motor is used for spindle and axis operation.

15.8.2 Initial spindle state

Initial spindle state

The following machine data is used to specify a spindle mode as initial state:

MD35020 $MA_SPIND_DEFAULT_MODE

Value	Initial spindle state
0	Speed control mode, position control deselected
1	Speed control mode, position control activated
2	Positioning mode
3	Axis mode

Time when the initial spindle state takes effect

The time when the initial spindle state 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)

15.8.3 Axis mode

Why axis mode?

For certain machining tasks (e.g. on lathes with end-face machining), the spindle not only has to be rotated with M3, M4 and M5 and positioned with SPOS, M19 and SPOSA, but also addressed as an axis with its axis identifier (e.g. "C").

Prerequisites

- 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.
- A position actual-value encoder is a mandatory requirement for axis mode.
- If the axis is not synchronized, e.g. M70 is programmed after POWER ON, the axis must first be referenced with G74. Only then does the mechanical position match the programmed one.

  Example:

```
M70
G74 C1=0 Z100
G0 C180 X50
```

Configurable M function

The M function used to switch the spindle to axis mode can be configured in the machine data:

MD20094 $MC_SPIND_RIGID_TAPPING_M_NR

The value on delivery is 70.

Functionality

If the axis mode is active and the rotary axis homed, all axis functions can be used.

References:
/FB2/Function Manual, Extended Functions; Rotary Axes (R2)

The most important functions are:

- Programming with axis name
- Use of zero offsets (`G54, G55`, `TRANS`, etc.)
- `G90`, `G91`, `IC`, `AC`, `DC`, `ACP`, `ACN`
- Use of kinematic transformations (e.g. `TRANSMIT`)
- Interpolation with other axes (path interpolation)
- Programming as a positioning axis

Special points to be noted

- The feed override switch is active.
- NC/PLC IS:
  DB21, ... DBX7.7 (Reset)
  does not terminate axis mode as standard.
- 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 position actual-value encoder is installed on the motor (indirect measurement system), the positioning and contouring accuracy may 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 axis mode, the machine data of the parameter set with index zero are effective in order to carry out adaptation in this mode.

Transition to axis mode

The transition to axis mode is performed by programming:

- the spindle with axis name
- from `M70` (or with the `M` function configured with MD20094 $MC_SPIND_RIGID_TAPPING_M_NR)

The relevant machine data when changing the servo parameter set are:

Machine data	Meaning
MD31050 $MA_DRIVE_AX_RATIO_DENOM	Measuring gear denominator
MD31060 $MA_DRIVE_AX_RATIO_NUMERA	Numerator load gearbox
MD32200 $MA_POSCTRL_GAIN	K_V factor
MD32452 $MA_BACKLASH_FACTOR	Weighting factor for backlash
MD32610 $MA_VELO_FFW_WEIGHT	Weighting factor for feedforward control
MD32800 $MA_EQUIV_CURRCTRL_TIME	Equivalent time constant current control loop for feedforward control
MD32810 $MA_EQUIV_SPEEDCTRL_TIME	Equivalent time constant speed control loop for feedforward control
MD32910 $MA_DYN_MATCH_TIME	Time constant for dynamic matching
MD36012 $MA_STOP_LIMIT_FACTOR	Factor for exact stop coarse/fine and zero speed control
MD36200 $MA_AX_VELO_LIMIT	Velocity monitoring threshold value

The dynamic limits of the axis stored in the machine data are applicable in axis operation.

The axis switches to the current feedforward control mode as designated by the MD and the commands `FFWON` and `FFWOF`.

Other notes on the servo parameter set:
References:
/FB1/Function Manual, Basic Functions; Velocities, Setpoint/Actual-Value System, Closed-Loop Control (G2)

When using resolution changes in (analog) drive actuators, the following NC program steps are required:

1. Changeover 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
```

2. Switch back to spindle mode

```
Programming                Comment
C=...
M71                        ; → 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                     ; NC traverses with spindle parameter set
or
SPOS=...
```

Change to spindle mode

The interpolation parameter (set 1 ... 5) is selected according to the currently valid gear step.

The feedforward control function is always activated, except for tapping with compensating chuck.
Machine data:
MD32620 $MA_FFW_MODE (feedforward control type)
must always be not equal to 0.

Feedforward control should always be operated with the value 100% to avoid alarms being output during positioning.

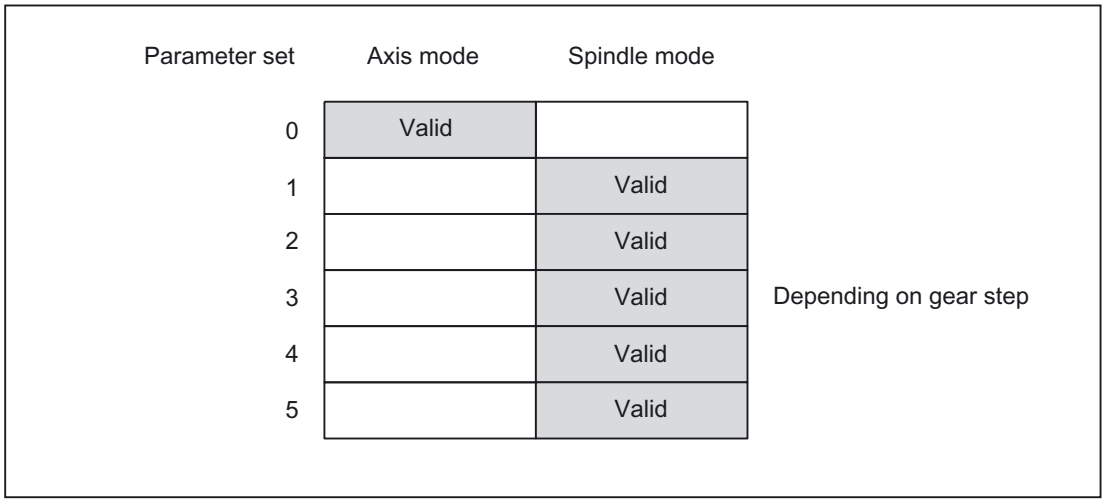


Figure 15-8 Validity of parameter sets for axis and spindle modes

Master spindle

In order to use diverse spindle functions in one channel, like for instance

- Revolutional feed (G95)
- Tapping with compensation chuck (G63)
- Thread cutting (G33)
- Dwell time in spindle revolutions (G4 S...)

it is necessary to define a master spindle in each channel:

- MD20090: SPIND_DEF_MASTER_SPIND (master spindle initial setting in channel)

The spindle number defined in machine data MD35000: SPIND_ASSIGN_TO_MACHAX (spindle number) of the channel spindle that ist be used as master spindle is entered in this machine data.

Spindle reset

The following machine data defines whether the spindle is to remain active after reset (IS: DB21,... DBX7.7) or end of program (M02/M30).

- MD 35040: SPIND_ACTIVE_AFTER_RESET (spindle active after reset)

To cancel spindle movements, an independent spindle reset is required:

- IS: DB31,... DBX2.2 (spindle reset)

Literature

Function Manual Basic Functions; Spindles

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 Computerized numerical control
CO	Connector output
CoL	Certificate of License
CP	Communications Processor: Communication 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 I/O
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
HMI	Human Machine Interface: SINUMERIK operator interface for operating, programming, and simulation
IBN	Start up
IPO	Interpolator cycle
JOG	JOG mode: manual mode for setting up the machine
LAN	Local Area Network
LED	Light Emitting Diode: light-emitting-diode display
LR	Position controller
LUD	Local User Data
MAC	Media Access Control
MCIS	Motion Control Information System
MCP	Machine Control Panel
MD	Machine data
MSGW	Message word
MLFB	Machine-readable product designation
MM	Motor module
MCP	Machine control panel
NC	NCK
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 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: programmable logic control (component of the CNC controller)
PUD	Global Program User Data
PD	Process date
RAM	Random Access Memory: 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	Solution Line Module
SMC	Sensor Module Cabinet-Mounted

SME	Sensor Module Externally Mounted
SMI	Sensor Module Integrated
SRAM	Static RAM: static RAM (battery-backed)
STW	Control word
GWPS	Grinding wheel peripheral speed
TCU	Thin Client Unit (communication with operator panels)
USB	Universal Serial Bus
VDE	Association of Electrical Engineering, Electronics and Information Technology
VO	Voltage output
STW	Status Word

A.2 Small SINAMICS Glossary

Active Line Module

Controlled, self-commutating feed/feedback unit (with -"IGBT"s in feed/feedback direction), which supplies the DC link voltage for the -> "Motor module".

Drive

The drive includes the motor (electric or hydraulic), the actuator (converter, valve), the control unit, 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, actuator, and control component form a single device; with an inventor system (e.g. -> "SINAMICS S"), the supply is ensured by means of -> "Line Module", thereby realizing a DC line to which the -> "Invertors" (-> "Motor Module"s) are connected. The (–> "Control unit") is implemented as a separate device and connected to the other components by means of –> "DRIVE-CLiQ".

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 –> "Drive"s can be implemented in a drive unit.
See –> "Drive System".

Drive component

Hardware component connected to a –> "Control Unit" via –> "DRIVE-CLiQ", for example. Drive unit are for instance: -> "Motor Module"s, -> "Line Module"s, -> "Motor"s, -> "Sensor Module"s and -> "Terminal Module"s.

The overall layout of a Control Unit together with the connected drive components is called -> "Drive unit".

Drive object

A drive object is an autonomous, individual software function with its own -> "Parameters" and may also have its own -> "Fault"s and -> "Alarm"s. 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

The drive system includes all the components in a product family (e.g. SINAMICS). A drive system comprises, for example, -The drive system includes all the components in a product family (e.g. SINAMICS). A drive system comprises, for example, SINAMICS. A drive system comprises -> "Line Module"s, -> "Motor Module"s, -> "Sensors", -> "Motors", -> "Terminal Module"s and -> "Sensor Module"s as well as additional components (reactors, filters, cables, etc.).
See -> "Drive unit"

Drive group

A drive group comprises a -> "Control Unit" and the and the -> "Motor Module"s and -> "Line Module"s connected via -> "DRIVE-CLiQ".

CompactFlash Card

Memory card for non-volatile storage of the drive software and corresponding –> "Parameters". The memory card can be plugged into the –> "Control Unit" from outside.

Control unit

Central control module in which the closed-loop and open-loop control functions for one or more -> ”SINAMICS” -> ”Line Module”s and/or -> ”Motor Module”s 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

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-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 Module"s, -> "Motor Module"s, -> "Motor"s, 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 transmit 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"

Supply

Input component of a converter system for generating a DC link voltage to supply one or more -> "Motor module"s, including all the required components (e.g. -> "Line module"s, fuses, reactors, line filters, and firmware, as well as proportional computing power (if required) in a -> "Control unit".

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".

Encoder

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 Sensor") or mounted on the external mechanics (– "External Sensor"). Depending on the type of movement, a distinction is made between rotary sensors ("rotary transducers") and translatory sensors (e.g. - Linear Sensors). In terms of measured value provision, a distinction is made between –> "Absolute Sensor"s (code sensors) and –> "Incremental Sensors"s.
See –> "Incremental Sensor TTL/HTL" –> "Incremental Sensor sin/cos 1 Vpp" –> "Resolver".

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)

Line Module

A Line Module is a power component that generates the DC link voltage for one or more –> "Motor Module"s 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".

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 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 Module"s and –> "Double Motor Module"s are available.

Motor encoder

A –> "Sensor" (e.g. –> "Resolver", –> "Incremental Sensor TTL/HTL", or –> "Incremental Sensor sin/cos 1 Vpp" that is integrated in or attached to the motor.
The sensor detects the motor speed. In the case of synchronous motors, it can also detect the rotor position angle (of the commutation angle for the motor currents).
For drives without an additional –> "Direct Position Measuring System", it is also used as a –> "Position Sensor" for position control.
In addition to the motor encoders, –> "External Sensor"s for –> "Direct Position Sensing" are available.

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".

PROFIBUS

Field bus 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 Drive

An electric servo drive comprises a motor, a –> "Motor Module", a –> "Servo Control" and, in most cases, a speed and position –> "Sensor"
Electric servo drives are normally extremely precise and have a high dynamic response. They are designed for cycle times to 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.

Servo Control

For -> "Motor"s 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.

SITOP Power

Components for –> "Electronics Power Supply".
Example: 24 V DC

Smart Line Module

Unregulated line infeed/feedback unit with a diode bridge for the infeed and stall-protected, line-commutated feedback via -> "IGBT"s.
The Smart Line Module supplies the DC link voltage for the -> "Motor Module"s.

Control 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 (–> "Sensorless Vector Control") and speed-torque control with speed feedback (–> "Sensor").

Status Word

Bit-coded -> "Process data" word, transmitted by -> "PROFIdrive" at cyclic intervals to control the drive states.

A.3 Publication-specific information

A.3.1 Feedback on the documentation

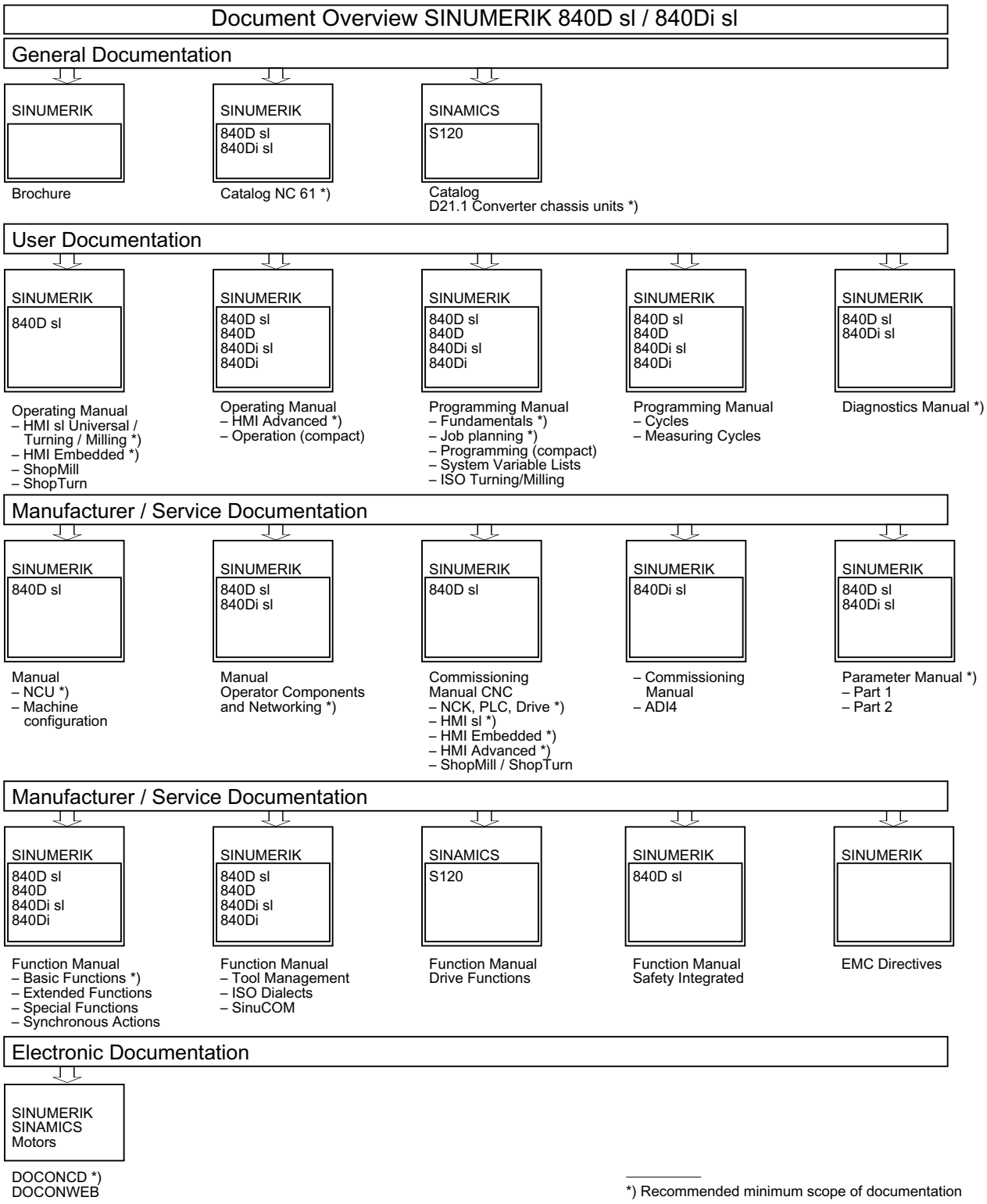
This document will be continuously improved with regard to its quality and ease of use. Please help us with this task by sending your comments and suggestions for improvement via e-mail or fax to:

E-mail:	mailto:docu.motioncontrol@siemens.com
Fax:	+49 (0) 9131/98 - 63315 Please use the fax form on the back of this page.

To:	From
SIEMENS AG A&D MC MS1 Postfach 3180 91050 ERLANGEN, GERMANY	Name:
	Address of your Company/Dept.
	Street:
	Zip code: City:
	Phone: /
Fax: +49 (0) 9131/98 - 63315 (documentation)	Fax: /

Suggestions and/or corrections

A.3.2 Overview



Index

A

Absolute encoders, 171
  Calibration of multiple axes, 173
  Operator-assisted calibration, 172
  Recalibration, 173
Absolute measuring systems
  Parameterization, 135
Acceleration, 148
  Checking, 148
Active Line Module, 347
Assign axis, 104
Assigning actual-value channels, 335
Assigning setpoint channels, 335
Assignment
  General and axis-specific machine data, 102
Automation License Manager, 275, 283
Axis
  Monitoring functions, 156
  Parameter sets, 129
  Reference point approach, 164
  Velocity matching, 153
Axis configuration, 327

B

BICO connections on the HMI, 302
Brake behavior OFF3, 214

C

CF card, 273, 277
Changing the password, 325
Channel axes, 326
Circularity test, 195
Clamping tolerance, 157
CoL, 273, 277
Cold restart, 336
Communication parameters, 285
CompactFlash card, 277, 348
Computational resolution, 108
Contour monitoring, 160
Control direction, 145
Control image (offline), 294
Control system (online), 283, 289, 294
  Switchover, 287, 289
Control unit, 348
Control Word, 351
Current control loop
  Measurement, 199
Customer login, 276
Cycle times, 119

D

Data backup DRIVE-CLiQ motors, 216
DB 31, ...
  DBB16-19, 341
  DBB82-91, 341
  DBX60.0, 341
DB21, ...
  DBX7.7, 341
Deleting the password, 325
Detailed view, 45
Direct access, 276
Display resolution, 108, 109
Distancecoded reference marks, 168
Double Motor Module, 349
Download to target system, 295
Download to Target System, 295
drift compensation, 152
Drive, 347
Drive component, 347
Drive components, 299
Drive group, 348
Drive object, 299, 348
drive parameters, 348
Drive states, 239
Drive system, 348
Drive unit, 347
DRIVE-CLiQ, 349
DSC, 138
Dynamic monitoring functions, 159
  Velocity monitoring, 160
Dynamic servo control, 138

E

Encoder frequency limit, 188
Encoder Monitoring
    Cut-off frequency, 161
    Cyclic monitoring of position tolerance, 162
    Position tolerance when switching over the encoder, 162
    Zero mark monitoring, 162
Encoder types
    Absolute measuring system, 135
Encoders, 349
Endlessly rotating rotary axis, 140
EQN 1325, 135
Ethernet connection, 275
Exact stop
    Coarse, 156
    Fine, 156
External Encoder, 349
external HMI, 15, 17

F

Factory settings, 66
Firmware version drive components, 243
Firmware version measuring systems, 243
Function Overview, 282

G

Gear stage speed, 187
GEAR_STEP_PC_MAX_VELO_LIMIT, 178
Geometry axes, 326

H

Hardware, 273
Hardware limit switches, 158
Hardware reference, 278
Hardware serial number, 274, 277
Hirth axes, 143
HMI Advanced, 17, 277, 285
HMI basic software, 283, 285
HMI Embedded, 16
Hub, 350
Hub Module Cabinet, 349
HW-Config, 45

I

Identification of the ALM, 245
Incremental measuring systems
    Parameter ization, 131
Indexing axes, 143
Indexing position tables, 143
Input limits, 109
Input resolution, 108
Inputs/outputs, 249
Installed components, 283
Interface signals, 41
Interlock, 323
internal HMI, 15
Internal HMI, 16
Internet, 294
Internet connection, 290
Interpolation cycle, 121
Intranet, 290
Intranet connection, 275
IP address, 286

J

JOG axis velocity, 153

K

Key
    *, 288
    F5, 288
KV factor
    Definition, 146

L

License, 273
License database, 275, 276
License information, 277, 289
License key, 274
License Key, 278
    copying, 278
    SINUMERIK, 278
License number, 273
License requirement, 289
Line Module, 350
Linear axis
    With linear scale, 133
    with rotary encoder on motor, 135
    With rotary encoder on motor, 131
    With rotary encoder on the machine, 132
Linear measuring system, 133

M

Machine axes, 326
Machine data
  Changing scaling, 114
  Loading of default data, 115
  Normalization of physical quantities, 111
Manufacturer-specific telegrams, 304
Max. axis velocity, 153
MCI board, 273
MD10000, 328
MD10002, 328
MD10050 SYSCLOCK_CYCLE_TIME, 123
MD1061 POSCTRL_CYCLE_TIME, 123
MD1070 IPO_SYSCLOCK_TIME_RATIO, 123
MD1071 IPO_CYCLE_TIME, 123
MD11640, 328
MD20050, 330
MD20070, 328, 330
MD20080, 328
MD20094, 340, 341
MD24110, 330
MD24120, 330
MD31050, 342
MD31060, 342
MD32200, 342
MD32452, 342
MD32610, 342
MD32620, 343
MD32800, 342
MD32810, 342
MD32910, 342
MD35020, 339
MD35030, 339
MD36012, 342
MD36200, 342
Measurement of speed control loop, 201
Measuring functions, 195, 196
  Cancel, 198
  Start, 197
Measuring system switchover
  Interface signals, 336
Menu command
  Edit, 284
  Connect to target system, 284
  PlugIn SINUMERIK, 284
  Refresh, 288
  View, 288
  Upload from target system, 291
  Download to target system, 295
MMC.INI, 285
Modulo axis, 140
Modulo display, 140
Motor, 350
Motor Encoder, 350
Motor Module, 350
My Computer, 288

N

NC utilization, 123
NX module, 19, 262

O

Option, 274
Option Slot, 350
Overview of functions, 282

P

Parameter sets of the position controller, 129
Parameters, 351
Peer-to-Peer, 275
Position control loop
  Measurement, 204
  Overshoots, 148
  Reference frequency response, 205
  Setpoint step change, 206
  Step height, 207
Position controller cycle, 119
Positioning accuracy of the control system, 118
Positioning axes, 142
Process data
  Actual values: G1_XACT1, 308
  Actual values: G1_XACT2, 308
  Actual values: G2_XACT1, 308
  Actual values: G2_XACT2, 308
  Actual values: G3_XACT1, 308
  Actual values: G3_XACT2, 308
  Actual values: NACT_A, 308
  Actual values: NACT_B, 308
  Control words: A_STW1, 307
  Control words: STW1, 307
  Control words: STW2, 307
  Control words:G1_STW, 307
  Control words:G2_STW, 307
  Control words:G3_STW, 307
  Setpoints: NSET_A, 307
  Setpoints: NSET_B, 307
  Setpoints: TRQRED, 307
  Setpoints:KPC, 307
  Setpoints:XERR, 307
  Status words: A_ZSW1, 308

Status words: G1_ZSW, 308
Status words: G2_ZSW, 308
Status words: G3_ZSW, 308
Status words: MELDW, 308
Status words: ZSW1, 308
Status words: ZSW2, 308
Process data for receiving, 307
Process data for sending, 307
Product, 274
PROFIBUS, 351
Programmed Spindle speed limitations, 188
Protection levels, 323
for machine data, 324
Influence via softkeys, 325
PTP link, 275, 290
Pulse multiplication factor, 179

R

Ramp-up time, 284
Rapid traverse in JOG mode, 153
Reference point approach, 164
Resolutions, 108
Rotary axes
Drive Optimization, 140
Rotary axis
with rotary encoder on motor, 135
With rotary encoder on motor, 132
With rotary encoder on the machine, 133
Rotary measuring system, 131

S

safe operation, 21
Safety Integrated, 13
Section, 285
Sensor Module, 351
Servo Control, 351
Servo Drive, 351
Servo gain, 146
Checking, 147
Servo trace, 195
Setting data
Normalization of physical quantities, 111
Setting the axis-specific setpoint parameters, 335
Setting the axis-specific setpoint/actual value parameters, 335
Setting the password, 325
Signal distortion, 161
SIMATIC, 283
SIMATIC Manager, 39
start, 39
SIMATIC S7 project, 41
SinuCom Update Agent, 216
SINUMERIK 840Di sl, 273
SINUMERIK plug-in, 283, 285
enable/disable, 284
SITOP Power, 351
Smart Line Module, 351
Software limit switches, 158
Software product, 273
Speed adjustment, 214
Speed setpoint matching, 150
Speed setpoint monitoring, 159
Spindle
Encoder matching, 179
Gear stages, 178, 181
Measuring systems, 179
Monitoring functions, 187
Parameter sets, 129, 178
Positioning, 183
Setpoint matching, 182
setpoint/actual value channels, 177
Synchronization, 185
Velocities, 181
Spindle data, 190
Spindle in setpoint range, 187
Spindle is stationary, 187
Spindle speed
Maximum, 187
Standard telegrams, 304
Static monitoring functions, 156
Status Word, 352
Supply, 349
Switching over the measuring system, 116
System basic cycle, 119
System data, 108
System requirements, 283
System resources, 123
System software SINAMICS S120, 243

T

TCP/IP, 275
Telegram assignment, 261
Telegrams
Manufacturer-specific, 304
Standard, 304
Telegrams for receiving, 305
Telegrams for sending, 306
Terminal assignment
Inputs/outputs, 249
Support on the HMI, 249
X122, 246, 248

X132, 247
Thread
Tapping/thread cutting, 129
Toolbox, 26
Topology of individual drive components, 256
Transfer license information
Drag-and-drop, 294
using menu commands, 295
Traversing direction, 145
traversing ranges, 118

V

Vector Control, 352
Velocities, 125
Max. axis velocity, 125
Max. tool path velocity, 125
Maximum spindle speed, 125
Upper limit, 125
Voltage limit, 126
Velocity monitoring
Actual, 160

W

Working area limitation, 157

Z

Zero speed tolerance, 156