SIEMENS

SINUMERIK 840D sl
SINAMICS S120

CNC Part 1 (NCK, PLC, Drive)

Commissioning Manual

Valid for

Control
SINUMERIK 840D sl/840DE sl

Drive
SINAMICS S120

Software	*Version*
NCU Software for 840D sl/840DE sl	1.3

01/2006 Edition
6FC5397-2AP10-1BA0

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

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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.

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Order No.: 6FC5397-2AP10-1BA0

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 monthly and also 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 Manual is intended for machine-tool users. This publication describes in detail all the facts the user needs to know for programming the SINUMERIK 840D sl/840D/840Di/810D control.

Standard version

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

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

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 queries, please contact our hotline:

Europe and Africa time zone:

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Note

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

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

Questions about the manual

If you have any queries (suggestions, corrections) in relation to this documentation, please fax or e-mail us:

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E-mail: mailto:motioncontrol.docu@siemens.com

Fax form: See the reply form at the end of the document.

Internet address

http://www.siemens.com/motioncontrol

EC declaration of conformity

The EC Declaration of Conformity for the EMC Directive can be found/obtained

- in the internet:

  http://www.ad.siemens.com/csinfo

  under the Product/Order No. 15257461
- at the relevant branch office of the A&D MC Business Division of

  Siemens AG

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Introduction

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1.1 Commissioning manuals for SINUMERIK 840D sl

Introduction

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

- CNC Part 1 (NCK, PLC, drive)
- CNC Part 2 (HMI)
  HMI Embedded (sl) / HMI Advanced
- CNC Part 3
  ShopMill
- CNC Part 4
  ShopTurn

Basic steps for commissioning SINUMERIK 840D sl

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

- Step 1 (described in CNC Part 1)
  - PLC commissioning
  - Drive commissioning
  - NCK commissioning
- Step 2 (described in CNC Part 2, 3, 4)
  - Commissioning functions in NCK/PLC

Commissioning CNC overview part 1 and Part 2, 3, 4

The following figure is a schematic representation of the commissioning steps that are described in the first part (1) and in Part 2, 3, 4 (2):

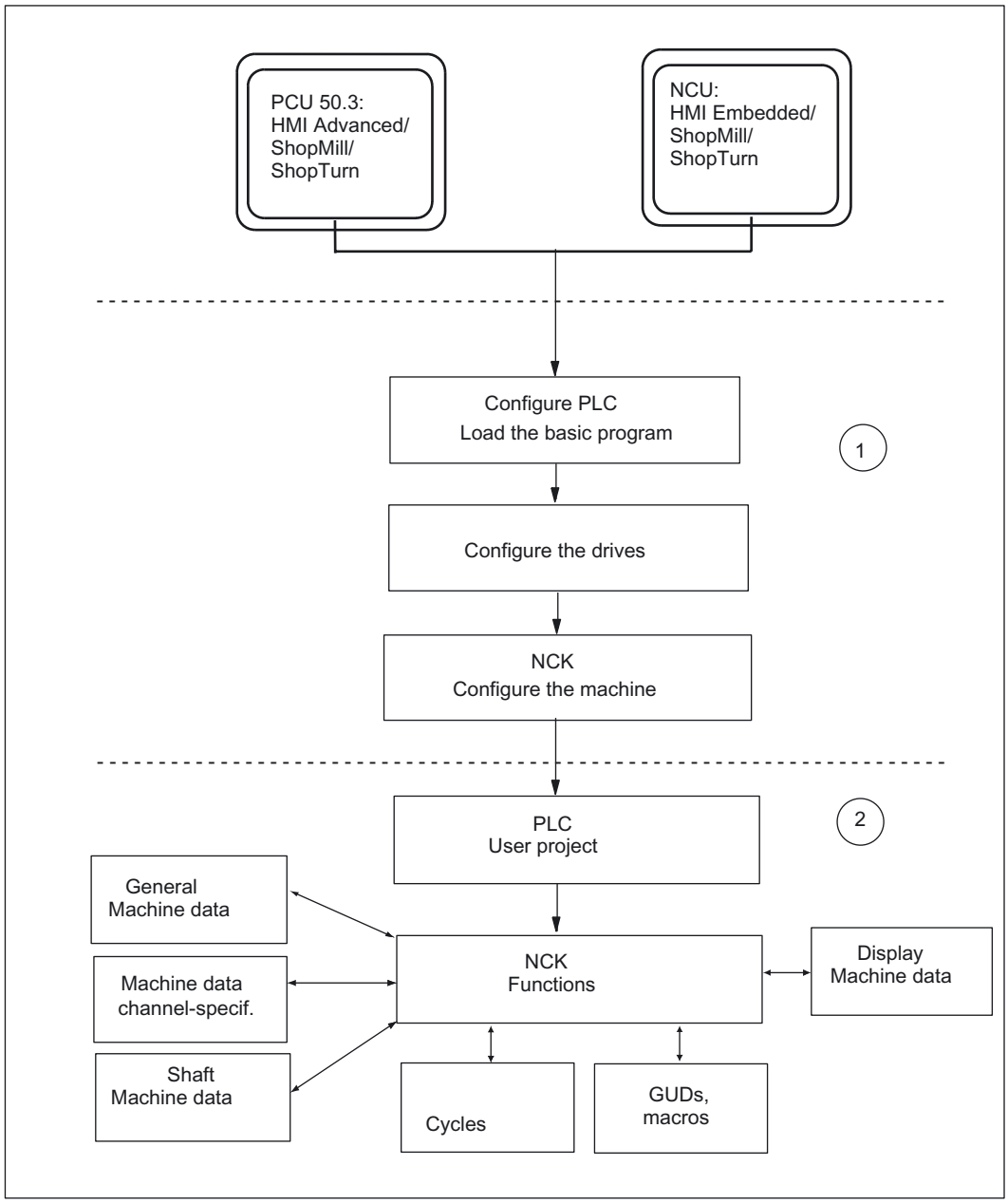


Fig. 1-1 Commissioning Overview Part (1), Part (2)

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.

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

Components for the commissioning

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

If there is no PCU 50.3 available in the control configuration, then the IBN tool on PG/PC must be used (the HMI Advanced Software, if applicable).

External HMIs are connected to socket X120 as a rule.

The internal HMI displays its user interface via TCU (Thin Client Unit), which is also connected to socket X120.

For the commissioning of the PLC, a PG/PC with
SIMATIC STEP7 Version 5.3 Service Pack 2 is required. This PG/PC is currently also connected via Ethernet to socket X120.

To be able to connect several communication peers to socket X120, you will require a network switch.

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.

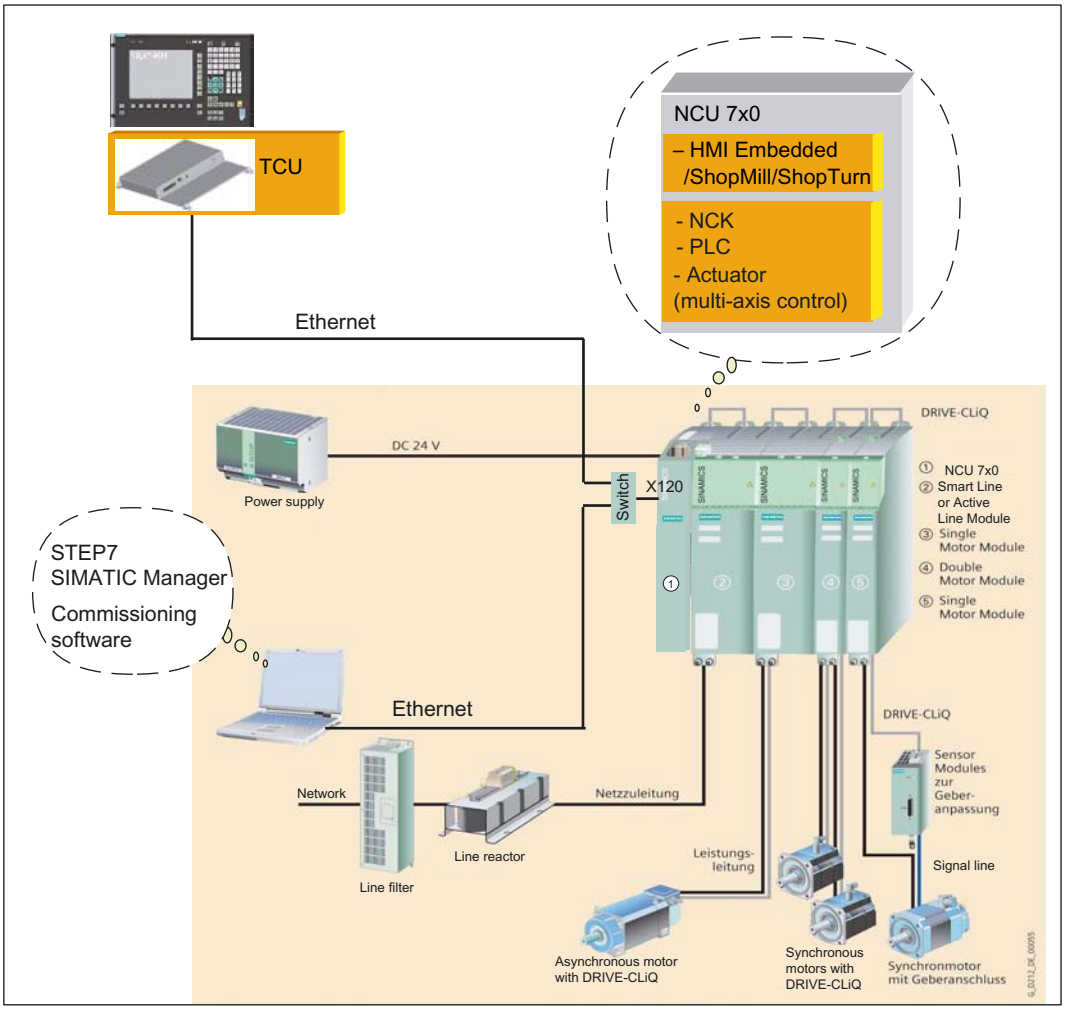


Fig. 1-2 Principle representation SINUMERIK 840D sl

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.

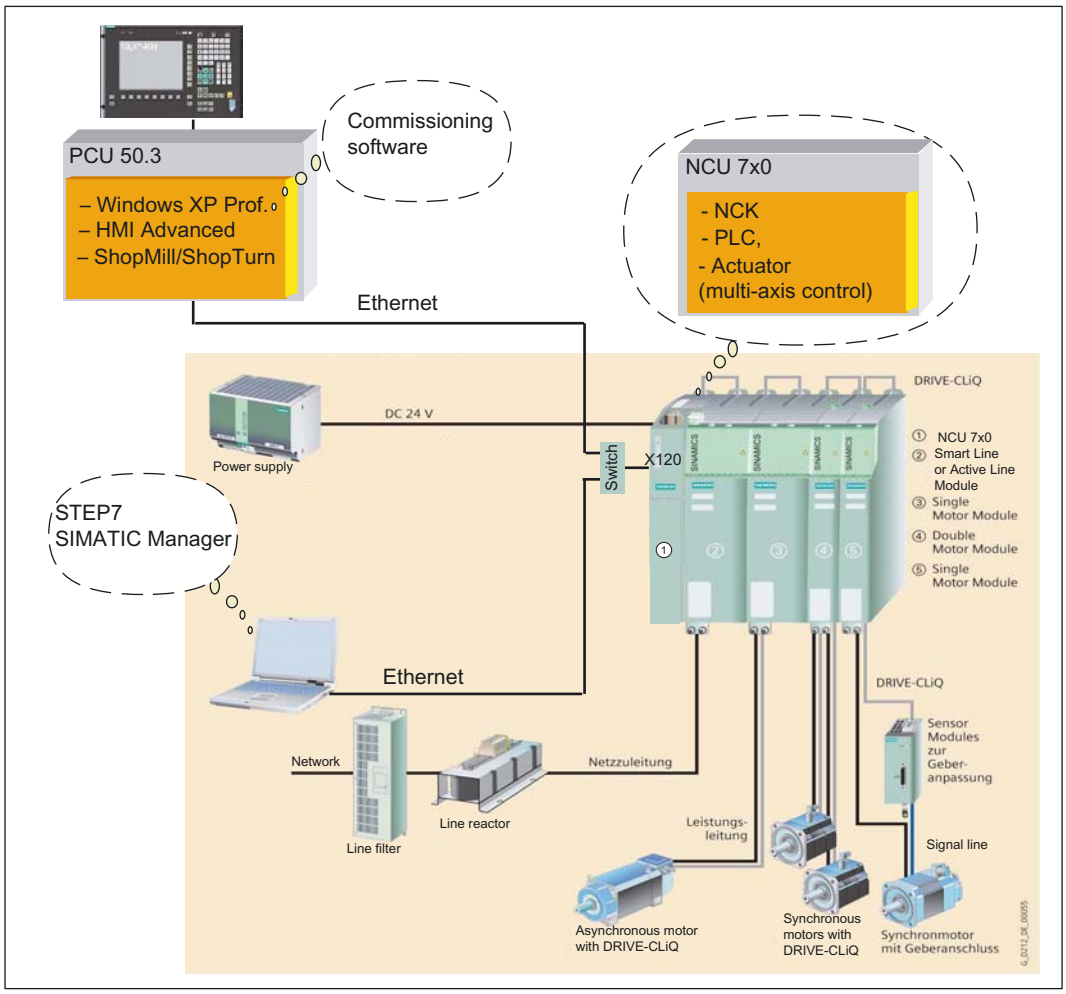


Fig. 1-3 Principle representation of SINUMERIK 840D sl with PCU 50.3

Schematic representation of the NCU 7x0

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

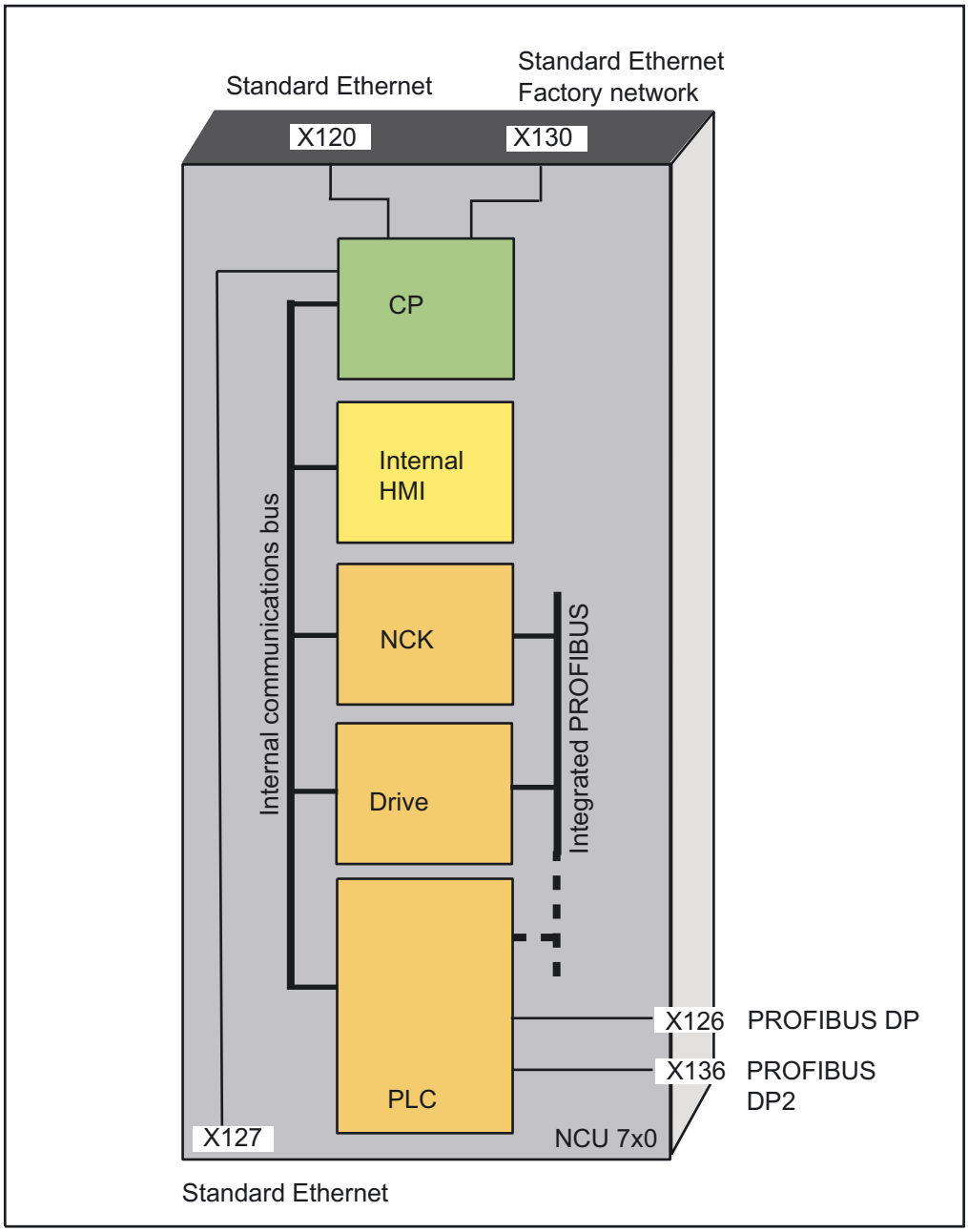


Fig. 1-4 Schematic representation of NCU 7x0

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 4-3)

Setting up the communication (Page 5-2)

Overview of creating a SIMATIC S7 project (Page 6-1)

Overview Installation and start-up of SINAMICS drives (Page 7-1)

Overview communication NCK<->Drive (Page 8-1)

Overview Commissioning NCK (Page 9-1)

Drive optimization (Page 10-1)

Overview of commissioning NX <-> Drive (Page 12-21)

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.

Note

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

References: SINAMICS S120 equipment manuals /GH1/ and /GH2/.

Note

You can find all the instructions on how to connect the Ethernet interface here:

References: /GDS/ equipment manual NCU

Note

To initialize an Ethernet, see also:

References: Commissioning HMI (IAM), Chapter "Commissioning TCU (IM5)"

3.2 Software and hardware requirements

Requirements

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

- Connection to NCU
  - Network switch to socket X120
  - Ethernet connection from PC/PG to network switch
  - Ethernet connection from TCU for internal HMI to network switch or
  - Ethernet connection from PCU 50.3 for external HMI to network switch
  - PROFIBUS connection of machine control panel to socket X126
- Software prerequisites
  - SIMATIC STEP 7 as of Version 5.3 Service Pack 2 on PC/PG (SIMATIC Manager)
  - STEP7 package for NCU7x0 on PC/PG (tool box)
  - GSD file (tool box)
  - XML lists with the motor code numbers (tool box)
  - 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
  - Fan/battery module (MLFB 6FC5348-0AA01-0AA0) to NCU (see following figure)

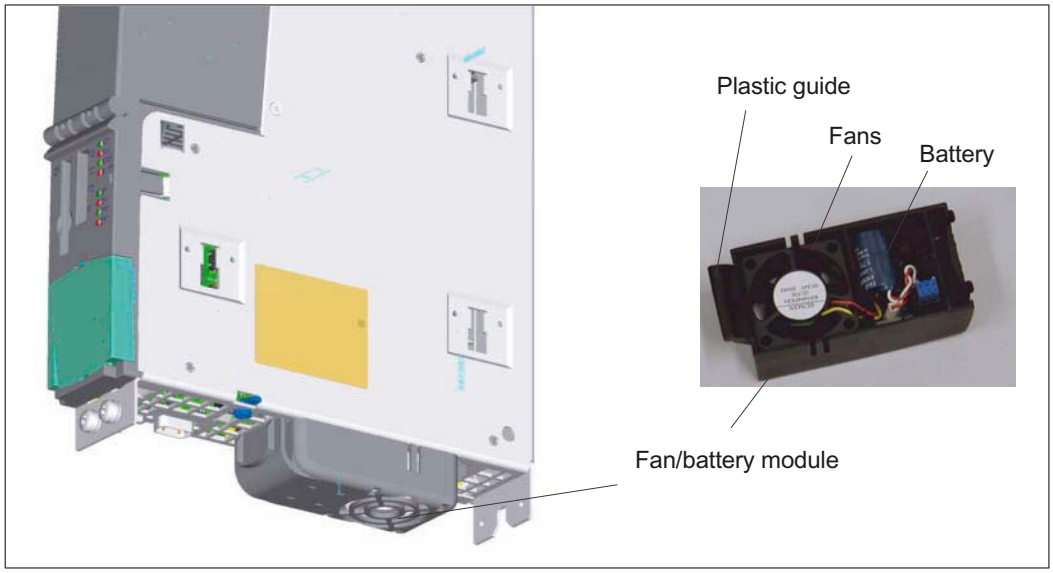


Fig. 3-1 Fan/battery module

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 enables expansion)
- X130 Ethernet interface for factory network
- For PG/PC
  - currently X120 Ethernet interface
  - coming soon - X127 Ethernet interface
- X130 PROFIBUS interface for machine control panel, for example

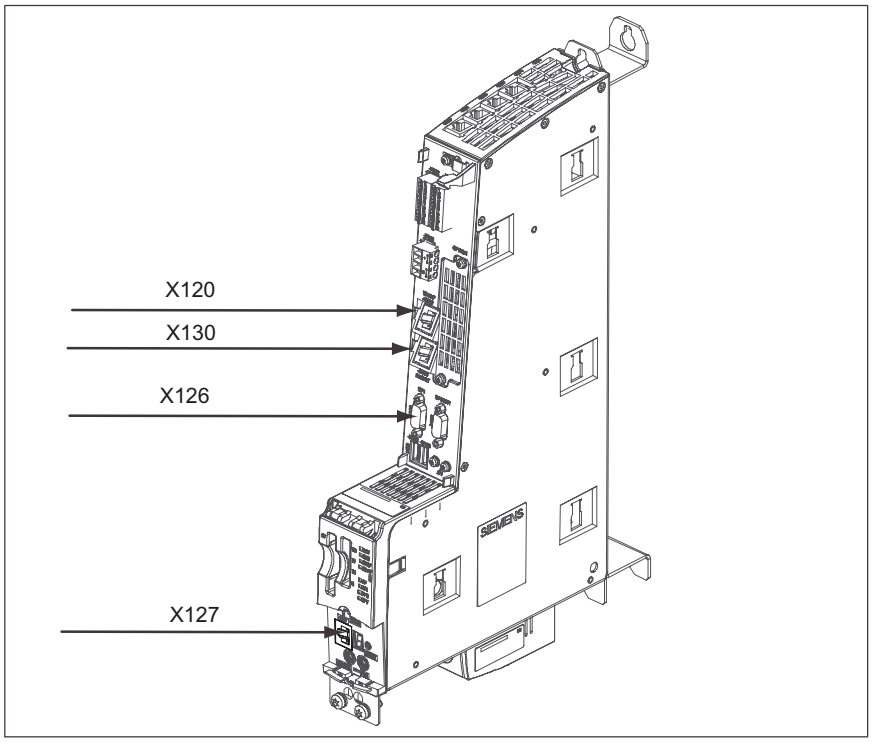


Fig. 3-2 Interfaces on the NCU for installation and startup

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	X120	Ethernet	192.168.214.1	255.255.255.0
Factory network	X130	Ethernet	Assigned by DHCP server, for example 10.10.255.200	
Coming soon - PC/PG	X127	Ethernet	192.168.215.1	255.255.255.248

3.4 Commissioning tool on PG/PC

Requirements

If you commission an SINUMERIK 840D sl, comprised of the TCU, NCU 7x0 and SINAMICS S120 drive components, then you require the commissioning tool on PG/PC.

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).

Power On and Boot Up

4

4.1 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

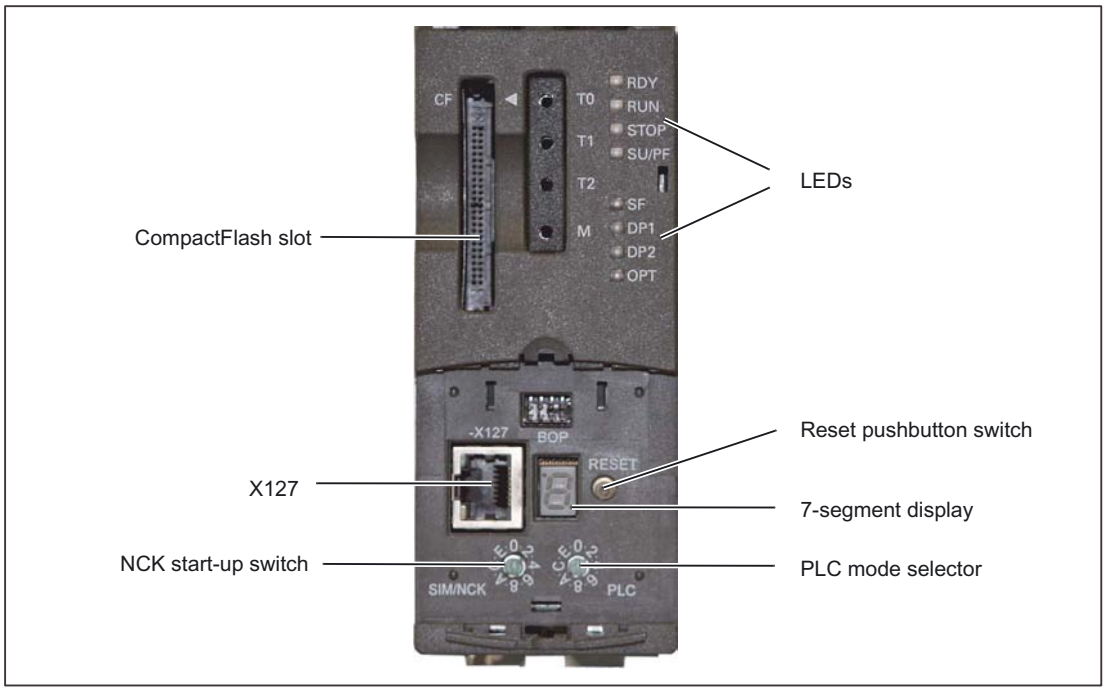


Fig. 4-1 Operating and display elements for installation and start-up at the NCU

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 CF 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

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

4.2 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 within 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 12-1)

4.3 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. Choose **Menu Select** 

, or on PG/PC button **F10**.
2. Choose **Startup**.
3. Choose **Password...**.
4. Choose **Set Password**.
5. Enter the manufacturer's password **SUNRISE**.
6. Choose **OK**.
7. Choose **Machine data**.

   The following picture displays the user interface which you use to carry out the startup as of Chapter "Execute NCK reset".

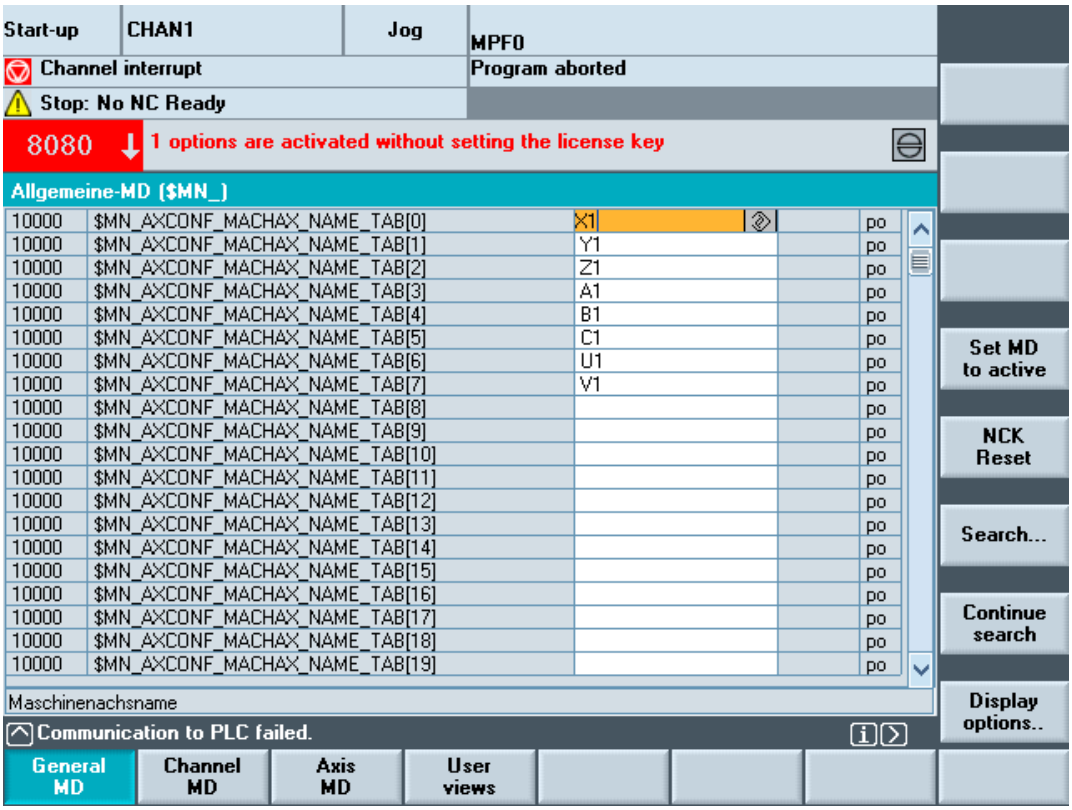


Fig. 4-2 Startup entry

The booting is completed; in the next step, carry out the startup of the PLC with the SIMATIC Manager.

Connect PG/PC with the PLC

5

5.1 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 the Start menu contains entry **SIMATIC Manager** 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.

5.2 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. In the **Access path** tab, look for the interface used in the **Interface parameterization used** selection field, such as: TCP/IP -> Realtek RTL8139/810x F…
3. Acknowledge 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

6

6.1 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:

- Creating a project
- Inserting a SIMATIC station 300
- Insert NCU 7x0 in HW config
- Configuring the properties of the network interfaces
- Insert machine control panel and hand wheel

Note

The tool box must be 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.

What is different for the PLC configuration for SINUMERIK 840D sl?

The following points on the PLC project configuration of a SINUMERIK 840Di are different:

- PLC address area for PROFIBUS drive communication starts with 4100 and cannot be changed to smaller values.
- Subnet ID of the integrated PROFIBUS can be changed, currently use ID 0046-0010.
- As a rule, the original slot configuration of the drive unit from the STEP7 catalog should not be modified.
- PROFIBUS machine control panel must be connected on the master system at X126.

PLC interface signals

Note

The PLC interface signals are laid out in:

References: /LIS2/ Lists Manual 2

6.1.1 Creating a project

Introduction

You have started the SIMATIC Manager.

Steps

1. To create a new project select menu items **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. Click **OK** to confirm the dialog.

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

6.1.2 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

Steps

1. Choose **Right mouse button > Insert New Object > SIMATIC 300 Station**.

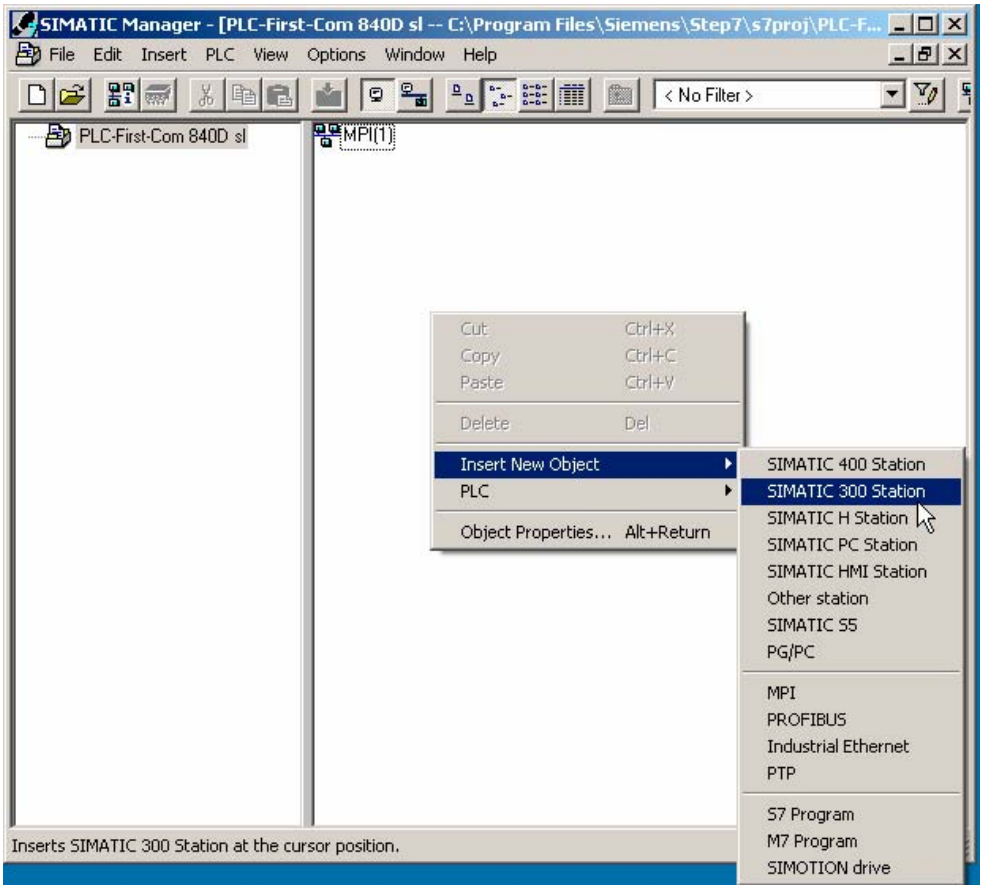


Fig. 6-1 Inserting a SIMATIC station 300

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).

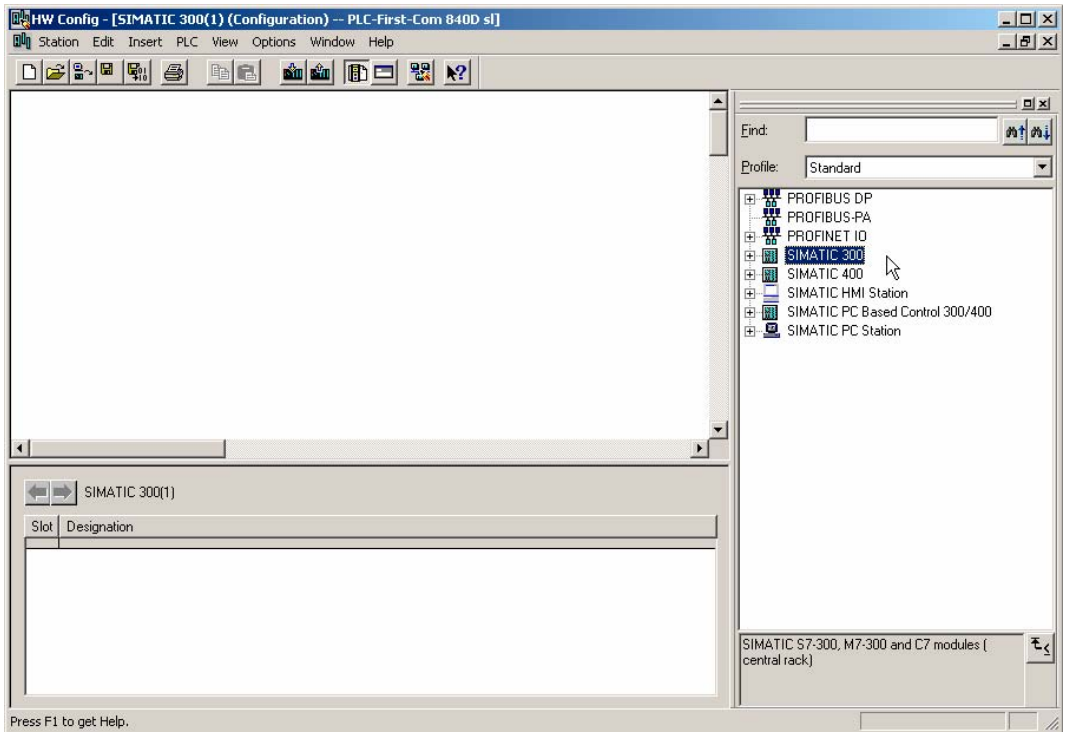


Fig. 6-2 HW-Config

6.1.3 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.

Operator input sequence steps

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

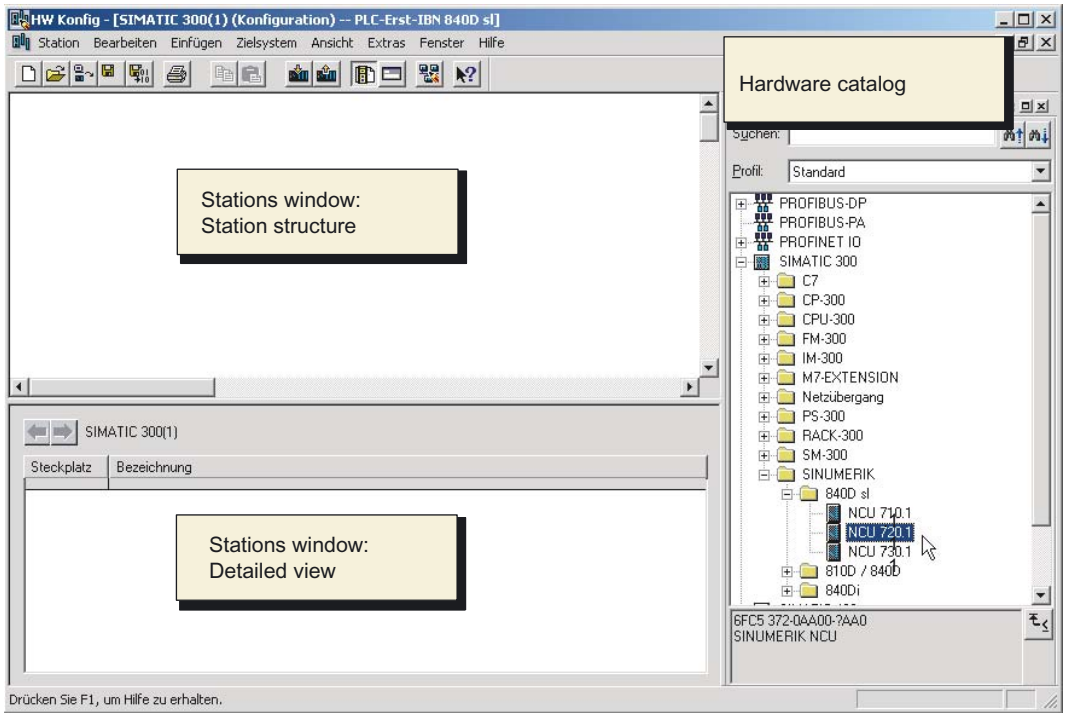


Fig. 6-3 NCU 720.1 in the catalog

3. Click with the left mouse button to select **NCU 720.1**, 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).

6.1.4 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
- 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).

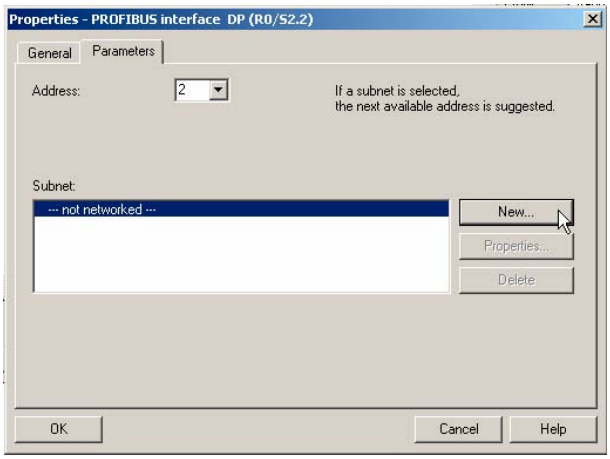


Fig. 6-4 Properties of PROFIBUS DP

3. Carry out the following:
   - The button **New…**:
   - The **Network Settings** tab in the "Properties New subnet PROFIBUS Subnet" dialog box opens.

4. Choose the transmission rate **12 Mbps** for the **DP** profile (see figure below).

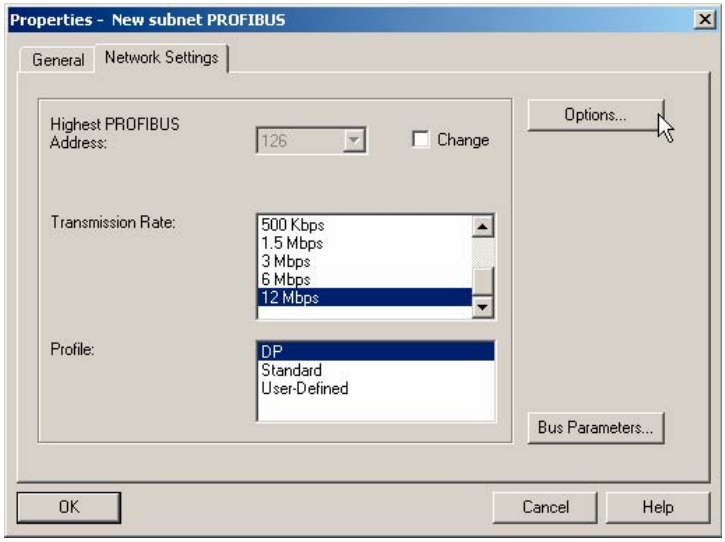


Fig. 6-5 Properties of the PROFIBUS interface

5. Confirm **Options** and then **Constant Bus Cycle Time** (see figure below).

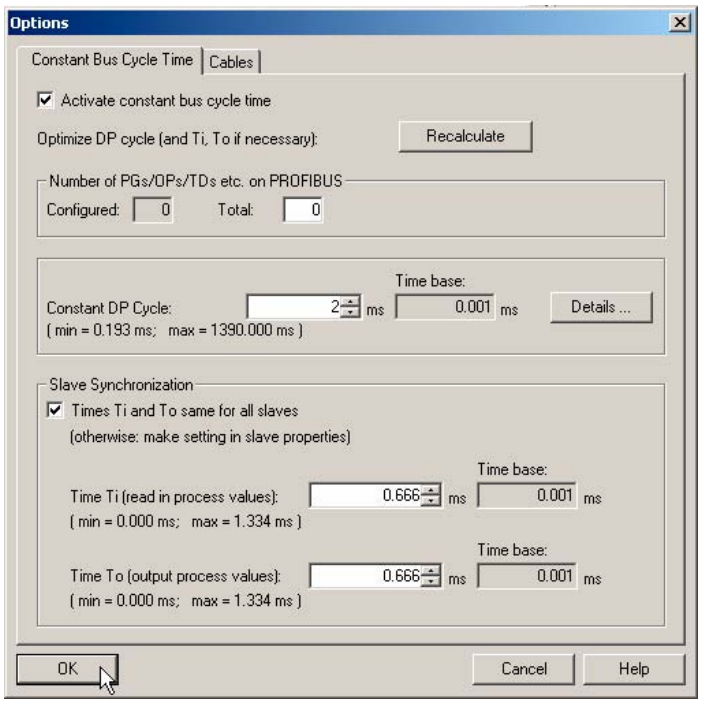


Fig. 6-6 Constant Bus Cycle Time

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 Constant Bus Cycle Time:
   - Click on **Activate equidistant bus cycle**

- Enter the cycle, e.g., **2 ms** for the **Constant DP Cycle** (for integrated PROFIBUS) (see MD10050 Syscock_Cycle_Time).
- Click on **Times Ti and To same for all slaves**
- The fields **Time Ti** and **Time To** must contain a value **< 2ms**.

7. Click **OK** three times.
8. Module NCU 720.1 with SINAMICS S120 is inserted into the HW config (see figure below).

Note

Press **F4** and confirm the "Reorganize" prompt to reorganize the display in the station window.

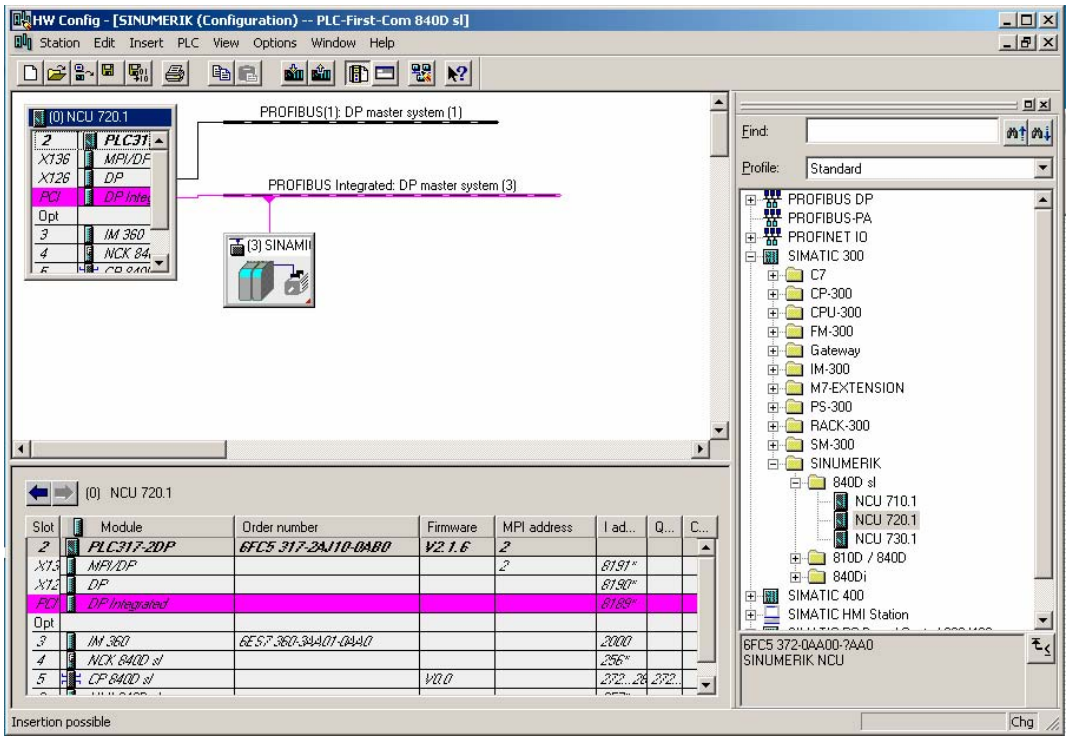


Fig. 6-7 HW config with NCU 720.1

Next, specify the properties for the Ethernet interface.

Operating steps for the Ethernet interface

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

1. Double-click on **CP 840D sl** in the basic rack of the NCU 720.1. The system opens the dialog box **Properties - CP 840D sl** (see figure below).

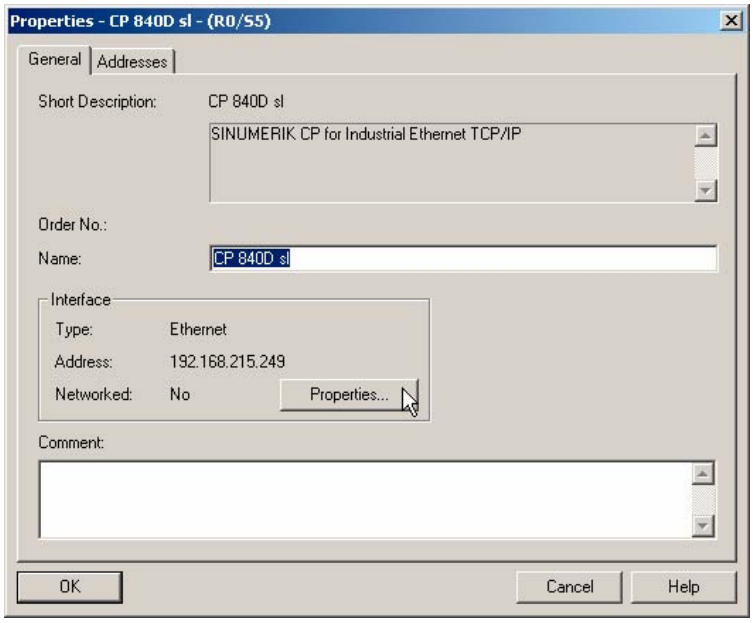


Fig. 6-8 General properties of the CP 840D sl

2. After pressing the **Properties** button, you can create a new Ethernet interface.

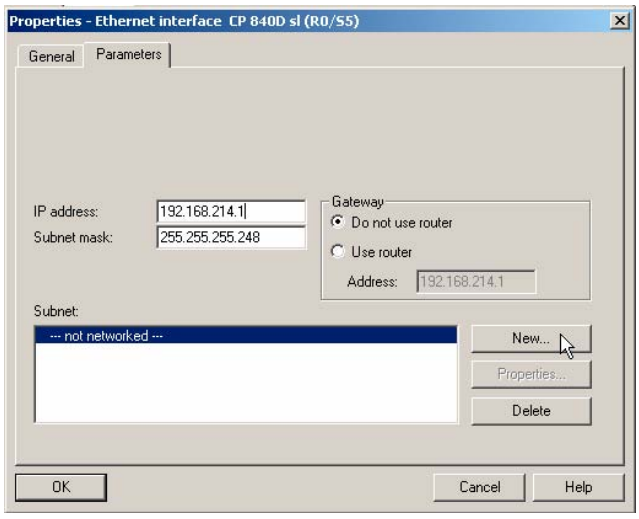


Fig. 6-9 Properties of the Ethernet interface

In the entry field for the **IP address**, the address for socket X127 is pre-assigned by default. Since the interface to socket X120 is used in this commissioning scenario, you must change the IP address.

1. For socket X120, enter the **IP address 192.168.214.1** and the **Subnet mask 255.255.255.0**.
2. Create the Ethernet interface using **New** and then **OK**.
3. Choose **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 line of the integrated PROFIBUS **PROFIBUS Integrated: New subnet Industrial Ethernet** and use the right mouse button to select the menu item **Object properties**.
2. In the **General** tab, select the **Properties** button.

   Enter the ID **0046-0010** in field **S7 subnet ID**.

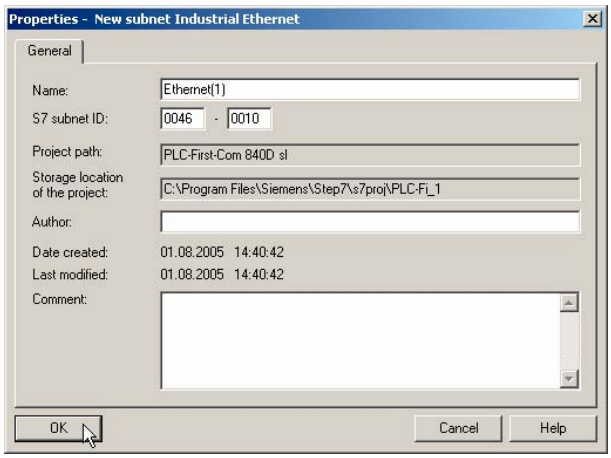


Fig. 6-10 Integrated PROFIBUS subnet ID

3. Choose **OK** twice.

Telegram lengths and input/output 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, configure a machine control panel in HW config.

See also

Configuring the communication between the PLC and the drive (Page 12-5).

6.1.5 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).

Operator input sequence steps

1. Search in the HW config at **Extras > Install GSD file…** in the installation directory for the tool box at, 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. Choose **Install**.
4. Choose **Close**.

6.1.6 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 new NCU 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 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. Choose **MCP** and enter under **Object properties** the PROFIBUS address **6**.

   Now you can assign the slots of the machine control panel, e.g., **Standard + Handwheel**.

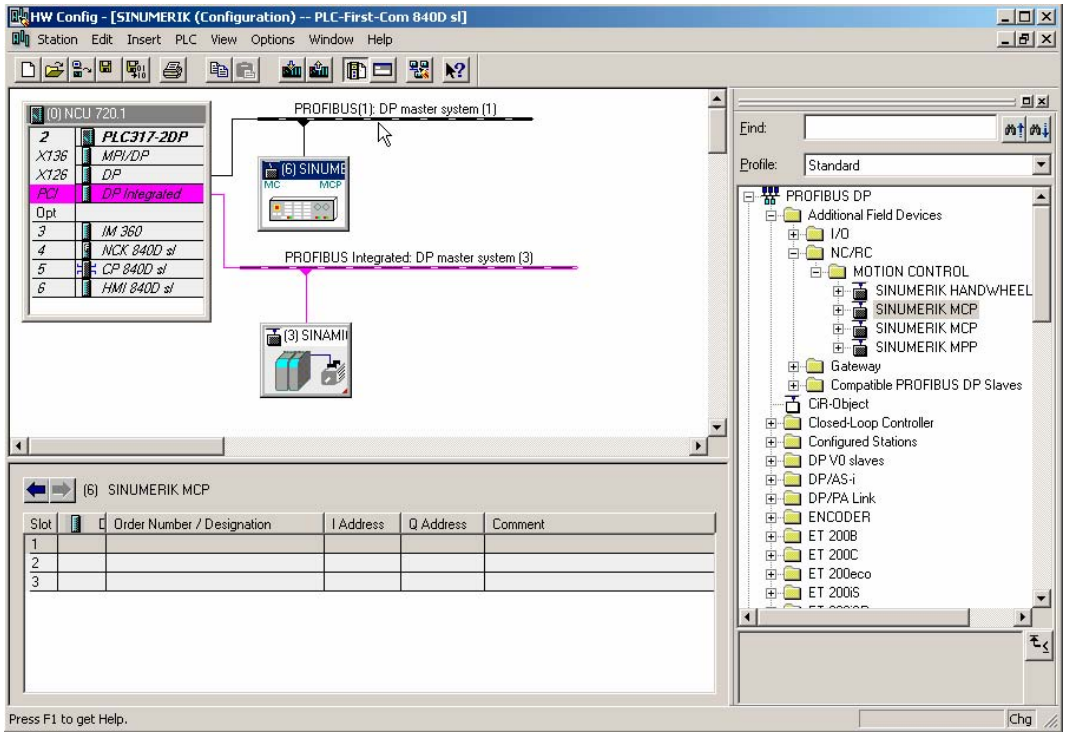


Fig. 6-11 Machine control panel in HW Config

5. In the hardware catalog under **SINUMERIK MCP** click with the left mouse button to select the **standard, handwheel** option and drag to Slot 1 (see figure below).

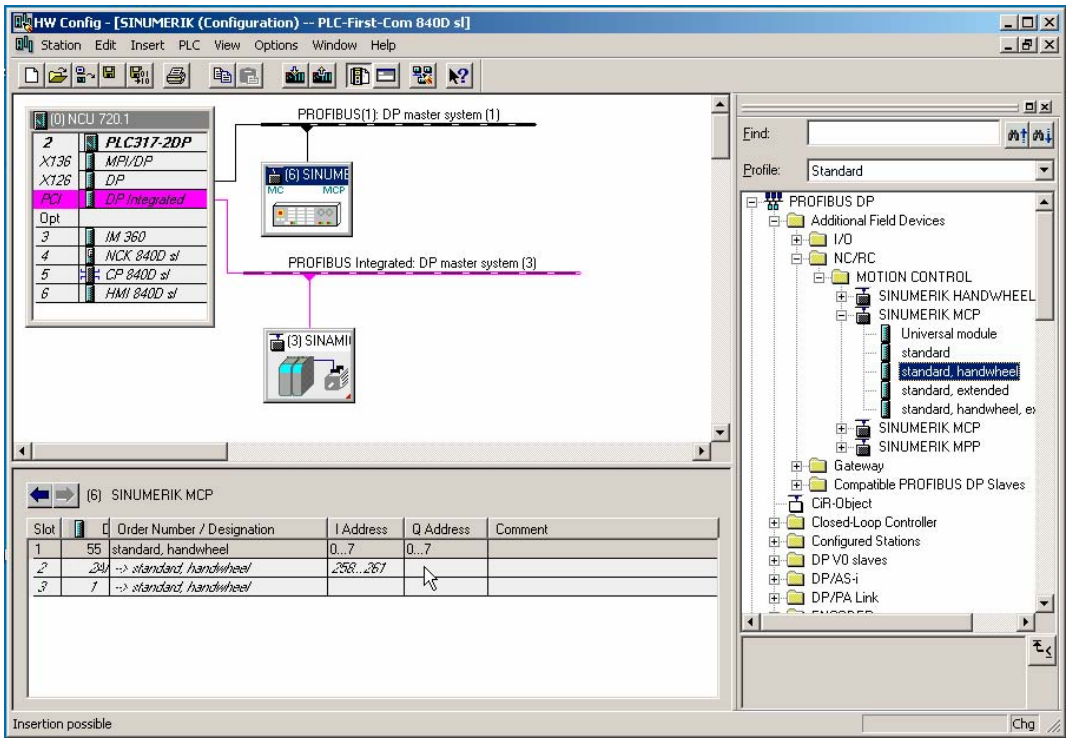


Fig. 6-12 Standard+Handwheel for slot

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.

See also

Modifying machine control panel in OB100 (Page 6-17)

6.1.7 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 command **Station > Save and Compile**.
2. Choose the **Load in module** command button to load the configuration to the PLC.

   The **Select Target Module** interactive screenform automatically displays both configured communication peers (see picture below).

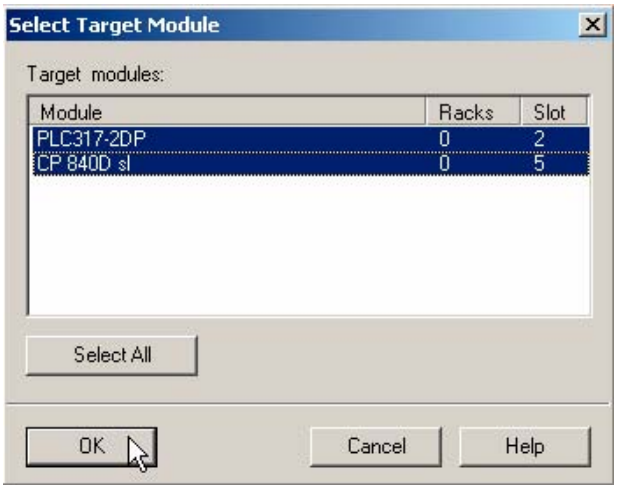


Fig. 6-13 Selecting target module

3. Confirm with **OK** to load into these two modules.
4. Confirm the dialog box subsequently displayed with **OK** or **No** for the query "…Should the module be started now (restart)?"

Note

You can check the communication interface at **Target system > Diagnosis > Operating mode**.

5. Close the "HW config" window.

The next step is to create the PLC program.

6.2 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.

6.2.1 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).

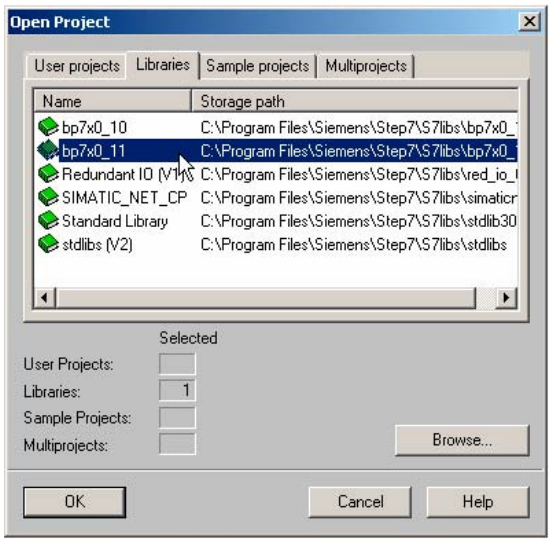


Fig. 6-14 Opening the library

2. Choose the library for the PLC basic program, e.g. **bp7x0_11** and confirm the dialog box 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 picture below).

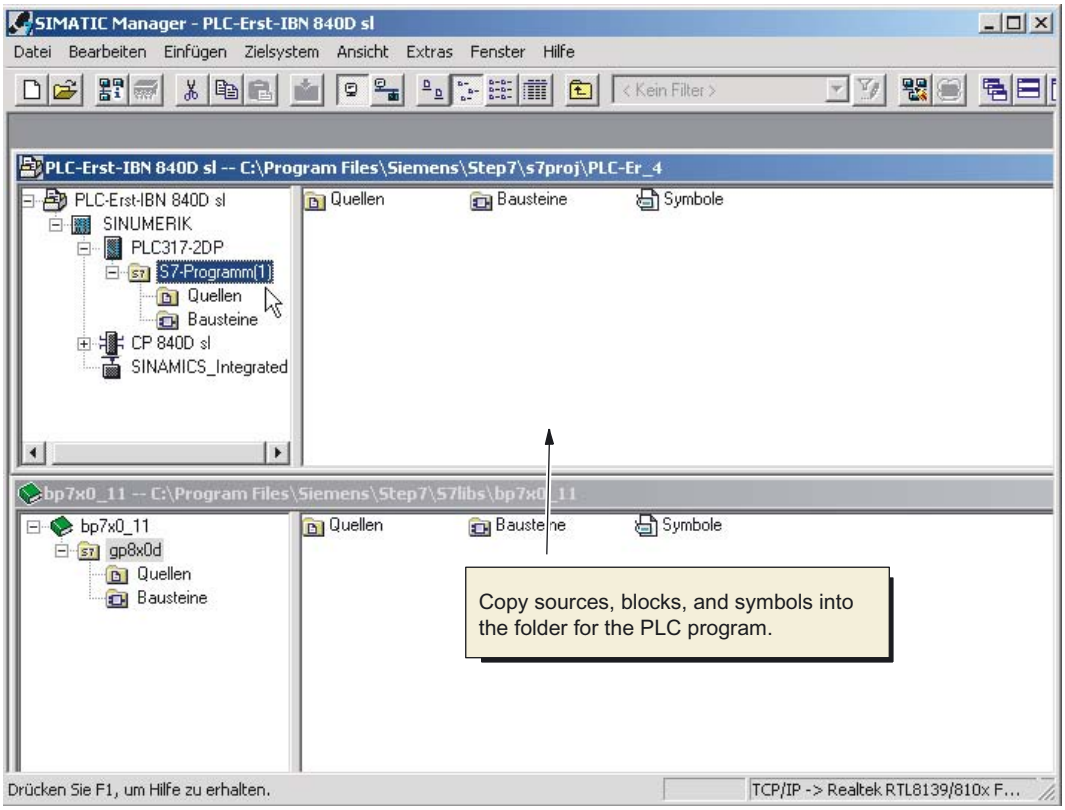


Fig. 6-15 Copy the PLC program

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.

6.2.2 Modifying 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.

Operator input sequence steps

- Under **Blocks** double-click to open on **OB100**.

  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
MCPBusAdress := 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.

6.3 Loading the project to the PLC

Introduction

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

Precondition

- An Ethernet network connection exists between STEP7 and the PLC.
- The configuration to be loaded corresponds to the actual station configuration.
- NCU 7x0 is active:
  - NCK is in cyclic mode
  - PLC in RUN or STOP status

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** operating status, each block loaded becomes active immediately. This can result in inconsistencies when executing the active PLC program. You are therefore advised to place the PLC in the **STOP** state before loading the configuration, if this has not already occurred.

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 > Download** (see picture below), or the symbol **Load**.

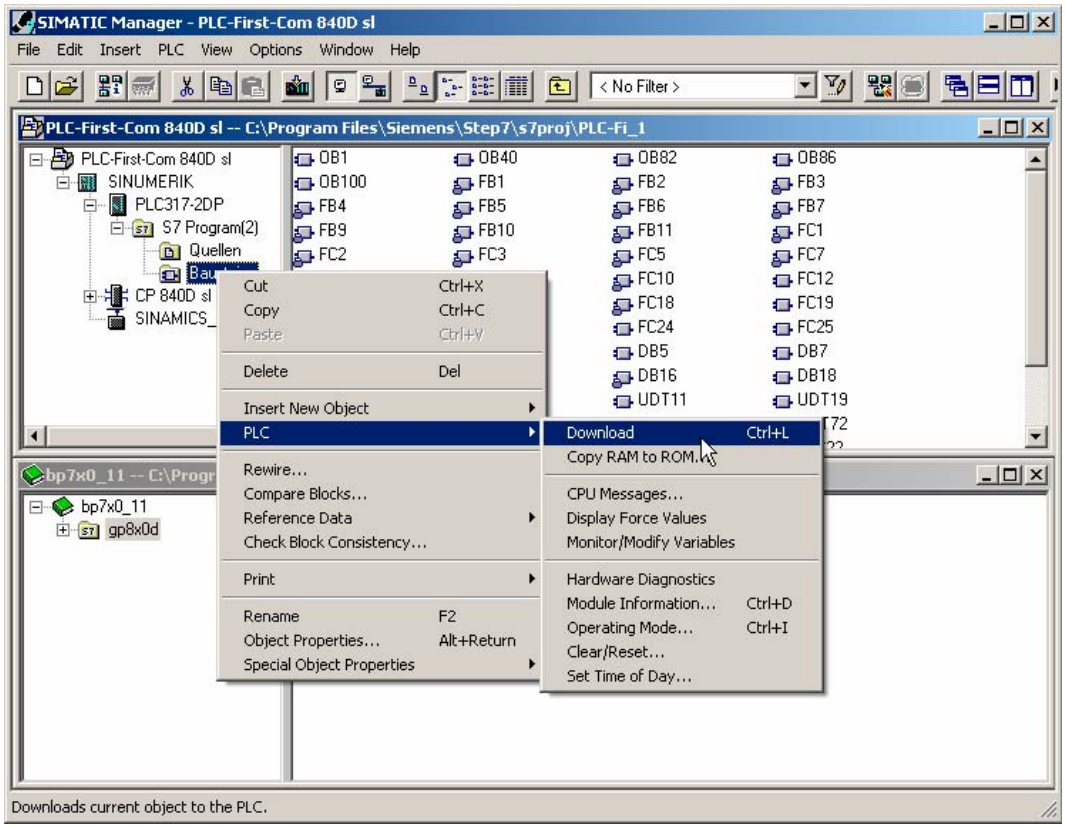


Fig. 6-16 Loading system blocks

3. If there is no connection to the destination system, you must confirm in sequence the following dialog requests with:
   - **OK** for "Check the correct order of modules for proper functioning"
   - **Yes** for "Do you want to load the system data?"
   - **Yes** for "Do you want to load the 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 **NCK Reset** is required for PLC-NCK convergence.

The next chapter describes the operator input sequence steps for triggering an NCK reset.

6.4 Carry out NCK reset

Introduction

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

- The system may display the following alarms in HMI in the operating area **Diagnosis > Alarms** (see picture below):

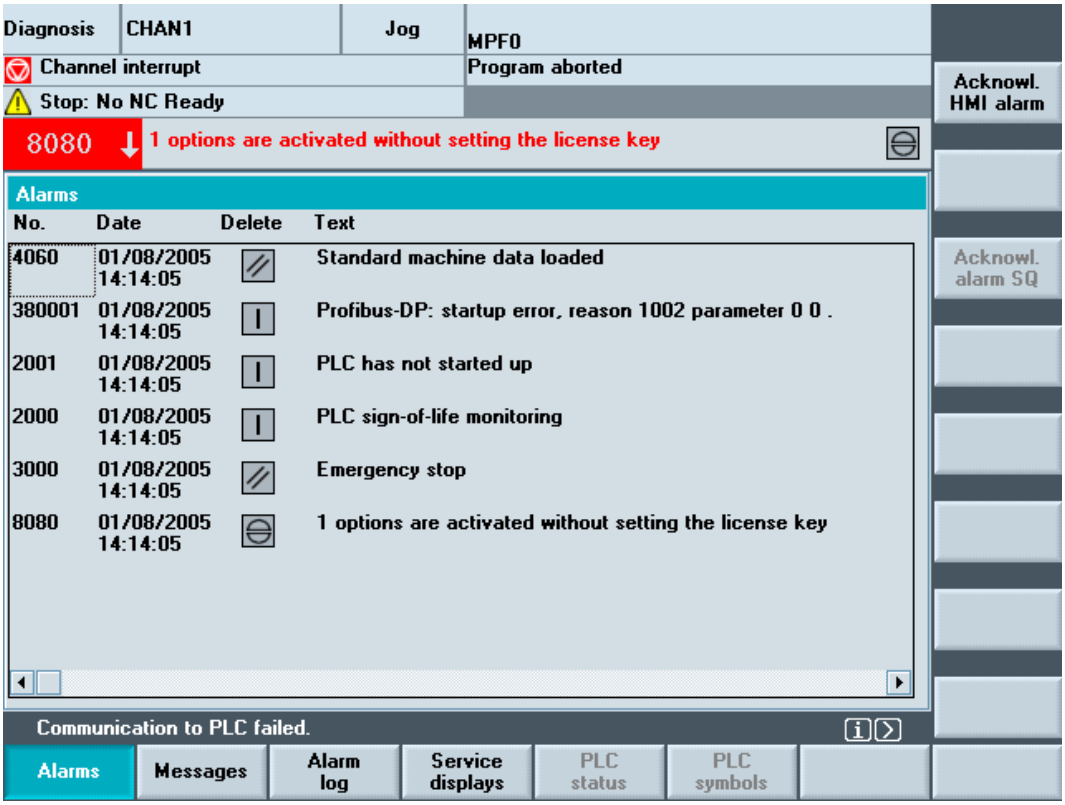


Fig. 6-17 Alarm responses

Steps for initiating an NCK reset

- Select the area **Start-Up** and then **NCK Reset** (see figure below).

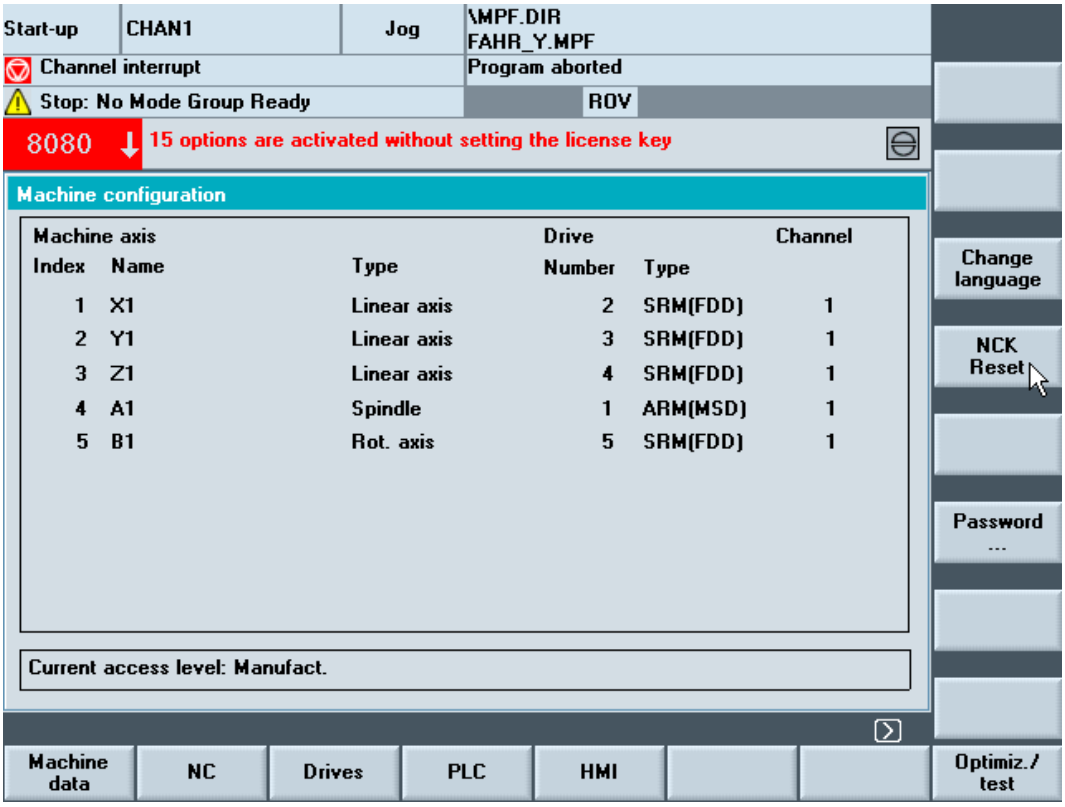


Fig. 6-18 NCK Reset

After you have initiated the NCK reset, the PLC goes into RUN mode.

6.5 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.

- Under **Start-up**, select the **Machine data** softkey.
- You can access the HMI as follows:

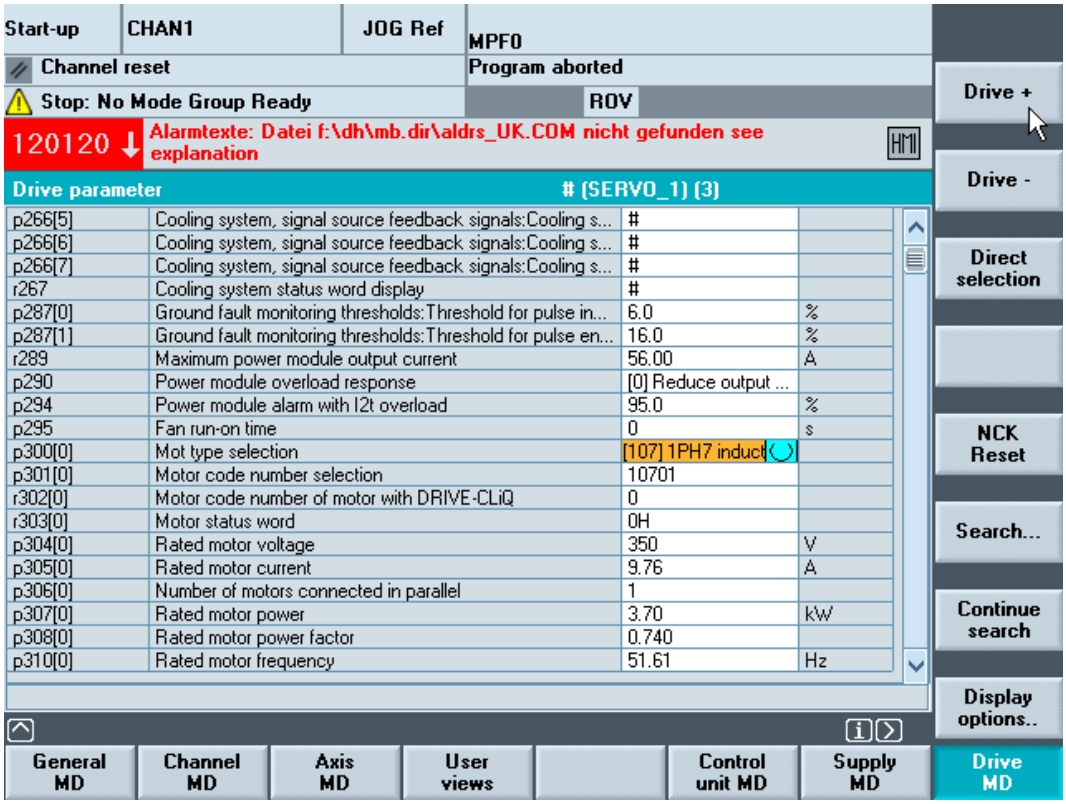


Fig. 6-19 PLC commissioning complete

Commissioning SINAMICS Drives

7

Introduction

Commissioning of the drive parameters occurs via HMI in the operating area **Commissioning**.

For the current state, the SINAMICS S120 drive is commissioned using macros applied to the SINAMICS machine data.

The machine data can be called via softkeys **Commissioning > Machine data**.

Startup sequence

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

1. Activate the factory settings
2. Update the component firmware (if necessary)
3. Configure the drive set
4. Configure the individual components manually (if necessary)
5. Define the PROFIBUS protocol
6. Identify the ALM (if present)
7. Optimize the drive

Note

Prior to starting a macro, switch off all drive enables.

7.1 Activate the factory settings

Introduction

Prior to making factory settings, make sure that the PLC has stopped sending enables to the drive.

Procedure for activating factory settings

1. Press the softkey **Control Unit MD.**
2. Select **Save/Reset**.
3. Check: p15 = 0 If not: p15 set to "0".
4. To check when activation of factory settings has ended, select parameter r3988 for monitoring.
5. Select **Factory settings** and confirm the prompt "Do you really want to…?" with **Yes**.
6. Communication is lost for a short period of around 10 seconds, during which time "#" is displayed as the machine-data value.
7. Boot-state check: If r3988 = 200H, save the factory settings using the **Save** softkey.
8. Wait for around 10 to 40 seconds until the message line displays "Drive [drive name (drive number)] saved".
9. Switch off system (drive set de-energized).
10. Switch system back on in order to bring all SINAMICS components to one uniform firmware revision level in the next step.

7.2 Update the component firmware

Introduction

Prior to initial startup, all SINAMICS components should have the same firmware version. The required software is part of the SINAMICS system software and is stored on the CF 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.

Precondition

All components of the Control Unit accessible (connected to NCU via Drive-CLiQ).

The update may be carried out for:

- "All components", (carry out preferably prior to starting the first commissioning)
- "Individual components" (e.g., needed after component exchange)

Procedure for updating all components

1. Press the softkey Control Unit MD.
2. Control Unit: set p9 = 1.
3. Control Unit: set p15 = 150399. The macro for updating the component firmware starts from the system.
4. Control Unit: p7829 choose for monitoring.
5. Now the components are updated in a predetermined order depending on their type; components of the same kind are updated at the same time. The order in which the individual components are updated is determined by the Drive-CLiQ link of the drive set. (SINAMICS system characteristics)
6. The macro is executed when parameter p7829 has changed its contents:
   p7829 = 0: Macro completed error-free
   p7829 = 1: Macro execution runs
   p7829 > 1: Error, value displayed is the corresponding error code.
   (The amount of time from the start of the update to the change of the display value to p7829 greatly depends on the SINAMICS configuration and is about 8-10 minutes.)
7. IMPORTANT: After the successful execution of macro 150399, the system has to be switched off and then back on to accept the new communication software. (Drive set de-energized)

Note

The new firmware only becomes active at the next system boot.

Please note:

Note

The update may run for several minutes depending on the system configuration. Do not switch off the system before the macro is completed! p7829 may NO LONGER be "1".

During the execution of the special macro 150399 "component update", the upper LED flashes for the SINAMICS module being processed at the moment (or the only LED for the SMC module) alternating RED-GREEN. For motors with DRIV-CLiQ interface and SME components, there is no visible way to recognize a running update.

The update order of the components connected to Drive-CLiQ is determined by the topology of the system. In this case, the system also processes the same kind of modules at the same time.

1. ALM & single-axis module
2. Double-axis modules
3. Motors with DRIVE-CLiQ interface
4. SMCs

Procedure for updating individual components

For component exchange, an update of individual components is necessary.

1. Press the softkey Control Unit MD.
2. Enter the component number in p7828
3. Start the update by entering "1" in p7829
4. The macro is executed when parameter p7829 has changed its contents:
   p7829 = 0: Macro completed error-free
   p7829 = 1: Macro execution runs
   p7829 > 1: Error, value displayed is the corresponding error code.
5. IMPORTANT: After the successful execution of the update, the system has to be switched off and then back on to accept the new communication software (Drive set de-energized).

See also

Procedure for calling ACX macros (Page 14-19)

7.3 Configuration of the drive

Introduction

The drive components can usually be configured using configuration macros and/or the drive wizard for HMI Advanced.

Drive configuration

This chapter briefly describes the commissioning procedure using a drive wizard. It describes in detail how to configure the drive using configuration macros.

Start an appropriate macro; once it has been executed:

- The drive-set topology will have been written to the NCK
- The drive components will have been parameterized

See also

Macros for commissioning (Page 14-17)

Terminal assignment NCU 7x0 (Page 14-22)

Procedure for calling ACX macros (Page 14-19)

7.3.1 Commissioning using a drive wizard

Introduction

On HMI Advanced you can configure the SINAMICS S120 drive online using a drive wizard. You can configure the following drive components:

- Active Line Modules (infeed)
- Motor modules and encoders (drives)

Drive configuration

The drive configuration can be called by selecting **Commissioning > Drives**.

1. Select the corresponding components, which are:
   - **Supply**
   - **Drives**
2. Once you have pressed the **Change** vertical softkey, run the drive wizard using the **Next >** horizontal softkey.
3. Parameterize the appropriate configuration in the dialog box that appears.

7.3.2 Drive components macro call

Macro call

For commissioning, you have to select the corresponding macro from the available system project design.

Procedure for calling macros

Start the macro with the following operation:

1. Start configuration macro:
   - Check: Control Unit: p9 = 1 (The configuration macros can only be started in the "factory setting" status p9=1.)
   - Control Unit: p15 written with value for configuration macro (such as "1")
   - Configuration macro is started
   - For monitoring, Control Unit: select p977
2. About 40 seconds after writing to p15:
   - Drive becomes "cyclical", all upper LEDs switch to GREEN
   - Control Unit: p977 is automatically set to "1", saving process is running
3. Waiting for the end of the saving process:
   - Control Unit: p977 is automatically set to "0". End ID of the macro run.

Please note

After the successful execution of the configuration macro, the system has to be switched off and then back on to check that the configured values have been properly accepted.

If the RDY LEDs signal YELLOW again or no edge change of the p977 occurs after a long period of time (more than 15 minutes), then an error has occurred.

Note on macro handling

Note

Operator errors that can occur

The following errors are frequently made when starting macros:

- Wrong status of p9
- Active enable signals to the modules
- Infeed (ALM) primarily not off-voltage

See also

Procedure for calling ACX macros (Page 14-19)

7.3.3 Reading the drive topology

Introduction

The drive topology is read automatically during successful completion of a configuration macro. All connected components are detected and drive-internal data transfer initialized.

ID

After the successful acceptance of the topology, the color of all the upper LEDs on the drive modules changes from YELLOW to GREEN. (The lower LED is always illuminated YELLOW.)

7.3.4 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 **Start-up**, 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.

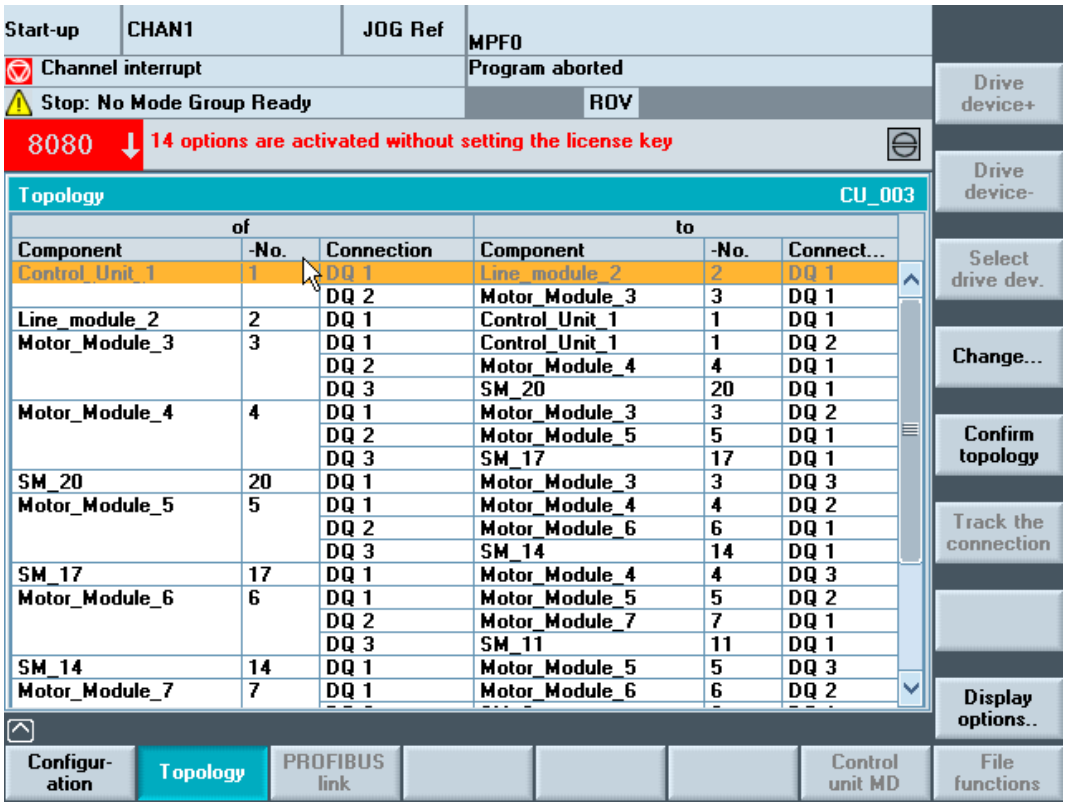


Fig. 7-1 Topology

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

See also

Manual configuration of direct measuring systems (Page 7-12)

7.3.5 Configuration of individual components (motor, encoder) -> drive data sets

Overview

When motor measuring systems are connected via SMC modules, the drive system is unable to detect the actual motors and encoders that are connected. In this case, the relevant drive module must be configured manually.

The following drive components must be configured manually via the drive machine data:

- SIEMENS standard motors
- Direct measuring systems

Requirements

The requirements are as follows:

- The MLFB numbers of the relevant motors are available.
- The XML lists for the motor codings, which were delivered with the tool box, are available.
- You are at the HMI in the operating area **Start-up > Machine data > Drive MD**.
- You have activated the parameter list for the relevant motor (drive), such as SERVO_03 (see picture below).

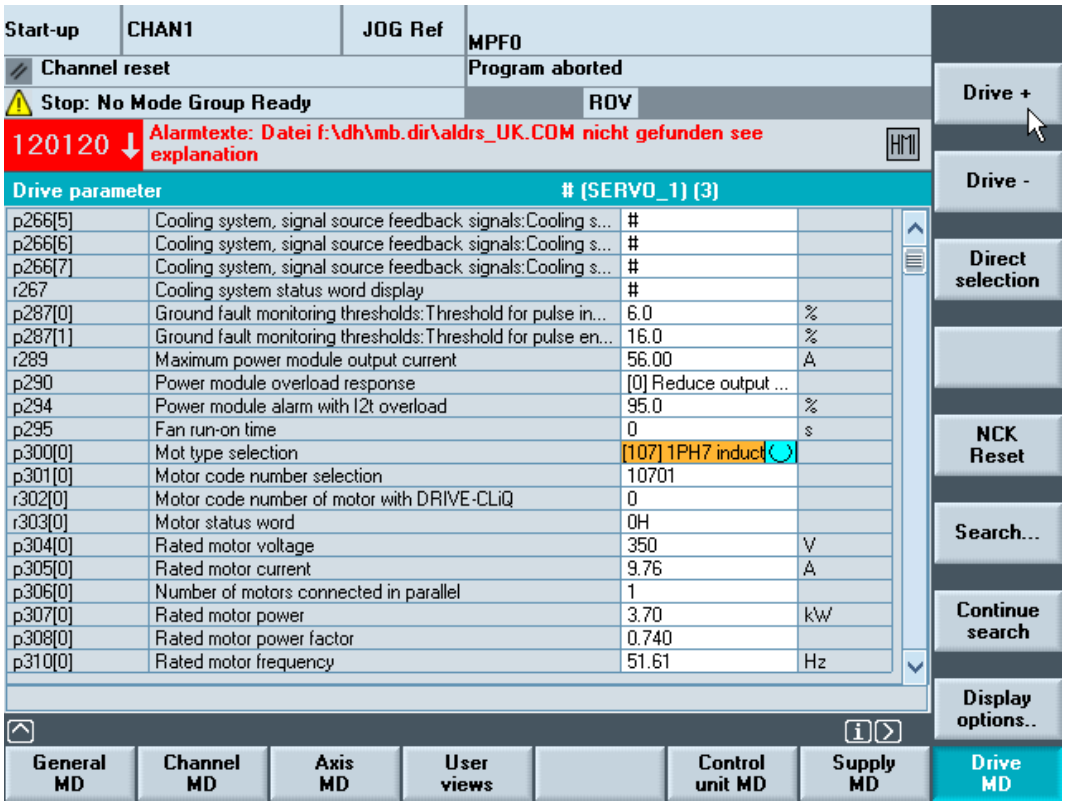


Fig. 7-2 Manual configuration

7.3.5.1 Choose motor coding from XML lists

Introduction

Motors without DRIVE-CLiQ interface can be configured via parameters p300, p301, p500 for the motor and p400 for the measuring system used.

If the motor code or the code for the measuring system are unknown, you can find them out from the XML lists delivered with the tool box.

Requirements

The MLFB number of the motor has to be known.

Procedure for determining the motor code number

1. Open the relevant file with Wordpad, for example (content is an XML format).
2. Search with the starting code of the MLFB, if the MLFB does not correspond completely, then choose "Find next" until you find the right entry.

   After the <const> block with the MLFB, the ID follows 2 blocks later. The ID is to be accepted and entered in parameter p301.

   Example from the file motsrm.acx.xml:

```
<SRMotor>
 <Const>
 <Name type="String">MLFB</Name>
 <Value type="String">1FT6132-xSF7x-xxxx</Value>
 </Const>
 <Const>
 <Name type="String">Measure</Name>
 <Value type="String">1</Value>
 </Const>
 <Const>
 <Name type="String">Id</Name>
 <Value type="UInt16">21616</Value>
 </Const>
 <Const>
 <Name type="String">Vnom</Name>
 <Value type="Float32">363</Value>
 <Unit type="UInt16">VOLTAGE_AC_EFF</Unit>
 <Number type="UInt16">304</Number>
```

7.3.5.2 Manual configuration of SIEMENS standard motors

Procedure for manual configuration of SIEMENS standard motors

If you have the relevant motor code of the individual motors, you can configure the motor for each individual drive object with the following drive parameters:

1. Under **Commissioning > Machine data > Drive MD**, use the **Drive+** vertical softkey to select the drive object.
2. Check: p10 = 1 (for unidentified components on the drive, parameter p10 is not changed for the execution of the configuration macro).
3. Enter the type group of the motor: E.g.: p300 = 104 (for 1PH4 motors).
4. Enter the motor code for SIEMENS standard motors: set p301=10401.
5. Enter the encoder type: set p400 = 2003 (Encoder 256 Pulse).
6. p500=102 (spindle) or =101 (axis drive) set/check (important for third-party motors).
7. Initiate value calculation: set p3900 = 3.
8. p3900 is automatically set to "0" by the system after the calculation of the values. When the motor commissioning is successfully completed, p10 is also automatically set to "0".
9. Check the parameter p2, return value may NOT be "46 dec" ("2E hex"), otherwise "abort startup mode."
10. Save module-specific: **Save/Reset > Save**.
    softkey or
    Save "All": set p977 = 1
11. You must wait until the message line displays "Drive [drive name (drive number)] saved".
12. Select the next drive object using the **Drive+** vertical softkey.
13. Continue at point 2 in order to parameterize additional modules.

7.3.5.3 Manual configuration of direct measuring systems

Procedure for manual configuration of direct measuring systems

The following drive parameters must be modified in the drive object for the Motor Module in order to activate a direct measuring system (2nd encoder) on the drive. To do this, you have to switch from **Control Unit MD** to **Drive MD** under **Commissioning > Machine data** for the appropriate Motor Module.

1. Configure drive basis:
   - Control Unit: set p9 = 3
   - Motor module: p140 = 2
   - Control Unit: set p9 = 0
   - Control Unit: p977 = 1 set (save!)
   - Switch drive on and off. In the process, the parameters p141[0]ff. are provided with an additional index: p141[0] & p141[1]…
2. Configure data block basis:
   - Control Unit: set p9 = 4
   - Motor module: p141[1] = Component number of the second encoder, see "Topology" screen
   - Motor module: p142[1] = Component number+1 of the second encoder, see "Topology" screen
   - Motor module: in all p188[0...7] = Activate encoder data set 2 MS, write in value = 1; that way, the second encoder of the drive is provided with MS under 141[1]ff. (Default value =99, no 2.MS available)
   - Control Unit: set p9 = 0
3. Configure encoder data:
   - Motor module: Check: set p10 = 1 (or p10 = 4)
   - Motor module: p400[1] = set encoder type of second encoder, e.g., 2001, see description p400
   - Motor module: set p10 = 4
   - Adjust encoder data p405[1] ..., etc., as needed (resolution, etc., see description p400)
   - Motor module: set p10 = 0
   - Control Unit: p977 = 1 set (save)

Please note:

The component number of the second encoder is determined via the "Topology" commissioning screen under **Commissioning > Drives > Drive units > Topology** on the HMI.

Note

For certain topologies (encoder was placed on X201 for the last motor module), the second encoder is already assigned to an axis.

For this reason, check the encoder assignment of the last motor module after the acceptance of the topology or modify for the standard (no second encoder assigned):

- p140=1 (number of encoder data sets (EDS))

  The encoder machine data belonging to the encoder only have the index [0] for the first encoder. The assignment of the encoder to the EDS is to be overridden via p188/189=99.
- p141[1] = 0
- p142[1] = 0
- p189[0..7] = 99

7.3.6 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 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 7-1 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 implemented	3	255[1)]
Not implemented	4	255[1)]
Not implemented	5	255[1)]
CU	6	1
ALM, only if protocol 370 is available	7	255[1)]
Not implemented	8	0[2)]
ALM (Standard for SINUMERIK)	9	2

1) Not active

2) End of exchange from 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 7-2 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

Component	Index p978	List of drive objects
Not available	3	255[1)]
Not available	4	255[1)]
Not available	5	255[1)]
CU	6	1
ALM, only if protocol 370 is available	7	255[1)]
Not available	8	0[2)]
Not available	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 operating area **Commissioning > Machine data > Control Unit MD**.

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 12-3).

7.3.7 Configuring data sets and the PROFIBUS protocol

Introduction

The following parameters can be set for the Motor Modules on all six drive objects using the macro 100116:

- Two encoder data sets in p140=2
- Eight drive data sets in p180=8
- PROFIBUS protocol p922 = 116 (SINUMERIK 840D sl)

Precondition

The prerequisite for calling up macro 100116 is the prior startup via configuration macro "1" or "5".

Procedure for calling macros

Start the macro with the following operation:

1. Shut down and restart system (POWER ON).
2. In the operating area, select **Commissioning > Machine data > Control Unit MD**.
3. Start configuration macro:
   - Control Unit: p9=3 (drive-basis configuration)
   - Control unit: p15=100116
   - Macro is started
   - For monitoring, Control Unit: select p977
4. About 40 seconds after writing to p15:
   - Drive becomes "cyclical", all upper LEDs switch to GREEN
   - Control Unit: p977 is automatically set to "1", saving process is running
5. Waiting for the end of the saving process:
   - Control Unit: p977 is automatically set to "0". End ID of the macro run.
6. Shut down and restart system (POWER ON).

Note

The macro runtime depends on the drive configuration and can last between approximately two and five minutes.

Parameter p9 is reset to zero before the settings are saved using the macro.

If encoders are active, the "Hardware fault active encoder xxx" error message may be output, but this has no effect on the execution of the macro.

7.3.8 Identification 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 approx. 20 seconds to complete.

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

Procedure for manual identification of the ALM

Identification of the ALM is carried out as follows:

1. The commissioning engineer disables the ALM (X122.1).
2. Select machine data for the infeed (ALM) under **Commissioning > Machine data > Infeed MD**.
3. Initiate identification on the ALM: p3410 = 5.
4. Connect ALM enable (enable must remain present during optimization).
5. ALM controller data are reset automatically and optimization is performed.
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.
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).

7.4 First commissioning of SINAMICS drive ended

First commissioning of SINAMICS drive ended

You have completed the first commissioning of the SINAMICS drives.

The acceptance of the topology has been successfully completed:

- All upper LEDs of the drive module are illuminating GREEN.
- The lower LEDs of the drive modules always illuminate YELLOW.

Continue with the steps for commissioning the NCK. You have chosen the operating area **Commissioning**.

Commissioning Communication NCK<->Drive

8

Introduction

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

What will be configured?

The following operator input sequence steps describe how you configure the following for the NCK machine data on the communication to the drive:

- General machine data
  - The telegram type for transfer
  - The logical addresses for the PLC
- Axis-specific machine data

  for the relevant axis, the axis component for transferring the setpoint and actual values.

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/setpoint/actual value.

SINAMICS S120	STEP7 (HW-config) DP slave properties		NCK machine data General MD			NCK machine data Axis MD	
Component	Telegram 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] Telegram 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

8.1 Configuration input/output address and telegram

Introduction

Following general machine data is preassigned with a default value (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.

8.2 Configuration setpoint/actual value

Introduction

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)

Steps

1. In the operating area **Commissioning > Machine data**, choose the softkey **Axis MD**.
2. Choose 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.

8.3 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

9

9.1 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

Overview of machine and setting data (Page 14-29)

9.2 System data

9.2.1 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 9-1 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

References:

/FB/ Description of Functions Basic Machine
G2 Velocities, Traversing Ranges, Accuracies, Chapter: I/O Resolution,

9.2.2 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 9-2 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

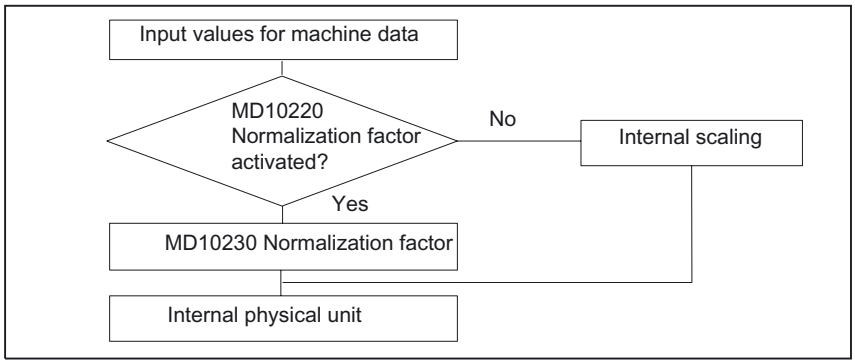
User-defined

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 9-3 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).

$$MD: SCALING\_USER\_DEF\_MASK = 'H14'; (Bit - No.4\ and\ Bit - No.2\ from\ example\ 1\ as\ hexadecimal\ value)$$

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

$$\Rightarrow\ MD:SCALING\_FACTORS\_USER\_DEF[4] = 304.8$$

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

Machine data

Table 9-4 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

Number	Name of identifier	Name / remarks	Reference
General ($MN_ ...)			
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	

9.2.3 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.

9.2.4 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.

9.2.5 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] changes 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
- Feedrates
- Acceleration rates
- Jerk
- Tool offsets

- Programmable, settable and work offsets external and DRF offsets
- Compensation values
- Protection zones
- Machine data
- Jog and handwheel factors

After switching, all above mentioned data are available in the physical units as described in Subsection "Scaling Physical Quantities for 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)
- PUD (**P**rogram global **U**ser **D**ata)
- Analog I/Os
- 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 account.

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 9-5 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 switchover to inch system	
10260	CONVERT_SCALING_SYSTEM	Basic system switchover active	

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

References:

/FB/ Description of Functions, Basic Machine,
G2 Velocities, Setpoint/Actual Value Systems, Closed-Loop Control, Chapter "Metric/Inch Measuring System"

9.2.6 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 9-6 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.]

9.2.7 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 9-7 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	

9.2.8 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 POSTCTL_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: $T_M + T_{Position\ control\ max} < T_{DP}$

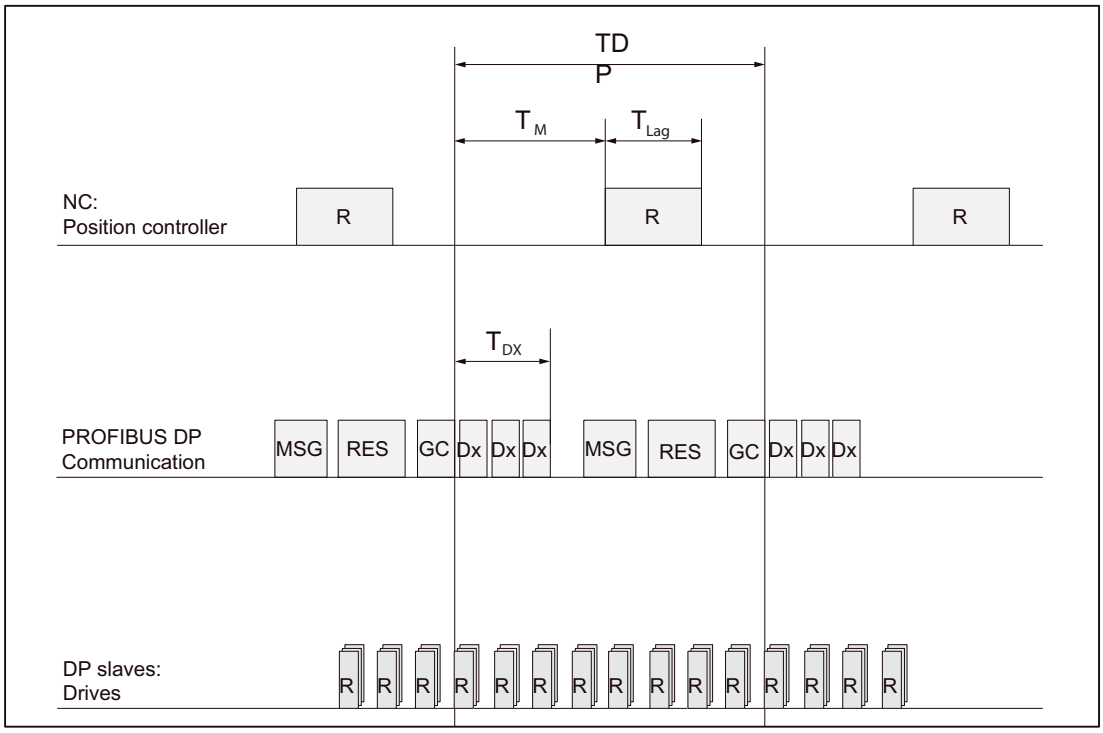


Fig. 9-1 Position control cycle offset compared to PROFIBUS DP cycle

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:

- 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".

References:

/FB/ Description of Functions - Special Functions, G3 Cycle Times

Machine data

Table 9-8 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	POSTCTL_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.

9.2.9 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.

References:

/PGA/ Programming Guide, Advanced, Chapter "Compressor COMPON/COMPCURVE"

Voltage limit

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

$$V_{min} \geq \frac{10^{-9}}{\text{Computational resolution } [\frac{\text{Incr.}}{\text{mm or degree}}] * \text{Interpolation cycle [s]}}$$

(for the computational resolution, see Chapter "Resolutions")

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

References:

/FB/ Description of Functions Basic Machine
G2 Velocities, Traversing Ranges, Accuracies, Section "Velocities"

9.3 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:

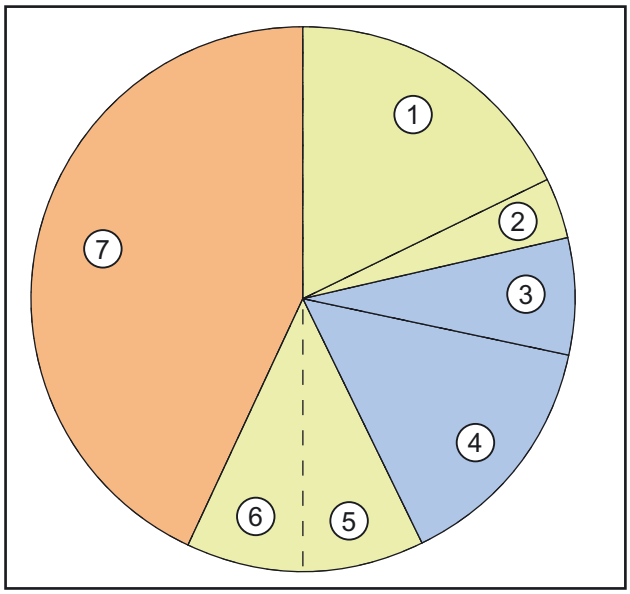


Fig. 9-2 Memory division

Legend	Description	User
1	Part programs and OEM cycles can be set via MD 18352: $MM_U_FILE_MEM_SIZE.	Users
2	In addition to part programs and OEM cycles, can be set via MD 18353: $MM_M_FILE_MEM_SIZE.	Users
3	SIEMENS cycles	Siemens AG
4	Reserved	Siemens AG
5	RAM in NCK	Users
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.	Users
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 13-1)

9.4 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. 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".

Parameter set no.	Axis	Spindle	Gear stage of 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.

Fig. 9-3 Validity of parameter sets for axis and spindle modes

Machine data

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

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

Table 9-9 Parameter-set-dependent machine data

Number	Name of identifier	Name	Reference
Axis/channelspecific ($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 feedforward 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	

9.5 Parameterize axis data

See also

Configure axis data - overview (Page 14-40)

Axis assignment (Page 14-46)

Axis names (Page 14-48)

9.5.1 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.

Linear axis with encoder on the machine

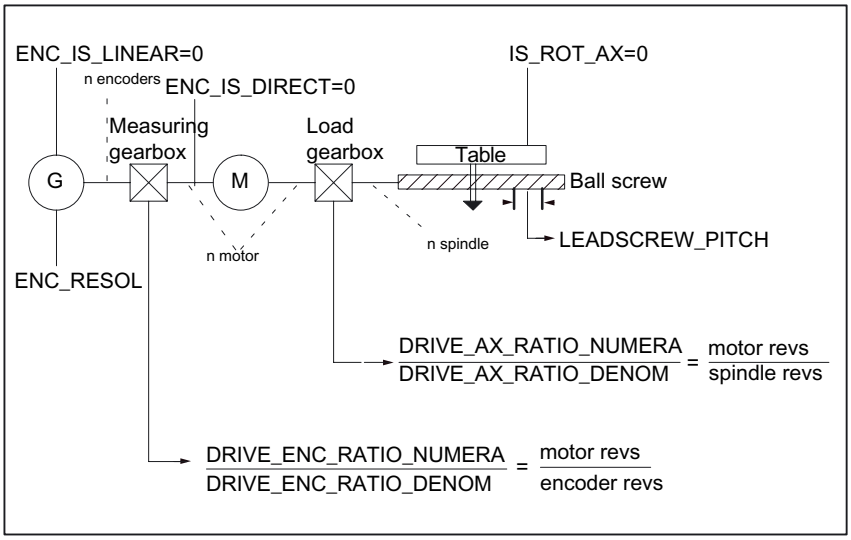


Fig. 9-4 Linear axis with encoder on motor

Linear axis with encoder on the machine

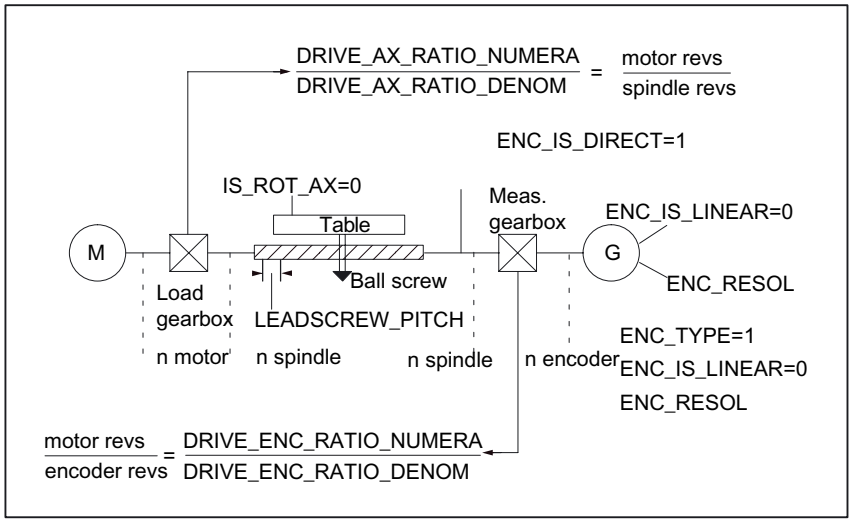


Fig. 9-5 Linear axis with encoder on the machine

Rotary axis with encoder on motor

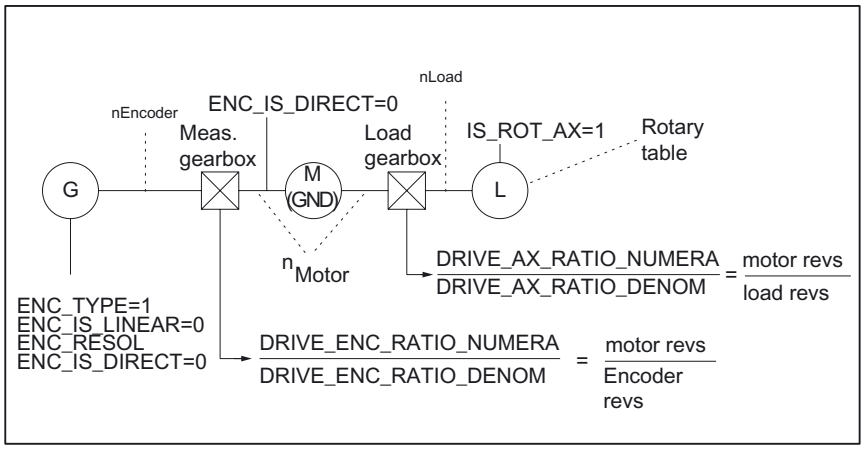


Fig. 9-6 Rotary axis with encoder on motor

Linear axis with encoder on the machine

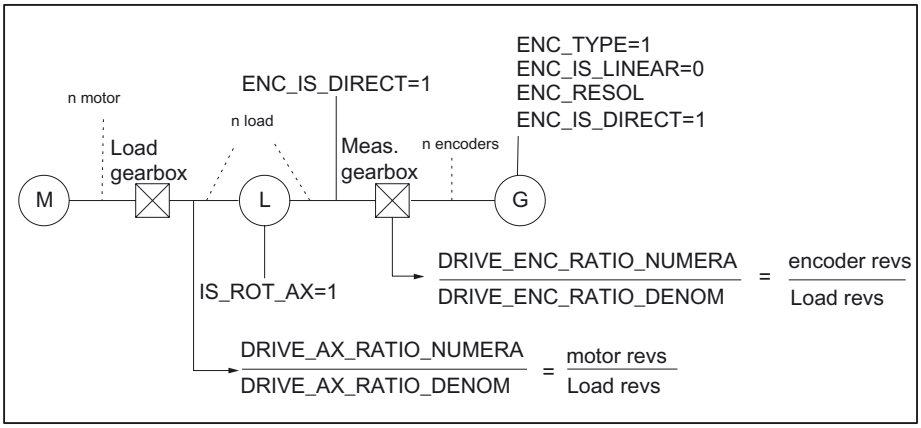


Fig. 9-7 Linear axis with encoder on the machine

Machine data

Table 9-10 Incremental measuring systems: Machine data

Number	Name of 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	Pitch of the ball screw	
31040	ENC_IS_DIRECT[n]	Encoder is connected directly to the machine	
31050	DRIVE_AX_RATIO_DENOM [n]	Load gearbox denominator	
31060	DRIVE_AX_RATIO_NUMERA [n]	Load gearbox numerator	
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

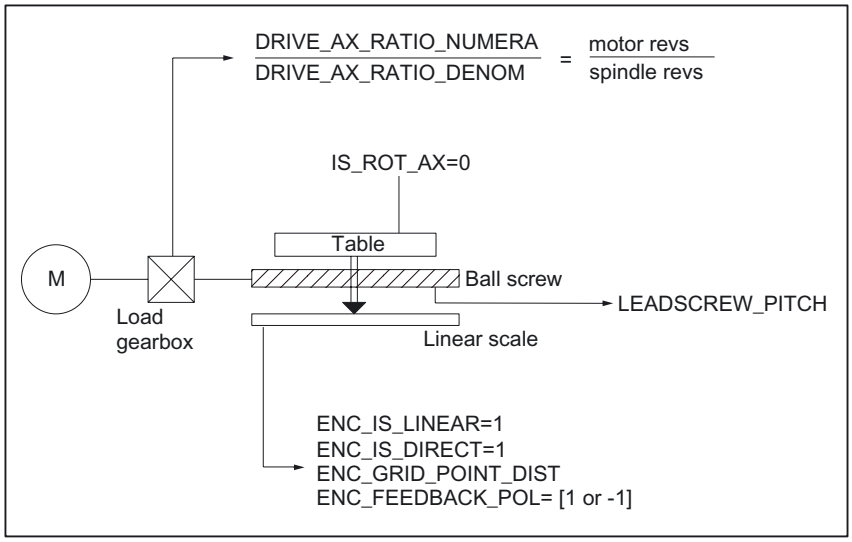


Fig. 9-8 Linear axis with linear scale

Machine data

Table 9-11 Linear measuring systems: Machine data

Number	Name of 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	Pitch of the ball screw	
31040	ENC_IS_DIRECT[n]	Encoder is connected directly to the machine	
31050	DRIVE_AX_RATIO_DENOM [n]	Load gearbox denominator	
31060	DRIVE_AX_RATIO_NUMERA [n]	Load gearbox numerator	
32110	ENC_FEEDBACK_POL[n]	Sign actual value (feedback polarity)	

9.5.2 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

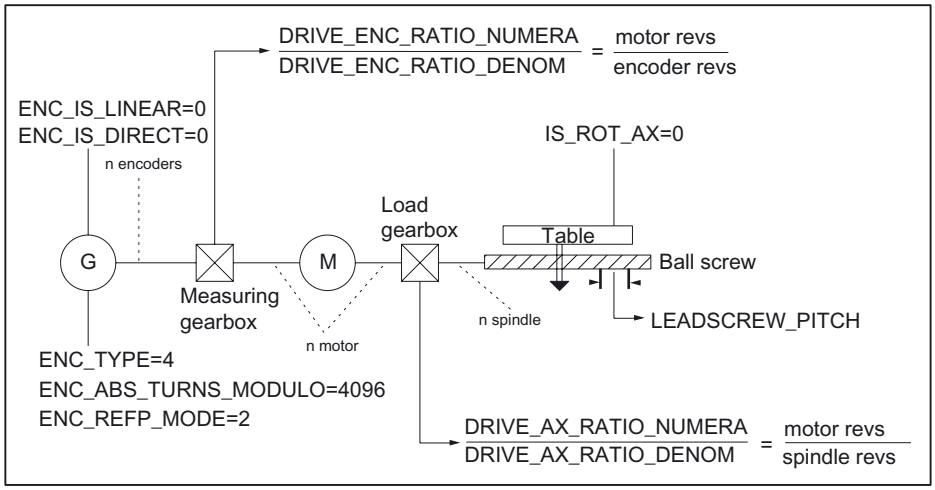


Fig. 9-9 Linear axis with absolute value encoder on motor

Rotary axis with absolute value encoder on motor

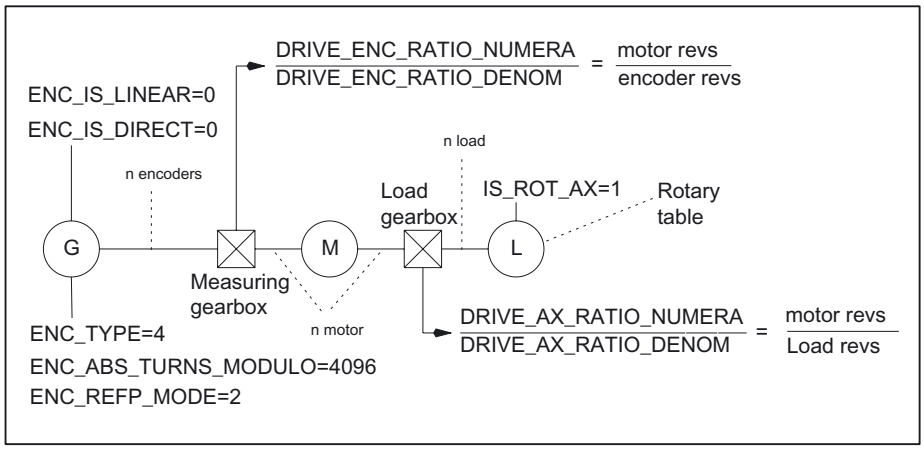


Fig. 9-10 Rotary axis with absolute value encoder on motor

Machine data

Table 9-12 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)	

Number	Identifier	Name/remarks	Reference
31030	LEADSCREW_PITCH[n]	Pitch of the ball screw	
31040	ENC_IS_DIRECT[n]	Encoder is connected directly to the machine	
31050	DRIVE_AX_RATIO_DENOM [n]	Load gearbox denominator	
31060	DRIVE_AX_RATIO_NUMERA [n]	Load gearbox numerator	
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

9.5.3 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.

Measuring system

DSC is only possible in conjunction with the motor measuring system.

Machine data

Table 9-13 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

9.5.4 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

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 9-14 Rotary axes: Machine data

Number	Name of 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 9-15 Rotary axes: Setting data

Number	Name of 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

References:

/FB/ Description of Functions - Extended Functions, R2 Rotary axes

9.5.5 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 occurs if the PLC axis or synaction is processed.

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)

will apply to this axis automatically.

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

Machine data

Table 9-16 Positioning axes: Machine data

Number	Name of 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 9-17 Positioning axes: Interface signals

DB number	Bit, byte	Name	Reference
Axis/spindle-specific		Signals from PLC to axis/spindle	

DB number	Bit, byte	Name	Reference
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	

References:

/FB/ Description of Functions - Extended Functions, P2 Positioning axes

9.5.6 Indexing axes

Indexing axes are rotary or linear axes that may only be traversed within their traversing range to defined positions, the indexing positions.

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

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_1[n] (indexing position table 2)

Machine data

Table 9-18 Indexing axes: Machine data

Number	Name of identifier	Name	Reference
General ($MN_ ...)			
10260	CONVERT_SCALING_SYSTEM	Basic system switchover active	G2
10270	POS_TAB_SCALING_SYSTEM	System of measurement of position tables	

Number	Name of identifier	Name	Reference
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/channelspecific ($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	

Interface signals

Table 9-19 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	

References:

/FB/ Description of Functions - Extended Functions, T1 Indexing axes

9.5.7 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.

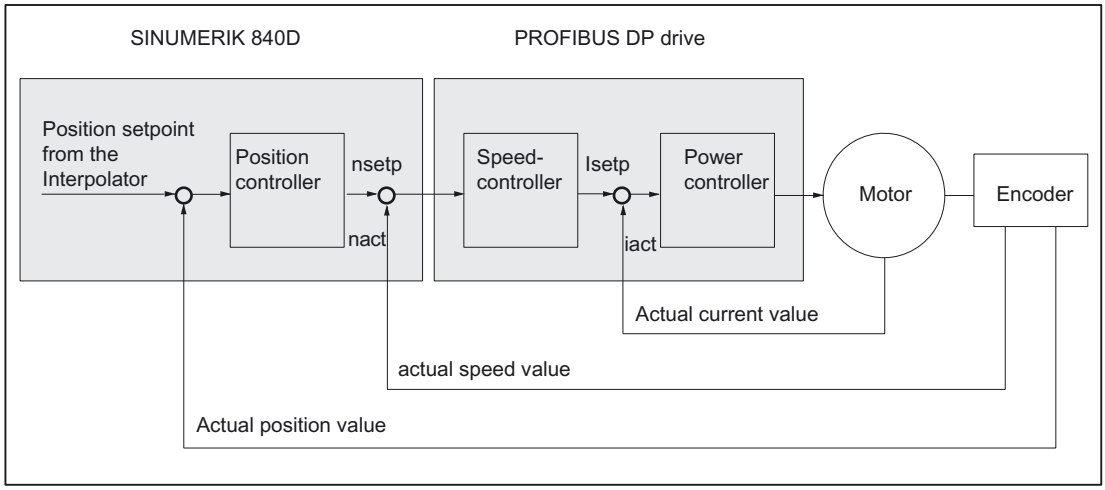


Fig. 9-11 Control loops

Traversing direction

If the axis does not traverse into the desired direction, the appropriate adaptation is made in

- MD32100 AX_MOTION_DIR (travel direction)

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

Control direction

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

- MD32110 ENC_FEEDBACK_POL (sign of actual value)

adjusted.

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 of the drive and the mechanical system of the machine.

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.

Via

- MD32200 POSCTRL_GAIN (K_V factor)

the K_V factor of the machine axis is entered.

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 are assigned by default:

- 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.

These factors are:

- MD32260 RATED_VELO
- MD32250 RATED_OUTVAL

Notice

Machine axes that interpolate one with another must have the same following error at the same velocities.

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

- 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. For checking, reduce the acceleration of the axis in

- MD32300 MAX_AX_ACCEL (Axis acceleration)

to make sure that the drive does not reach its current limit when accelerating and decelerating.

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 a storage oscilloscope or the HMI Advanced servo trace software. The speed setpoint is recorded for this purpose.

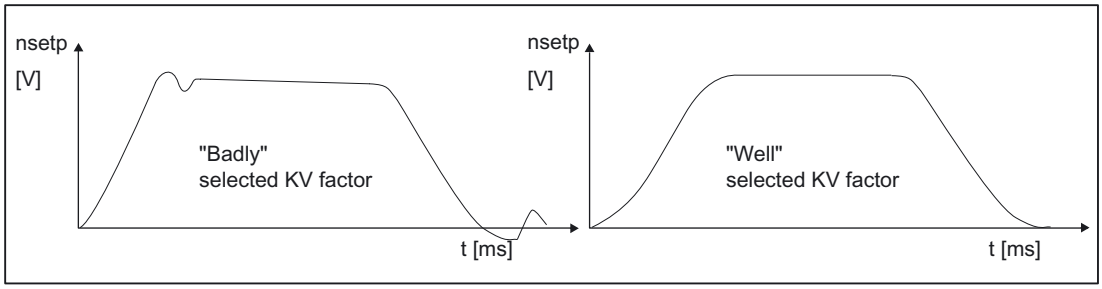


Fig. 9-12 Speed setpoint characteristic

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 to a little less than the maximum possible value.

The real K_V factor must precisely match that set because monitoring functions are derived from the K_V factor that would otherwise respond (e.g., contour monitoring).

Acceleration

The machine axes are accelerated and decelerated with the acceleration entered in

- MD32300 MAX_AX_ACCEL (Axis acceleration)

This value should allow the axes to be accelerated and positioned rapidly and accurately while ensuring that the machine is not unduly loaded.

Default values

The default values of the acceleration are in the range from 0.5 m/s² to 2 m/s².

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 (heavy workpiece).

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 machining must not cause the current limit to be reached. Excessive current during machining causes falsification of the contour. 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.

Machine data

Table 9-20 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]	Servo gain factor	
32300	MAX_AX_ACCEL[n]	Axis acceleration	
32900	DYN_MATCH_ENABLE[n]	Dynamic response adaptation	
32910	DYN_MATCH_TIME [n]	Time constant for dynamic matching	

References:

/FB/ Description of Functions, Basic Machine,
G2 Velocities, Setpoint/Actual Value Systems, Closed-Loop Control Module, Chapter "Closed-Loop Control Module"

9.5.8 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.

Note

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

- Message: "Wait, axis enable missing"

This axis and any axes that interpolate with it are not traversed.

Manual comparison

If a value not equal to 0 is entered in machine data

- MD32250 RATED_OUTVAL (rated output voltage) [%]

the NCK assumes that speed setpoint matching will be performed manually.

Note

The max. 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

$$n_{motor} = \frac{V_{axis} * \frac{\text{MD31060 DRIVE\_RATIO\_NUMERA}}{\text{MD31050 DRIVE\_RATIO\_DENOM}}}{\text{MD31030: LEADSCREW\_PITCH}}$$

Motor speed for rotary axis/spindle

$$n_{motor} = n_{load} \frac{\text{MD31050 DRIVE\_RATIO\_NUMERA}}{\text{MD31050 DRIVE\_RATIO\_DENOM}}$$

- v_{Axis} [mm/min]
- MD31060 DRIVE_RATIO_NUMERA (numerator load gearbox)
- MD31050 DRIVE_RATIO_DENOM (denominator load gearbox)
- MD31030 LEADSCREW_PITCH (pitch of the ball screw) [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.

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

- 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 switchover > Diagnosis > Service displays > Service axis/spindle

Machine data

Table 9-21 Speed setpoint matching: Machine data

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

References:

/FB/ Description of Functions, Basic Machine,
G2 Velocities, Setpoint/Actual Value Systems, Closed-Loop Control Module, Chapter "Velocities, Traversing Ranges, Accuracies"

9.5.9 Drift compensation

Digital drives

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

Machine data

Table 9-22 Drift compensation: Machine data

Number	Identifier	Name/remarks	Reference
axis spec. ($MA_ ...)			
36720	DRIFT_VALUE	Basic drift value, always = 0	G2

9.5.10 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 MD303300 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 9-23 Velocities: Machine data

Number	Name of 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 9-24 Velocities: Setting data

Number	Name of 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	

References:

/FB/ Description of Functions, Basic Machine,
G2 Velocities, Setpoint/Actual Value Systems, Closed-Loop Control, Chapter "Velocities, Traversing Ranges, Accuracies"

/FB/ Description of Functions - Extended Functions, H1 Jog with/without Handwheel

9.5.11 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"

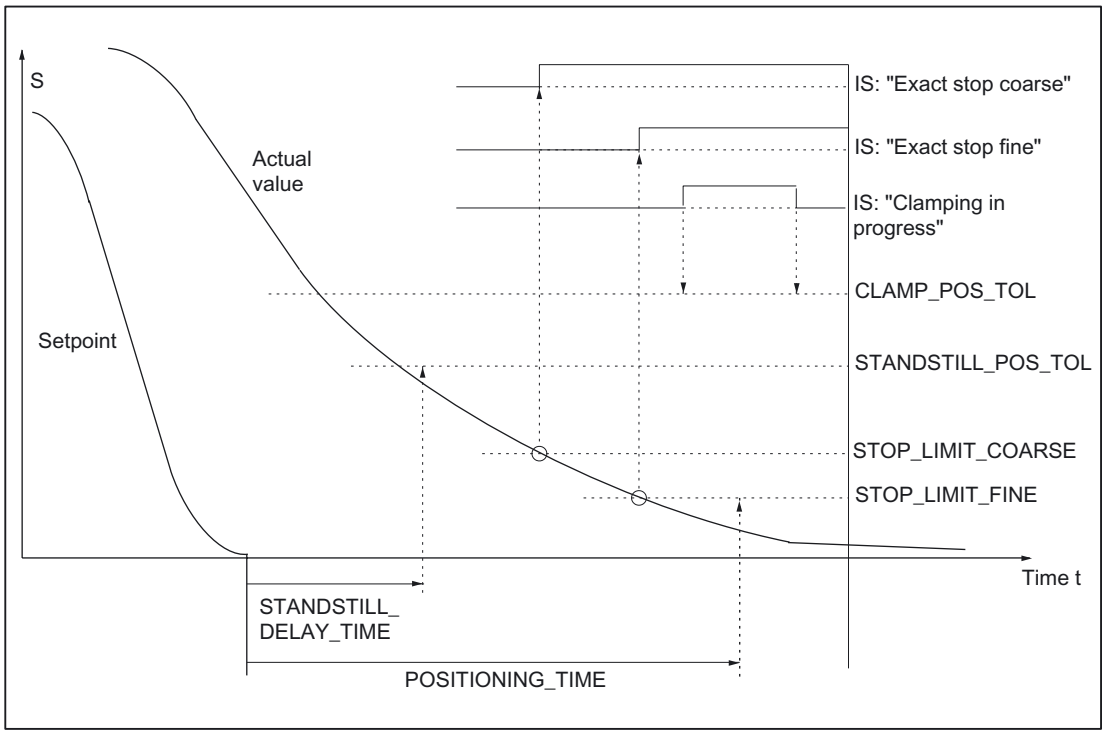


Fig. 9-13 Static monitoring functions

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.

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

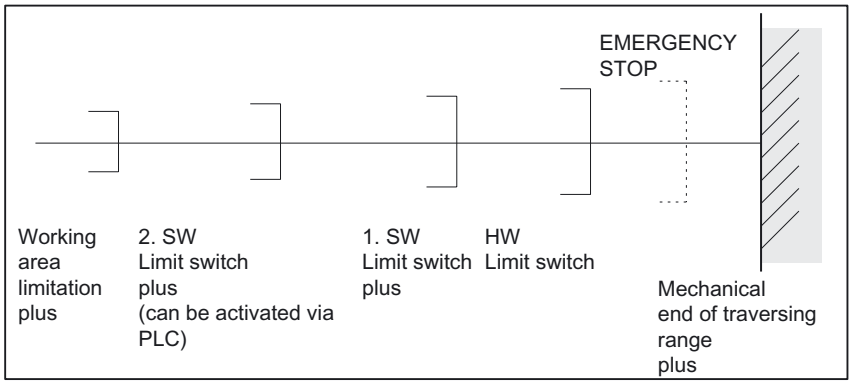


Fig. 9-14 Overview of end limitations

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 %)

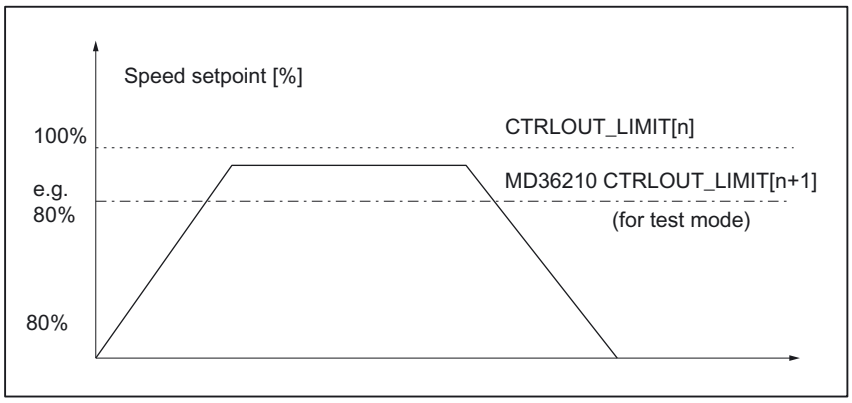


Fig. 9-15 Speed setpoint limitation

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).

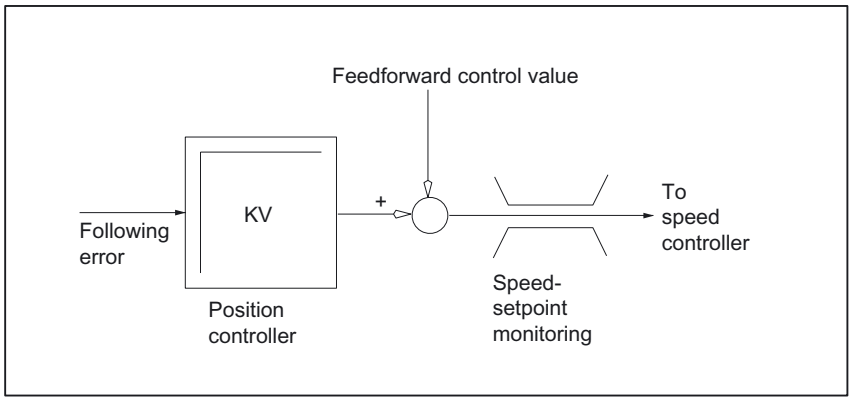


Fig. 9-16 Speed setpoint calculation

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)

Cause of errors/error handling

- Check speed setpoint cable
- 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 following error measured and 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)

Cause of errors/error handling

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
  operation area: **DIAGNOSIS > Service displays > Service axis.**
- Check optimization of the speed controller
- Check smooth running of the axes
- Check machine data for travel 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)

Cause of errors/error handling

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. Via

- 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 feature:
A value of 100 will additionally disable the hardware monitoring of the encoder.

Error response

- Alarm: "25020 Zero mark monitoring"

and stopping the machine axes using a speed setpoint ramp whose characteristic is set in

- MD36610 AX_EMERGENCY_STOP_TIME (Time for braking ramp when an error occurs)

Cause of errors/error handling

- 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 position actual value switchover)

Error response

- Alarm: "25100 Measuring system cannot be switched over"

The requested switchover to another encoder is not carried out.

Cause of errors/error handling

- The specified permissible tolerance is too small.
- The position measuring system to which you will switch over 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

- MD36610 AX_EMERGENCY_STOP_TIME (Time for braking ramp when an error occurs)

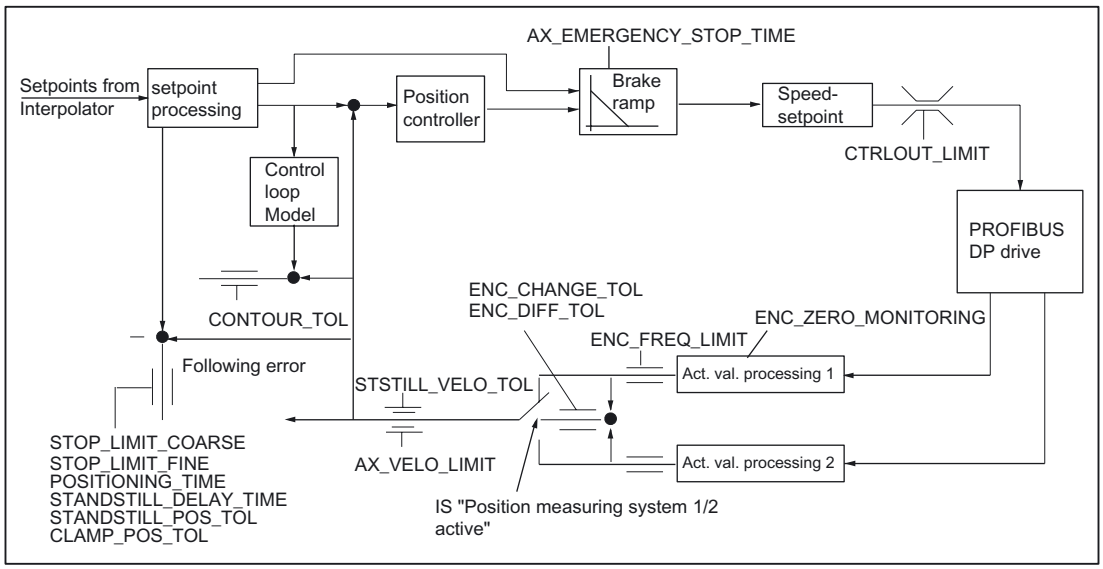


Fig. 9-17 Monitoring for SINUMERIK 840D sl

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.

References:

/FB/ Description of Functions, Basic Machine, A3 Axis Monitoring, Protection Zones

9.5.12 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. Reference point approach is started using traverse direction keys PLUS or MINUS (depending on the parameterized reference point approach direction).

9.5.12.1 Incremental measuring system

Incremental measuring systems

With incremental measuring systems, referencing is carried out using a reference point approach divided into 3 phases:

1. Traversing to the reference cam
2. Synchronizing to the encoder zero marker
3. Approach reference point

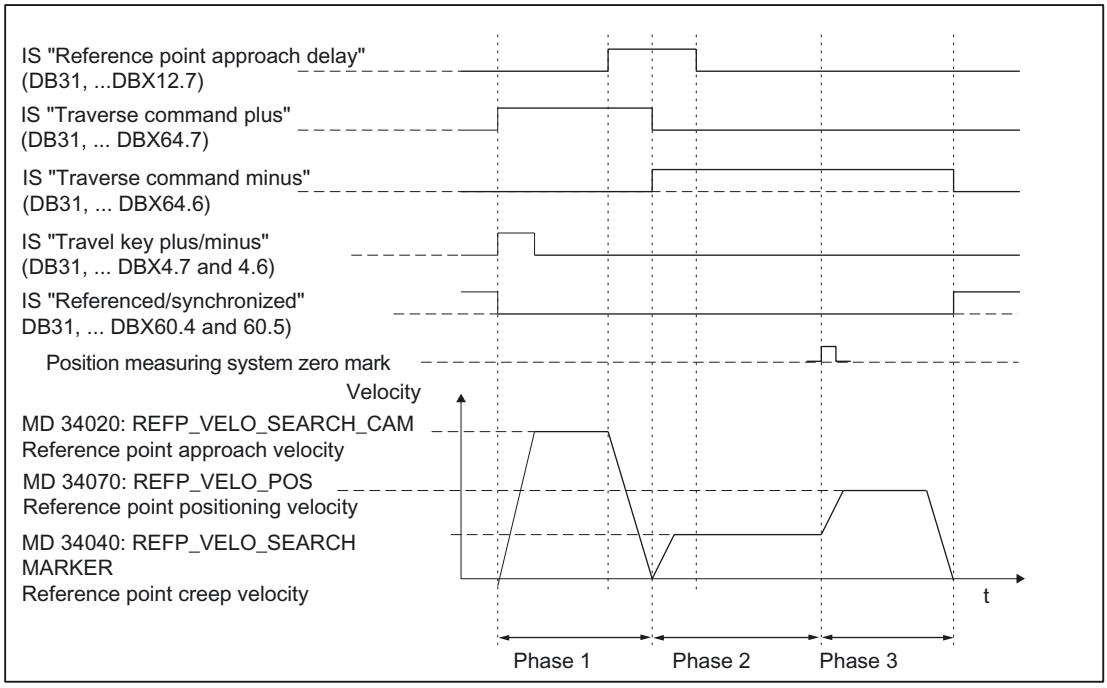


Fig. 9-18 Signal chart: Referencing with an incremental measuring system (principle)

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)
- 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.
- If the machine axis travels a predetermined maximum distance from the initial position toward the reference cam defined in
  - MD34030 REFP_MAX_CAM_DIST (max. distance to the reference cam) without reaching the reference cam
  - IS: DB31, ... DBX12.7 ("Reference point approach delayed") = 0 the axis stops, and alarm 20000 "Reference cam not reached" is output.

Warning

If the reference cam is not calibrated exactly, it is possible that a wrong zero marker 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 marker

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.
- If the machine axis travels as from exiting the reference cam:
- IS: DB31, ... DBX12.7 ("Reference point approach delay") = 0

  a max. distance parameterized in the machine data:
- 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 are active.

References:

/FB1/ Description of Functions, Basic Machine, R1 Reference point approach,
Chapter "Referencing with incremental measuring systems"

9.5.12.2 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

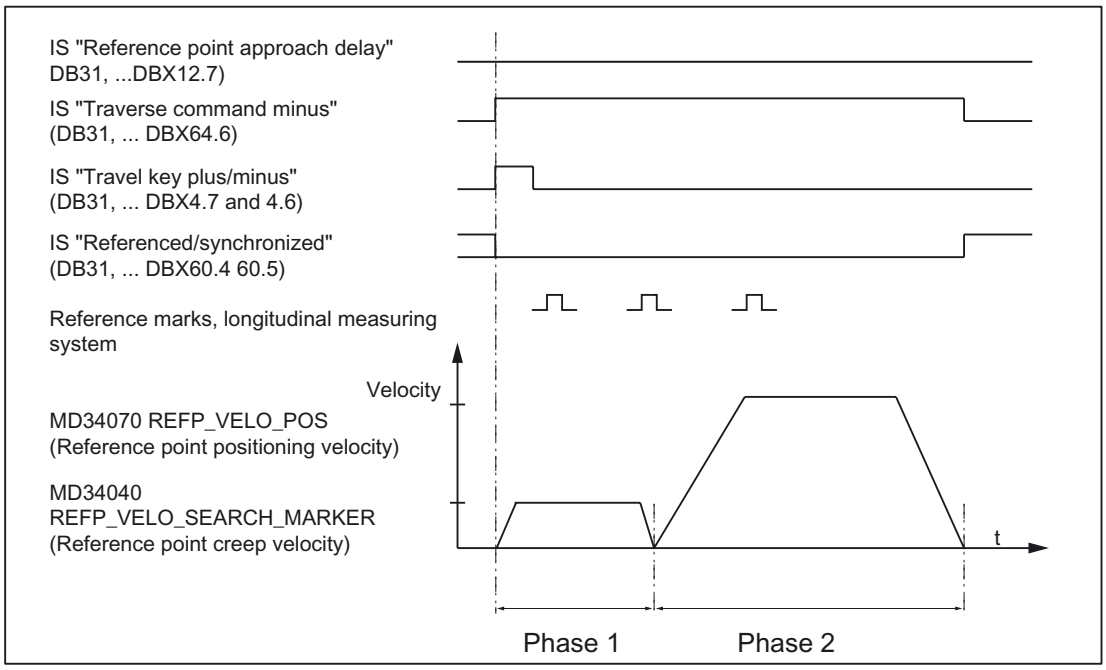


Fig. 9-19 Signal chart: Distance-coded reference marks (principle)

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 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.

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.

References:

/FB1/ Description of Functions, Basic Machine, R1 Reference point approach, Chapter "Referencing on length measuring systems with distance-coded reference marks"

9.5.12.3 Absolute encoders

Absolute encoders

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 value encoder
- The absolute encoder is calibrated:

  MD34210 ENC_REFP_STATE[n] = **2** (absolute value 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 reference cam

The calibration using the probe and reference cam is described in:

References:

/FB/ Description of Functions, Basic Machine, R1 Reference point approach, Chapter "Automatic calibration using probe", Calibration with reference cam

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 on the user interface:

- MD34100 $MA_REFP_SET_POS[n] (reference point value)

Calibrating several absolute value encoders

For time-optimized calibration of the absolute value 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 value encoder
- Removal/installation of the motor with the absolute value encoder
- SRAM data loss of the NC, battery power failure
- 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 value encoder by manually resetting the status to "encoder not calibrated" and to perform calibration again.

References:

/FB1/ Description of Functions, Basic Machine, R1 Reference point approach, Chapter "Referencing with absolute encoders"

9.5.12.4 Interface signals and machine data

Interface signals

Table 9-25 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

DB number	Bit, byte	Name	Reference
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 9-26 Referencing: Machine data

Number	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	Reference cam delay time in plus direction	S1
31123	BERO_DELAY_TIME_MINUS	Reference cam 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]	

Number	Identifier	Name	Reference
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 reference cam	
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
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	

References:

/FB/ Description of Functions, Basic Machine, R1 Reference point approach

9.6 Parameterization of spindle data

See also

Spindle data overview (Page 14-52)

Spindle modes (Page 14-52)

Default mode setting (Page 14-55)

Axis mode (Page 14-56)

More information on spindles (Page 14-59)

9.6.1 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.

9.6.2 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.

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)

- 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.

References:

FB1/ Description of Functions, Basic Machine, S1 Spindles, Chapter "Gear Stage Change"

9.6.3 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]
- Encoder gear stage = 1:1

- Load gear stage = 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 (load rev. denominator) = 1
- MD31080 DRIVE_ENC_RATION_NUMERA (load rev. 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]
- Encoder gear stage = 1:1
- Load gear stage 1= 2.5:1 [motor rev./spindle rev.]
- Load gear stage 2= 1:1 [motor rev./spindle rev.]

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

$$\text{Internal Resolution} = \frac{360}{2048 * 128} * \frac{1}{1} * \frac{1}{1} * 1000 = 1.3733 \quad \frac{\text{int. increments}}{\text{encoder pulse}}$$

One encoder increment corresponds to 1.3733 internal increments.

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

9.6.4 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.

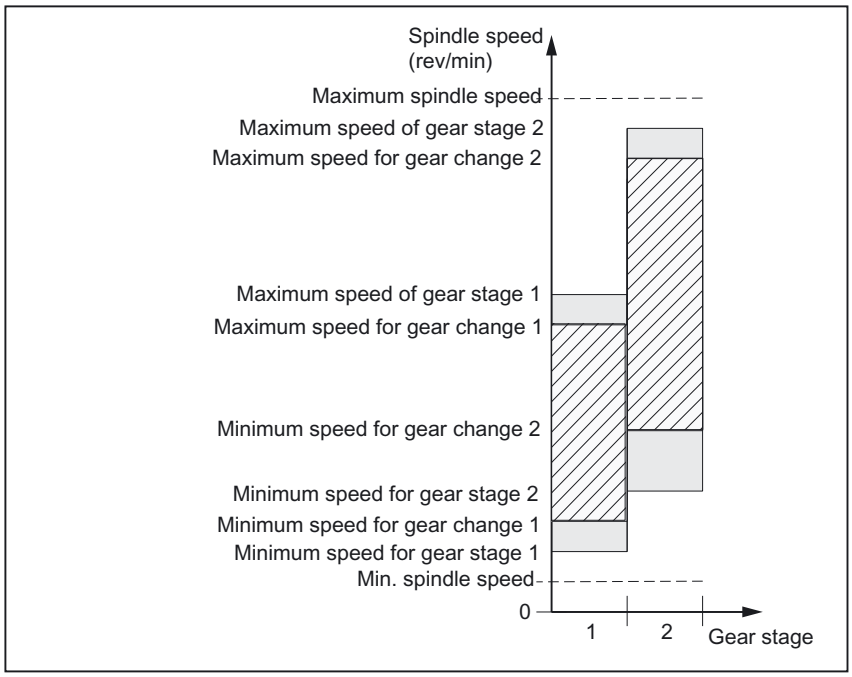


Fig. 9-20 Example for speed ranges for automatic gear stage selection (M40)

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 9-27 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 9-28 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	

9.6.5 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.

References:

/PA/, "Programming Guide, S1 Spindles"

Functionality

- To absolute position (0-360 degrees)
- Incremental position (+/- 999999.99 degrees)
- Block change when position reached
- Block change on block end criterion

The control brakes the spindle down to creep speed at the acceleration rate for speed operation.

If the creep speed has been reached (INT "Spindle in setpoint range"), 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).

The acceleration rate for position control mode must be set such that the current limit is not reached. The acceleration rate must be entered separately for each gear stage.

If the spindle is positioned from zero speed, it is accelerated up to a maximum speed corresponding to creep speed; the direction is defined via machine data. The contour monitoring function is activated as soon as the control mode switches to position control.

Machine data

Table 9-29 Spindle positioning: Machine data

Axisspecific ($MA_ ...)			
35300	SPIND_POSCTRL_VELO	Creep 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 9-30 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	

9.6.6 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 speed-transforming gears between the encoder and spindle (e.g. encoder mounted on motor), then a reference cam signal connected to the drive module 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 9-31 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 9-32 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	

9.6.7 Spindle monitoring

Axis/spindle stops

If the actual speed entered in machine data

- MD36060 STANDSTILL_VELO_TOL (maximum velocity/speed for "axis/spindle stopped")

falls below the programmed velocity/speed, the interface signal

- IS DB31,... DBX61.4 (axis/spindle stationary)

is set. If

- MD35510 SPIND_STOPPED_AT_IPO_START (feed enable for "Spindle stopped") is set,

the path feed is enabled.

Spindle in setpoint range

If the spindle reaches the tolerance range specified in machine data

- MD35150 SPIND_DES_VELO_TOL (spindle speed tolerance)

interface signal

- IS DB31,... DBX83.5 (spindle in setpoint range)

is set. If

- MD35510 SPIND_STOPPED_AT_IPO_START (feed enable for "Spindle stopped") is set,

the path feed is enabled.

Maximum spindle speed

The maximum spindle speed is entered in 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"

Machine data

- MD36200 AX_VELO_LIMIT (threshold value for velocity monitoring)

also limits the speed of the spindle. When the speed is exceeded, an alarm is generated.

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).

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 functions

- G25 S... (min. spindle speed)
- G26 S... (max. spindle speed)

can be used to specify a spindle speed limitation in a parts program. The limitation is active in all operating modes.

The function LIMS=...

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

can be used to specify a spindle speed limit for G96 (constant cutting rate). This limitation is operative only when G96 is active.

Encoder limit frequency

If the encoder cut-off frequency

- MD36300 ENC_FREQ_LIMIT (encoder limit frequency)

is exceeded, the synchronization of the spindle is lost and the spindle functionality reduced (thread, G95, G96).

The spindle will be resynchronized once the encoder frequency falls below the value defined in machine data

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

The encoder limit frequency value must be such that the mechanical encoder speed limit is not exceeded or else the synchronization from high speeds will be incorrect.

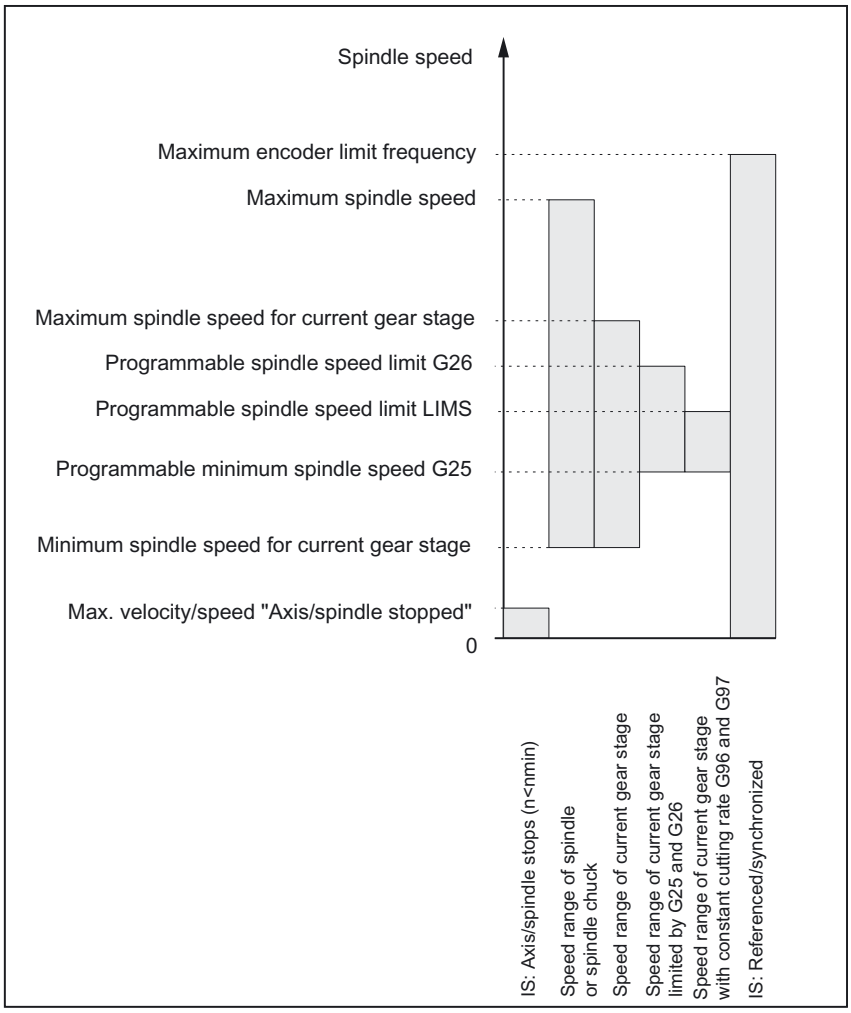


Fig. 9-21 Ranges of spindle monitoring functions/speeds

References:

/FB1/ Description of Functions, Basic Machine, S1 Spindles, Chapter "Spindle monitoring functions"

9.6.8 Spindle data

Machine data

Table 9-33 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	

Number	Name of identifier	Name	Reference
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	
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 9-34 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

Number	Name of identifier	Name	Reference
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 9-35 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	

DB number	Bit, byte	Name	Reference
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	
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

10

Introduction

In the operational area **Commissioning > Optimization/Test** you have the option to optimize the drives. The following functions are available:

- Current controller
- Speed controller
- Position controller
- Function generator
- Circularity test
- Servo trace

This chapter provides instructions on parameterization.

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].

Speed controller settings

If standard optimization produced drive oscillation:

- Using parameter p1460, reduce p gain in the speed controller and
- Save module-specific: set p971 = 1.

Brake behavior AUS3

Depending on the requirements, the brake behavior for each drive can be adjusted to the signal 2.AUS3. 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

Managing User Data

11

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 11-1 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	

11.1 User 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

11.2 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

11.3 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

Operating sequence for original image

The original image of the PLC is represented by the PLC-data state immediately after loading the S7 project into the PLC.

1. Set the PLC to the 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.

Operating sequences 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.

Operating sequences 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)

11.4 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 startup. Compensation data can be saved at the same time if necessary. The drive data are saved as binary data which cannot be modified.

Precondition

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.

Operating sequences

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

   Services > ETC key ">" > Series 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

12

12.1 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.

12.2 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".

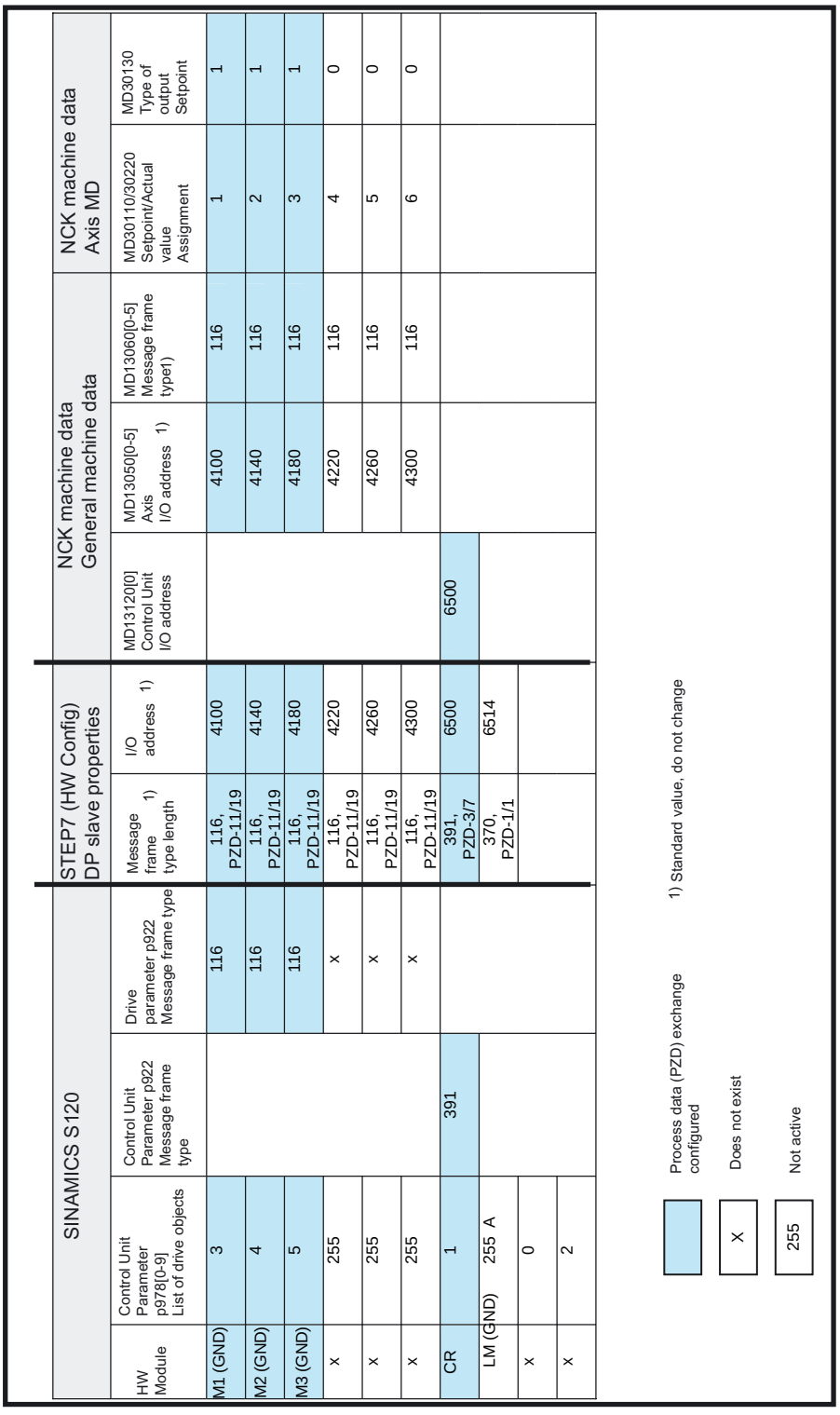


Fig. 12-1 Assignment

12.3 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.

Operator input sequence steps

1. To view this configuration, click in the HW Config on the module **SINAMICS Integrated** and make selection using the **right mouse button > Object properties**.
2. Choose the tab **Configuration** and then the tab **Overview**.

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

   The picture shows user-defined telegrams for 6 axes.

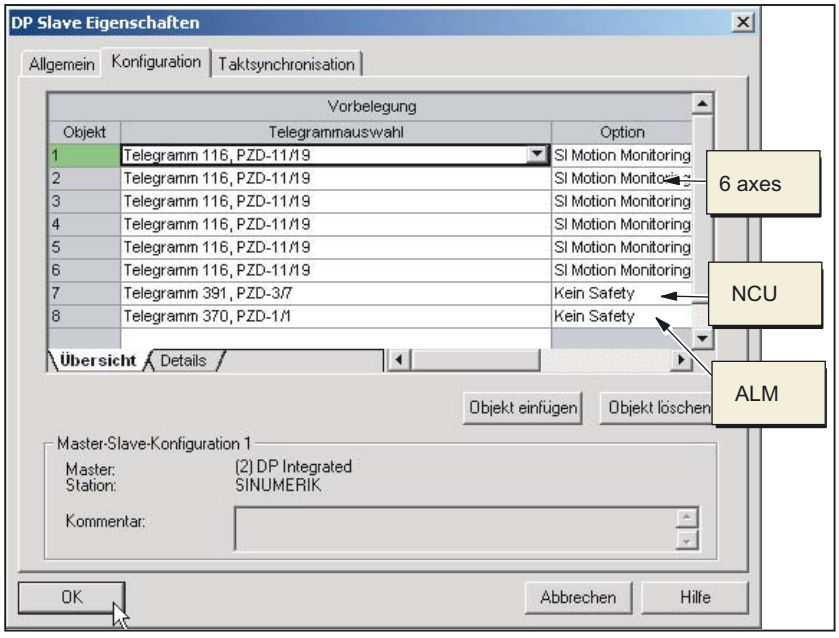


Fig. 12-2 Message length

3. Click on **OK** to quit 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 picture shows how the default values MD13050 DRIVE-LOGIC_ADRESS[0…5] correspond to the input/output addresses for standard configuration of the PLC.

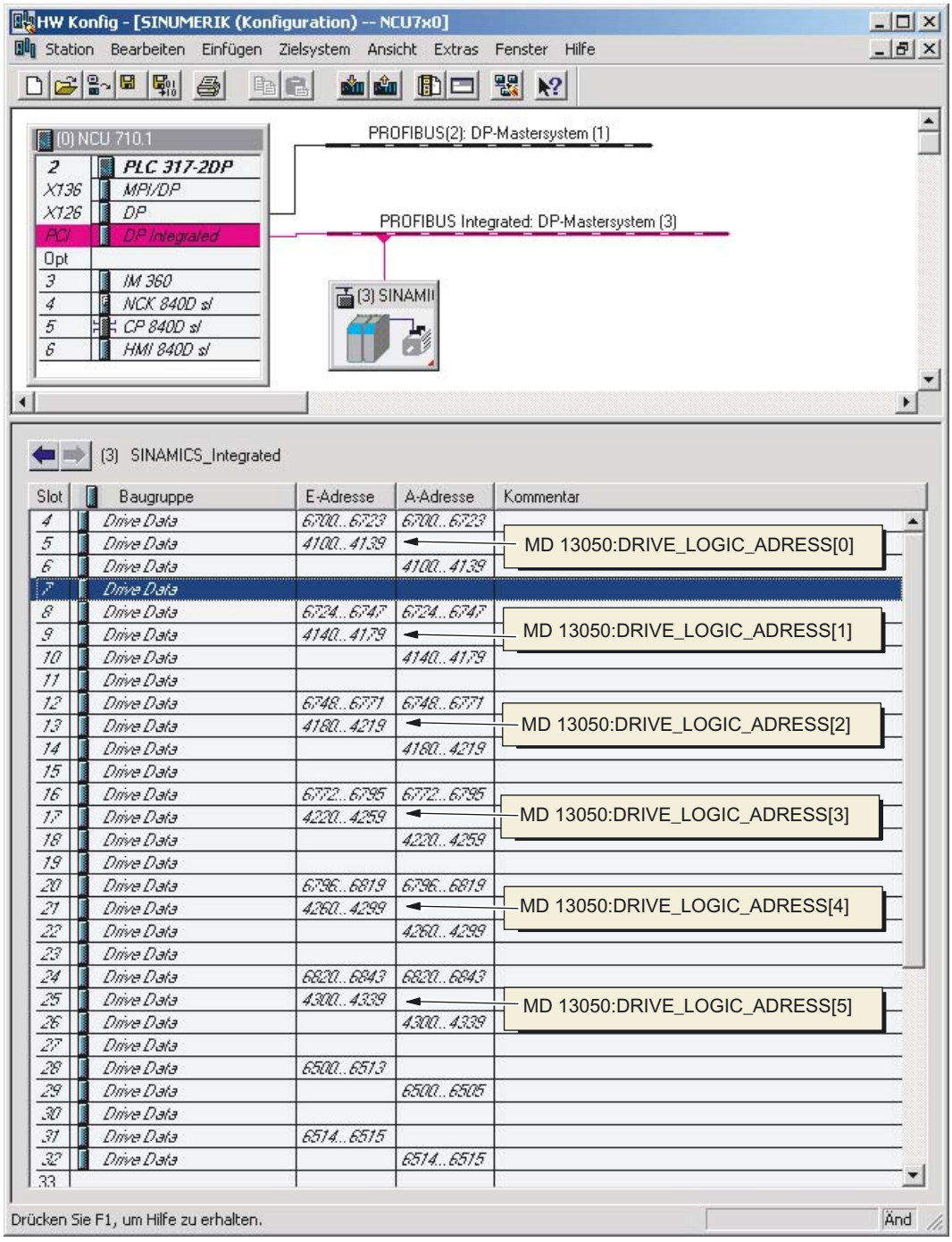


Fig. 12-3 SINAMICS Integrated addresses

12.4 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 6-5)
Configuring the properties of the network interfaces (Page 6-6)
Adding a machine control panel and handwheel in HW Config (Page 6-12)
End hardware configuration and load to the PLC (Page 6-14)
Overview Creating a PLC program (Page 6-15)

12.4.1 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 picture below).

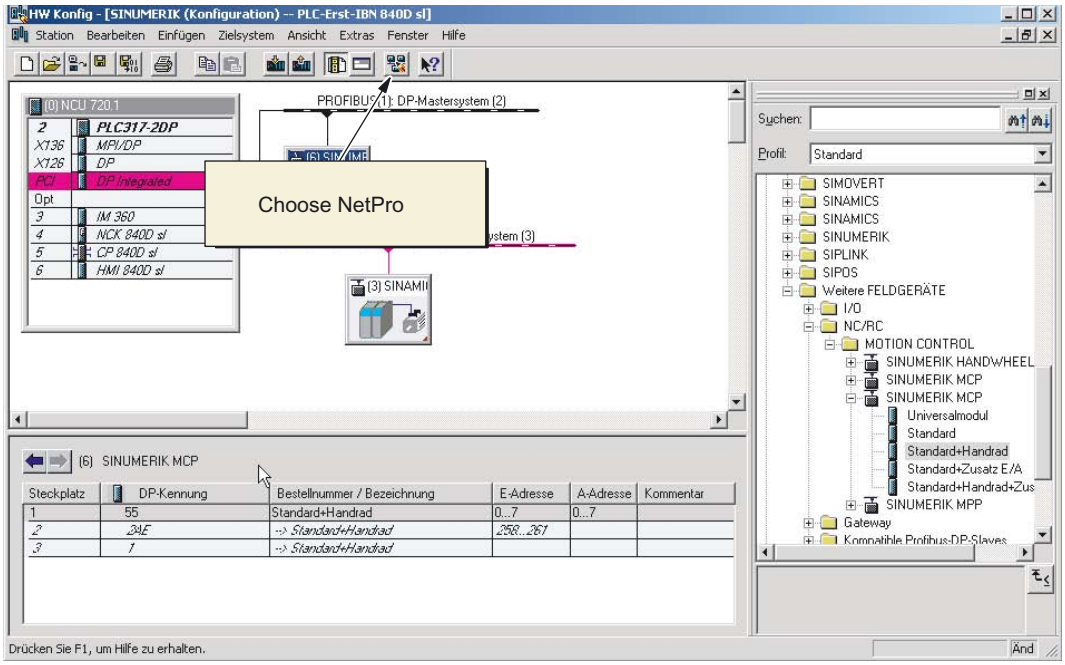


Fig. 12-4 HW config project "PLC-Erst-IBN 840D sl"

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. Choose the button **NetPro** (see picture above).
2. From the catalog under **Stations**, insert the PG/PC via Drag&Drop into the network configuration (see picture below).

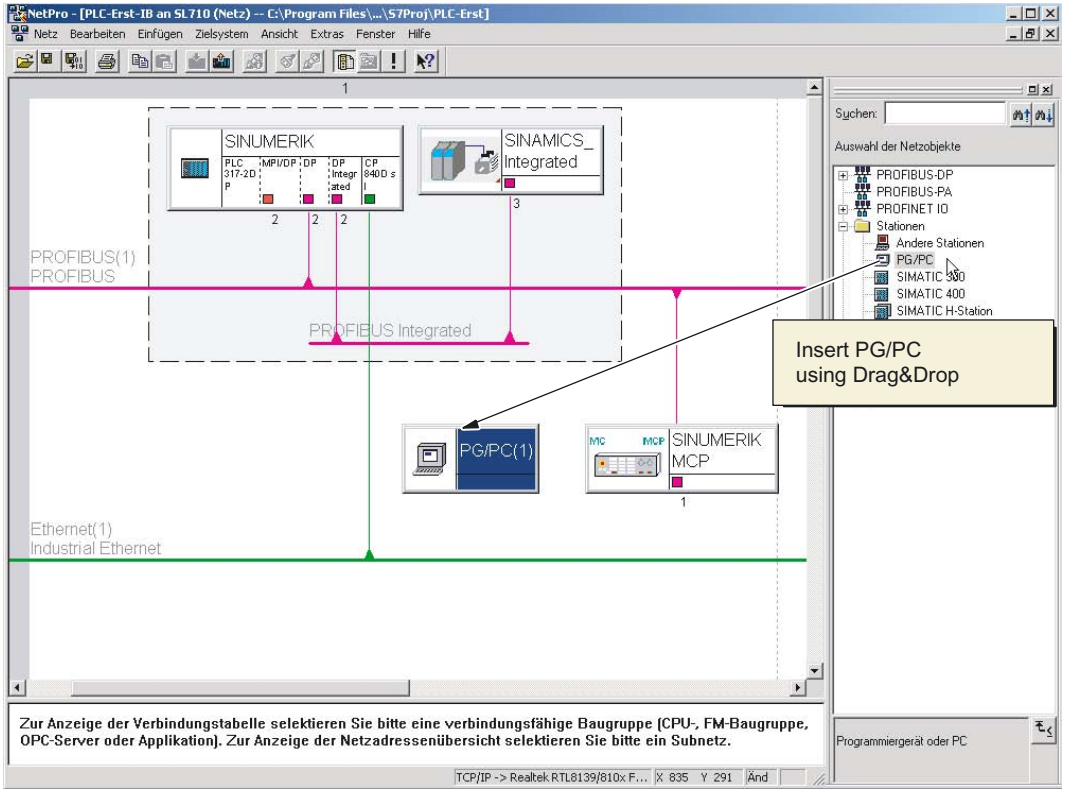


Fig. 12-5 Insert PG/PC

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

12.4.2 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. Choose **right mouse button > Object properties**.
3. In the dialog box displayed, choose the tab **Interfaces** in the dialog **Properties - PG/PC** (see picture below).

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

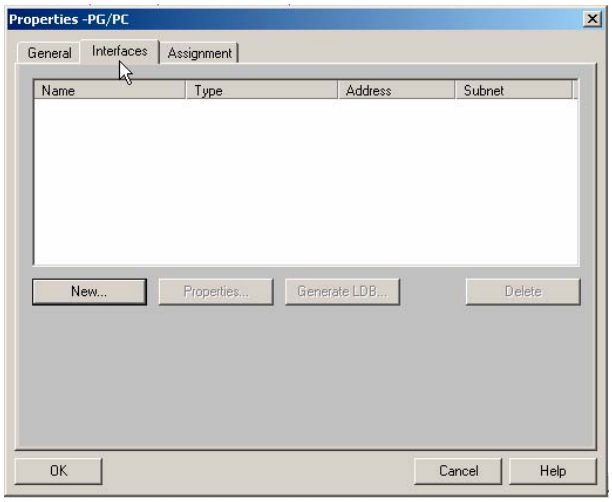


Fig. 12-6 Properties - PG/PC

Operator input sequence steps - Configuring interfaces at PG/PC

1. Choose **New...** to configure the Ethernet interface first.
2. In the type selection field, choose **Industrial Ethernet** (see picture below).

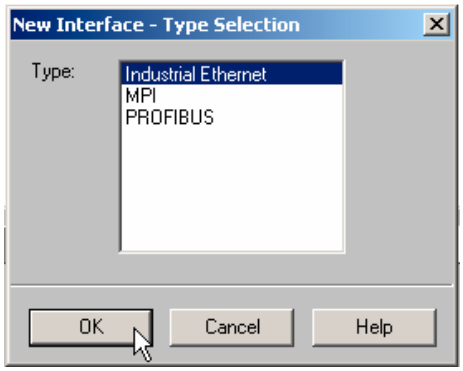


Fig. 12-7 Type Industrial Ethernet

3. Choose **OK**.
4. In the subsequent dialog box, choose the subnet **Ethernet(1)** and enter the IP address and the subnet screen form of your PG/PC (see the picture below). E.g.:
   - IP address, such as, 192.168.0.3
   - Subnet screen form = 255.255.0.0

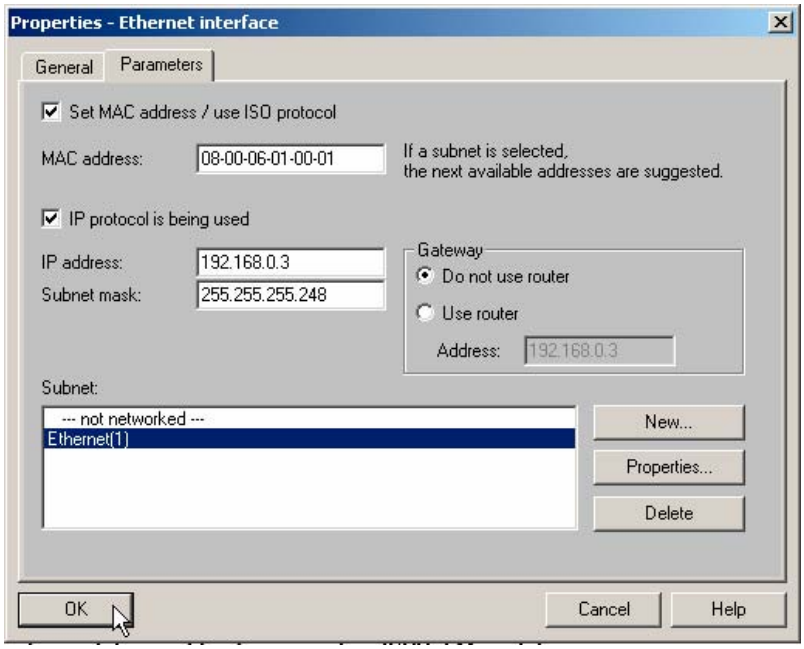


Fig. 12-8 Properties - Ethernet Interface

5. Choose **OK**.
6. Via **New...** you can configure additional interfaces.

7. When you have configured the interfaces, all the configured interfaces are visible under the tab **Interfaces** (see picture below).

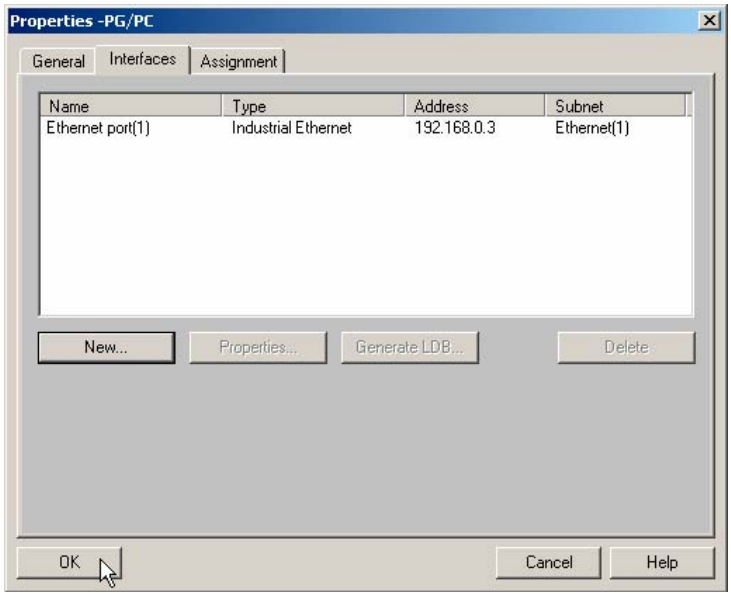


Fig. 12-9 Configured interfaces

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.

12.4.3 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. Choose the tab **Assignment**.
2. Choose **Ethernet port(1)** in the selection field **Configured Interfaces**.
3. Choose the installed network card **TCP/IP -> Realtek RTL8139/810xF…** in the selection field **Interface Parameter Assignments in the PG/PC** (see picture below).

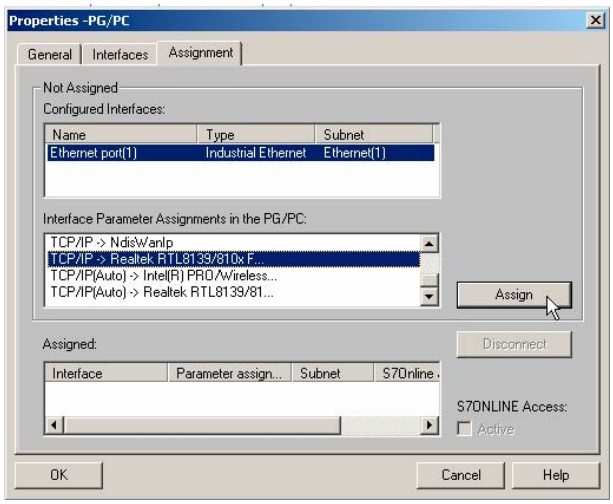


Fig. 12-10 Selecting

4. Select **Assign** and confirm the subsequent message on processing the 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 picture below).

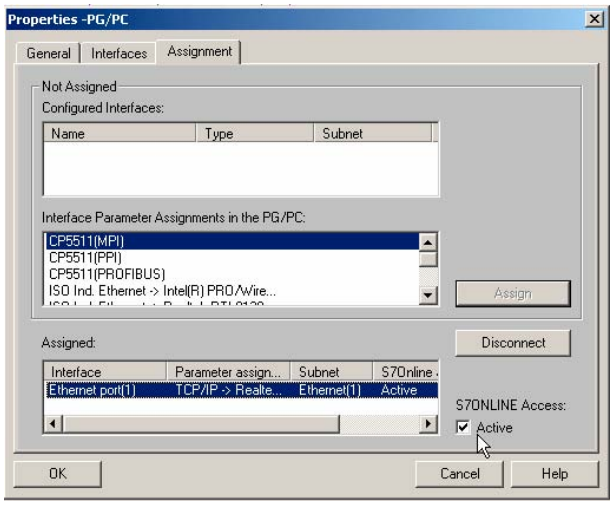


Fig. 12-11 Assigning Ethernet interface

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

   From those interfaces assigned, one must be marked as **Active**.

6. Choose **Ethernet port** in the field **Assigned** and mark the field next to it **Active**.

7. Choose **OK** to end the dialog **Properties - PG/PC**.

   In NetPro, the PG/PC interface declared as **Active** is highlighted in YELLOW (see picture below).

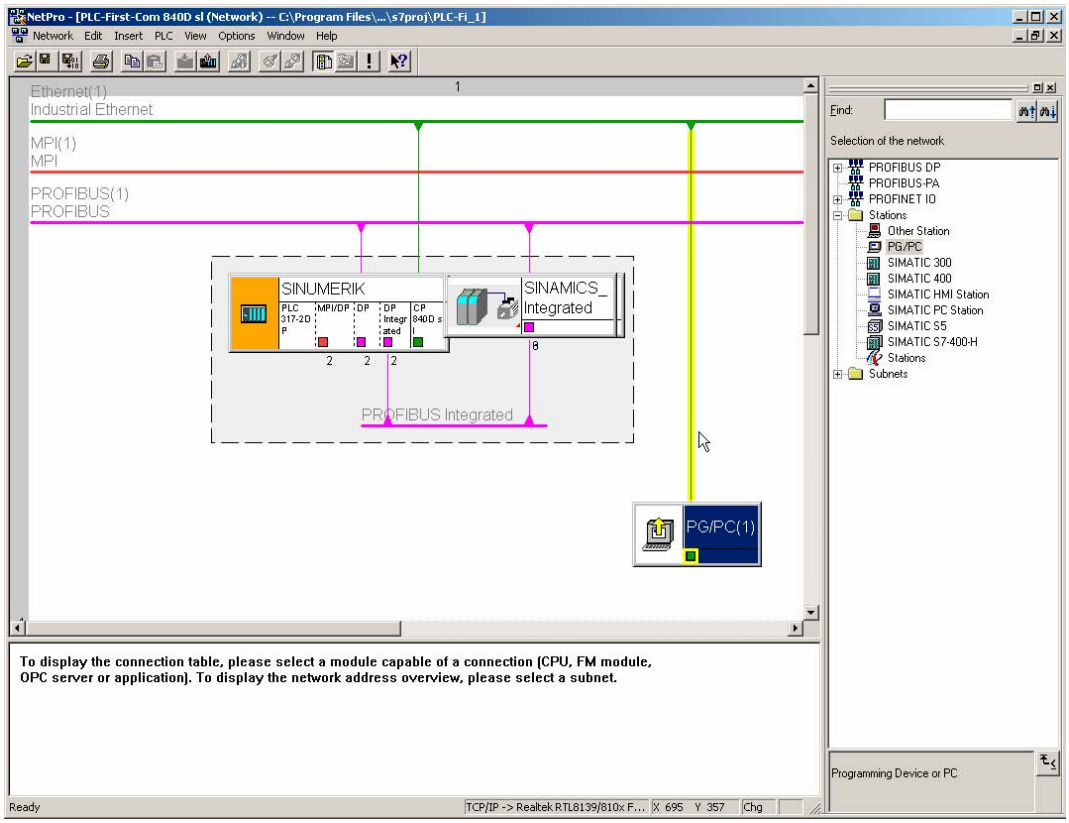


Fig. 12-12 Configured PG/PC in the network configuration

8. Choose **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.

12.4.4 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. Choose the button **Load to module**.

   The target module interactive screenform automatically displays both configured communication peers.
3. Confirm the load into the module with **OK**.
4. Confirm the dialog box subsequently displayed 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.

12.5 Tips for commissioning SINAMICS drives

Introduction

This chapter describes instructions and tips on:

- Component exchange SINAMICS S120
- Diagnostics for pending alarms
- Drive module parameter RESET, individual
- Drive module version display

12.5.1 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.

Operator input sequence 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 (rarely the case) is automatically acknowledged by the system.

12.5.2 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.

12.5.3 Drive module parameter RESET, individual

Introduction

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

Note

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

Operator input sequence steps

1. Set the factory settings on the selected drive module: p0010 = 30
2. Activate the factory settings on this drive module: p0970 = 1
3. Device automatically carries out RESET of all parameters for this module.
4. Save module-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.

12.5.4 Drive module version display

Introduction

Using certain parameters from individual drive modules, 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 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

12.6 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 1-7)

Overview of creating a SIMATIC S7 project (Page 6-1)

Overview Installation and start-up of SINAMICS drives (Page 7-1)

Overview communication NCK<->Drive (Page 8-1)

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.

  – You select 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 chain for the **PROFIBUS Integrated DP master system** in the "Station design" station window.

  – After releasing the mouse key, you have inserted the NX module.

- Commissioning SINAMICS drives

  – You have put the topology of the SINAMICS drives belonging to the NCU into operation (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 Control Unit +/-** softkeys**.**

  – 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/telegram/setpoint/actual value.

SINAMICS S120	**STEP7 (HW-config) DP slave properties**		**NCK machine data General MD**			**NCK machine data axis MD**	
Component	Telegram 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] telegram 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 telegram".
  - 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 (telegram 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 (acquisition actual value),"1" for incremental encoder or "4" for absolute value encoder.

Note

The commissioning engineer must ensure that the operationally ready signal of the infeed is interconnected with the parameter p864 from each drive.

Licensing 13

13.1 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
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:

Term	Description
	• 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

13.2 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.

13.3 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

13.4 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.

13.5 License database

The license database contains all the customer-specific license information relevant to 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 via Siemens A&D Mall at 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).

13.6 CF Card and hardware serial numbers

The CF Card (Compact Flash Card) contains, in addition to the system and user software and the remanent 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 are 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.

13.7 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.

13.8 Assigning via Web License Manager

13.8.1 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".

13.8.2 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.

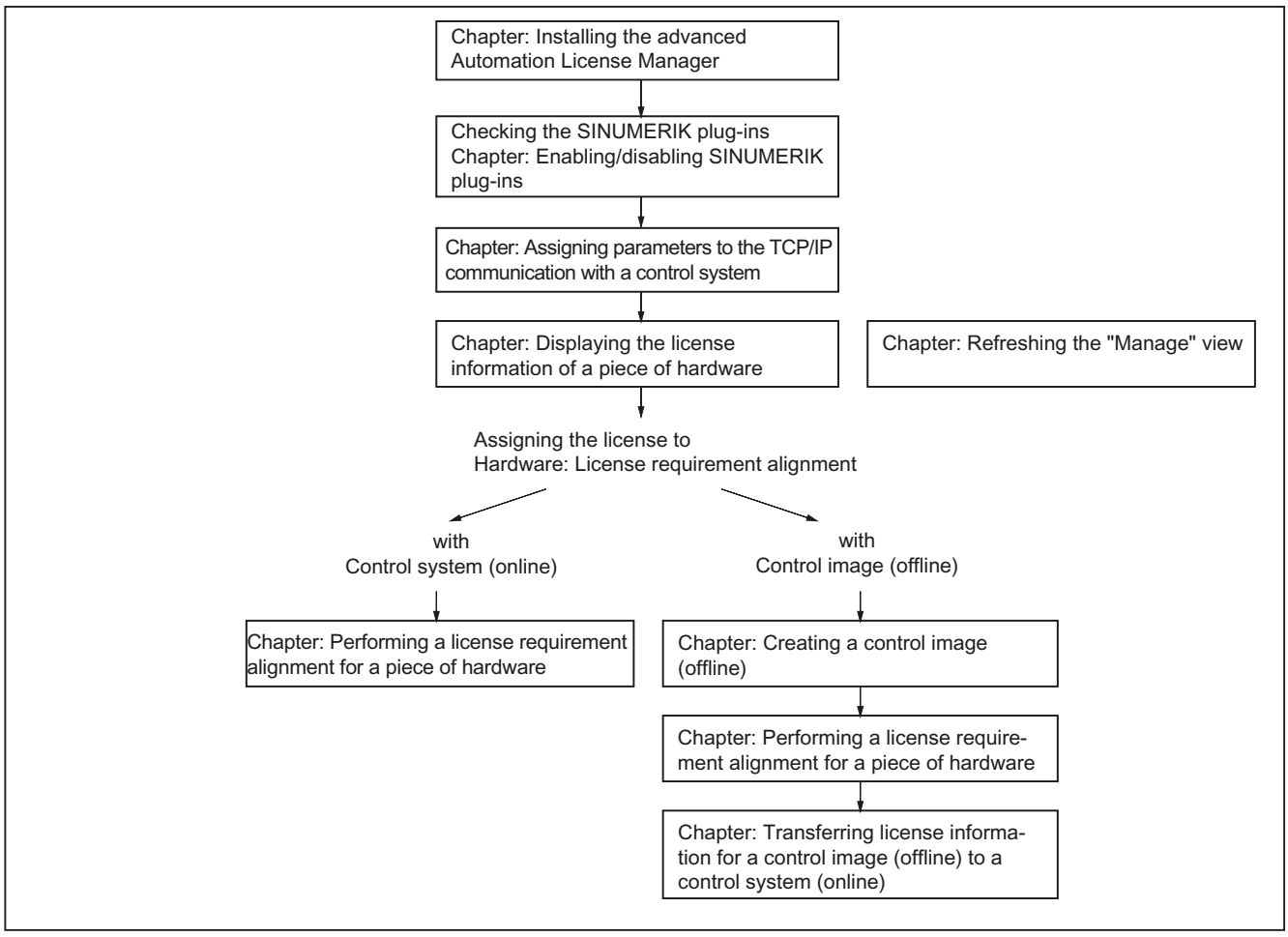
5. After completing the assignment process, enter the License Key displayed on the Web License Manager into the licensing dialog of the HMI user interface.
   HMI Advanced/HMI Embedded:

   Operating-area switchover: Commissioning > Key: etc. (">") > Licenses > Overview
6. Confirm the entry of the new License Key by pressing the softkey: "Transfer".

13.9 Assigning via Automation License Manager

13.9.1 Function overview

The following figure provides an overview of the functions available and the sequence in which they should be applied.



13.9.2 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 is installed as part of this process.

13.9.3 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".

Execution

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 > PlugIn 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 displays the data in the navigation and object area according to the status of the SINUMERIK plug-in.

The folder symbols and names are displayed in the navigation area depending on the status of the SINUMERIK plug-in and the communication link to the SINUMERIK control:

- SINUMERIK plug-in disabled:

  PlugIn SINUMERIK - - - - disabled - - - -
- SINUMERIK plug-in enabled, but no communication link with SINUMERIK control:

  SINUMERIK - online - - - - no link available - - - -

  SINUMERIK - offline - - - - no data available - - - -
- SINUMERIK plug-in enabled, communication link established with SINUMERIK control:

  SINUMERIK <control type> - <hardware serial number>

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"

13.9.4 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 13-1 User-specific file: MMC.INI

Statements
[GLOBAL]
NcddeMachineName = *AddressParameter*
NcddeDefaultMachineName = *AddressParameter*
NcddeMachineNames = *AddressParameter*
[*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.

13.9.5 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.

13.9.6 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 piece of hardware.

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. Open the control system file in the navigation area of the Automation License Manager and select the control system (online).
2. Enable the default object view: "SINUMERIK".
   Principle

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. For a detailed description please refer to section: "General functions" > "Assigning parameters to the TCP/IP communication with a control system"
3. Start the Automation License Manager
4. Open the control system file in the navigation area of the Automation License Manager and select the control system (online).

Result

The license information for the control system is displayed in the object area of the Automation License Manager.

13.9.7 Creating a control image (offline)

Background

It is essential to create a control image (offline) for the following reasons:

- The license information must be later transferred to the hardware.
- The computer (PC/PG) on which the Automation License Manager is installed is not simultaneously connected to the Internet and the control system. Consequently, the license information must be transferred to the hardware in three individual stages.
  - 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 means of a 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.

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 menu command: "Upload from target system"

Perform the following actions to create a control image (offline) using menu command: "Upload from target system":

1. Open the "online" control system file in the navigation area of the Automation License Manager and select the control system (online).
2. Create the control image (offline) using menu command: **License Key > Upload from target system**.

Result

The control image (offline) is displayed in the "online" control system file with the current license information for the control system. If a control image (offline) already exists in the "online" control system file, the image is overwritten with the current license information.

13.9.8 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 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.

Execution

Perform the following actions for license requirement alignment with a control system (online) or a control image (offline):

1. Open the corresponding control system file in the navigation area of the Automation License Manager and select the control system (online) or the control image (offline).
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:
"Transferring license information for a control image (offline) to a control system (online)"

Result

A new License Key has been generated and loaded to the control (online) or the control image (offline).

13.9.9 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, for the following reasons:

- 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 be met before you can transfer a control image (offline) to the hardware:

- 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 actions to transfer a control image (offline) to the hardware using drag and drop:

1. Open the "online" control system file in the navigation area of the Automation License Manager and select the control image (offline).
2. Select any line from the license information displayed in the object area.
3. Drag the selected line to the control system (online) release the mouse key.

Procedure using menu commands

Perform the following actions to transfer a control image (offline) to the hardware using menu command: "Download to target system":

1. Open the "online" control system file in the navigation area of the Automation License Manager and select the control image (offline).
2. To transfer the control image (offline) to the hardware, select menu command: **License Key > Download to target system**

Result

The license information for the hardware is now identical to the information for the control image (offline), including the License Key.

13.10 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

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14.1 Basic information on SINAMICS S120

See also

Small SINAMICS Glossary (Page A-1)

14.1.1 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.

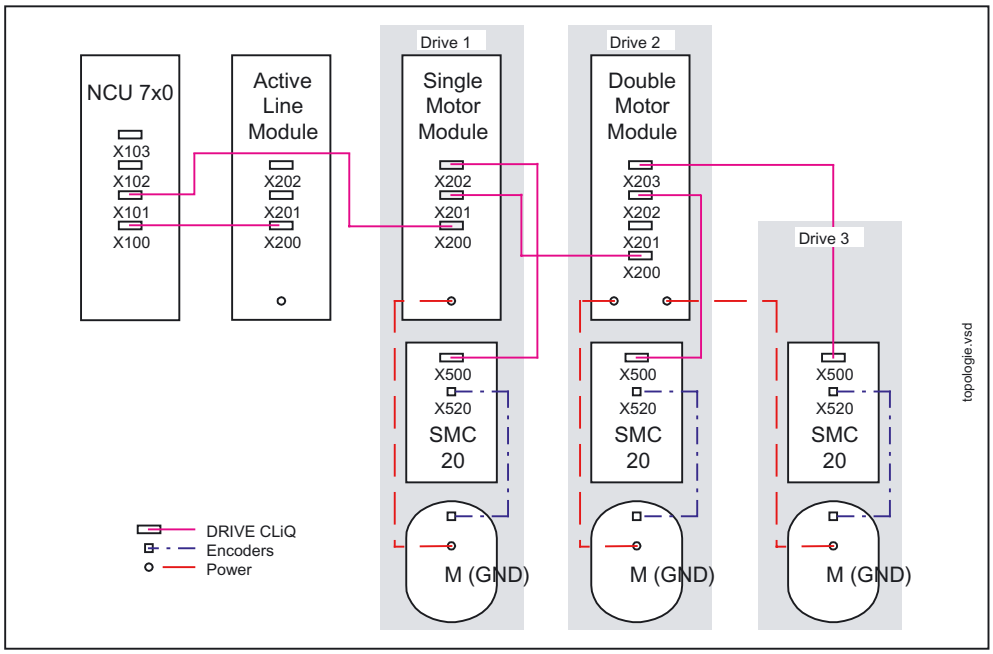

Fig. 14-1 Optional rules

- 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.

14.1.2 What are drive objects (DOs) and drive components?

Introduction

The components that belong to the drive group are reflected in the parameterization in a drive object.

Each drive object has its own parameter list.

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 (N. 10), Encoder (No. 9) und SMC (No. 8).

The component number is assigned by the drive after topology recognition.

The component number in each case can be viewed in the parameter list for the relevant drive object. E.g.: under **Commissioning > Machine data > Drive MD > Axis +**.

Table 14-1 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

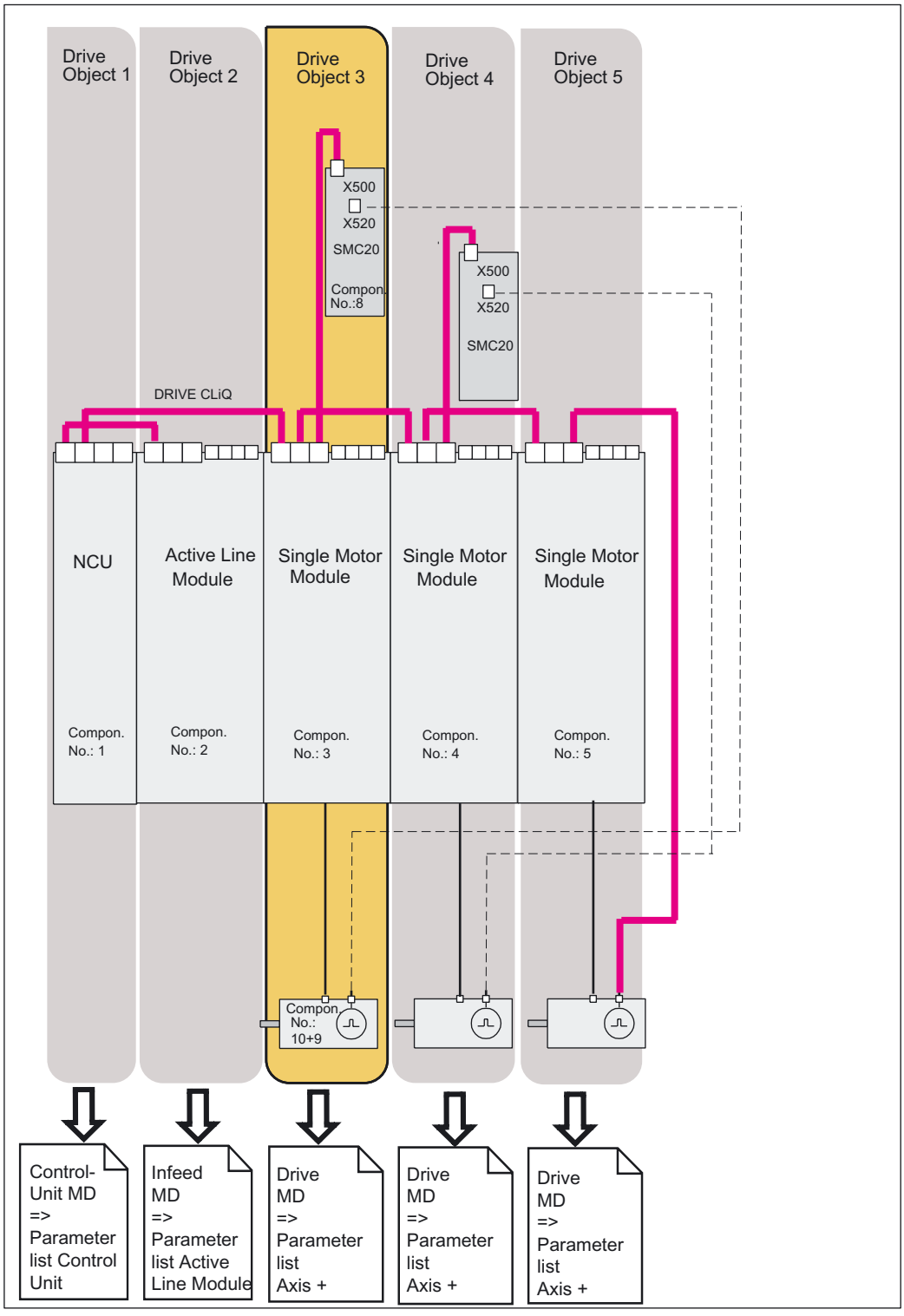

Fig. 14-2 Drive group

14.2 Transfer telegrams

Introduction

The transfer telegrams from NCK to the drive are transferred via an internal PROFIBUS on the NCU. They are:

- Send telegrams (drive->NCK)
- Receive telegrams (drive->NCK)

Telegrams

The telegrams are standard telegrams with pre-defined assignment of the process data. These telegrams 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.

Note

References: Refer to /IH1/ SINAMICS S120 Installation and Start-Up Manual

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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 message frames

  The standard message frames are structured in accordance with the Prairie Profile V3.1. The internal process data links are set up automatically in accordance with the message frame number setting.

- Manufacturer-specific message frames

  The manufacturer-specific message frames 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 message frames can be set via p0922:

  – For axes (SERVO)

    102 Speed control with torque reduction, 1 position encoder

    103 Speed control with torque reduction, 2 position encoders

    105 DSC with torque reduction, 1 position encoder

    106 DSC with torque reduction, 2 position encoders

    116 DSC with torque reduction, 2 position encoders, supplementary data (also parameterization)

  – For Control Unit

    390 message frame without probe (for NCX)

    391 message frame for up to 2 probes (for NCU)

14.2.1 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.

Note

References: Refer to /IH1/ SINAMICS S120 Commissioning Manual for a description of the process data.

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	Position controller gain factor
TRQDER	Torque reduction
A_CTW1	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.

Note

References: Refer to /IH1/ SINAMICS S120 Commissioning Manual for a description of the process data.

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
MSGW	Message word
A_STW1	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

14.2.2 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)

- More

  Manufacturer-specific message frame 106, 2 encoders with DSC (Dynamic Servo Control) (for axes)

  Message frame 999 for free BICO interconnection (for the infeed, ALM)

Message frames for receiving

The following table contains the structure of the message frames with the process data for receiving the control words and setpoints (NCK->drive).

Table 14-2 Message frames with the process data for receiving (NCK->drive)

PZD receive word	Message frame 106	Message frame 116	Message frame 390	Message frame 391
PZD 1	STW1	STW1	STW1	STW1
PZD 2	NSET_B	NSET_B	Digital outputs	Digital output
PZD 3				STW_PROBES
PZD 4	STW2	STW2		
PZD 5	TRQDER	TRQDER		
PZD 6	G1_STW	G1_STW		
PZD 7	G2_STW	G2_STW		
PZD 8	XERR	XERR		
PZD 9				
PZD 10	KPC	KPC		
PZD 11				

Message frames for sending

The following table contains the structure of the message frames with the process data for sending the status words and actual values (drive->NCK).

Table 14-3 Message frames with the process data for sending (drive->NCK)

PZD sending word	Message frame 106	Message frame 116	Message frame 390	Message frame 391
PZD 1	ZSW1	ZSW1	ZSW1	ZSW1
PZD 2	NACT_B	NACT_B	Digital inputs	Digital inputs
PZD 3				ZSW_PROBES
PZD 4	ZSW2	ZSW2		TIMESTAMP_PROBE_1N
PZD 5	MSGW	MSGW		TIMESTAMP_PROBE_1P
PZD 6	G1_ZSW	G1_ZSW		TIMESTAMP_PROBE_2N
PZD 7	G1_XIST1	G1_XIST1		TIMESTAMP_PROBE_2P
PZD 8				
PZD 9	G1_XIST2	G1_XIST2		
PZD 10				
PZD 11	G2_ZSW	G2_ZSW		
PZD 12	G2_XIST1	G2_XIST1		
PZD 13				
PZD 14	G2_XIST2	G2_XIST2		
PZD 15				
PZD 16		LOAD		
PZD 17		TORQUE		
PZD 18		POWER		
PZD 19		CURR		

14.3 Control- and status-word bits for NCK<->drive communication

14.3.1 NCK to drive

Introduction

The NCK transfers data to the drive using message frames via a PROFIBUS interface (internal PROFIBUS). Setpoints exist for speed control and torque and are preceded by a control word in the message frame.

PLC interface for STW1

Signal provided by NCK	VDI interface (PLC)	Remarks	Bit in STW1	Meaning
Axis controllable from NCK: • Servo enable • Measuring system selected and OK • Pulse enable • …	DB(AX).DBX2.1 DB(AX).DBX1.5/6 DB(AX).DBX21.7		0	OFF1
Always "1", "TRUE"	No signal		1	OFF2
Always "1", "TRUE"	No signal		2	OFF3
VDI signal pulse enable	DB(AX).DBX21.7		3	Enable inverter
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

Signal provided by NCK	VDI interface (PLC)	Remarks	Bit in STW1	Meaning
Always "0", "FALSE"	No signal	Signal not used	11	Reserved
"Release holding brake"	DB(AX).DBX20.5		12	Open holding brake
Always "1", "TRUE"	No signal	Signal is used as the identifier to shut down the drive's ramp-function generator (isochronous Profibus drive)	13	Ramp-up time zero for controller enable
Always "1", "FALSE"	No signal	Signal not used	14	Open-loop torque-controlled mode
Customer-specific signal	No signal for SINAMICS		15	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
			13	
			14	
			15	

14.3.2 Drive to NCK

Introduction

The drive transfers the data to the NCK using message frames via a PROFIBUS interface (internal PROFIBUS). Actual values exist for the speed control and torque and are preceded by a status word in the message frame.

PLC interface for ZSW1

Meaning	Bit in ZSW1	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
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

Meaning	Bit in ZSW1	Remarks	VDI interface (PLC)	Signal processing in the NCK
Only used in "positioning mode": Spindle positioning ON	15	Irrelevant for SINUMERIK	No signal	No evaluation

PLC interface for ZSW2

Meaning	Bit in ZSW2	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 signalW	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

14.4 Macros for commissioning

Introduction

For the sake of simplifying the drive commissioning, macros are included in the SW. By starting and executing these ACX macros in the commissioning phase, it is possible to pre-configure the drive set connected to the NCU for the most part.

Advantage

Advantage of using macros:

- Default terminal assignment on the NCU
- The DOs of all drive objects are connected (topology)
- Automatic commissioning of motors with DRIVE-CLiQ interfaces

Functions in the configuration macro

- In each configuration macro, both probe signals are connected for all axes configured accordingly. As a result, you do not have to carry out any additional parameterization of the probe signals.
- For the default settings of reference cams, only the corresponding input or output on the NCU is configured via the macro. You must make the link to the corresponding axis (reference cam) via separate links.
- The safety (SH/SBC) interconnection is to be made according to the "SINAMICS S120" Commissioning Manual, Chapter "SINAMICS Safety Integrated (Booksize)".
- If there is no line contactor upstream of the infeed, the SH and SBC functions are absolutely essential.
  An acceptance test must be carried out on the SH/SBC function.

14.4.1 Macros for commissioning

Introduction

To commission the drives, the following macro types are available:

- Update macro 150399

  This macro executes an update of all drive components.
- Macro for infeed (Line Module) **with** Drive CLiQ -> "1"
- Macro for infeed (Line Module) **without** Drive CLiQ -> "5"
- Macros 100116 for preassigning the data sets and message-frame types

Overview

The table below lists macros for commissioning. Using the macros "1" or "5" allows a standard terminal circuit to be achieved. This terminal circuit can be modified according to the terminal plan.

Table 14-4 Macros for commissioning

Number	File name	Description
1	pm000001.acx	Line Module **with** DRIVE CLiQ: • Interconnection p0840 (infeed) • Interconnection 2. OFF 3 (rapid stop) • Reserving input and output terminals for two SH/SBC groups • Bero 1 – equivalent zero mark • 1. Probe • 4 x Digital NC – Input ($A_IN[1] …[4]) • Feedback Line Module • 2x Digital NC – Output ($A_OUT[1] …[2]) ALM: • Shutdown of network identification (p3410=0) SLM with DRIVE-CLiQ: • Network identification of the SLM is performed automatically on the next pulse enable (p3410=5).
5	pm000005.acx	Line Module **without** DRIVE CLiQ : • Interconnection p0864 to all drives • Interconnection 2. OFF 3 (rapid stop) • Reserving input and output terminals for two SH/SBC groups • Bero 1 – equivalent zero mark • 1. Probe • 4 x Digital NCK – Input ($A_IN[1] …[4]) • 4x Digital NCK – Output ($A_OUT[1] …[4])
100116	pm100116.acx	The following parameters are set on all 6 drives: • Set up two encoder data sets p140=2 • Eight drive data sets p180=8 • Profibus protocol p922 = 116
150399	pm150399.acx	Update of all drive components

14.4.2 Procedure for calling ACX macros

Introduction

Warning

Prior to starting the macro for drive configuration, switch off all drive enables.

The active line module must be disconnected from the mains (line contactor).

Process when calling a macro

The principle processes for calling an individual macro are laid out below.

These steps include:

- Process for update macro call 150399 (left in the picture)
- Process for configuration macro call (on the right in the picture)

Note

Prior to executing the configuration macro, the update macro 150399 must be started.

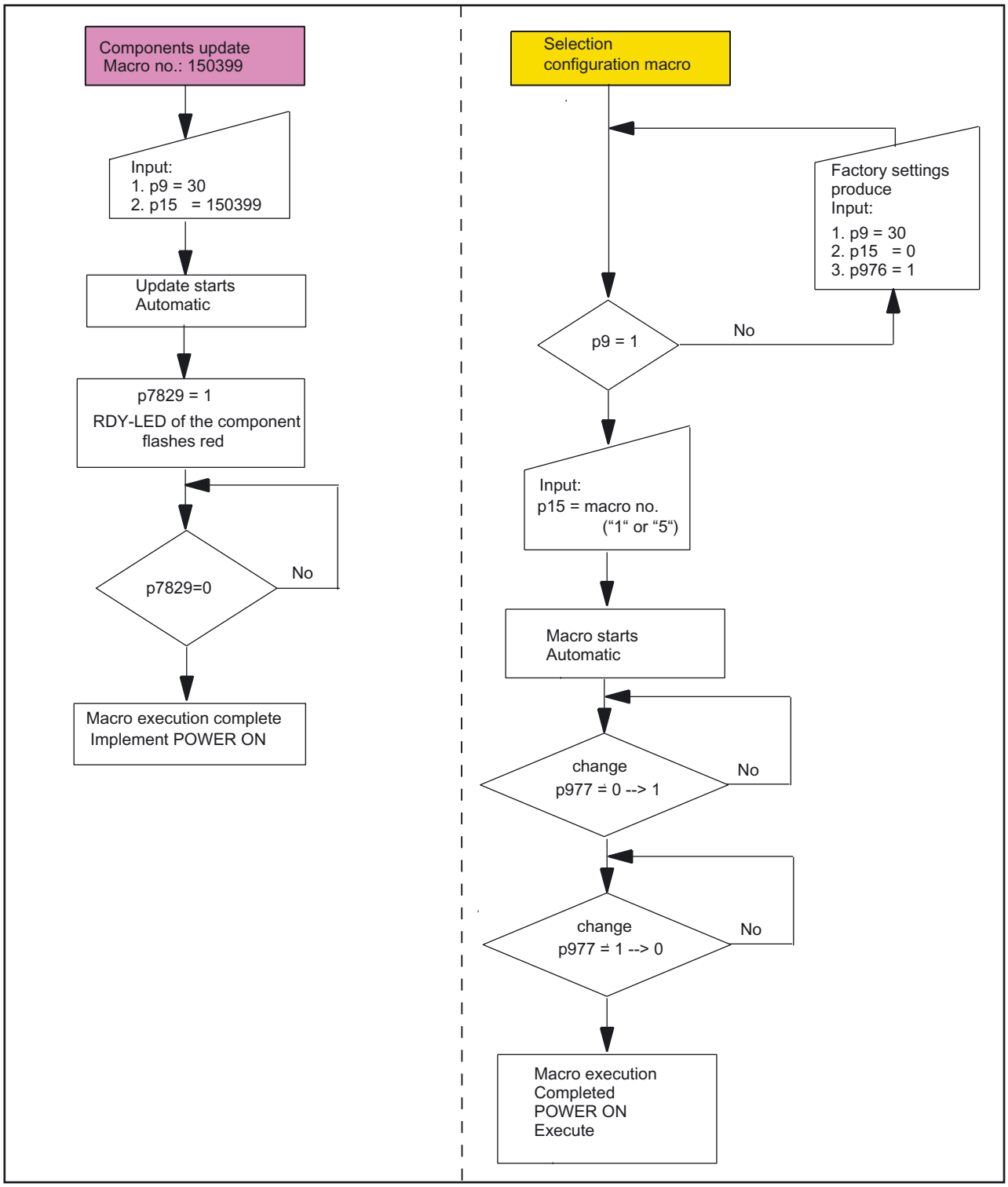

Fig. 14-3 Process macro call for update (left) and for configuration (right)

Occurring operator errors

Operator errors that frequently occur when starting macros include:

- incorrect status of p9
- active release to the modules
- primary infeed (ALM) not switched to voltage-free mode

Note

If you have doubts, load the factory settings prior to executing a macro.

See Chapter "Making the factory setting".

See also

Activate the factory settings (Page 7-2)
Update the component firmware (Page 7-3)
Drive components macro call (Page 7-6)

14.4.3 Terminal assignment NCU 7x0

Introduction

With the configuration macros for commissioning, the following terminals at the NCU 7x0 are preassigned:

- X122
- X132

Terminal assignment X122 (NCU 7x0)

Pin no.	Function	Assignment recommendation	BICO source/acceptor		Macro number
1	Input[1)]	ON/OFF 1 Infeed Line Module with DRIVE CLiQ Connection	CU: r0722.0	Infeed p840	1
		ON/OFF 1 Infeed Line Module without DRIVE CLiQ Connection	SLM X21.1	Drive p864	5
2	Input	"AUS3 – 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 1 - Group 1 SINAMICS Safety Integrated (SH enable = p9601)	CU: r0722.2	p9620 (all drives in the group)	No preassignment
4	Input	SH/SBC - Group 1 SINAMICS Safety Integrated (SH enable = p9601)	CU: r0722.3	p9620 (all drives in the group)	No preassignment
5	Ground for pin 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	No preassignment
8	Input	SH/SBC 1 - Group 2 SINAMICS Safety Integrated	CU: p0739	p9774 bit 1 BICO from CU after the first drive in the group	No preassignment
9	Ground for pins 7, 8, 10, 11				
10	Input	Bero 1 – equivalent zero mark	CU: r 0722.10	p495 = 2	-
11	Input	Probe 1 Central Measuring (check that MD13210 = 0!)	CU: p0680[0] = 3	Every drive p488 Index=encoders 1,2,3=0	1/5

Pin no.	Function	Assignment recommendation	BICO source/acceptor		Macro number
		Probe 1 Decentralized Measuring (check that MD13210 = 0!)	CU: p0680[0] = 0	each drive p488 Index = encoder 1,2,3 = 3	-
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/acceptor		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	-
5	Ground for pin 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
		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
		Line contactor control	LM: r0863.1		-
9	Ground for pins 7, 8, 10, 11				
10	Output	Digital output $A_OUT[3]	CU: p2091.2	CU: p0744	1/5
	Input	Bero 2 – equivalent zero mark	CU: r 0722.14	Drive: p0495 = 5	-
		2. OFF 2	CU: 2091.0	Drive: p0845	-
11	Output	Digital output $A_OUT[4]	CU: p2091.3	CU: p0745	1/5
	Input	Probe 2 Central Measuring (check that MD13210 = 0!)	CU: p0680[1] = 6	Each drive p489 Index = encoder 1,2,3 = 0	
		Probe 2 Decentralized Measuring (check that MD13210 = 0!)	CU: p0680[1] = 6	Each drive p489 Index = encoder 1,2,3 = 0	
12	Ground for pins 7, 8, 10, 11				

Terminal assignment X122 (NX 10/15)

Pin no.	Function	Assignment recommendation	BICO source/acceptor		Macro number
1	Input[1)]	ON/OFF 1 Infeed Line Module with DRIVE CLiQ Connection	NX: r0722.0	Drive p864	-
2	Input	"AUS3 – 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)	No preassignment
4	Input	SH/SBC - Group 1 SINAMICS Safety Integrated (SH enable = p9601)	NX: r0722.3	p9620 (all drives in the group)	No preassignment
5	Ground for pin 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	
8	Input	SH/SBC 1 - 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 – zero mark substitute	NX: r0722.10	Drive: p495 = 2	
11	Input	Bero 2 – zero mark substitute	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!

14.5 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

Note

For a complete description of the basic PLC program, its structure and all modules including their call parameters, please refer to:

References: /FB1/ Description of Functions, Basic Machine P3, 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:

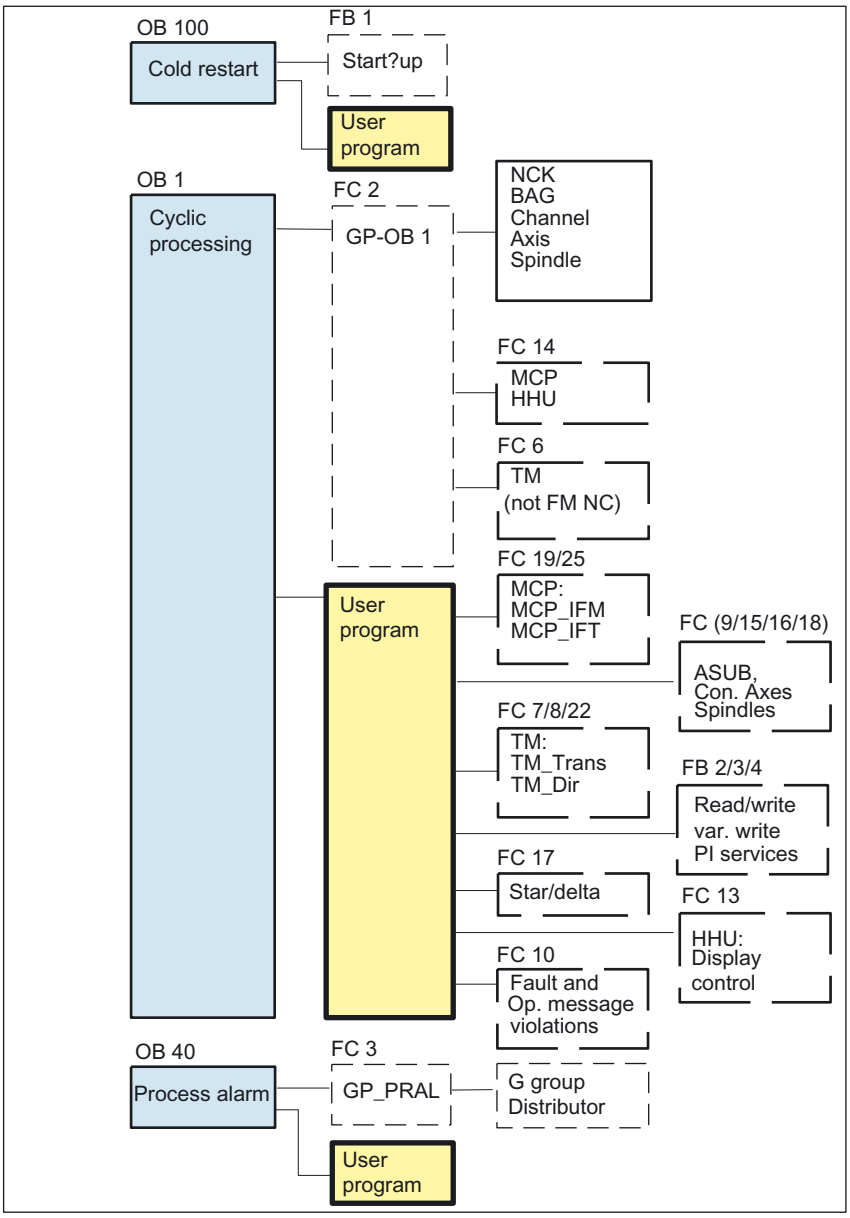

Fig. 14-4 PLC program structure

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

Note

A precise description of the variables and options for modifying their parameterization is given in

References: /FB/, P3, "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

Overview Creating a PLC program (Page 6-15)

14.5.1 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

Overview Creating a PLC program (Page 6-15)

14.6 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 14-5 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	Channel-specific machine data
from 29000 to 29999	Reserved
from 30000 to 38999	Axis-specific machine data
from 39000 to 39999	Reserved
from 41000 to 41999	General setting data
from 42000 to 42999	Channel-specific setting data
from 43000 to 43999	Axis-specific setting data
from 51000 to 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 9-1)

14.6.1 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 "***".

14.6.2 Handling the machine data

Introduction

To display and input machine data, appropriate screen forms are provided.

Example

Selection of displays:

When you 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.

14.7 Protection levels

Introduction

Access to programs, data and functions is useroriented and controlled via eight hierarchical protection levels. These are divided into

- Four password levels for Siemens, machine manufacturer and end user
- Four key settings for the end user

Protection levels

There are access levels 0 to 7 (see table below), where

- 0 is the highest and
- 7 is the lowest level

Table 14-6 Access 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 14-7 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".

Note

For information about changing access levels, please refer to

References: /BA/ Operator's Guide

/FB/ A2, Various Interface Signals

14.7.1 Protection level fundamentals

Introduction

The following options are available for protection levels:

- Protection levels used with passwords can be influenced using softkeys:
  - **Set password**
  - **Delete password**
- The protection levels can be modified per script.

Setting the password

For the four possible password levels with their access permissions, the passwords can be entered in the control area **Commissioning** by choosing the soft key **Password > Set password**.

Note

References: /BA/ Operator's Guide

Resetting the password

Please note that a password remains valid until access authorization is reset with the soft key **Delete Password**.

Access authorization is therefore not automatically deleted during POWER ON!

Default passwords

The following default passwords are defined for protection levels 1 to 3:

- Protection level 1: SUNRISE
- Protection level 2: EVENING
- Protection level 3: CUSTOMER

Notice

For a system boot in which standard machine data is loaded, the passwords are set to the default values.

These passwords should be changed to ensure effective access protection.

Modifying protection levels per script

The protection level of individual machine and/or setting data can be modified in the file SGUD.DEF.

Example

The axial machine data item CTRLOUT_SEGMENT_NR requires protection level 3 for reading and protection level 2 for writing.

Syntax:

```
REDEF $ machinedatastring APR n APW m
APR n: Defining the protection level n for reading (Read) the data
APW m: Defining the protection level for writing (Write) the data
SGUD.DEF file:
%_N_SGUD_DEF
;$PATH=/_N_DEF_DIR
REDEF $MA_CTRLOUT_SEGMENT_NR APR 3 APW 2
M30
```

Note

References: /PGA/ Programming Guide Advanced

Chapter: Defining protection levels for user data (GUD)

14.8 Axis data

Introduction

The term "axis" is often used either as a single term in conjunction with SINUMERIK 840D sl or in a compound, 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.

Note

References: /FB/ Description of Functions - Basic Machine,

K2 Axes, Coordinate Syst., Frames, Workpiece numbers IWS,
Chapter: Axes

14.8.1 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.

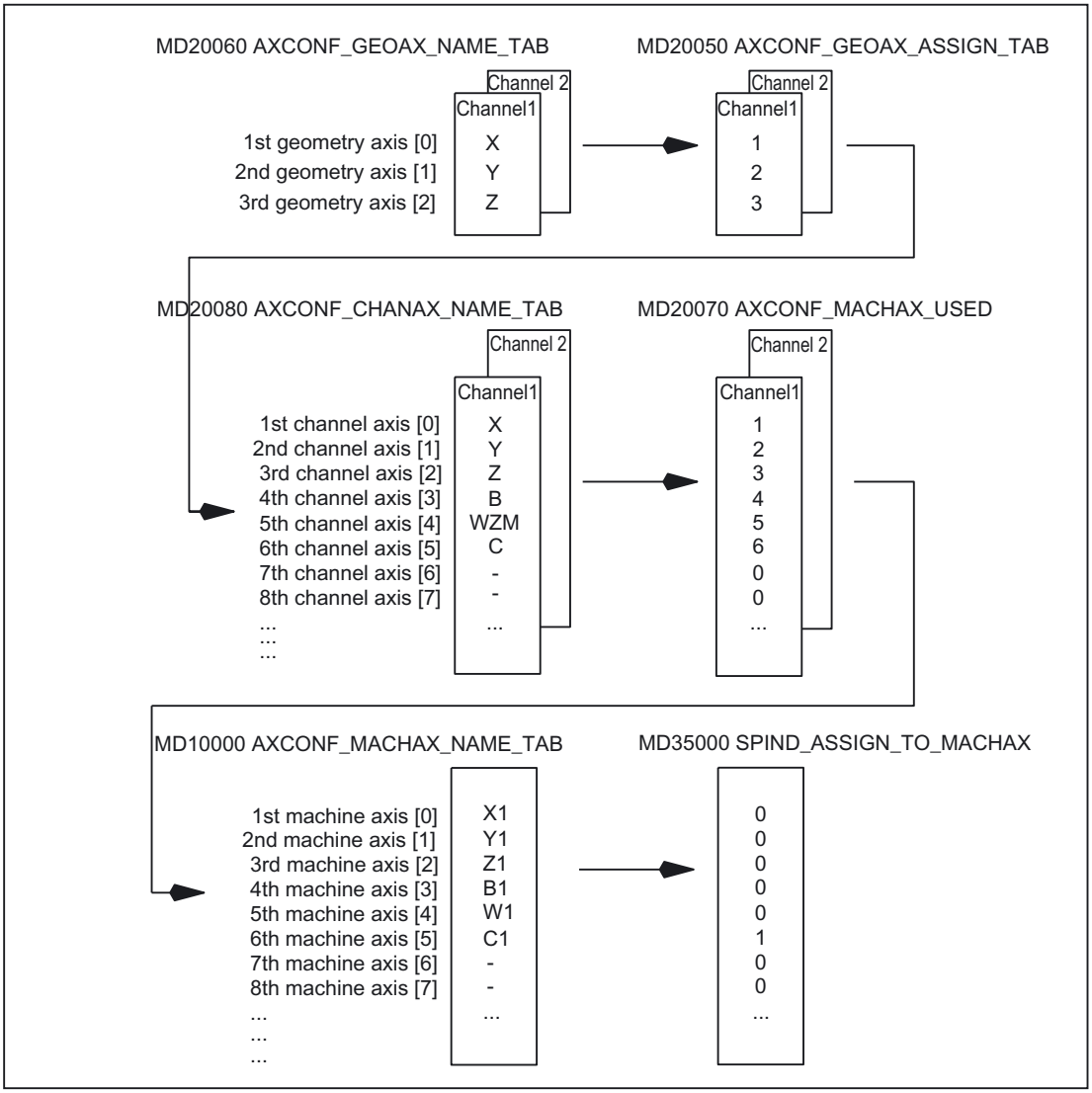

Fig. 14-5 Axis configuration

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.

References:
/FB2/ Description of Functions, Expansion Functions; Several Control Panels on Multiple NCUs, Decentralized Systems (B3)

Example

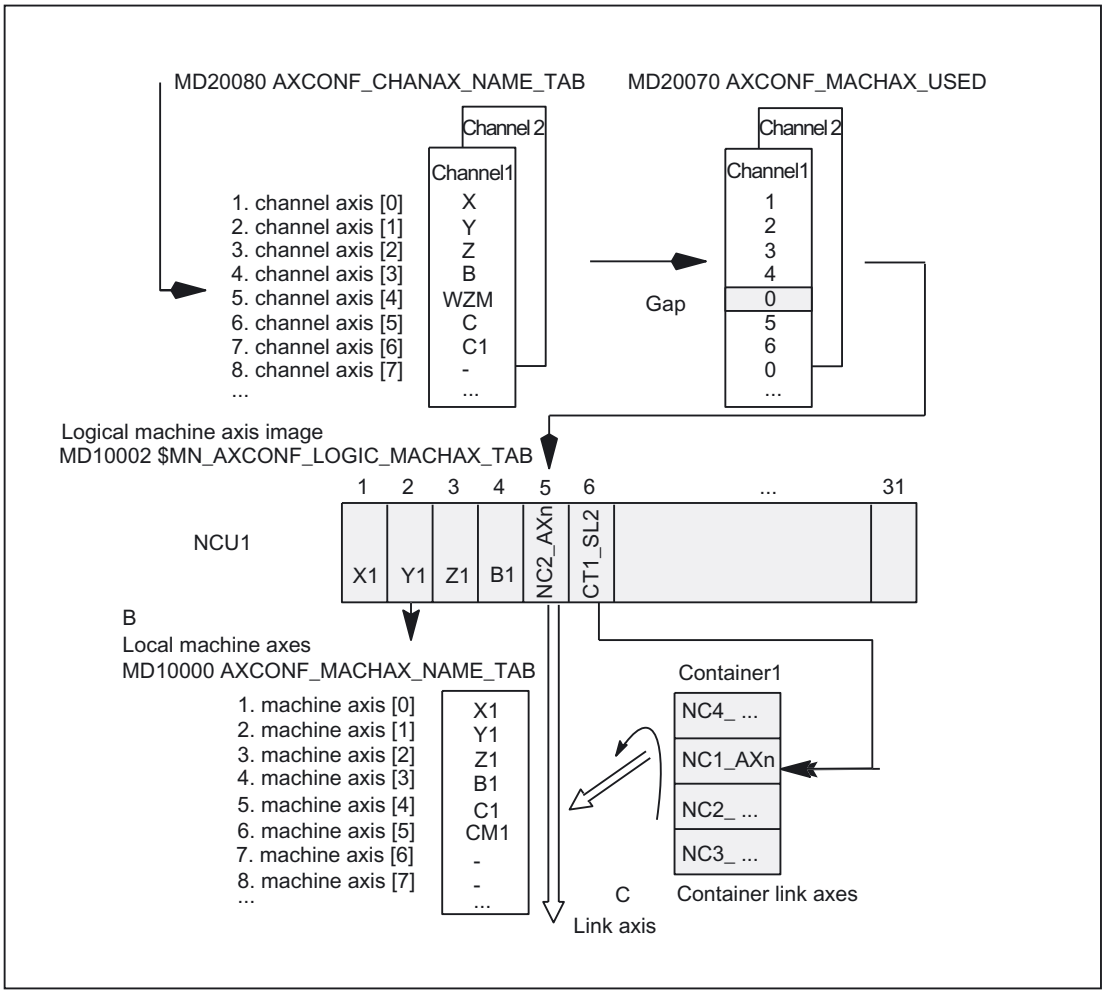

Fig. 14-6 Axis configuration with channel axis gap

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.

14.8.2 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

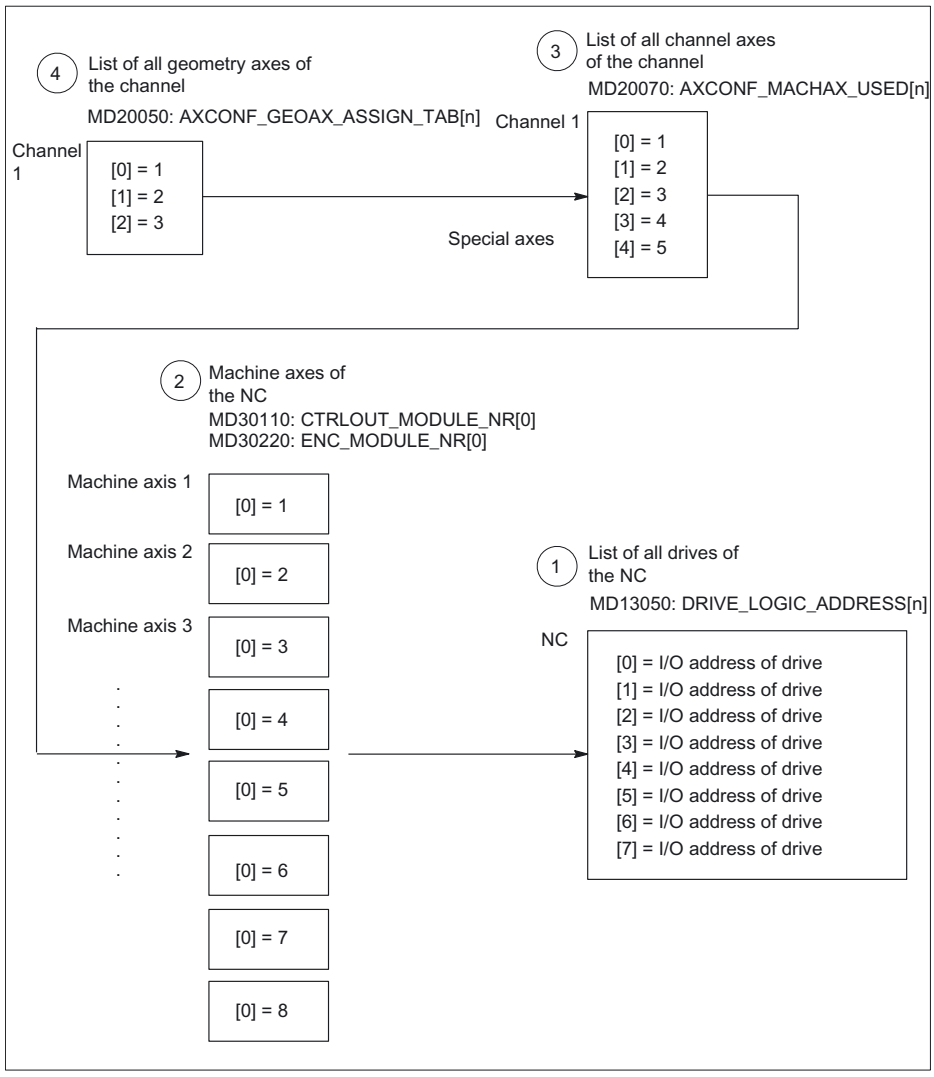

Fig. 14-7 Axis assignment

(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 (explicit) and how many channel axes are present in the channel (implicate) 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 14-8 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

14.8.3 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 14-9 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

14.8.4 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 module.

In the two axis-specific machine data:

- MD30110 CTRLOUT_MODULE_NR[0] (setpoint assignment: logic drive number)
- MD30220 ENC_MODUL_NR[n] (actual value assignment: logic 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, ... DBX1.5 (position measuring system 2 selected)

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

References:

/FB/ Description of Functions, Basic Machine, A2, Various Interface Signals

Machine data

Table 14-10 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: Logic drive number for position measuring system 1	
30220	ENC_MODULE_NR[1]	Actual value assignment: Logic drive number for position measuring system **2**	
30230	ENC_INPUT_NR[0]	Actual value assignment: Position measuring system 1 1 = G1_XIST encoder 1 position actual value 1 2 = G2_XIST encoder 1 position actual value 2	
30230	ENC_INPUT_NR[1]	Actual value assignment: Position measuring system **2** 1 = G1_XIST encoder 2 position actual value 1 2 = G2_XIST encoder 2 position actual value 2	
30240	ENC_TYPE[0]	Type of actual value recording 0 = Simulation 1 = Incremental encoder 4 = Absolute value encoder with EnDat interface	

Interface signals

Table 14-11 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	

References:

/FB/ Description of Functions, Basic Machine
G2 Velocities, Setpoint/Actual Value Systems, Closed-Loop Control, Chapter "Setpoint/Actual Value System"

/FB/ Description of Functions, Basic Machine
G2 Velocities, Traversing Ranges, Accuracies, Section "Interface Signals to Axis/Spindle"

14.9 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.

14.9.1 Spindle modes

Spindle modes

The spindle can have the following modes:

- Control mode
- Oscillation mode
- Positioning mode
- Synchronous mode synchronous spindle (S3)
- Rigid tapping

References:
/PA/ Programming Guide, Fundamentals
/PAZ/ Programming Guide, 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:

Switching between spindle modes

Interface signals or programming commands can be used to switch between the spindle modes and axis operation:

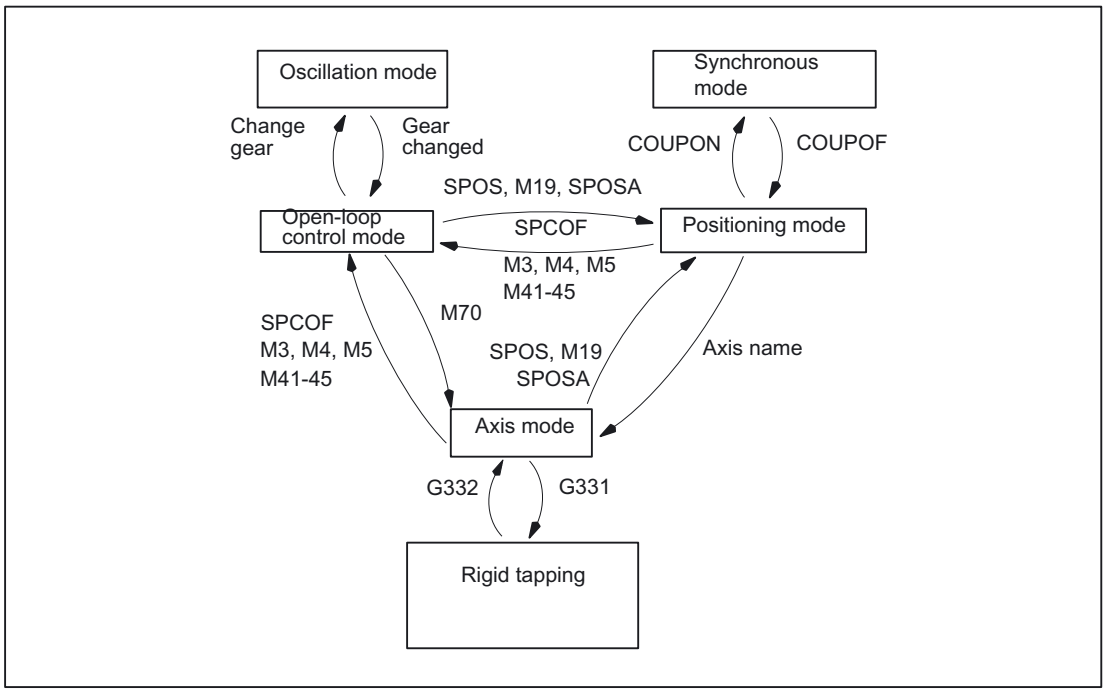

Fig. 14-8 Switching between spindle modes

- Open-loop control mode → Oscillation mode

  The spindle changes to oscillation mode if a new gear step has been specified using automatic gear step selection (`M40`) in conjunction with a new `S` value or by `M41` to `M45`. The spindle only changes to oscillation mode if the new gear step is not equal to the current actual gear step.

- Oscillation mode → Open-loop control mode

  When the new gear is engaged, IS:
  DB31, ... DBX84.6 (Oscillation mode)
  is reset and the spindle is switched
  to open-loop control mode with IS:
  DB31, ... DBX16.3 (Gear changed).
  The last programmed spindle speed (`S` value) is reactivated.

- Open-loop control mode → Positioning mode

  To stop the spindle from rotation (`M3` or `M4`) with orientation or to reorient it from standstill (`M5`), `SPOS`, `M19` or `SPOSA` are used to switch to positioning mode.

- Positioning mode → Open-loop control mode

M3, M4 or M5 are used to change to open-loop control mode if the orientation of the spindle is to be terminated. The last programmed spindle speed (S value) is reactivated.

- Positioning mode → Oscillation mode

  If the orientation of the spindle is to be terminated, M41 to M45 can be used to change to oscillation mode. When the gear change is complete, the last programmed spindle speed (S value) and M5 (control mode) are reactivated.

- Positioning mode → Axis mode

  If a spindle was stopped with orientation, the assigned axis name is used to program a change to axis mode. The gear step is retained.

- Open-loop control mode → Axis mode

  Switching from open-loop control mode to axis mode can be also achieved by programming M70. In this case, a rotating spindle is decelerated in the same way as for M5, position control is activated and the zero parameter set is selected.

- Axis mode → Open-loop control mode

  To terminate axis mode, M3, M4 or M5 can be used to change to open-loop control mode. The last programmed spindle speed (S value) is reactivated.

- Axis mode → Oscillation mode

  To terminate axis mode, M41 to M45 can be used to change to oscillation mode (only if the programmed gear step is not the same as the actual gear step). When the gear change is complete, the last programmed spindle speed (S value) and M5 (control mode) are reactivated.

14.9.2 Default mode setting

Machine data

The default setting of the spindle mode allows configuration of the basic spindle setting following Power On, NC-START and RESET using machine data:
MD35020 $MA_SPIND_DEFAULT_MODE
and
MD35030 $MA_SPIND_DEFAULT_ACT_MASK

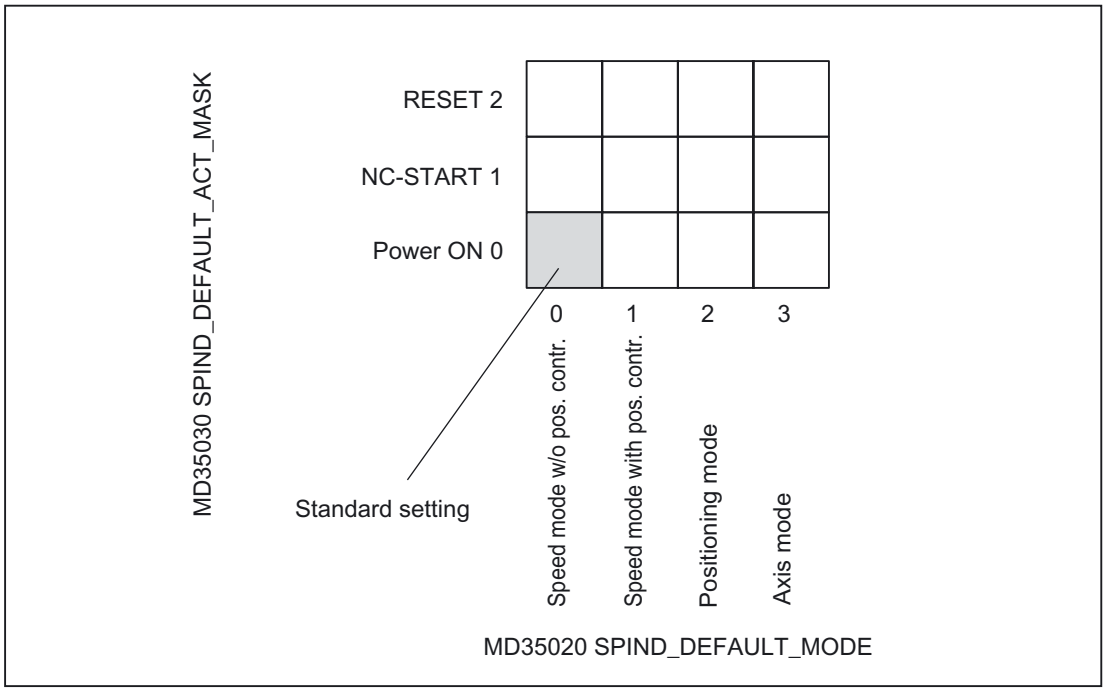

Fig. 14-9 Programmable defaults for spindle operating mode

14.9.3 Axis mode

Why axis mode?

For certain machining tasks (e.g., on turning machines 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 own 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 homed 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, which switches the spindle to axis mode, can be configured in 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.
- NC/PLC IS:
  DBB16 to DBB19 and DBB82 to DBB91 in DB31, ...
  are of no significance if NC/PLC IS:
  DB31, ... DBX60.0 (Axis/No spindle)
  is set to zero.
- 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

Transition to axis mode by programming:

- The spindle with its own identifier or by M70 and by means of the `M` function:
  MD20094 $MC_SPIND_RIGID_TAPPING_M_NR
- The relevant machine data when changing the servo parameter set are:

MD31050 $MA_DRIVE_AX_RATIO_DENOM	(Measuring gear denominator)
MD31060 $MA_DRIVE_AX_RATIO_NUMERA	(Numerator load gear unit)
MD32200 $MA_POSCTRL_GAIN	(Servo gain factor (Kv))
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 circuit 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	(Threshold value for velocity monitoring)

- 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:

Table 14-12 Change over to axis mode

SPOS=...	
M5	Closed-loop controller enable off (by PLC)
	→ Output to PLC
M70	Switch actuator (by PLC on account of M70)
	Closed-loop controller enable on (by PLC)
C=...	NC travels with axis parameter set

Table 14-13 Switch back to spindle mode

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 travels 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.

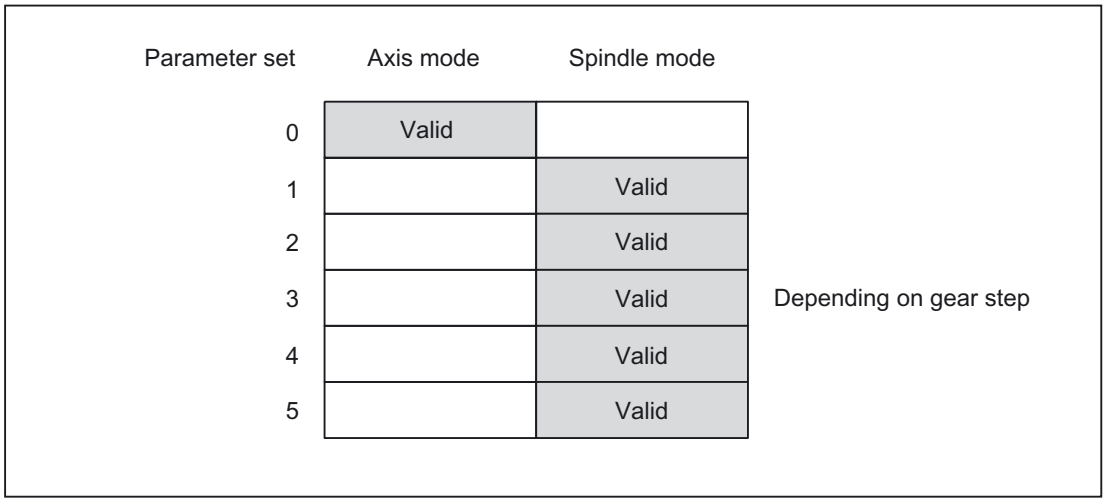

Fig. 14-10 Validity of parameter sets for axis and spindle modes

Master spindle

In order to utilize various spindle functions, for example

- 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 is to 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)

Note

References: /FB1/ Description of Functions, Basic Machine, S1 Spindles

Appendix

A

A.1 Small SINAMICS glossary

Active Line Module

Controlled, self-commutating feed/feedback unit (with –> "IGBT"s in feed/feedback device), which supplies the DC link voltage for the –> "Motor Module"s.

Compact Flash Card

Memory card for non-volatile storage of the drive software and corresponding –> "Parameter"s. 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

Control word

Bit-coded –> "Process data" word. –> "PROFIdrive" transmits this word at cyclic intervals to control the drive states.

Double Motor Module

Two motors can be connected to and operated with a Double Motor Module.
See –> "Motor Module" –> "Single Motor Module"
Former term: –> "Double-axis module"

Drive

The drive includes the motor (electric or hydraulic), the actuator (converter, valve), the control unit, 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"), the line infeed, the actuator, and the control component form a single device from the point of view of the user. With an inverter system (e.g. –> "SINAMICS S"), the supply is ensured by means of –> "Line Module"s, thereby realizing a DC line to which the –> "Inverter"s (– "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 component

Hardware component connected to a –> "Control Unit" via –> "DRIVE-CLiQ", for example –> "Motor Module"s, –> "Line Module"s, –> "Motor"s, –> "Sensor Module"s, and –> "Terminal Module"s.
The overall arrangement of a Control Unit including the connected drive components is called a –> "Drive Unit".

Drive group

A drive line-up comprises a –> "Control Unit" as well as the –> "Motor Module"s and –> "Line Module"s connected via -DRIVE-CLiQ.

Drive object

A drive object is a self-contained software function with its own –> "Parameter"s and, if necessary, its own –> "Fault"s and –> "Alarm"s. The drive objects may exist by default (e.g. On Board I/O) and may be easy to create (e.g. –> "Terminal Board" 30, TB30). It may also be possible to create them more than once (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) that belong to a drive. A drive system comprises, for example, –> "Line Module"s, –> "Motor Module"s, –> "Encoder"s, –> "Motor"s, –> "Terminal Module"s, and –> "Sensor Module"s, as well as additional components (reactors, filters, cables, etc.).
See –> "Drive Unit".

Drive unit

The drive unit includes all the components connected via –> "DRIVE-CLiQ" that are required for carrying out drive tasks: -> "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-CLiQ

Abbreviation for "Drive Component Link with IQ".
Communication system for connecting the different components of SINAMICS drive system (e.g. –> "Control Unit" –> "Line Module"s –> "Motor Module"s –> "Motor"s and speed/position encoders.
The DRIVE-CLiQ hardware is based on the Industrial Ethernet standard and uses twisted-pair lines. The DRIVE-CLiQ line provides the transmit and receive signals, as well as the +24 V power supply.

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 Encoder") or mounted on the external mechanics (– "External Encoder"). Depending on the type of movement, a distinction is made between rotary encoders ("rotary transducers") and translatory encoders (e.g. –> "Linear Encoder"s). In terms of measured value provision, a distinction is made between –> "Absolute Encoder"s (code sensors) and –> "Incremental Encoder"s.
See –> "Incremental Encoder TTL/HTL" –> "Incremental Encoder sin/cos 1 Vpp" –> "Resolver".

External encoder

Position encoder that is not built in or mounted on the –> "Motor", but fitted instead via a mechanical transmission element or mechanical intermediate element.
The external encoder (see –> "Externally-Mounted Encoder") is used for –> "Direct Position Detection".

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, 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 (–> "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 encoder

An –> "Encoder" (e.g. –> "Resolver", –> "Incremental Encoder TTL/HTL", or –> "Incremental Encoder sin/cos 1 Vpp" that is integrated in or attached to the motor.
The encoder detects the motor speed. In the case of synchronous motors, it can also detect the rotor position angle (of the commutation angle for the motor currents).
For drives without an additional –> "Direct Position Measuring System", it is also used as a –> "Position Encoder" for position control.
In addition to the motor encoders, –> "External Encoder"s for –> "Direct Position Sensing" are available.

Motor Module

A Motor Module is a power component (DC-AC inverter) 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.

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 Parameter"s and –> "Adjustable Parameter"s.

PROFIBUS

Field bus to IEC 61158, Chapters 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 Modules

Hardware module for evaluating speed/position encoder signals and providing detected actual values as numerical values at a -> DRIVE CLiQ Socket".
Three mechanical Sensor Module variants are available:
- SMCxx = Sensor Module Cabinet-Mounted
- SME = Sensor Module Externally Mounted (with a high degree of protection)

Servo control

This type of control enables operation with an extremely high –> "Dynamic Response" and –> "Precision" for –> "Motor"s with a –> "Motor Encoder".
In addition to speed control, position control can be implemented.

Servo drive

An electric servo drive comprises a motor, a –> "Motor Module", a –> "Servo Control" and, in most cases, a speed and position –> "Encoder"
Electric servo drives are normally extremely precise and have a high dynamic response. They are designed for cycle times 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.

SITOP Power

–> "Electronics Power Supply" component.
Example: 24 V DC

Smart Line Modules

Unregulated line infeed/feedback with a diode bridge for the infeed and stall-protected, line-commutated feedback via –> "IGBT"s.
The Smart Line Module provides the DC link voltage for the –> "Motor Module"s.

Status word

Bit-coded –> "Process data" word –> "PROFIdrive" transmits this word at cyclic intervals to detect the drive states.

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".

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 (–> "Encoder").

List of Abbreviations / Acronyms

B

B.1 Abbreviations

ACX	Compressed format from XML
ALM	Active Line Module
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
Command output disable	Command output disable
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: differentialsynchro transmitter function
DRIVE-CLiQ	Drive Component Link with IQ
DSC	Dynamic servo control
DWORD	Doubleword
EMC	Electro-Magnetic Compatibility
EN	European standard
EQN	Designation for an absolute encoder with 2048 sine signals per revolution
ESD	Electrostatic Sensitive Device
GC	Global Control
GSD	Device master file
GUD	Global User Data

GWPS	Grinding wheel peripheral speed
HMI	Human Machine Interface: SINUMERIK operator interface for operating, programming, and simulation
IBN	Start up
IPO	Interpolator cycle
IS	Interface signal
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
MCP	Machine control panel
MD	Machine data
MLFB	Machine-readable product designation
MM	Motor module
MSGW	Message word
NC	NCK
NCK	Numerical Control Kernel: NC kernel with block preparation, travel range, etc.
NCU	Numerical Control Unit: NCK hardware unit
NX	Numerical Extension (axis extension module)
OB	Organization block
OLP	Optical Link Plug Optical link plug
PCU	PC Unit: computer unit
PD	Process date
PELV	Protective Extra-Low Voltage
PG	Programming device
PII	Process input image
PIO	Process output image
PLC	Programmable Logic Control: programmable logic control (component of the CNC controller)
PUD	Global Program User Data
RAM	Random Access Memory: Random Access Memory (can be read and written)
RDY	Ready
REF	Reference point
RES	Reset
RTCP	Real Time Control Protocol
SBC	Safe brake activation
SD	Setting Data
SH	Safe standstill
SIM	Single Inline Module
SL	Automation System
SLM	Solution Line Module

SMC	Cabinet-mounted sensor module
SME	Sensor Module Externally Mounted
SRAM	Static RAM: static RAM (battery-backed)
STW	Control word
STW	Status Word
TCU	Thin Client Unit (communication with operator panels)
USB	Universal Serial Bus
VDE	Association of Electrical Engineering, Electronics and Information Technology
VO	Voltage output

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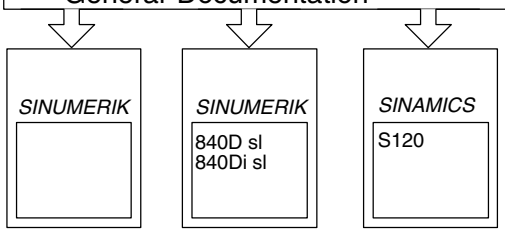

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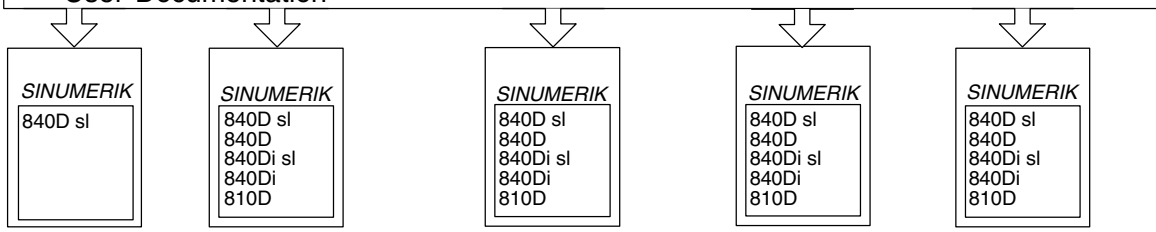

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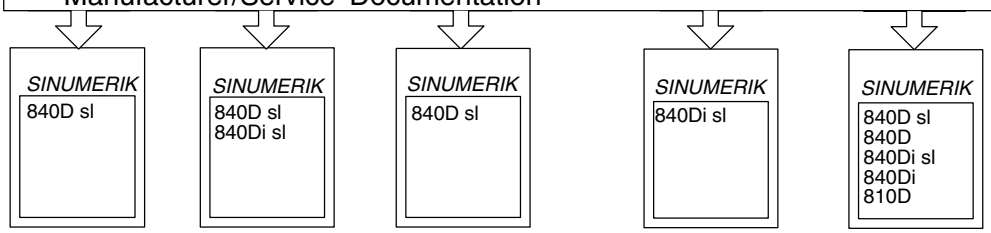

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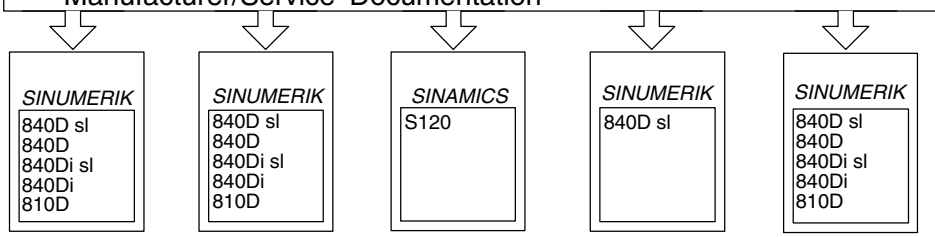

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