SIEMENS

SINUMERIK

SINUMERIK ONE
Work steps for configuring and commissioning

Commissioning Manual

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Valid for:
SINUMERIK ONE + export version

Create MyVirtual Machine V1.3
CNC software V6.20

07/2022
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Legal information

Warning notice system

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

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

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

⚠ **CAUTION**
indicates that minor personal injury can result if proper precautions are not taken.

NOTICE
indicates that property damage can result if proper precautions are not taken.

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

Qualified Personnel

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

Proper use of Siemens products

Note the following:

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

Trademarks

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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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1 Introduction

1.1 About SINUMERIK

From simple, standardized CNC machines to premium modular machine designs – the SINUMERIK CNCs offer the right solution for all machine concepts. Whether for individual parts or mass production, simple or complex workpieces – SINUMERIK is the highly dynamic automation solution, integrated for all areas of production. From prototype construction and tool design to mold making, all the way to large-scale series production.

Visit our website for more information SINUMERIK (https://www.siemens.com/sinumerik).

1.2 About this documentation

Target group

This publication is intended for experts involved in the engineering and commissioning of a SINUMERIK ONE.

Purpose

This Commissioning Manual gives you a guide which leads you through the most important work steps for configuring and commissioning your machine with a SINUMERIK ONE CNC. It is intended to give you an overview of the tools and functions used in a virtual environment, and to quickly guide you to the first work results in the development, design and commissioning on the real machine. If, because of your requirements, you want to clarify more detailed functionalities, we give you a reference to more detailed documentation at the end of each chapter. We wish you every enjoyment and success getting started with our new SINUMERIK ONE system.

Benefits

This Commissioning Manual enables the target group to develop the product, system or plant quickly and efficiently, and then test and commission it properly and safely.

Standard scope

This documentation only describes the functionality of the standard version. This may differ from the scope of the functionality of the system that is actually supplied. Please refer to the ordering documentation only for the functionality of the supplied drive system.

It may be possible to execute other functions in the system which are not described in this documentation. This does not, however, represent an obligation to supply such functions with a new control or when servicing.

For reasons of clarity, this documentation cannot include all of the detailed information on all product types. Further, this documentation cannot take into consideration every conceivable type of installation, operation and service/maintenance.

The machine manufacturer must document any additions or modifications they make to the product themselves.

Websites of third-party companies

This document may contain hyperlinks to third-party websites. Siemens is not responsible for and shall not be liable for these websites and their content. Siemens has no control over the information which appears on these websites and is not responsible for the content and information provided there. The user bears the risk for their use.

1.3 Documentation on the internet

1.3.1 Documentation overview SINUMERIK ONE

Comprehensive documentation about the functions provided in SINUMERIK ONE Version 6.13 and higher is provided in the Documentation overview SINUMERIK ONE (https://support.industry.siemens.com/cs/ww/en/view/109768483).



You can display documents or download them in PDF and HTML5 format.

The documentation is divided into the following categories:

- User: Operating
- User: Programming
- Manufacturer/Service: Functions
- Manufacturer/Service: Hardware
- Manufacturer/Service: Configuration/Setup
- Manufacturer/Service: Safety Integrated
- Information and training
- Manufacturer/Service: SINAMICS

1.3.2 Documentation overview SINUMERIK operator components

Comprehensive documentation about the SINUMERIK operator components is provided in the Documentation overview SINUMERIK operator components (https://support.industry.siemens.com/cs/document/109783841/technische-dokumentation-zu-sinumerik-bedienkomponenten?dti=0&lc=en-WW).

You can display documents or download them in PDF and HTML5 format.

The documentation is divided into the following categories:

- Operator Panels
- Machine control panels
- Machine Pushbutton Panel
- Handheld Unit/Mini handheld devices
- Further operator components

An overview of the most important documents, entries and links to SINUMERIK is provided at SINUMERIK Overview - Topic Page (https://support.industry.siemens.com/cs/document/109766201/sinumerik-an-overview-of-the-most-important-documents-and-links?dti=0&lc=en-WW).

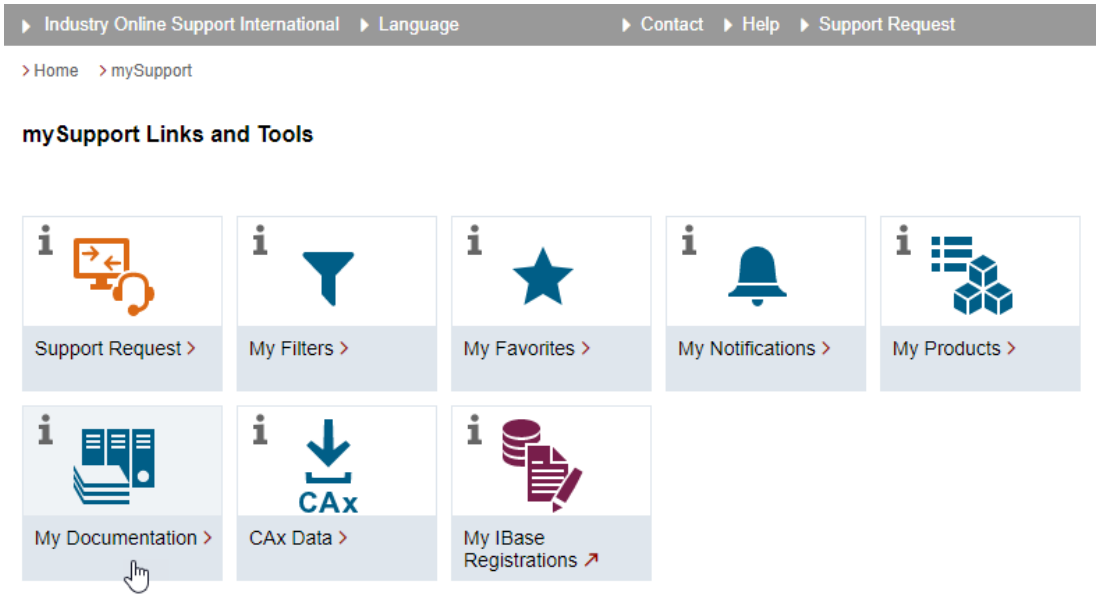
1.4 Feedback on the technical documentation

If you have any questions, suggestions or corrections regarding the technical documentation which is published in the Siemens Industry Online Support, use the link "Send feedback" link which appears at the end of the entry.

1.5 mySupport documentation

With the "mySupport documentation" web-based system you can compile your own individual documentation based on Siemens content, and adapt it for your own machine documentation.

To start the application, click on the "My Documentation" tile on the mySupport homepage (https://support.industry.siemens.com/cs/ww/en/my):



The configured manual can be exported in RTF, PDF or XML format.

Note

Siemens content that supports the mySupport documentation application can be identified by the presence of the "Configure" link.

1.6 Service and Support

Product support

You can find more information about products on the internet:

Product support (https://support.industry.siemens.com/cs/ww/en/)

The following is provided at this address:

- Up-to-date product information (product announcements)
- FAQs (frequently asked questions)
- Manuals
- Downloads
- Newsletters with the latest information about your products
- Global forum for information and best practice sharing between users and specialists
- Local contact persons via our Contacts at Siemens database (→ "Contact")
- Information about field services, repairs, spare parts, and much more (→ "Field Service")

Technical support

Country-specific telephone numbers for technical support are provided on the internet at address (https://support.industry.siemens.com/cs/ww/en/sc/4868) in the "Contact" area.

If you have any technical questions, please use the online form in the "Support Request" area.

Training

You can find information on SITRAIN at the following address (https://www.siemens.com/sitrain).
SITRAIN offers training courses for automation and drives products, systems and solutions from Siemens.

Siemens support on the go





With the award-winning "Siemens Industry Online Support" app, you can access more than 300,000 documents for Siemens Industry products – any time and from anywhere. The app can support you in areas including:

- Resolving problems when implementing a project
- Troubleshooting when faults develop
- Expanding a system or planning a new system

Furthermore, you have access to the Technical Forum and other articles from our experts:

- FAQs
- Application examples
- Manuals
- Certificates
- Product announcements and much more

The "Siemens Industry Online Support" app is available for Apple iOS and Android.

Data matrix code on the nameplate

The data matrix code on the nameplate contains the specific device data. This code can be read with a smartphone and technical information about the device displayed via the "Industry Online Support" mobile app.

1.7 Important product information

Using OpenSSL

This product can contain the following software:

- Software developed by the OpenSSL project for use in the OpenSSL toolkit
- Cryptographic software created by Eric Young.
- Software developed by Eric Young

You can find more information on the internet:

- OpenSSL (https://www.openssl.org)
- Cryptsoft (https://www.cryptsoft.com)

Compliance with the General Data Protection Regulation

Siemens observes standard data protection principles, in particular the data minimization rules (privacy by design).

For this product, this means:

The product does not process or store any personal data, only technical function data (e.g. time stamps). If the user links this data with other data (e.g. shift plans) or if he/she stores person-related data on the same data medium (e.g. hard disk), thus personalizing this data, he/she must ensure compliance with the applicable data protection stipulations.

Rules for SINUMERIK-conformal telegram configuring of SINAMICS drives

To configure the data exchange between a SINUMERIK 828D, SINUMERIK ONE or SINUMERIK MC and SINAMICS S120 drives, the following rules must be observed for the PROFIBUS/PROFINET configuration of the drives:

- For SINAMICS drive devices (CU3xx) on PROFIBUS/PROFINET, the PROFIBUS/PROFINET configuration must be identical to the standard configuration of the telegrams of the drives on the integrated PROFIBUS (SINAMICS Integrated or NX) of a SINUMERIK 828D or SINUMERIK ONE with regard to the telegrams structure.
- The identical structure of the telegrams refers specifically to the sequence of telegrams for a drive (CU3xx). The telegrams must be configured in the following order:
  - Telegrams for SERVO or HLA drive objects
  - Telegram for the Control Unit drive object
  - Telegram for the infeed drive object
- The following rules must be observed for the telegrams of the individual drive objects:
  - The input and output address of a telegram must have the same value.
    Exception: User-specific telegrams that only have input or output values.
  - The input and output data of a telegram are generally transferred via the same slot. If two different slots are used for data exchange (for PROFIBUS or PROFIBUS Integrated), make sure that the input slot is defined first. The output slot must have the following slot number.

Fundamental safety instructions

2

2.1 General safety instructions



⚠ WARNING

Electric shock and danger to life due to other energy sources

Touching live components can result in death or severe injury.

- Only work on electrical devices when you are qualified for this job.
- Always observe the country-specific safety rules.

Generally, the following steps apply when establishing safety:

1. Prepare for disconnection. Notify all those who will be affected by the procedure.
2. Isolate the drive system from the power supply and take measures to prevent it being switched back on again.
3. Wait until the discharge time specified on the warning labels has elapsed.
4. Check that there is no voltage between any of the power connections, and between any of the power connections and the protective conductor connection.
5. Check whether the existing auxiliary supply circuits are de-energized.
6. Ensure that the motors cannot move.
7. Identify all other dangerous energy sources, e.g. compressed air, hydraulic systems, or water. Switch the energy sources to a safe state.
8. Check that the correct drive system is completely locked.

After you have completed the work, restore the operational readiness in the inverse sequence.



⚠ WARNING

Electric shock due to connection to an unsuitable power supply

When equipment is connected to an unsuitable power supply, exposed components may carry a hazardous voltage. Contact with hazardous voltage can result in severe injury or death.

- Only use power supplies that provide SELV (Safety Extra Low Voltage) or PELV- (Protective Extra Low Voltage) output voltages for all connections and terminals of the electronics modules.



⚠ WARNING

Electric shock due to equipment damage

Improper handling may cause damage to equipment. For damaged devices, hazardous voltages can be present at the enclosure or at exposed components; if touched, this can result in death or severe injury.

- Ensure compliance with the limit values specified in the technical data during transport, storage and operation.
- Do not use any damaged devices.



⚠ WARNING

Electric shock due to unconnected cable shields

Hazardous touch voltages can occur through capacitive cross-coupling due to unconnected cable shields.

- As a minimum, connect cable shields and the cores of cables that are not used at one end at the grounded housing potential.



⚠ WARNING

Electric shock if there is no ground connection

For missing or incorrectly implemented protective conductor connection for devices with protection class I, high voltages can be present at open, exposed parts, which when touched, can result in death or severe injury.

- Ground the device in compliance with the applicable regulations.

NOTICE

Damage to equipment due to unsuitable tightening tools.

Unsuitable tightening tools or fastening methods can damage the screws of the equipment.

- Only use screw inserts that exactly match the screw head.
- Tighten the screws with the torque specified in the technical documentation.
- Use a torque wrench or a mechanical precision nut runner with a dynamic torque sensor and speed limitation system.
- Adjust the tools used regularly.

⚠ WARNING

Spread of fire from built-in devices

Built-in devices can cause a fire and a pressure wave in the event of a fault. Fire and smoke can escape from the control cabinet and cause serious personal injury and property damage.

- Install built-in appliances in a robust metal control cabinet that is suitable for protecting people from fire and smoke.
- Only operate built-in devices with the control cabinet doors closed.
- Ensure that smoke can only escape via controlled and monitored paths.

⚠ WARNING

Unexpected machine movement caused by radio devices or mobile phones

Using radio devices, cellphones, or mobile WLAN devices in the immediate vicinity of the components can result in equipment malfunction. Malfunctions may impair the functional safety of machines and can therefore put people in danger or lead to property damage.

- Therefore, if you move closer than 20 cm to the components, be sure to switch off radio devices, cellphones or WLAN devices.
- Use the "SIEMENS Industry Online Support app" only on equipment that has already been switched off.

⚠ WARNING

Fire due to inadequate ventilation clearances

Inadequate ventilation clearances can cause overheating of components with subsequent fire and smoke. This can cause severe injury or even death. This can also result in increased downtime and reduced service lives for devices/systems.

- Ensure compliance with the specified minimum clearance as ventilation clearance for the respective component.

NOTICE

Overheating due to inadmissible mounting position

The device may overheat and therefore be damaged if mounted in an inadmissible position.

- Only operate the device in admissible mounting positions.

⚠ WARNING

Unexpected movement of machines caused by inactive safety functions

Inactive or non-adapted safety functions can trigger unexpected machine movements that may result in serious injury or death.

- Observe the information in the appropriate product documentation before commissioning.
- Carry out a safety inspection for functions relevant to safety on the entire system, including all safety-related components.
- Ensure that the safety functions used in your drives and automation tasks are adjusted and activated through appropriate parameterizing.
- Perform a function test.
- Only put your plant into live operation once you have guaranteed that the functions relevant to safety are running correctly.

Note

Important Safety instructions for Safety Integrated

If you want to use Safety Integrated functions, you must observe the Safety instructions in the Safety Integrated documentation.

⚠ WARNING

Malfunctions of the machine as a result of incorrect or changed parameter settings

As a result of incorrect or changed parameterization, machines can malfunction, which in turn can lead to injuries or death.

- Protect the parameterization against unauthorized access.
- Handle possible malfunctions by taking suitable measures, e.g. emergency stop or emergency off.

2.2 Equipment damage due to electric fields or electrostatic discharge

Electrostatic sensitive devices (ESD) are individual components, integrated circuits, modules or devices that may be damaged by either electric fields or electrostatic discharge.



NOTICE

Equipment damage due to electric fields or electrostatic discharge

Electric fields or electrostatic discharge can cause malfunctions through damaged individual components, integrated circuits, modules or devices.

- Only pack, store, transport and send electronic components, modules or devices in their original packaging or in other suitable materials, e.g conductive foam rubber of aluminum foil.
- Only touch components, modules and devices when you are grounded by one of the following methods:
  - Wearing an ESD wrist strap
  - Wearing ESD shoes or ESD grounding straps in ESD areas with conductive flooring
- Only place electronic components, modules or devices on conductive surfaces (table with ESD surface, conductive ESD foam, ESD packaging, ESD transport container).

2.3 Warranty and liability for application examples

Application examples are not binding and do not claim to be complete regarding configuration, equipment or any eventuality which may arise. Application examples do not represent specific customer solutions, but are only intended to provide support for typical tasks.

As the user you yourself are responsible for ensuring that the products described are operated correctly. Application examples do not relieve you of your responsibility for safe handling when using, installing, operating and maintaining the equipment.

2.4 Security information

Siemens provides products and solutions with industrial security functions that support the secure operation of plants, systems, machines and networks.

In order to protect plants, systems, machines and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art industrial security concept. Siemens' products and solutions constitute one element of such a concept.

Customers are responsible for preventing unauthorized access to their plants, systems, machines and networks. Such systems, machines and components should only be connected to an enterprise network or the internet if and to the extent such a connection is necessary and only when appropriate security measures (e.g. firewalls and/or network segmentation) are in place.

For additional information on industrial security measures that may be implemented, please visit
https://www.siemens.com/industrialsecurity (https://www.siemens.com/industrialsecurity).

Siemens' products and solutions undergo continuous development to make them more secure. Siemens strongly recommends that product updates are applied as soon as they are available and that the latest product versions are used. Use of product versions that are no longer supported, and failure to apply the latest updates may increase customer's exposure to cyber threats.

To stay informed about product updates, subscribe to the Siemens Industrial Security RSS Feed under
https://www.siemens.com/cert (https://www.siemens.com/cert).

Further information is provided on the Internet:

Industrial Security Configuration Manual (https://support.industry.siemens.com/cs/ww/en/view/108862708)

⚠ WARNING

Unsafe operating states resulting from software manipulation

Software manipulations, e.g. viruses, Trojans, or worms, can cause unsafe operating states in your system that may lead to death, serious injury, and property damage.

- Keep the software up to date.
- Incorporate the automation and drive components into a holistic, state-of-the-art industrial security concept for the installation or machine.
- Make sure that you include all installed products into the holistic industrial security concept.
- Protect files stored on exchangeable storage media from malicious software by with suitable protection measures, e.g. virus scanners.
- On completion of commissioning, check all security-related settings.

2.5 Residual risks of power drive systems

When assessing the machine- or system-related risk in accordance with the respective local regulations (e.g., EC Machinery Directive), the machine manufacturer or system installer must take into account the following residual risks emanating from the control and drive components of a drive system:

1. Unintentional movements of driven machine or system components during commissioning, operation, maintenance, and repairs caused by, for example,
   - Hardware and/or software errors in the sensors, control system, actuators, and cables and connections
   - Response times of the control system and of the drive
   - Operation and/or environmental conditions outside the specification
   - Condensation/conductive contamination
   - Parameterization, programming, cabling, and installation errors
   - Use of wireless devices/mobile phones in the immediate vicinity of electronic components
   - External influences/damage
   - X-ray, ionizing radiation and cosmic radiation
2. Unusually high temperatures, including open flames, as well as emissions of light, noise, particles, gases, etc., can occur inside and outside the components under fault conditions caused by, for example:
   - Component failure
   - Software errors
   - Operation and/or environmental conditions outside the specification
   - External influences/damage
3. Hazardous shock voltages caused by, for example:
   - Component failure
   - Influence during electrostatic charging
   - Induction of voltages in moving motors
   - Operation and/or environmental conditions outside the specification
   - Condensation/conductive contamination
   - External influences/damage
4. Electrical, magnetic and electromagnetic fields generated in operation that can pose a risk to people with a pacemaker, implants or metal replacement joints, etc., if they are too close
5. Release of environmental pollutants or emissions as a result of improper operation of the system and/or failure to dispose of components safely and correctly
6. Influence of network-connected communication systems, e.g. ripple-control transmitters or data communication via the network

For more information about the residual risks of the drive system components, see the relevant sections in the technical user documentation.

Overview 3

3.1 Overview of the engineering with a digital twin

This chapter describes a typical procedure in the engineering process and the basic commissioning of a SINUMERIK ONE control with a digital twin. The engineering process is based on the use of a virtual and a real version of the SINUMERIK ONE control, and consists of two subareas:

- **Virtual machine (SINUMERIK ONE Create MyVirtual Machine)**
  First commissioning of the control in Create MyVirtual Machine, using the virtual machine.
- **Real machine (SINUMERIK ONE)**
  Accept and adapt the commissioning data from Create MyVirtual Machine in the real machine. Complete the commissioning for hardware-relevant components, for example the drive commissioning.

Engineering process subdivided into individual components

During engineering, the work steps are typically performed for each component (PLC, drive, NCK, HMI, and I/O). The component-by-component process with transfer to the real machine is shown in the following figure.

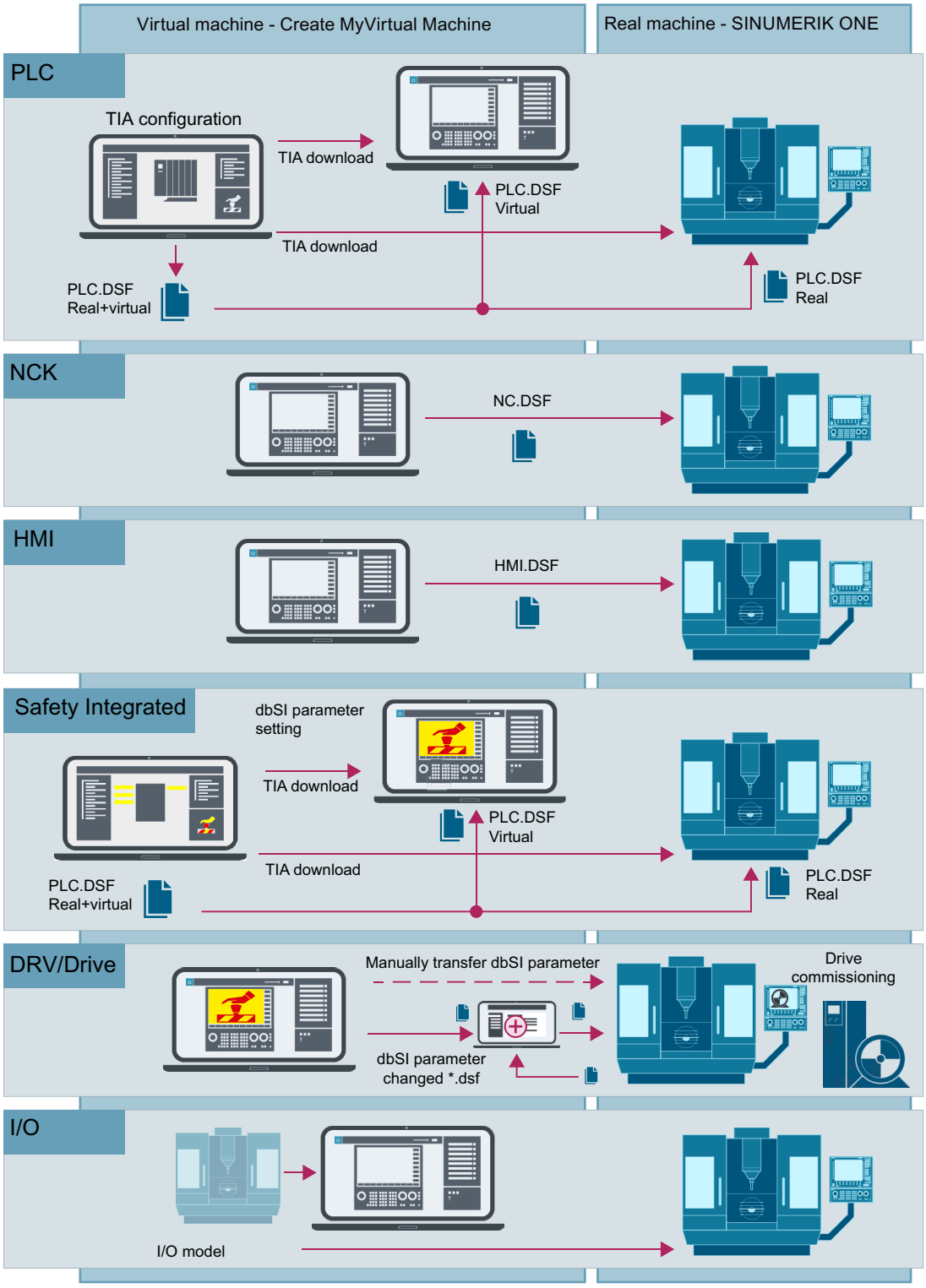


Figure 3-1 Overview of the engineering process and data transfer from the virtual to the real machine

3.2 Basic commissioning sequence

Objective of basic commissioning

As example, you will commission a control with 5 axes and one spindle for the basic commissioning. After successful basic commissioning, the axes can be traversed via the machine control panel.

Design of the simple example machine

- Machine with 5 axes
  - 3 linear axes (X, Y, Z)
  - 2 rotary axes (B, C)
  - 1 spindle (SP)
- Machine control panel
  - The MCP483 Milling version is used for the virtual machine. The parameters are assigned at the FC1 as an Ethernet machine control panel with inputs from bit E0.0 and outputs from bit A0.0 (also possible symbolically via variable table).
  - Any machine control panels can be connected to the real machine via Ethernet and PROFINET. You assign parameters to the signals via I/Os or DB.

Create MyVirtual Machine for virtual commissioning

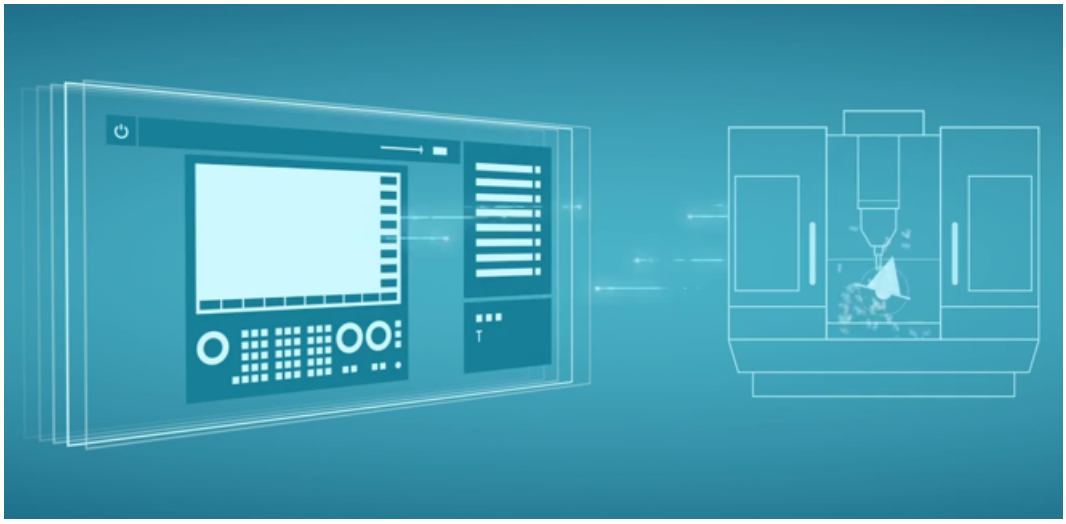


Figure 3-2 Virtual SINUMERIK ONE during the commissioning phase in interaction with an I/O device simulation

Sequence example of basic commissioning

The possible individual steps for the engineering process of a SINUMERIK ONE are described in the following.

Steps	Description	More information
Installing engineering software and configuring communication	• Install TIA Portal with all necessary option packages (e.g. SINUMERIK STEP 7 Toolbox) and Create MyVirtual Machine • Configure the communication between the TIA Portal and Create MyVirtual Machine	Create MyVirtual Machine Installation Instructions CNC software Installation Instructions TIA Portal Installation Instructions Documentation overview SINUMERIK ONE (https://support.industry.siemens.com/cs/ww/en/view/109768483)
Commissioning a PLC TIA Portal	• Configure hardware and communication in the TIA Portal • Integrate basic PLC program and create user program	TIA Portal online help SINUMERIK Toolbox online help PLC Function Manual Programming guidelines and programming style guide for SIMATIC S7-1200 and S7-1500 (https://support.industry.siemens.com/cs/ww/en/view/81318674)
Downloading to control Create MyVirtual Machine TIA Portal	• Create machine project in Create MyVirtual Machine • Load hardware configuration and software from TIA Portal into Create MyVirtual Machine • Saving and restart of the machine project	Create MyVirtual Machine online help TIA Portal online help
NC commissioning Create MyVirtual Machine	• Assign axis names and assign axes • Assign drives and encoders • Saving and restart of the machine project • Testing the previous commissioning on the machine control panel	SINUMERIK ONE List Manual SINUMERIK Operate online help Function Manuals Documentation overview SINUMERIK ONE (https://support.industry.siemens.com/cs/ww/en/view/109768483)
PLC Safety Integrated safety program TIA Portal	• Configuring Safety Integrated • Creating safety programs	TIA Portal online help Commissioning Safety Integrated Programming guidelines and programming style guide for SIMATIC S7-1200 and S7-1500 (https://support.industry.siemens.com/cs/ww/en/view/81318674) SIMATIC - Failsafe LDrvSafe library (https://support.industry.siemens.com/cs/ww/en/view/109485794) for controlling Safety Integrated Functions for the SINAMICS drive family

Steps	Description	More information
Downloading to control Create MyVirtual Machine TIA Portal	• Load complete TIA Portal project into machine project of Create MyVirtual Machine	Create MyVirtual Machine online help TIA Portal online help
NC Safety Integrated commissioning Create MyVirtual Machine	• Assigning axes to drives • Activate safety • Configuring safety parameters in sim-Drive • Performing a reduced acceptance test	Commissioning Safety Integrated SINUMERIK Operate online help Documentation overview SINUMERIK ONE (https://support.industry.siemens.com/cs/ww/en/view/109768483)
I/O	• Further input/output modules • I/O simulation for testing	
Transition to the real SINUMERIK ONE	• Transfer and adapt setup data	Commissioning Manual final commissioning steps Documentation overview SINUMERIK ONE (https://support.industry.siemens.com/cs/ww/en/view/109768483)
Preparing a control SINUMERIK ONE	• Connecting • SD card with CNC software (V6.20) • Start up to install CNC software	SINUMERIK ONE Equipment Manual Commissioning, new installation and upgrade Commissioning Manual final commissioning steps Documentation overview SINUMERIK ONE (https://support.industry.siemens.com/cs/ww/en/view/109768483)
Creating and loading PLC and NC archives Create MyVirtual Machine TIA Portal SINUMERIK ONE	• Start up control with standard CNC software • Create archives in Create MyVirtual Machine • Load PLC data from TIA Portal project or TIA Portal PLC archive into real controller • Load archives into the real machine • Switch off and start up the control	TIA Portal online help Create MyVirtual Machine online help SINUMERIK ONE Equipment Manual Documentation overview SINUMERIK ONE (https://support.industry.siemens.com/cs/ww/en/view/109768483)
Drive commissioning SINUMERIK ONE	• Commissioning drives • Perform automatic commissioning • Configure safety parameters	SINUMERIK Operate online help Commissioning Manual final commissioning steps Documentation overview SINUMERIK ONE (https://support.industry.siemens.com/cs/ww/en/view/109768483)

⚠ WARNING

Machine projects must be checked and approved when being transferred to a real SINUMERIK ONE control system

Archives and data from machine projects in Create MyVirtual Machine must be checked and approved on a real control system.

Transferring the data from a simulation project without carrying out a check is not permitted for machine operation.

Requirements and engineering tools

4

4.1 Requirements and engineering tools for a virtual machine

General information

Additional engineering software is required to create PLC projects for SINUMERIK with SIMATIC PLC S7-1500 and load them into Create MyVirtual Machine.

Note

SINUMERIK Virtual CNC software add-on packages

Create MyVirtual Machine consists of a software package which provides the framework application for the operation of a virtual SINUMERIK controller. You have to additionally install the required version of the SINUMERIK Virtual CNC software. These installation packages include the simulation of the components NCK, PLC, HMI, drive replacement component and communication mechanisms. Besides the frame application, you can install different versions of the SINUMERIK Virtual CNC software in parallel.

Installation environment overview

The engineering software for PLC projects can be installed on the same computer as the engineering software for SINUMERIK projects (Create MyVirtual Machine), on another computer, or in a virtual machine. SIMATIC STEP 7 Professional and Create MyVirtual Machine communicate via Ethernet.

The table provides the overview of the required and optional software components. Also observe the installation sequence.

- **Installation on a computer: Steps 1-5**
  When you install the complete software on a computer, you must first install SIMATIC STEP 7 Professional with all the required option packages and only then Create MyVirtual Machine.
- **Installation on different computers**
  - First computer: Steps 1 and 2
    Install SIMATIC STEP 7 Professional with all required option packages
  - Second computer: Steps 3 to 5
    Install Create MyVirtual Machine and the required versions of the SINUMERIK Virtual CNC software and templates for machine projects.

Step	PLC projects engineering software	SINUMERIK projects engineering software
1	SIMATIC STEP 7 Professional V17 Update 4 (TIA Portal) incl. SIMATIC Safety (license)	
2	**Option package required for HW configuration and PLC programming** SINUMERIK STEP 7 Toolbox V17 Update 10 contains • SINUMERIK 840D sl STEP 7 Toolbox V17 Update 10 • SINUMERIK ONE STEP 7 Toolbox V17 Update 10	
3		Create MyVirtual Machine V1.3 or higher
4		SINUMERIK Virtual CNC SW V6.20 or higher (the current version CNC SW V6.20 requires Create MyVirtual Machine V1.3 or higher)
5		Templates for machine projects, suitable for SINUMERIK Virtual CNC-SW V6.20
-		**Optional:** • Software for the peripheral simulation for connection to the Open Interface • SINUMERIK Virtual CNC Software Language Extensions Additional display languages for SINUMERIK Operate

Note

Two-computer solution

When you work with two computers, you must configure the inbound connections of the TCP communication in the firewall on the computer with Create MyVirtual Machine. Observe the "Cross-computer communication via Ethernet" section in the SINUMERIK Virtual CNC SW Installation Instructions.

More information

- For the installation of SIMATIC STEP 7 Professional and other option packages, observe the software requirements and the installation instructions in the appropriate software documentation.
- More information about installing the CNC software can be found in the *SINUMERIK Virtual CNC SW installation instructions*.
- More information about installing Create MyVirtual Machine can be found in the *SINUMERIK Create MyVirtual Machine installation instructions*.
- More information about installing templates for machine projects is provided in the *Installation instructions for machine projects Create/Run MyVirtual Machine*.

4.2 Create MyVirtual Machine

Description

Create MyVirtual Machine includes the well-proven SINUMERIK Operate commissioning and operating software, and supplements this to include a virtual machine control panel and simulation control. The operation of Create MyVirtual Machine corresponds to that of a real control equipped with a SINUMERIK Operate user interface and machine control panel.

Creating machine projects

You manage the machine projects (*.vcp; **v**irtual **c**ommissioning **p**roject) in the Create MyVirtual Machine project management.

A machine project manages all the data required to operate the machine. The machine project file contains NC, HMI, PLC and drive data stating the version of the CNC software used.

How to create machine projects

Start Create MyVirtual Machine before creating a new machine project.

1. Create a new machine project.
2. Select the "CNC SW version". This CNC SW version is used in the project, and corresponds to the version of the SINUMERIK components used in the virtual machine. All installed versions of the CNC software are displayed in the drop down list. V6.20 is used for the example.
3. Confirm with "Create project". The Create MyVirtual Machine project view is displayed with "Project settings" and default values.

4. Configure the "Project settings".
   - HMI resolution (depending on the available monitor resolution)
   - Navigation Bar (displays a quick navigation bar on the left)
   - Control panel type ("MCP 483 Milling" is used for the example)

   Start the machine in the next step. This places the machine in simulation mode. The starting corresponds to the switch-on and ramp-up of a real machine.
5. Click on the button "Start machine" in the control area. The button can be clicked only when it is no longer grayed out.
   The machine start is completed when all components have green status. Because an empty machine project was started without a PLC program, a PLC error message is displayed.

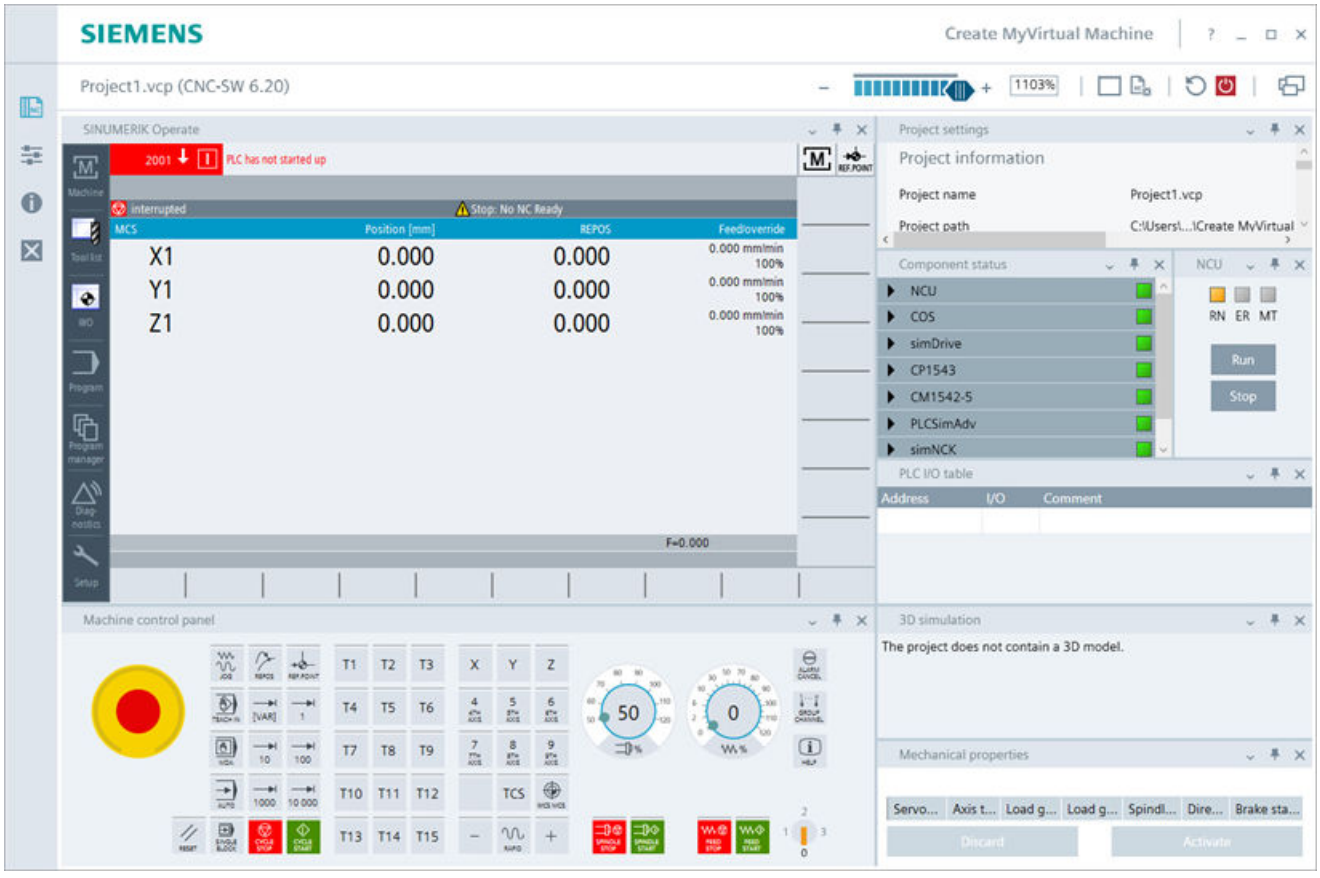


Figure 4-1 Create MyVirtual Machine: Empty, newly-created machine project

The newly created machine project has a standard configuration. To adapt this machine, you must commission the machine in a further step, e.g. download the hardware configuration and the PLC program from the TIA Portal or load an archive.

Saving machine projects

The current state of the machine project is backed up on saving. When the machine project is next opened, you continue working with the most recently saved status. Machine projects can only be saved if the simulation control has **Stop** status. Changes are not automatically saved.

1. In the control area, click the button  "Exit machine". The machine is exited.
2. In the menu bar, select  "Save" or  "Save as". The save dialog is opened
3. Save the project directly, or select a location where you want to save it – and enter a new name for the machine project.
4. Confirm with "Save". The machine project is saved with a *.vcp file extension.

4.3 Requirements for a real machine

Prerequirements for components involved

The complete system is mechanically and electrically connected, and has been tested for faults. Observe the safety instructions in the relevant, valid product documentation.

References

You can find further details in the following manuals:

- Installing the SINAMICS S120 drive components: SINAMICS S120 Equipment Manual
- Connecting the interfaces: SINUMERIK NCU Equipment Manual NCU 1740, NCU 1750, NCU 1760, PPU 1740

4.4 Software/hardware of a real machine

Requirements for commissioning

The following conditions have to be fulfilled to commission the SINUMERIK NCU:

- Hardware requirements
  - SINUMERIK NCU 1740, NCU 1750, NCU 1760 or PPU 1740
  - SD card
  - MCP (set for operation and enables)
  - Operator panel with TCU for displaying SINUMERIK Operate
  - SITOP 24 V power supply
  - Optional: Operator panel with PCU/IPC and Windows 10
- Connections to the NCU
  - The MCP, operator panel, and an optional IPC are connected to X120 (a switch is required when using an IPC)
  - Commissioning a PLC via an Ethernet connection of engineering PC/PG to X127
  - All connections required for actuators, sensors (PROFINET, PROFIBUS) and drives (DRIVE-CLiQ)
- Software requirements
  - CNC software on SD Card
  - SIMATIC STEP 7 Professional V17 (TIA Portal) with all necessary option packages (see also Engineering software PLC projects (Page 33))

Licensing 5

5.1 Licensing Create MyVirtual Machine

License for Create MyVirtual Machine

A license is required for operation of the Create MyVirtual Machine and can be obtained in a license file (*.lic). A license file can include one or more licenses. The license is managed via a licensing application. The application is installed automatically when setting up Create MyVirtual Machine.

Licenses for Create MyVirtual Machine and options

The installation of Create MyVirtual Machine also includes the open interface and the 3D simulation. If you use the functions of these options, additional licenses are required.

The following licenses are required for operation.

- Create MyVirtual Machine (Create MyVirtual Machine /Operate)
- Optional: Open interface (Create MyVirtual Machine /Open)
- Optional: 3D Simulation (Create MyVirtual Machine /3D)

Further information

Information regarding licensing can be found in the Create MyVirtual Machine installation instructions.

Additional license keys for SINUMERIK

You do **not** require any additional SINUMERIK licenses, e.g. license keys, for the hardware or options when working with Create MyVirtual Machine, as you are only working with virtual drives. Configuration and commissioning of the machine is performed virtually. The necessary license requirement is then only determined directly at the control with transition to the real SINUMERIK ONE with real drives.

5.2 Licensing SINUMERIK ONE

SINUMERIK ONE 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 serial number
  Via the hardware serial number contained in the SINUMERIK License Key, there is a direct relationship between the License Key and the hardware on which it may be used. That means a license key that was generated for the hardware serial number of a particular SD card is also only valid on this SD card and is rejected as invalid on another SD card.
- Total number of assigned licenses
  A SINUMERIK license key not only refers to a single license, instead it is the "technical representative" of all licenses that are assigned to the hardware at the time of its generation.

Web license manager

The use of the installed system software and the options activated on a SINUMERIK ONE control require the licenses purchased for this purpose to be 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 and the hardware serial number.

By using the web license manager, you can assign licenses to hardware in a standard web browser. To finish the assignment, the license key must be read into the control via the user interface.

Further information

For basic information on licensing, refer to the *Commissioning Manual Final Work Steps For Commissioning,* "Licensing" section.

Information regarding licenses and their use can be found in the online help for SINUMERIK Operate.

Internet: Web license manager (http://www.siemens.com/automation/license)

Engineering PLC (virtual machine) 6

6.1 SINUMERIK ONE PLC - which basic program?

From version SINUMERIK ONE V6.20, there are 2 types of PLC basic program.

- SINUMERIK ONE basic PLC program - compatible to the known basic program of SINUMERIK 840 D sl
- SINUMERIK ONE PLC Basic Program plus - state-of-the art software architecture for maximum flexibility

You must decide on one of the two variants before programming the PLC user program. The PLC basic programs are **not** compatible and **cannot** be combined The specific attributes of the two variants are briefly described in the following section.

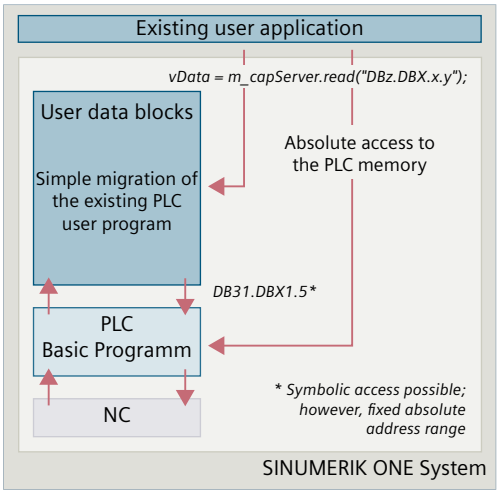
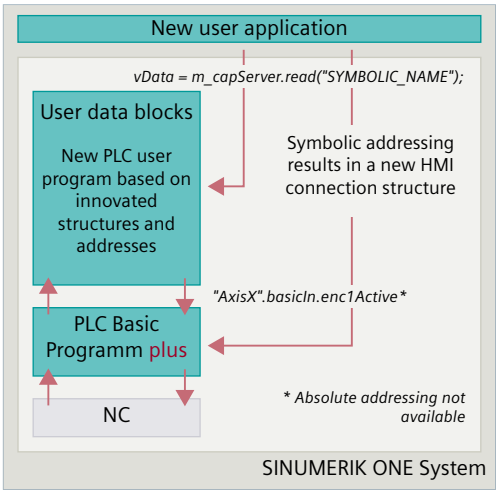
Fundamental attributes of the PLC basic program

Fundamentally, a PLC basic program provides system libraries with blocks in the TIA Portal in order to exchange cyclic data between the NCK and PLC. For the PLC Basic Program plus there are no fixed data blocks for the interface signals as before; instead, the interface signals are provided as NCK-related data types. Optimized data blocks (instances) are used for data exchange, which are modular and can be freely configured. This means that you can already implement a modular CNC machine design in the architecture of the PLC user program.

With the PLC Basic Program and with the PLC Basic program plus, you can implement the full functional scope of state-of-the-art CNC machines in your PLC user program. The TIA Portal provides you with current configuring and programming tools as well as the option of symbolic programming.

Attributes of the PLC basic program

Typical features of the two variants are shown in the following table.

PLC Basic Program	PLC Basic Program plus
Fast switchover from SINUMERIK 840D sl to SINUMERIK ONE, as existing PLC user programs can be migrated and the interface is compatible. Low associated costs, as experience has already been gained with SINUMERIK PLC programming.	PLC user programs are completely rewritten with the advantage of having an excellent platform for ongoing developments. The costs associated with a switchover depend very heavily on the previous structure of the PLC project.
 PLC Basic Program, schematic diagram	 PLC Basic Program plus, schematic diagram
• Functional scope addresses the requirements of current machine concepts for the PLC. Good basis if only a few changes apply when it comes to future PLC requirements.	• Innovations/expanded functionality in the areas of PLC, TIA Portal SINUMERIK (NC) are already available in the current version. – Software units (TIA Portal) – Offline compiler checks due to the data type-based interface – Actual value and distances to go in the interface – Larger communications RAM
• Absolute access to the data memory, however symbolic interface also possible	• Structured and fully symbolic interface split up into function groups
	• Modular series machines are very well supported • Improved integration of programming in the TIA Portal • SINUMERIK user alarms support the modular program structure

Decision-making criteria

Analyzing the machine concept is decisive when selecting the basic program. You draw-up the requirements relating to the software architecture of the PLC user program based on the machine concept.

The PLC Basic Program plus should be selected if the machine concept is modular with flexible expansion and extension options, and if the focus is on a basis for future-proof platform to address ongoing development.

The PLC Basic program is a suitable solution if the machine concept is used in standard machines with few possibilities of expansion.

SINUMERIK ONE PLC Basic Program in this documentation

The SINUMERIK ONE PLC Basic Program is used for the following PLC sample project and all of the descriptions about PLC programming.

More information

More information about PLC basic programs is provided in the following documentation.

- *Function Manual SINUMERIK ONE PLC Basic Program*
- *Function Manual SINUMERIK ONE PLC Basic Program plus*

6.2 PLC commissioning: Overview

The PLC of a SINUMERIK control with SIMATIC S7-1500 is commissioned only in the TIA Portal.

You commission the PLC by performing the following work steps:

1. Configuring the PLC
   - Create a project
   - Add NCU
   - Configure network settings
   - Establish the communication connection
   - Load hardware configuration into the PLC
2. Creating and loading the PLC program
   - Integrating the basic PLC program into the project
   - Edit the blocks
   - Load the PLC program into the PLC
   - Completing the basic commissioning of the PLC

Requirement

The necessary engineering software and additional components are installed, and communication between Create MyVirtual Machine and the TIA Portal is configured.

See also

Requirements and engineering tools for a virtual machine (Page 33)

6.3 Creating a TIA Portal project

Introduction

You create a new project in the following. Within a project, all of the automation tasks required, for example the hardware configuration and the PLC programming, are performed.

Requirement

- The TIA Portal has been started. The functionalities of a SINUMERIK NCU are available to you in the TIA Portal via the installed SINUMERIK Toolbox.

Procedure

1. Click "Create new project" in the portal view.
2. Assign a project name and select the storage location of the project (path).
3. Click "Create".
4. After creating the project, switch to the "Project view" of the TIA Portal.

Result

A new, empty project is created.

6.4 Configuring the PLC

6.4.1 Structure of SINUMERIK NCU

Subcomponents of the NCU

A SINUMERIK NCU comprises the following integrated subcomponents:

- PLC
- NCK
- CP
- HMI (SINUMERIK Operate)
- SINAMICS Integrated (DRIVE)

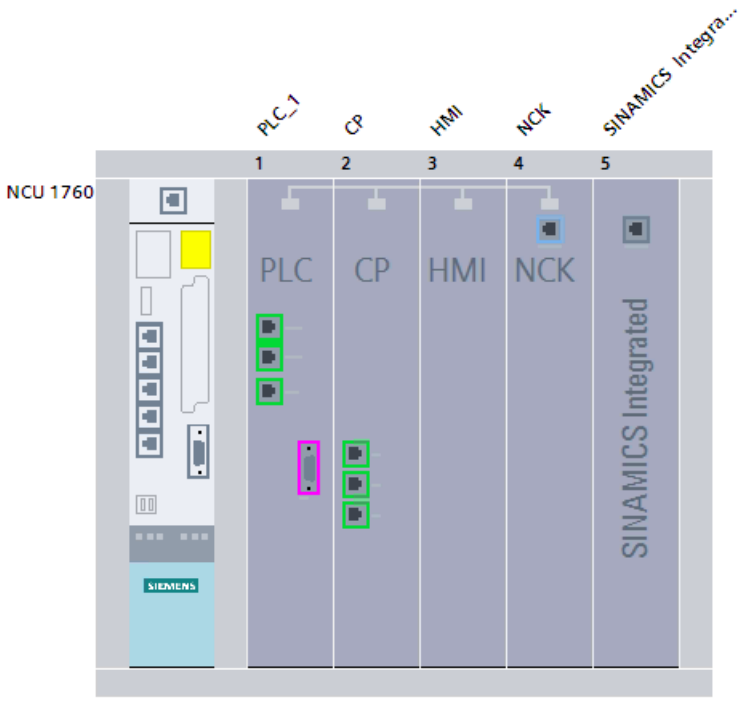


Figure 6-1 Structure of a SINUMERIK NCU 1760

These subcomponents are always a fixed component of an NCU and can only be handled in combination with the NCU. Subcomponents cannot be individually pasted, copied or moved in the project or across projects (e.g. in libraries).

Note

Copying and pasting the NCU or the DP master system

You can copy and insert NCUs within a project. For this purpose, switch to the network view or to the topology view of the project view.

The DP master system (PROFIBUS Integrated) cannot be individually copied, pasted or deleted. It is considered as an integral part of the NCU.

If you copy an NCU, all integrated subcomponents are also copied, e.g. SINAMICS Integrated or PROFIBUS Integrated.

Additional connectable components

Optionally, the following components can be connected to the NCU:

- NX10.3 and NX15.3 modules

These components are not inserted automatically when an NCU is inserted, but must be integrated manually.

6.4.2 Insert NCU

Requirement

- A project is open in the TIA Portal.

Inserting the NCU

To insert a SINUMERIK NCU in the project view, proceed as follows:

1. Click "Add new device" in the project navigation.
2. Click the "Controllers" button.
3. In the folder structure under "Controller", open the corresponding SINUMERIK device family (e.g. SINUMERIK ONE) and the necessary NCU, and select them.

4. Select the firmware version that matches the envisaged firmware version of the real NCU in the "Version" drop-down list. In the example, V6.20.
5. Confirm your selection with "OK".

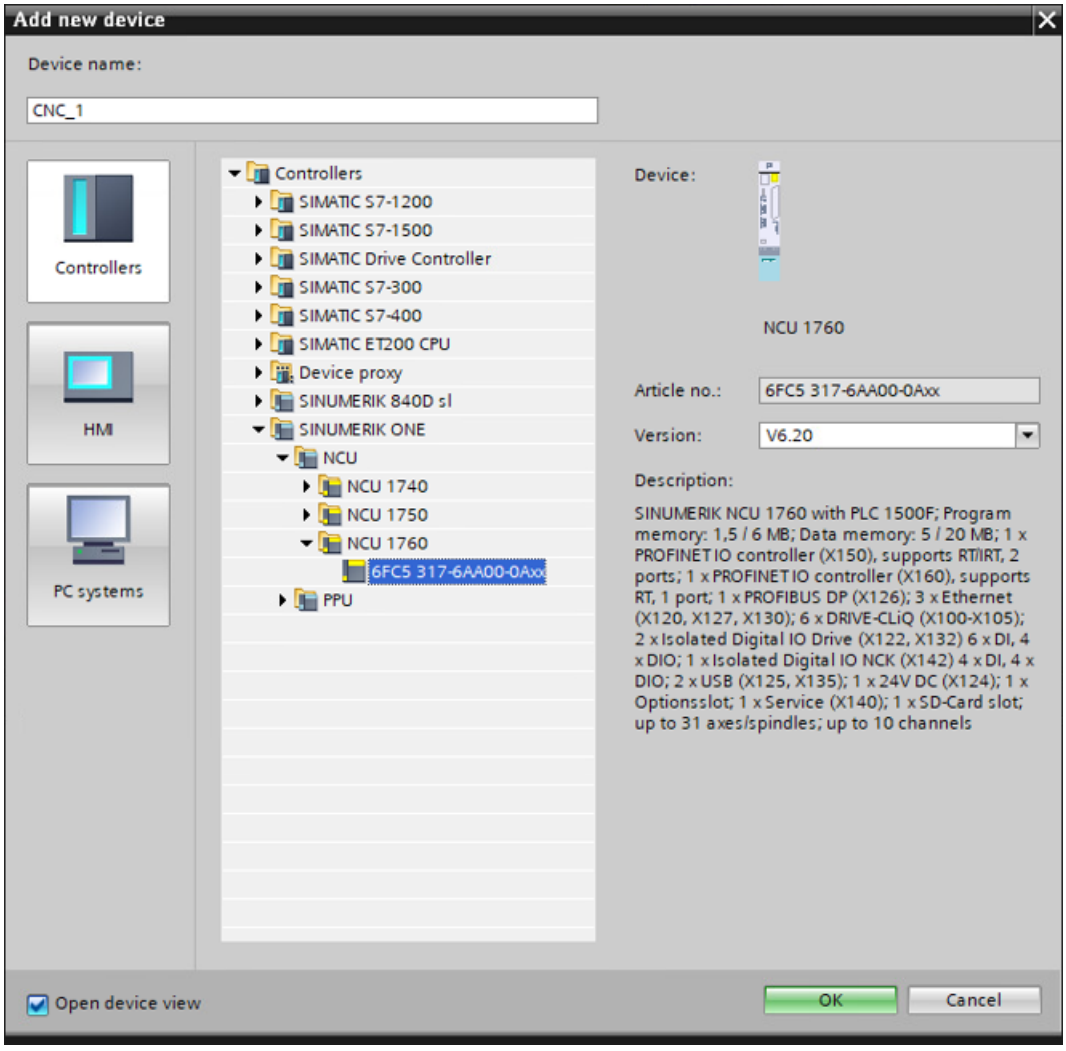


Figure 6-2 Inserting SINUMERIK NCU 1760

From version V6.20 (PLC version V2.9), after inserting the NCU, a wizards opens to configure the protection and security settings for the PLC and the communication.

Protection and PLC security (from V6.20)

For the first steps with the sample project in Create MyVirtual Machine you can deactivate the PLC security settings in the wizard that is displayed.

This is how you deactivate the PLC security settings

1. Deactivate the following settings and confirm using "Next".
   - Password to protect confidential PLC configuration data
   - Mode of the PG/PC and HMI communication
   - PLC access level
2. In the last step "Overview", confirm your settings with "Finish".

NOTICE
Activating protection and PLC security For security-relevant areas with high protection requirements, work with the default security settings and keep these active. After completing the sample project or completing the commissioning phase, activate all security settings to guarantee maximum protection against third-party access to project data and the CPU.

More information is provided in Section Protection and PLC security (Page 51).

Result

The SINUMERIK NCU is created as new device.

Up to 6 axes can be used as standard without any further additional components (NX10.3/ NX15.3). Only 5 axes and one spindle are used for the basic commissioning. No additional components are required.

6.4.3 Protection and PLC security

Introduction

When inserting an NCU or replacing an NCU module from version V6.20 (PLC firmware 2.9), a wizard opens for the PLC security settings to configure access protection for the PLC and the PG/ PC and HMI communication. The following settings are configured.

- Password to protect confidential PLC configuration data
- Access level password to protect the PLC against unauthorized access
- Mode of the PG/PC and HMI communication

Note

Secure password management

If you use password protection, you must secure the process for managing and handling passwords over the complete product lifecycle, so that when required, you always have access to the various passwords.

All settings in the wizard are transferred into the inspector window of the PLC property in area "Protection & Security", where they can be changed.

Password to protect confidential PLC configuration data

Confidential PLC configuration data are data such as private keys, which are required for the correct function of certificate-based protocols, for example. These configuration data are PLC-specific.

The password to protect confidential PLC configuration data is configured in the TIA Portal in PLC properties in area "Protection & Security > Protection of the PLC configuration data".

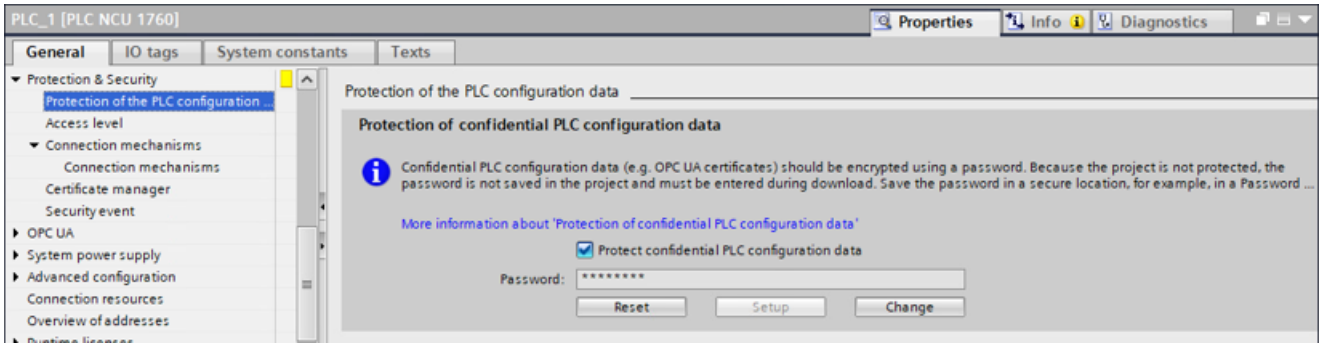


Figure 6-3 Protecting PLC configuration data

If the password in the TIA Portal for the project is set (possible from PLC Firmware 2.9), this password must also be saved in the internal PLC of the SINUMERIK. Otherwise, the PLC will no longer run up. The password is saved in the hardware, and is not contained in the project itself.

Note

If you have set a password on the hardware, you must first delete/adapt this if you wish to operate a project on this hardware without/with a different password.

You have the following options of setting the password in the NCU:

- Setting the password via the TIA Portal
  More information on this topic is provided in the TIA Portal help under "Protection of confidential configuration data".
- Setting the password via SINUMERIK Operate
  You can set the password in operating area "Commissioning" under "Security > PLC Security". The password is saved in the PLC.

Note

It is recommended that the password is set via SINUMERIK Operate.

The configured password is used in the TIA Portal to generate the key information to protect confidential configuration data and therefore protect this data. However, neither the password nor the key information is saved in the project for security reasons. In order that the key information reaches the PLC, it is newly generated when loading the hardware configuration, so that the password has to be entered once at this position.

Access level password to protect the PLC against unauthorized access

The PLCs have different access levels to restrict access to certain functions, such as hardware configuration, PLC project, safety and access via S7 communication and blocks.

The access levels of a PLC are configured in the TIA Portal in PLC properties in area "Protection & Security > Access level"

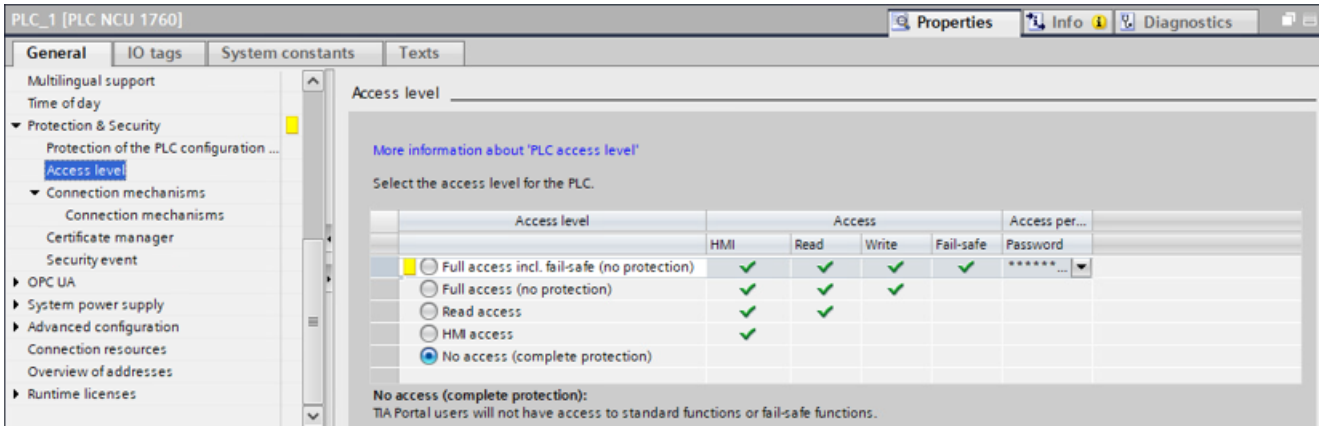


Figure 6-4 PLC access level, "No access (complete protection)" is configured

More information on this topic is provided in the TIA Portal help under "Parameterizing access levels".

From PLC firmware 2.9, the default setting for the access level is "No access (complete protection)". When using this setting, you can assign a password for every access level. This prevents anybody from downloading the PLC project or overwriting it without knowing the passwords. The password is still required to communicate with the PLC via S7 communication.

If you set an access level other than "Full access including fail-safe (no protection)", to function correctly, SINUMERIK Operate needs to know the password that you set in the line for "Full access including failsafe (no protection)" (see diagram above "Access level for the PLC").

Therefore, save the access level password for "Full access including fail-safe (no protection)" in SINUMERIK Operate under "Commissioning > Security > PLC Security > PLC access level password".

Note for reasons relating to product security (Safety), when the access level password is set, when restoring a PLC archive, the access level password must be manually entered.

Mode of the PG/PC and HMI communication

In addition to assigning a password to protect confidential PLC configuration data, you also have additional options to set how the CPU responds in operation. This includes how the CPU may communicate with the PG/PC and the HMI. If you select the connection mechanism for PG/HMI communication, in the same context you can select a PLC communication certificate to secure the connection or initiate that the TIA Portal generates a new connection. If you have assigned a password, or you have deactivated the option to protect confidential PLC configuration data (i.e. a password is not set), then in area "Protection & Security > Connection mechanisms", a certificate with the appropriate settings and a valid default name is preset.

Note

If you only allow safe PG/PC and HMI communication, the PLC software on the control inhibits communication with PG/PC/HMI that still do not support this communication.

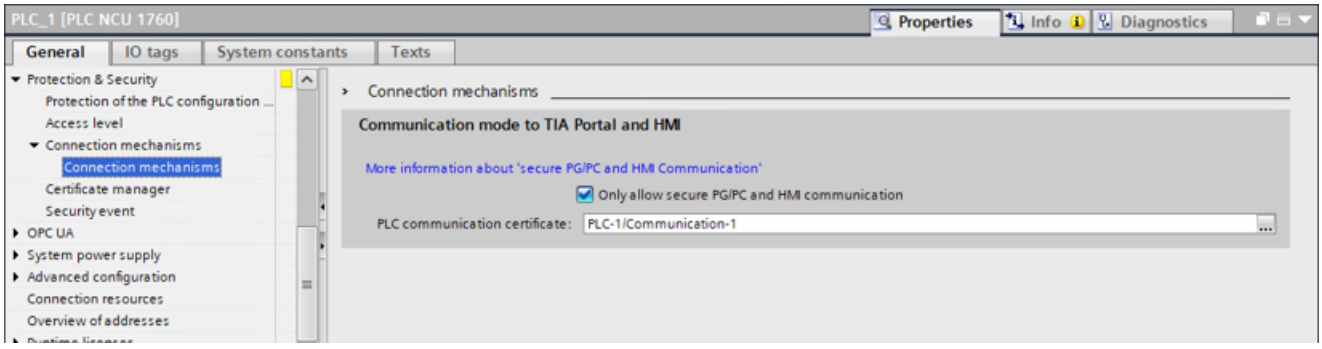


Figure 6-5 Mode of the PG/PC and HMI communication

More information on this topic is provided in the TIA Portal help under "Secure PG/HMI communication".

More information

More information about protection and security is provided in the following documentation.

- TIA Portal online help under "Secure PG/HMI -communication" and "Protection & Security"
- SINUMERIK Operate online help under "PLC security settings".

6.4.4 Default telegram configuration

After inserting the SINUMERIK ONE NCU, standard telegrams for 6 axes (DriveAxis0x telegrams), the Control Unit (DriveCU01 telegram) and the infeed (Infeed01 telegram) are created and preassigned default values. Accept the default settings for the project sample.

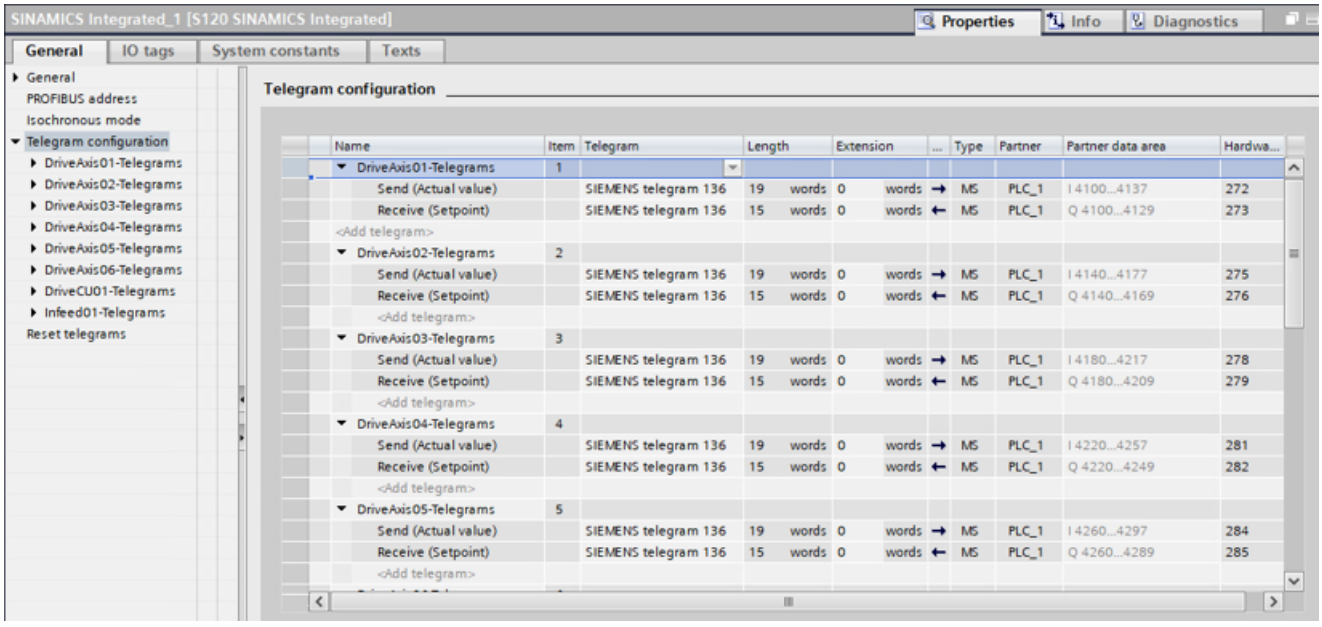


Figure 6-6 SINUMERIK ONE telegram configuration

6.4.5 Setting the IP address in the project

To load the project into Create MyVirtual Machine, you must use Create MyVirtual Machine to determine the IP address of the network adapter on the target computer. Use the IP of the computer on which Create MyVirtual Machine is installed as the IP address.

Requirement

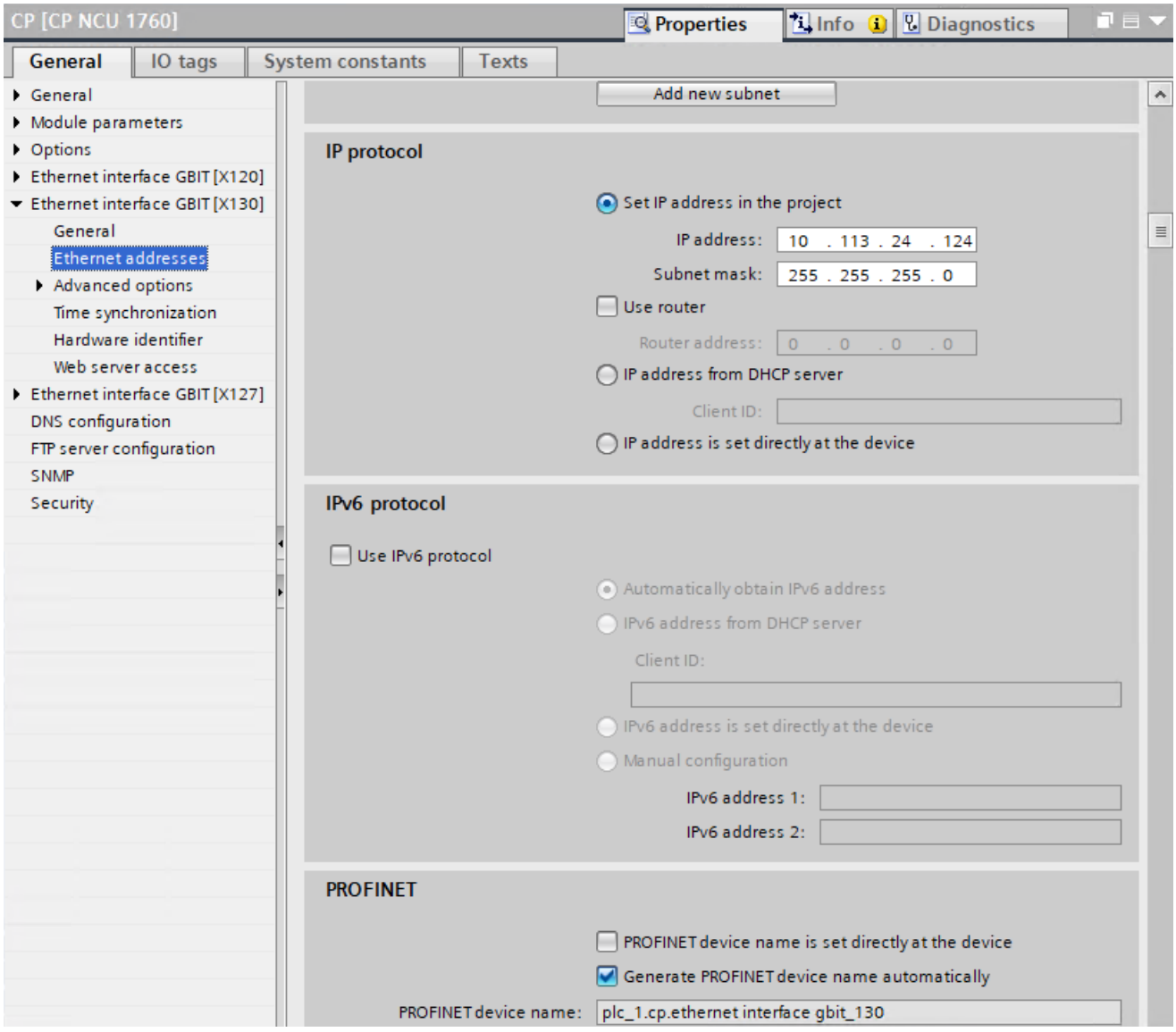
The network adapter through which the target computer (with Create MyVirtual Machine) is connected to the shared network must also be assigned to the S7ONLINE and SINUMERIK_CP1543 access points in the computer's communication settings. This allows the machine simulation to communicate via the shared network via the CP and the assigned network adapter.

More information can be found in the *SINUMERIK Virtual CNC SW Installation Instructions* in the "Configuring" section.

Procedure

To set the IP address of the CP in the project, proceed as follows:

1. Select the CP in the network view or device view. You can go online via one of the X120, X130 or X127 interfaces. X130 is used in the example.
2. Switch to "Properties > General > Ethernet interface [X130] > Ethernet addresses".
3. Enter the required configuration at "IP protocol > Set IP address in the project".



4. Deactivate the option "PROFINET > Allow adaptation of the PROFINET device name directly in the project". The automatically generated PROFINET name is used.

Enter the IP address during the download

You can also enter the IP address directly during the download. In this case, an IP address is not configured for the CP. If Create MyVirtual Machine and TIA Portal are installed on the same computer, enter either the IP address of the computer or use the virtual IP address of the local host (e.g. 127.0.0.1).

Note

IP address of the local host

You enter the IP address of the local host only during a download or when going online directly via the IP address. This IP address is not permitted in the configuration of an interface, and is rejected with an error message.

6.4.6 Activating the simulation-capability of blocks

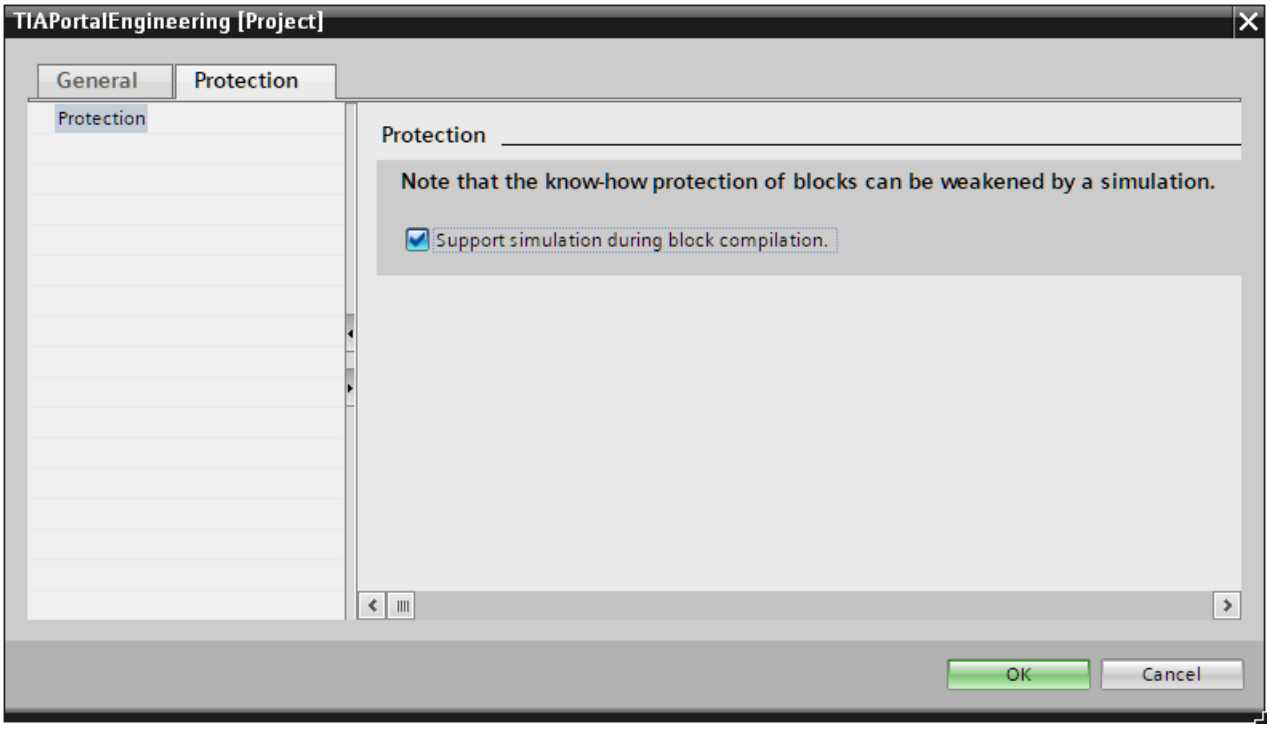
If you want to use a TIA Portal project in a simulated environment (Create MyVirtual Machine), you must activate the simulation capability in the project properties before you compile the project. This setting is deactivated by default because it can affect the know-how protection.

When loaded to the simulation, the blocks are checked to ensure that they can be simulated. In the case of an error, the following message is displayed: "'MyKhpBlock [FC30]' cannot be simulated. If the block originates from a library, then use a library that supports simulation. Otherwise, in the project properties, activate option "When compiling blocks that support simulation and recompile the block".

Procedure

To activate the simulation capability of blocks in a project, proceed as follows:

1. In the project tree, right-click the project and select the "Properties" command.
2. Activate the "Support the simulation-capability of blocks for compilation" option under the "Protection" tab. Confirm with "OK".



6.4.7 Activating the receiving of messages for PLC

To allow messages to be displayed after loading, you must initially set the receiving of messages for the PLC.

Procedure

To receive messages, follow these steps:

1. Double-click the "Online & Diagnostics" folder of the PLC in the project navigation.
2. Click the "Online accesses" group in the area navigation.
3. Select the "Receive messages" option.

Note

If you select this procedure, messages are only received after you have re-established an online connection to the device.

6.4.8 Compile hardware configuration

Procedure

To compile the configured hardware configuration, proceed as follows:

1. In the project tree, right-click "CNC_1" and select the "Hardware (changes only)" command in the "Compile" shortcut menu.
   The consistency of the hardware configuration is tested in the compilation process. Remedy any errors that may occur and compile the project again.

Result

The NCU including all integrated subcomponents (PLC, NCK, CP, HMI, SINAMICS Integrated) was compiled. In addition, all optional components connected to the NCU (e.g. NX) were also compiled.

6.4.9 Loading the hardware configuration into the PLC

Requirement

- The simulation-capability of blocks is activated (Page 57).
- TIA Portal and Create MyVirtual Machine are installed on the same PC system, or there is a network connection between them.
- The IP address at X130 of the CP is configured.
- The project or hardware configuration is compiled.
- Create MyVirtual Machine has started.
- The machine project is loaded or created, and the machine is started (Page 35):
  - Create MyVirtual Machine works with machine projects which are saved as "*.vcp files". All user data for a selected version of the virtual SINUMERIK CNC SW are stored in the machine projects. Before a TIA Portal project can be loaded into Create MyVirtual Machine, such a machine project must be opened and the machine simulation must be started. When an existing project is opened, it is overwritten during the course of the procedure described below. A new machine project is saved in a new "*.vcp file".
  - After opening a machine project, the machine simulation has to be started by clicking the button  in the simulation control.

Note

General reset before loading into a PLC with Safety Integrated (F-PLC)

If the actual hardware has been operated in Safety Integrated (F-PLC) mode and you now want to load a configured hardware configuration with changed Safety Integrated mode, you must perform a general reset of the PLC prior to loading.

Note

CNC SW and TIA Portal project version

Before downloading, check the version of the TIA Portal project and CNC SW. The versions must be compatible, e.g. CNC SW V6.20 and SINUMERIK ONE STEP 7 Toolbox V17 Update 10 with hardware and basic PLC program V6.20.

As of version CNC SW 6.13 and SINUMERIK ONE STEP 7 Toolbox V16, cross-version compatibility between CNC software and TIA Portal projects or DSF archives is guaranteed. Existing TIA Portal projects or DSF archives can also be loaded or read into an NCU with newer CNC SW versions.

Examples:

- An existing TIA Portal project with older configuration can be loaded into an NCU with a newer CNC SW version.
- Existing DSF backup/setup archive, created with an older CNC SW version, can be read into an NCU with newer CNC SW.

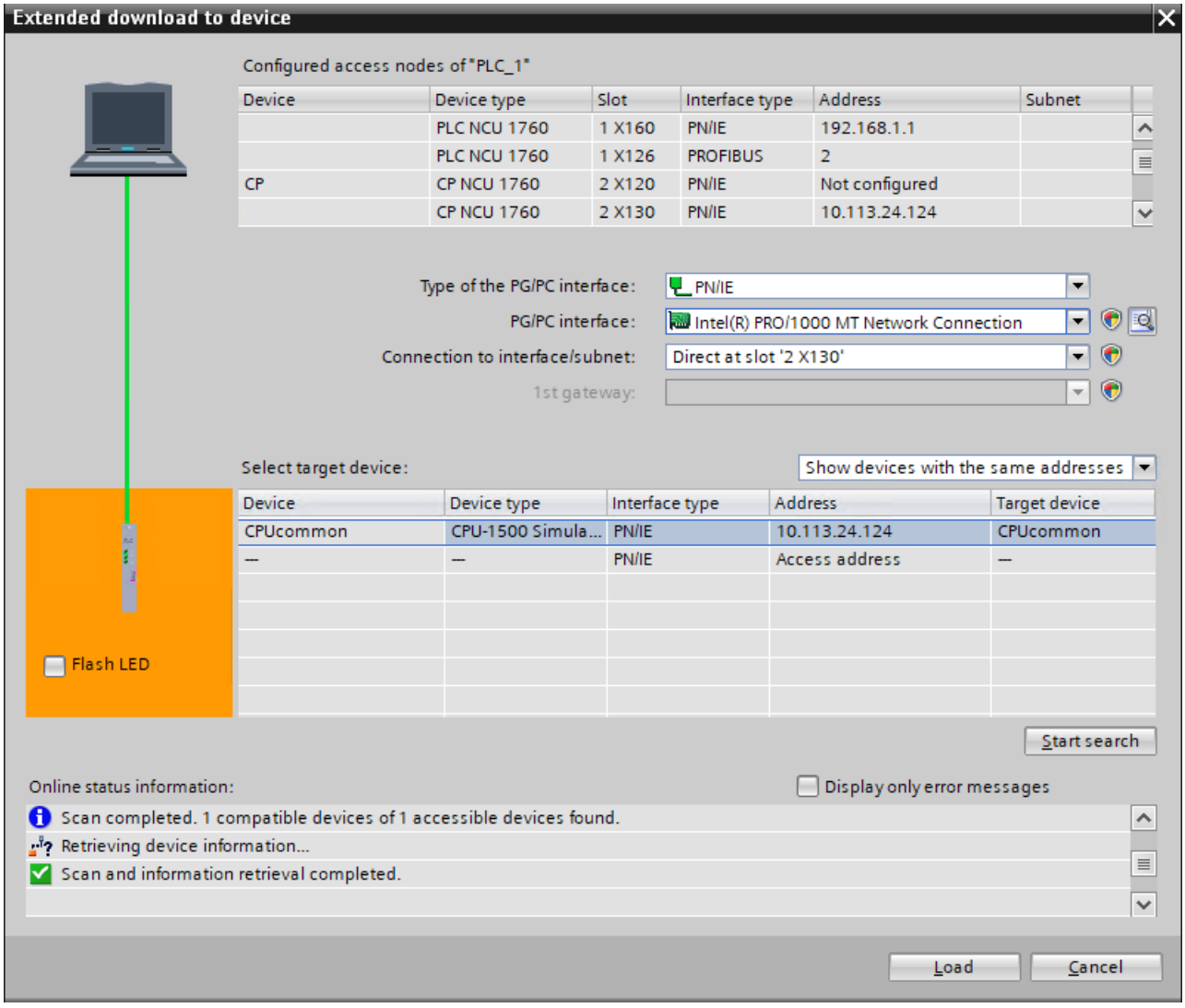
Procedure

To load the hardware and software configurations into the virtual SINUMERIK, proceed as follows:

1. In the project navigator, right-click the NCU, and select the command "Load to device > Hardware configuration".
2. Make the following settings in the "Extended load" dialog:
   - PG/PC interface type: PN/IE
   - PG/PC interface: Deployed network card, e.g. "Intel (R) PRO/1000 MT Network Connection"
   - Connection with interface/subnet: Directly at slot '2 X130'
   - Select target device: "Display devices with the same addresses".

   Alternatively, you can enter an IP address directly in the list "Compatible nodes in the target subnet" in the "Address" column and press the ENTER button. The search starts immediately, "Start search" does not need to be clicked.
   In this case an IP address does not have to be configured for the CP.

3. Click "Start search".
   A search is made for the target devices, and they are displayed in the dialog.



4. Select the appropriate target device, e.g. based on the IP address, and confirm with "Load".
   The "Load preview" dialog opens.
5. Check the information in the "Load preview" dialog and confirm with "Load".
6. In the "Results of the load procedure" dialog, select whether the PLC should be restarted, and then confirm with "Complete".

Note

At this time, the PLC cannot yet be started because a basic PLC program has not yet been loaded.

If an incompatible device is detected when connecting, the "Communication setting" on the target computer must be checked with Create MyVirtual Machine. (Under LLDP/DCP, uncheck the DCP checkbox for the network adapter used).

6.5 Creating a PLC program

6.5.1 Structure of the PLC program

The PLC program of a SINUMERIK ONE is modular and comprises the following parts:

- Organization blocks (OB)
  The SINUMERIK PLC basic program must be opened and initialized in the respective organization blocks (OB) of the PLC program. You also call your PLC user program in these organization blocks.
  See: PLC program execution structure (Page 62)
- Basic PLC 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.
  See: Inserting basic program blocks (Page 69)
- PLC user program
  The PLC user program is the user-specific part of the PLC program by which the PLC basic program has been augmented or extended.
- Safety program of the F-PLC (optional)
  When the SINUMERIK Safety Integrated (F-PLC) mode is used, you supplement the PLC program with a safety program.
  See: Configuring SINUMERIK Safety (Page 127)
  Further information can also be found in the *Safety Integrated Commissioning Manual* (https://support.industry.siemens.com/cs/ww/en/view/109768483).

6.5.2 Sequence structure of the PLC program

Overview

The SINUMERIK ONE PLC basic program comprises various function blocks (FB), functions (FC) and data blocks (DB). These blocks are called by various parts of the PLC program and organize the exchange of signals and data between the PLC user program and the NCK, HMI, and machine control panel components. From a chronological viewpoint, the main part of the PLC basic program runs ahead of the PLC user program, but must partly be called via the same organization blocks.

The following figure and associated description illustrate the structure of the PLC program:

Note

Information on the PLC basic program blocks required in the project

The following description does not list all PLC basic program blocks individually that are required for an executable project. This kind of information or which dependencies exist between the individual PLC basic program blocks is available in the overview tables of the PLC basic program reference.

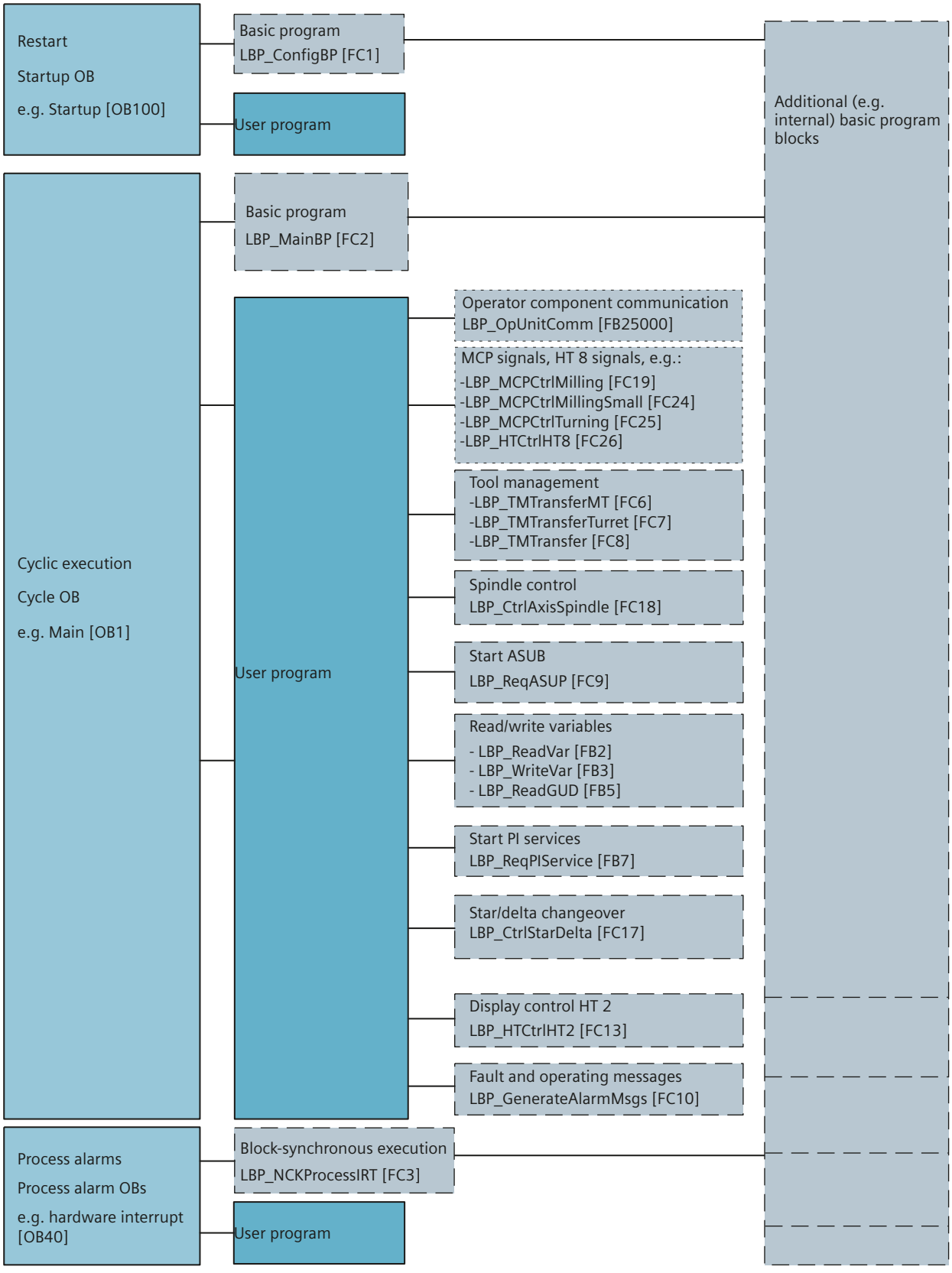

Restart
Startup OB
e.g. Startup [OB100]
Basic program
LBP_ConfigBP [FC1]
User program
Cyclic execution
Cycle OB
e.g. Main [OB1]
Basic program
LBP_MainBP [FC2]
User program
Operator component communication
LBP_OpUnitComm [FB25000]
MCP signals, HT 8 signals, e.g.:
-LBP_MCPCtrlMilling [FC19]
-LBP_MCPCtrlMillingSmall [FC24]
-LBP_MCPCtrlTurning [FC25]
-LBP_HTCtrlHT8 [FC26]
Tool management
-LBP_TMTransferMT [FC6]
-LBP_TMTransferTurret [FC7]
-LBP_TMTransfer [FC8]
Spindle control
LBP_CtrlAxisSpindle [FC18]
Start ASUB
LBP_ReqASUP [FC9]
Read/write variables
- LBP_ReadVar [FB2]
- LBP_WriteVar [FB3]
- LBP_ReadGUD [FB5]
Start PI services
LBP_ReqPIService [FB7]
Star/delta changeover
LBP_CtrlStarDelta [FC17]
Display control HT 2
LBP_HTCtrlHT2 [FC13]
Fault and operating messages
LBP_GenerateAlarmMsgs [FC10]
Process alarms
Process alarm OBs
e.g. hardware interrupt [OB40]
Block-synchronous execution
LBP_NCKProcessIRT [FC3]
User program
Additional (e.g. internal) basic program blocks

Figure 6-7 Structure of the PLC program (SINUMERIK ONE)

The PLC always starts up in RESTART mode, i.e. the PLC operating system runs the block **Startup [OB100]**after initialization:

- In Startup [OB100], call **LBP_ConfigBP [FC1]**, which configures and initializes the PLC basic program.
  - LBP_ConfigBP [FC1] calls further PLC basic program blocks internally.
- In addition, you need to insert the respective calls for your **PLC user program** in Startup [OB100].

Once Startup [OB100] has run, the PLC commences cyclic mode at the beginning of **Main [OB1]**:

- In cyclic mode, the PLC basic program is called with **LBP_MainBP [FC2]** in Main [OB1]. Complete processing of the NCK-PLC interface is carried out. A cyclic monitoring function is activated between PLC and NCK once boot-up and the first OB cycle have been completed. LBP_MainBP [FC2] calls further PLC basic program blocks internally.
- In addition, you need to insert the respective calls for your **PLC user program** in Main [OB1].
  - To facilitate communication with the various operator components, for the real SINUMERIK ONE, first call block "LBP_OpUnitComm [FB25000]". This means that actual operator component data is available for subsequent program parts.
  - You configure the transfer of machine control panel signals (for example, MCP or HT8) in this part of your user program and call the required basic program block, for example **LBP_MCPCtrlMilling [FC19]**.
  - From the PLC user program, you can call various PLC basic program blocks yourself at any point, e.g. to start ASUB or PI services or for tool management.
- Configure the **LBP_GenerateAlarmMsgs [FC10]** so that the alarms that occur are entered in the alarm buffer of the PLC.

If a hardware interrupt is triggered during runtime due to a configured hardware event, cyclic program processing is interrupted and the corresponding hardware interrupt OB is triggered.

- If a command that requires a synchronous reaction in the PLC program is processed during runtime in an NC part program, this reaction is executed in the part of the basic program that is synchronous with the block (LBP_NCKProcessIRT [FC3]). You configure the signal exchange and the hardware interrupt required for it in the NCK properties and you call the **LBP_NCKProcessIRT [FC3]** in the corresponding hardware interrupt OB, e.g. in **Hardware Interrupt [OB40]**. LBP_NCKProcessIRT [FC3] calls further PLC basic program blocks internally.
- In addition, you insert the respective calls for your **PLC user program** in this and/or in different hardware interrupt OBs and define the associated events in the properties of the corresponding device or module.

A PLC failure produces the "2000 Sign-of-life monitoring PLC" alarm in SINUMERIK Operate. No return is made to the interruption point (for example, in the event of a power failure). Some data of the PLC basic program is stored in a retentive memory area.

6.5.3 Relevant organization blocks

In the following, you will find a list of all of the organization blocks from which the SINUMERIK PLC basic program must be opened.

See also: PLC program execution structure (Page 62)

The organization blocks are not available as a copy template in the system library because you can also insert calls of your user program in the OBs.

Instead, add these organization blocks yourself and insert call and initialization of the basic program at the beginning of each OB (Page 72).

Table 6-1 Organization blocks of the SINUMERIK PLC basic program

Name (default setting)	**Address (default setting)**	**Description**	**PLC basic program block to be called**
Main	OB1	Cycle OBs are higher-level logic blocks in the program which are cyclically processed and in which you can program instructions or call additional blocks. See also: STEP 7 help on the topic Cycle OB.	LBP_MainBP [FC2]
Startup	OB100	Startup OBs are processed once when the mode of the CPU switches from STOP to RUN. After execution of the startup OB, the execution of the cycle OB is started. See also: STEP 7 help on the topic Startup OB.	LBP_ConfigBP [FC1]
Hardware interrupt	OB40	Hardware interrupt OBs interrupt the cyclic program processing due to a hardware event. You define the event in the hardware properties. See also: STEP 7 help on the topic Hardware Interrupt OB.	LBP_NCKProcessIRT [FC3]

6.5.4 Opening the system library

Procedure

Proceed as follows to open and display the system library of the SINUMERIK PLC basic program:

1. Switch to the task card "Libraries" and open the library "SINUMERIK ONE PLC Basic Program V6.20".

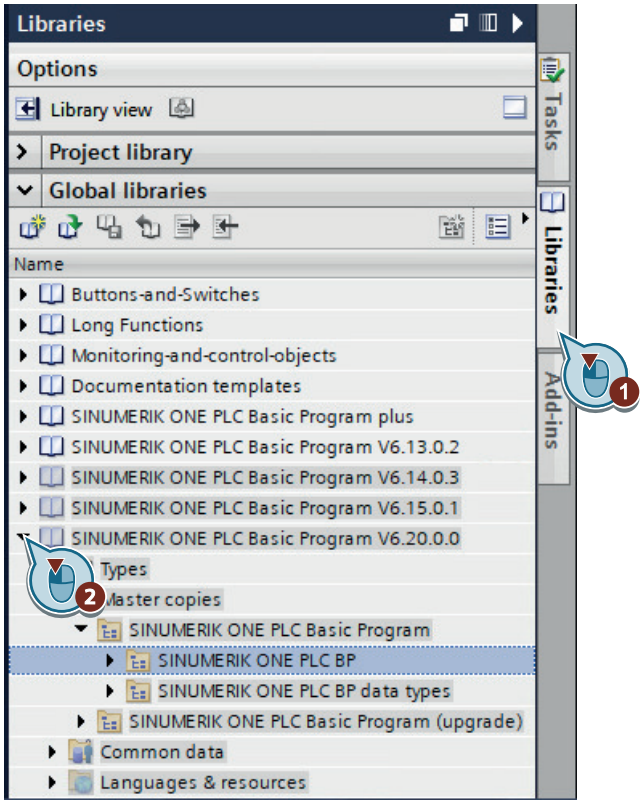


Figure 6-8 Opening the PLC basic program library

Result

The library is opened. In the subfolders, you will find the components of the PLC basic program structured in the following way:

Lower-level folders	Purpose	Contents
Copy templates > SINUMERIK ONE PLC Basic Program > SINUMERIK ONE PLC BP	Use this "Copy templates" folder when you insert a new SINUMERIK ONE.	Contains all of the blocks that are needed for the maximum configuration (31 axes, 10 channels) of a SINUMERIK ONE. The individual blocks are sorted into the subfolders "DB", "FB", "FC" and "Internal".
Copy templates > SINUMERIK ONE PLC Basic Program (upgrade) > SINUMERIK ONE PLC BP	Use this copy template folder when you upgrade or migrate from an older version of the PLC basic program.	Contains all of the know-how-protected blocks that are needed for the maximum configuration (31 axes, 10 channels) of a SINUMERIK ONE. Blocks that are supplemented with user-specific adaptations are not included. The individual blocks are sorted into the subfolders "DB", "FB", "FC" and "Internal".
Copy templates > SINUMERIK ONE PLC Basic Program > SINUMERIK ONE PLC BP data types	The content of this copy template folder is used by the PLC basic program and must be copied into the PLC data types folder.	Contains all PLC data types (UDT) that are used by the basic PLC program.

You can copy these block copy templates and PLC data types copy templates directly or together with the folder structure into your project.

6.5.5 Inserting PLC data types

The PLC interface data blocks of the basic program make it possible to access various interfaces and data from the PLC program (axes/spindles, channels, mode groups, alarms/messages, tool management, PLC/HMI, MCP/HT).

PLC data types (UDT), which define the content of the data blocks, are available in the system library of the SINUMERIK ONE PLC basic program. Copy these PLC data types into your project.

Procedure

Proceed as follows to copy the PLC data types into your project:

1. Switch to task card "Libraries" and open system library "SINUMERIK ONE PLC Basic Program V6.x"
2. Drag and drop the folder "Master copies > SINUMERIK ONE PLC Basic Program > SINUMERIK ONE PLC BP data types" into the folder PLC data types of your project (e.g. under "CNC_1 > PLC_1 > PLC data types").

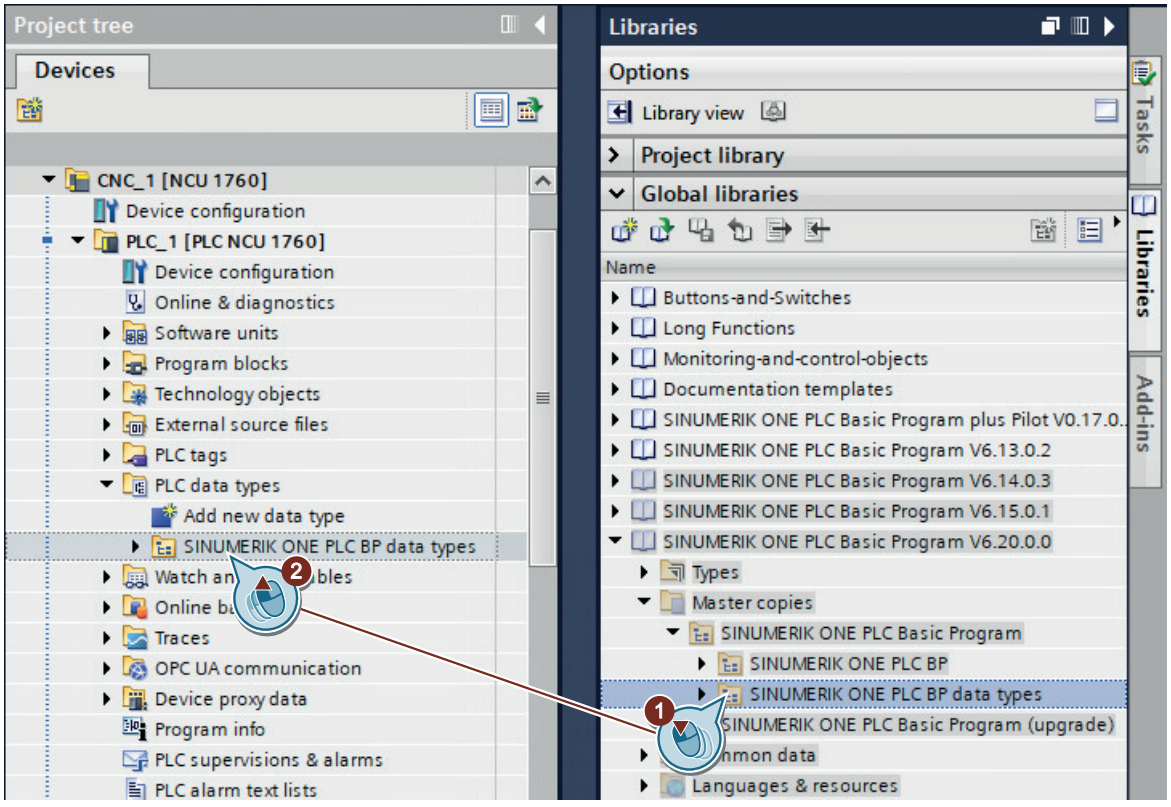


Figure 6-9 Inserting PLC data types using SINUMERIK ONE PLC Basic Program V6.x as example

Result

The data types were copied into your project and assigned to the corresponding blocks of the PLC basic program.

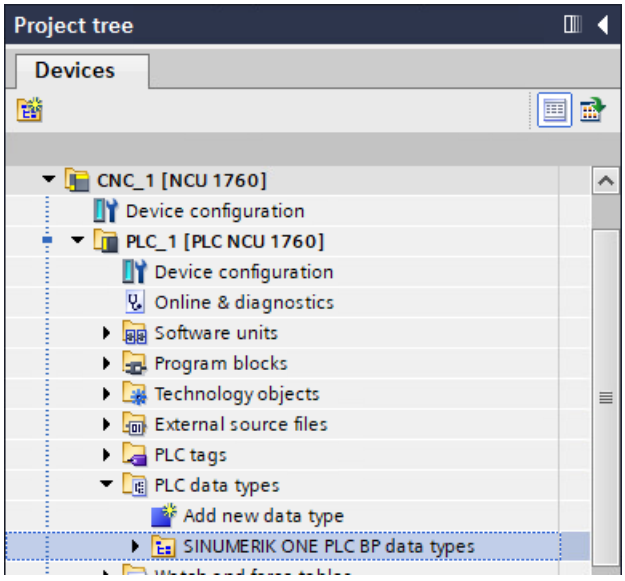


Figure 6-10 Data types folder

Note

Deleting unused data types

Check the "PLC data types" folder, if applicable, for data types that are not used by the blocks. By inserting the SINUMERIK ONE PLC data types, for example, no (obsolete) data types of the SINUMERIK 840D sl are overwritten, since they have different names.

6.5.6 Inserting PLC basic program blocks

Requirement

- An NCU 17x0 is added.
- The data types of the PLC basic program blocks are inserted.

Procedure

To copy program blocks of the basic program from a master copy to the program blocks folder of the project tree, proceed as follows:

1. Switch to the task card "Libraries" and open the system library "SINUMERIK ONE PLC Basic Program V6.x"
2. You have several options for copying the PLC basic program blocks to your project:
   – Drag and drop the corresponding folder "SINUMERIK ONE PLC BP" into the folder Program blocks, e.g. under "CNC_1 > PLC_1 > Program blocks".

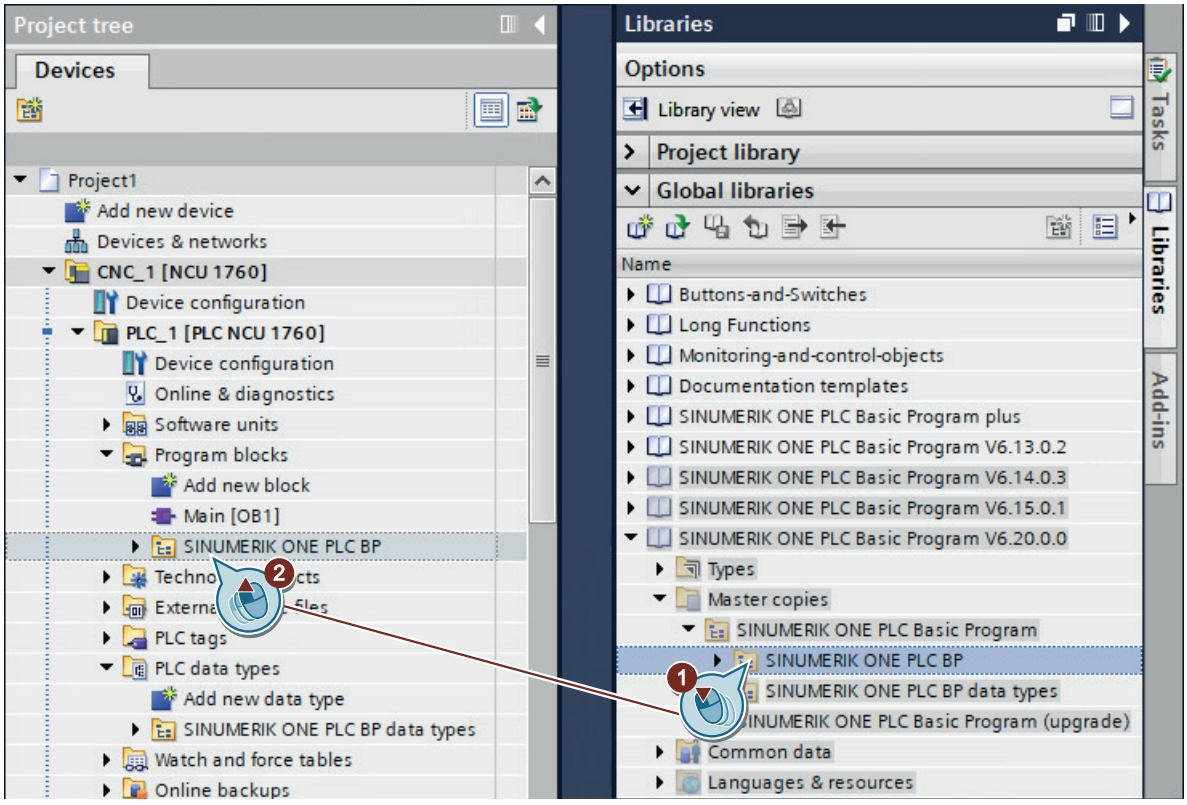


Figure 6-11 Adding the PLC basic program

Note

Copying this folder changes the user-defined folder structure

Copying the "SINUMERIK ONE PLC BP" folder automatically creates new groups (subfolders) in your "Program Blocks" folder and moves the existing blocks there.

If you have already organized the PLC basic program into separate groups and would like to keep this structure, copy the individual block copy templates from the lower-level folders instead.

– Open the copy templates folder and, if applicable, other lower-level folders and manually define the blocks which you would like to copy by selecting them and then dragging and dropping them into the program blocks folder.
To select successive objects, click on the first object, press and hold the Shift key and then click on the last object.
To select non-successive objects, press and hold the Ctrl key and click on the objects one-by-one.

The blocks are copied to your project. A check is made for duplicate block names and, if applicable, the "Conflicts during copying" dialog is displayed.

3. In the project tree, right-click "Program blocks" and select the "Software (compile all blocks)" command in the "Compile" shortcut menu.
The PLC program is compiled and a check is made for duplicate block addresses.

Result

The blocks of the SINUMERIK PLC basic program have been copied to your project. Any folder structure of the copy template was imported.

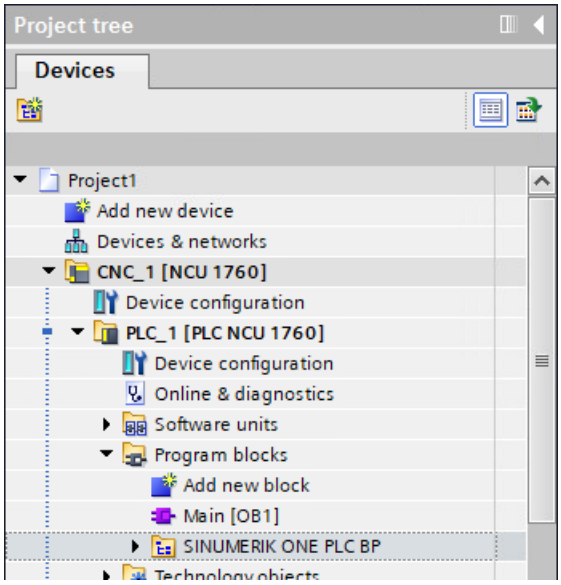


Figure 6-12 Program blocks folder

Now you can check the copied blocks and, if applicable, manually delete the PLC basic program blocks that you do not require (e.g. unused axis DB, channel DB, FB or FC).
If you have unused blocks in your project, some tasks take unnecessarily long, e.g. the loading or the creation and import of SINUMERIK archives.

6.5.7 Edit blocks

The individual blocks of the PLC basic program or the user program can be edited directly in the TIA Portal Portal using the STEP 7 editors.

Information about these functions and editors is available in the higher-level help "Programming the PLC" and in the STEP 7 Professional System Manual.

6.5.8 Inserting program code for calling the basic program

Because the organization blocks of the PLC program must contain both calls of the SINUMERIK PLC basic program and calls of your PLC user program, these organization blocks are not available as master copies in the system library.

See also: Sequence structure of the PLC program (Page 62)

Instead, add these organizational blocks yourself and then insert the calls of the SINUMERIK PLC basic program.

For example, you can type these calls directly in the editor, copy them from a program example (SCL) and paste them into the editor, or create them with drag and drop as described below.

Requirement

- The respective organization block is added.

  Note

  Selecting the programming language for Main [OB1]

  A newly added NCU already contains Main [OB1] in the LAD programming language. You can change the programming language to FBD in the block properties or delete the existing block and add it back again as an STL or SCL block.

- The basic SINUMERIK PLC program blocks that are to be called from the respective organization block are added in the "Program blocks" folder of the project tree.

Procedure

To insert the program code for calling the SINUMERIK PLC basic program with drag and drop, proceed as follows:

1. In the project tree, double-click the relevant organization block, e.g. "CNC_1 > PLC_1 > Program blocks > OB > Startup [OB100]".
   The organization block is opened.
2. Drag the basic program block to be called from the program blocks folder and drop it in Network 1 of the relevant organization block.
   - The startup OB, e.g. Startup [OB100], must include the call of LBP_ConfigBP [FC1] in network 1.

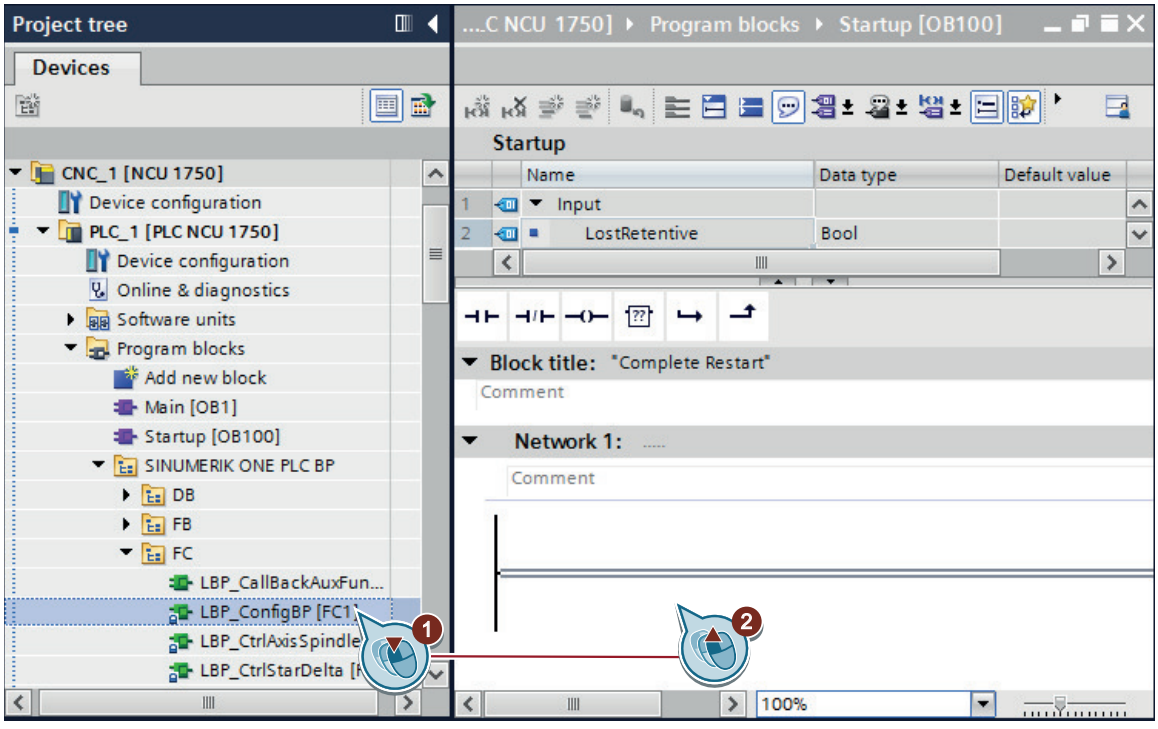


Figure 6-13 Inserting basic PLC program call (example of LBP_ConfigBP [FC1] in Startup [OB100] in LAD programming language)

   - The cycle OB, e.g. Main [OB1], must include the call of LBP_MainBP [FC2] in network 1.
   - The hardware interrupt OB, e.g. Hardware interrupt [OB40], must include the call of LBP_NCKProcessIRT [FC3] in network 1.

Result

The calls of the SINUMERIK PLC basic program have been added. For the hardware interrupt OB or the call of LBP_NCKProcessIRT [FC3], the event-driven signal exchange NCK to PLC (Page 74) must be configured in addition.

6.5.9 Defining NCK hardware interrupt event

If a hardware interrupt is triggered by a module during runtime, the hardware interrupt OB defined in the associated event is tripped or entered in the queue according to its priority.

The hardware interrupt mechanism is also used by the event-driven signal exchange (NCK to PLC) to make NCK signals accessible in the PLC program. You must activate the event-driven signal exchange in the NCK properties. The hardware interrupt OB to be assigned should be used exclusively for this event, and only contain the call of LBP_NCKProcessIRT [FC3].

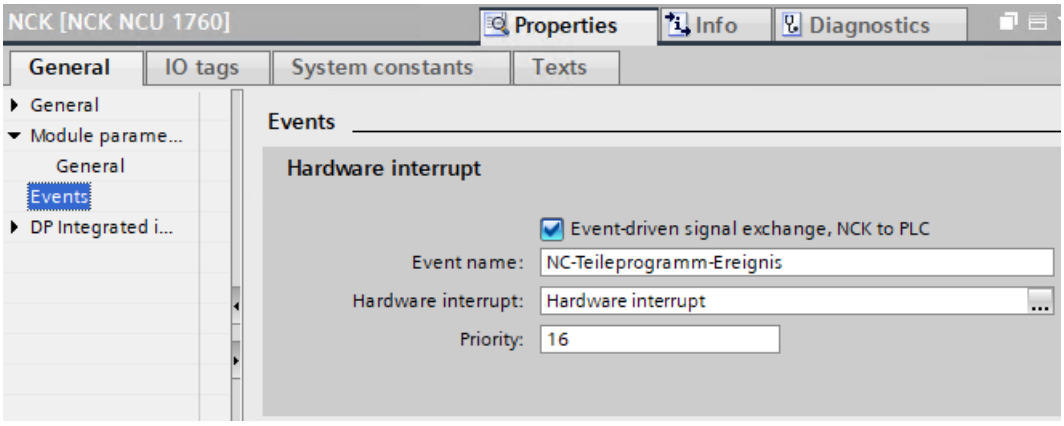
Requirement

- An NCU 17x0 is added.

Procedure

Proceed as follows to configure process alarms in the properties of the NCK:

1. Click on the NCK in the network view or device view.
2. In the "Properties" inspector window, select the "Events" entry.
   The hardware interrupt settings are displayed. The event-controlled signal exchange from the NCK to the PLC is activated by default.



3. Make the following settings:

Setting	Purpose
Event name	Name for identification of the event, for example, in the list of the start events of assigned hardware interrupt OBs and the system constants. A language-neutral event name is set as default. You can change the event name as necessary and select a language-neutral name, for example.
Hardware interrupt	Select an existing hardware interrupt OB from the list and confirm with the check mark button or click on "Add" to add a new block and assign it to the event.
Priority	Define the priority of this event in relation to other hardware interrupt OBs or the priority in the queue. The valid value range of the priority can be found in the tooltip. **The following applies:** • Small numerical value → low priority (e.g. 2) • Large numerical value → high priority (e.g. 26)

Result

The properties of the NCK process alarm events have been specified and may have been assigned to a process alarm OB. The event is also listed in the properties of the selected hardware interrupt OB under "Start events". A corresponding system constant was added.

For the NCK signals to be processed in the PLC basic program, you must call LBP_NCKProcessIRT [FC3] in the hardware interrupt OB (e.g. hardware interrupt [OB40]) next.

6.5.10 Retentivity behavior of the PLC basic program

The following data of the PLC basic program data is stored in a retentive memory area to avoid data loss in the event of a voltage failure.

Name	Block address/number:
LBP_AlarmMsgs	DB2
LBP_ParamAlarmMsgs	DB5
LBP_ConfigData	DB7
LBP_InternalDB8	DB8
LBP_NC	DB10
LBP_ModeGroup	DB11
LBP_HMI	DB19
LBP_Chan1 ... LBP_Chan10	DB21 ... DB30
LBP_Axis1 ... LBP_Axis31	DB31 ... DB61
LBP_TMLoad	DB71
LBP_TMSpindle	DB72
LBP_TMTurret	DB73
LBP_MFuncDecListConfig	DB75
LBP_PowerrideConfig	DB78
LBP_CtrlEnergy	DB1000
LBP_SentronPac	DB1001
LBP_SpindleTempSensor	DB1002
LBP_TMLoadMT	DB1071
LBP_TMSpindleMT	DB1072
LBP_TMTurretMT	DB1073

6.5.11 Compiling software and loading it into the PLC

Requirement

- Create MyVirtual Machine has started with a loaded hardware configuration.
- The machine project is in simulation mode.

Procedure

To load the software configuration from the TIA Portal in the virtual SINUMERIK, proceed as follows:

1. In the project navigator, right-click "NCU", then select "Compile > Hardware and software (changes only)" from the shortcut menu.
2. In the project navigator, right-click the "NCU" and select the command "Load to device > Software (all)".

3. Execute the individual steps of the download as described in the section Loading the hardware configuration into the PLC (Page 59).
4. Select "Start PLC" explicitly in the "Results of the load procedure" dialog when downloading the project.
5. Confirm with "Finish".
6. Switch to Create MyVirtual Machine.
7. Exit the machine and save the machine project.
8. Then restart the machine. The downloaded project data are now active.

6.6 PLC sample program

6.6.1 Overview

The fundamental content of the basic PLC program and PLC user program are explained briefly using a sample machine. The sample machine has five axes, one spindle, and is technology-independent. The program examples are used to show a possible PLC programming procedure.

After downloading the PLC project into the control, you can traverse the axes of the machine with the control panel.

Description of the necessary PLC programs

The sample programs are created in LAD. Alternatively, you can create the programs in FBD or SCL.

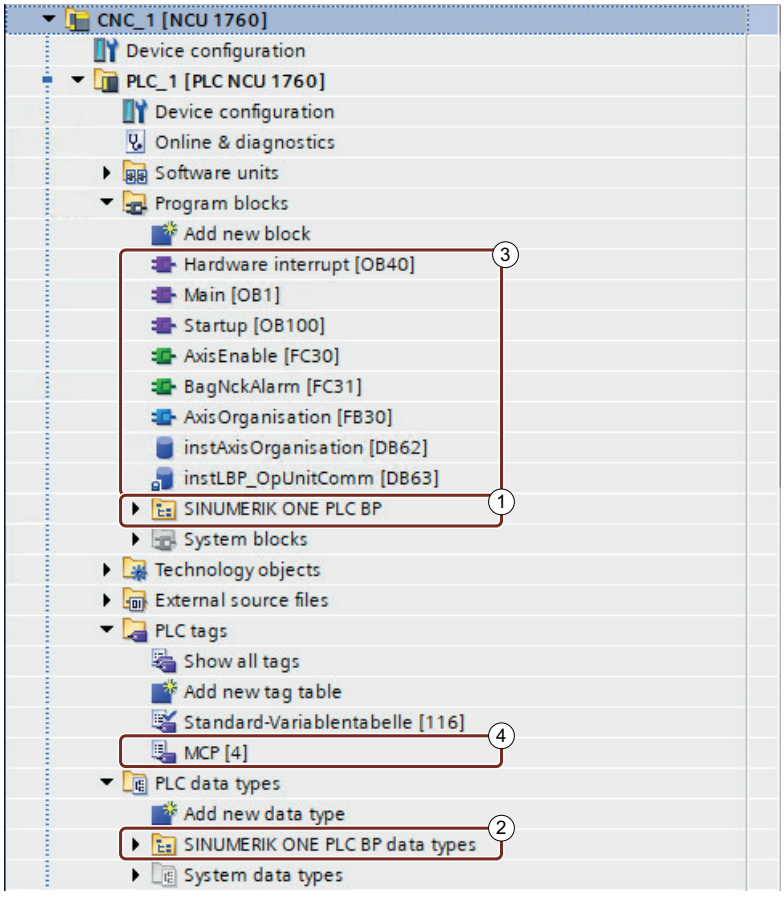


Figure 6-14 Sample PLC programs SINUMERIK in the TIA Portal

Necessary elements	Description
SINUMERIK Toolbox library	
Basic PLC program ①	SINUMERIK basic PLC program inserted from library
PLC data types ②	SINUMERIK PLC data types inserted from library

Necessary elements	Description
Program blocks ③	
Hardware interrupt [OB40]	Reaction to hardware interrupts Calls: • LBP_NCKProcessIRT [FC3]
Main [OB1]	Main OB for cyclic mode Calls: • LBP_MainBP [FC2] • LBP_MCPCtrlMilling [FC19] machine control panel • LBP_OpUnitComm [FB25000] activation real machine control panel (**real** machine only) • LBP_Handwheels [FC25002] handheld unit (if present, **real** machine only) • User FB: AxisOrganisation [FB30] set axis enables • User FC: BagNckAlarm [FC31] emergency stop • LBP_GenerateAlarmMsgs [FC10] alarm handling
Startup [OB100]	Configuring and initializing the basic program Configuring the addresses, inputs and outputs of the machine control panel Calls: • LBP_ConfigBP [FC1] basic program
AxisEnable [FC30]	Set enables of each axis for override, pulse control, closed-loop controller and position measuring system
BagNckAlarm [FC31]	Programming the function of the emergency stop
AxisOrganisation [FB30]	Activate axes 1 to 6 and enable override Calls: • AxisEnable [FC30]
instAxisOrganisation [DB62]	Instance data block for axis enables
instLBP_opUnitComm [DB63]	Instance data block for real machine control panel
Variable table	
MCP ④	Variable table with data types for machine control panel (MCP) and emergency stop.

6.6.2 Individual steps for basic PLC commissioning

The PLC programs for the virtual and real machines are identical except for the connection to the machine control panel. For the real machine, you also have to call LBP_OpUnitComm [FB25000] in the main OB. The PLC program is also executable on the virtual machine with LBP_OpUnitComm [FB25000], only an error message is displayed.

How to program the PLC

1. Insert the basic PLC program and the PLC data types from the library into the project.
2. Create a variable table, e.g. "MCP", and insert the data types.
3. Create an organization block "Startup [OB100]" and insert the function call.
4. Create an organization block "Hardware interrupt [OB40]" and insert the function call.

5. Create a function, e.g. "AxisEnable", and program the enables.
6. Create a function block, e.g. "AxisOrganisation", and insert the "AxisEnable" function call for each axis enable.
7. Create a function "BagNckAlarm" in which you program the reaction to the tripping of the emergency stop.
8. Open the automatically generated organization block "Main [OB1]" and insert the function and function block calls.
9. In the shortcut menu of the PLC, select "Compile > Software (changes only)".

See also

Creating a variable table for MCP (Page 80)

Startup [OB100] (Page 81)

Hardware Interrupt [OB40] (Page 83)

AxisEnable [FC30] (Page 84)

AxisOrganisation [FB30] (Page 87)

BagNckAlarm [FC31] (Page 89)

Main [OB1] (Page 91)

6.6.3 Creating a variable table for MCP

To allow the symbolic programming of the machine control panel (MCP), create a variable table, and paste the basic program data types for the MCP into it. You then program the symbolic names of the data types in the PLC program.

Variable table with data types LBP_typeMcp483Milling

1. Create a new variable table, e.g. "MCP", in the "PLC variables" folder in the project navigator.
2. With drag & drop, move the basic PLC program data types "LBP_typeMcp483MillingInput" and "LBP_typeMcp483MillingOutput" from the "PLC data types > ONE PLC BP data types" folder into the open variable table.

3. Enter a "Name" and the "Address" 0.0.

Note

The address ranges of the machine control panel relate to the virtual machine. The address ranges on the real machine must be adapted to correspond to the existing configuration.

Name	Basic PLC program data type	Address
MCPIn	"LBP_typeMcp483MillingInput"	%I0.0
MCPOut	"LBP_typeMcp483MillingOut-put"	%Q0.0

4. Create the variables "EStop" and "EStopLED" and enter the "Data type" and the "Address". These are used for the emergency stop button.

Name	Data type	Address
EStop	Bool	%I9.0
EStopLED	Bool	%Q19.0 (for virtual machine)

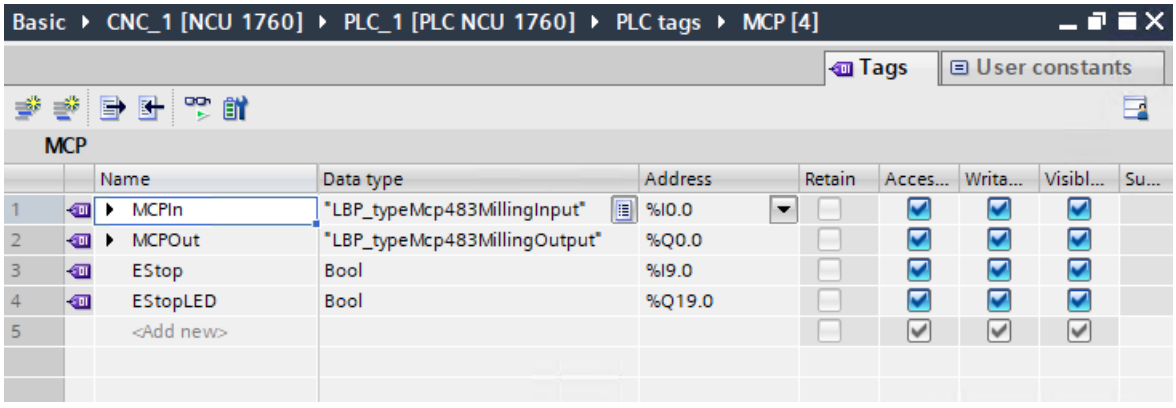


Figure 6-15 Variable table for machine control panel and emergency stop

6.6.4 Startup [OB100]

In the Startup [OB100], configure and initialize the basic program and configure the addresses, inputs and outputs of the machine control panel.

Creating a simple Startup OB

1. Double-click the organization block "Startup [OB100]" in the project navigator.
   The OB is opened in the Editor.
2. Insert the basic program block "LBP_ConfigBP [FC1]" into the organization block "Startup [OB100]" by drag and drop.
   The program code is inserted.

3. You configure the inputs/outputs in the block as follows.

Input/output	Value	Comment
MCPNum	1	Number of the MCP
MCP1In	P#I0.0 "MCPIn"	Pointer to the input address range (from MCP variable table)
MCP1Out	P#Q0.0 "MCPOut"	Pointer to the output address range (from MCP variable table)
MCP1BusAdr	192	The bus address of the MCP is set by DIP switches on the real SINUMERIK ONE. The bus address is not relevant to the virtual machine and therefore can be configured to the value of the real machine.

Note

Creating pointers automatically

The pointers for the MCP1In and MCP1Out signals are automatically completed when you enter the names of the input/output. For example "MCPIn", and then select "No entry" and confirm with the enter key.

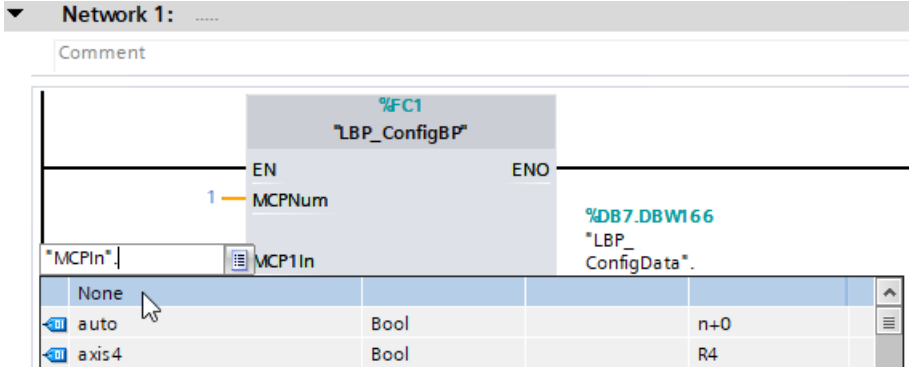


Figure 6-16 Pointers to MCP data types

4. Keep the default settings of the other inputs/outputs.

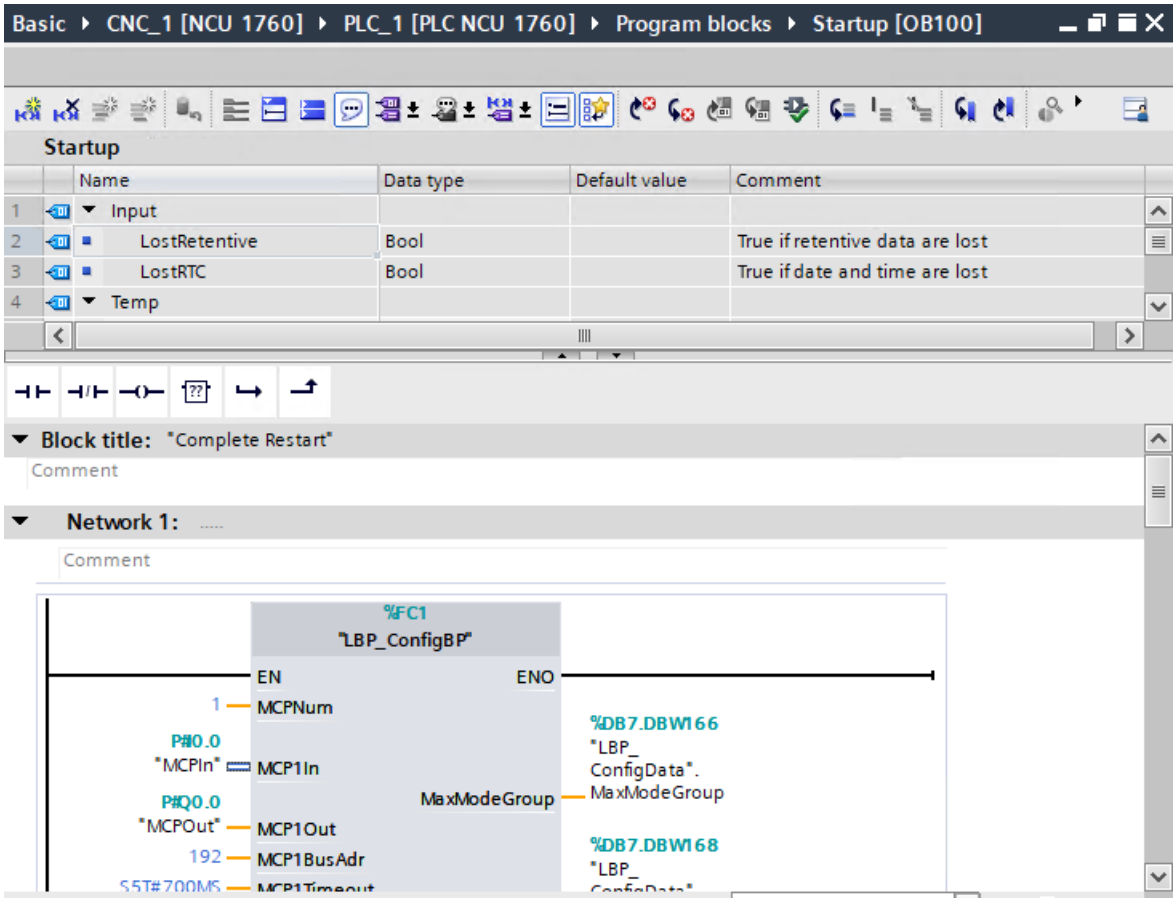


Figure 6-17 Startup [OB100], section of the changed inputs/outputs

6.6.5 Hardware Interrupt [OB40]

You configure the reaction to hardware interrupts in the OB.

Creating the hardware interrupt OB

1. Create a new organization block "Hardware Interrupt" and open it in the Editor.
2. Paste the basic program block "LBP_NCKProcessIRT [FC3]" into the Editor with drag and drop.
   The function calls additional basic PLC program blocks internally.
   The program code is inserted. You do not have to make any changes.

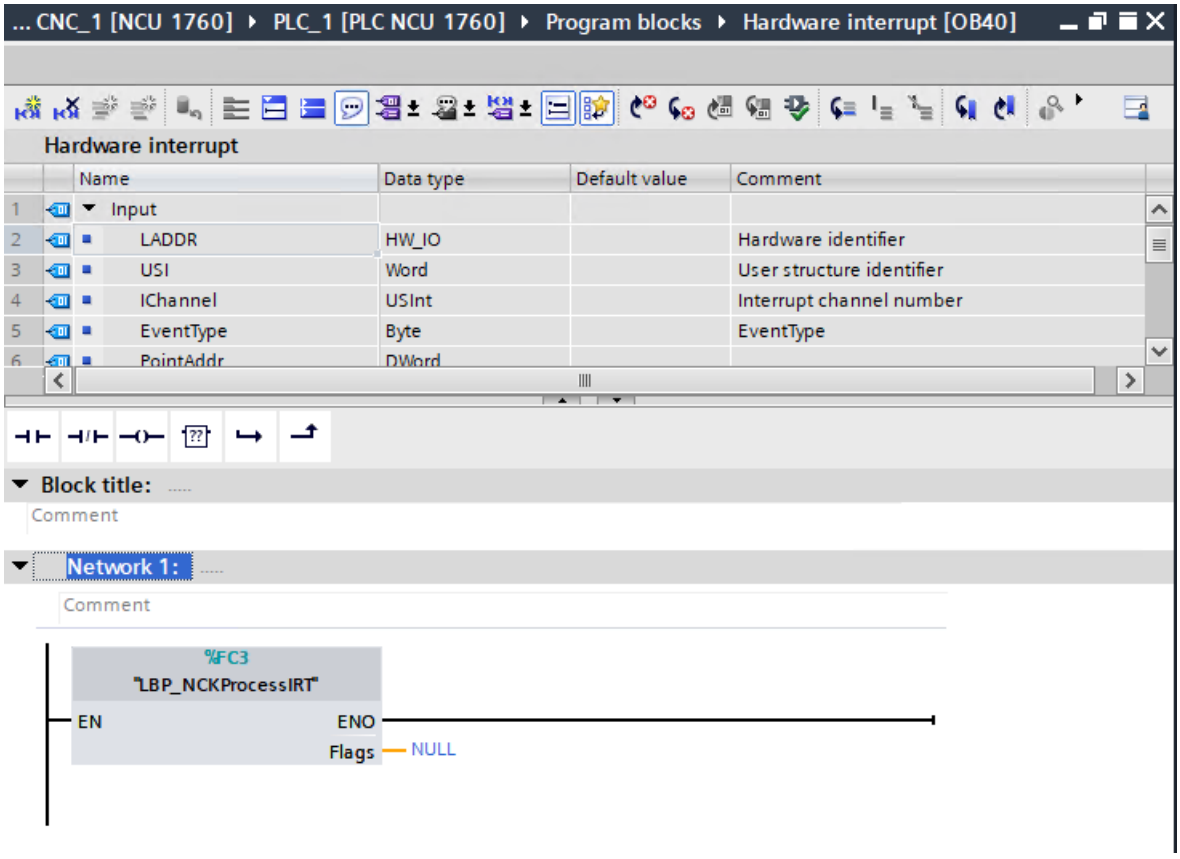


Figure 6-18 Hardware interrupt

3. Configure the hardware interrupt in the properties of the NCK (Page 74). In the device view, select the NCK and select "Properties > General > Events" in the inspector window.
4. Activate "Event-controlled signal exchange NCK to PLC", and configure the "Event names", and select "Hardware Interrupt" as the hardware interrupt.

6.6.6 AxisEnable [FC30]

The controller, pulse enables and the enables of the measuring system are set for the axes in the FC "AxisEnable". This function is called for all configured axes in the function block "AxisOrganisation".

Creating a function for axis enable

1. Create a new function, e.g. "AxisEnable", and open it in the Editor.
2. Create the following variables in the block interface.

Type/name	Data type	Comment
Input: Enable	Bool	Enable
InOut: AxisDB	LBP_typeAxisX	Interface between user program and axis/spindle, contains signals from/to axis/spindle.

3. Create four networks each with an NO contact and an assignment and enter the stated, symbolic variable names:

No.	Network comment	Variable NO contact	Variable assignment
1	Activate override	Enable	AxisDB.A_ORactive
2	Pulse enable	Enable	AxisDB.A_PulseEnable
3	Controller enable	Enable	AxisDB.A_ContrEnable
4	Enable position measuring system 1	Enable	AxisDB.A_PosMeas1

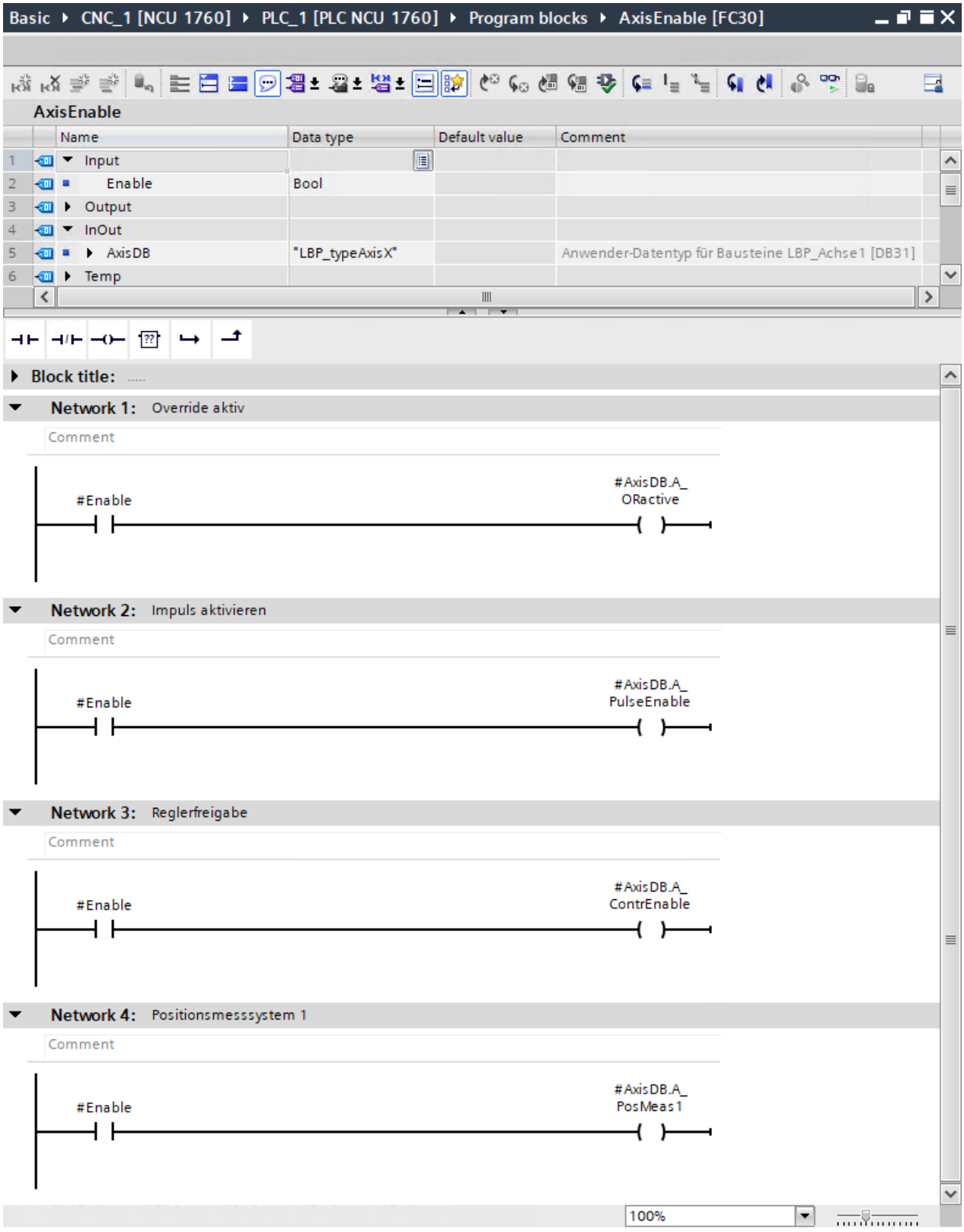


Figure 6-19 Sample program LAD: AxisEnable, axis enables

6.6.7 AxisOrganisation [FB30]

In the FB "AxisOrganisation", configure the axes which you want to enable with the function call "AxisEnable".

Creating a function for axis enable

1. Create a new FB, e.g. "AxisOrganisation", and open it in the Editor.
2. Create the following variable in the block interface.

Type/name	Data type	Comment
Input: Enable	Bool	Enable

3. Insert an empty box into the first network. In it, you program the enables for axis 1 (Axis[1]).
4. Move the mouse pointer over the triangle in the top right-hand corner of the empty box, and enter "AxisEnable". The empty box is changed to the respective function call. Placeholders are inserted for the parameters.
5. Insert an NO contact each at the "EN" and "Enable" inputs of the function call.
6. Configure the function as follows.

Input function	Variable	Comment
EN	"LBP_ConfigData".ActiveAxis[1]	Checks whether axis1 is configured or used.
Enable	Enable	Enable
AxisDB	LBP_Axis1	Axis/spindle signals PLC NC axis1

If Axis1 is used and an enable is present, the axis [1] is enabled.

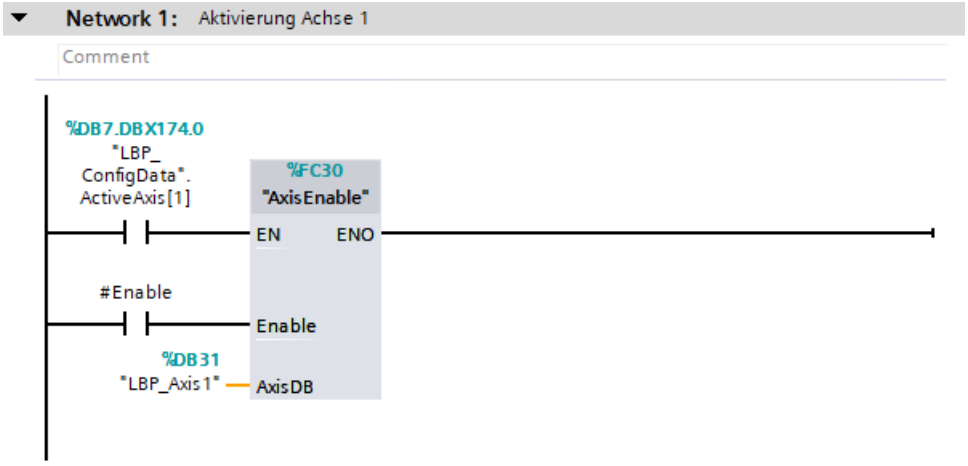


Figure 6-20 Sample program LAD: Enable axis with index [1]

7. The enable must be programmed for all axes. Copy the programmed network 1 according to the number of axes used. 6 axes are used in the example. After copying, there are 6 identical networks present.

8. Replace index 1 by the corresponding axis indices 2 to 6 in the copied networks in the comment and in the variable name. The network for axis 2 is shown in the figure.

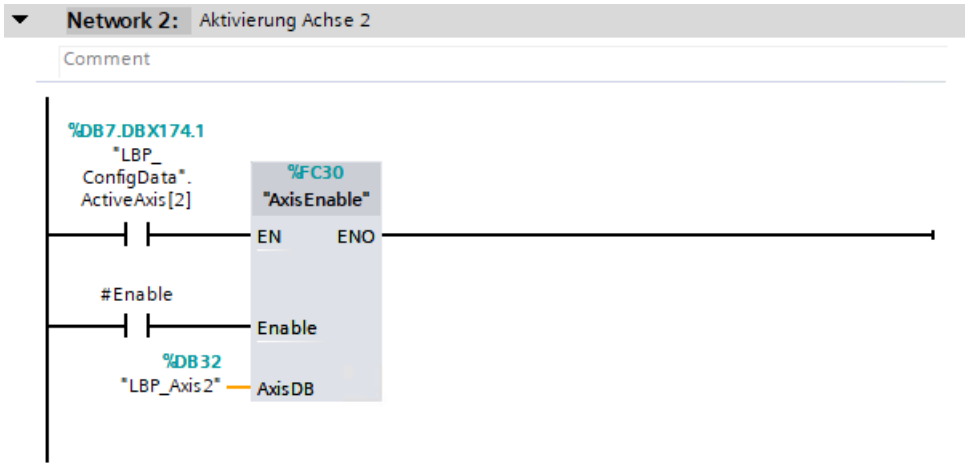


Figure 6-21 Sample program LAD: Enable axis with index [2]

9. Insert a new network with an NO contact and an assignment and define the variables. With this, you activate the feedrate override for channel 1. If you use more than one channel, you must activate the feedrate override for each channel.

Variable	Comment
Enable	Enable
"LBP_Chan1".A_FD_ORA	Path feedrate override activated in channel 1

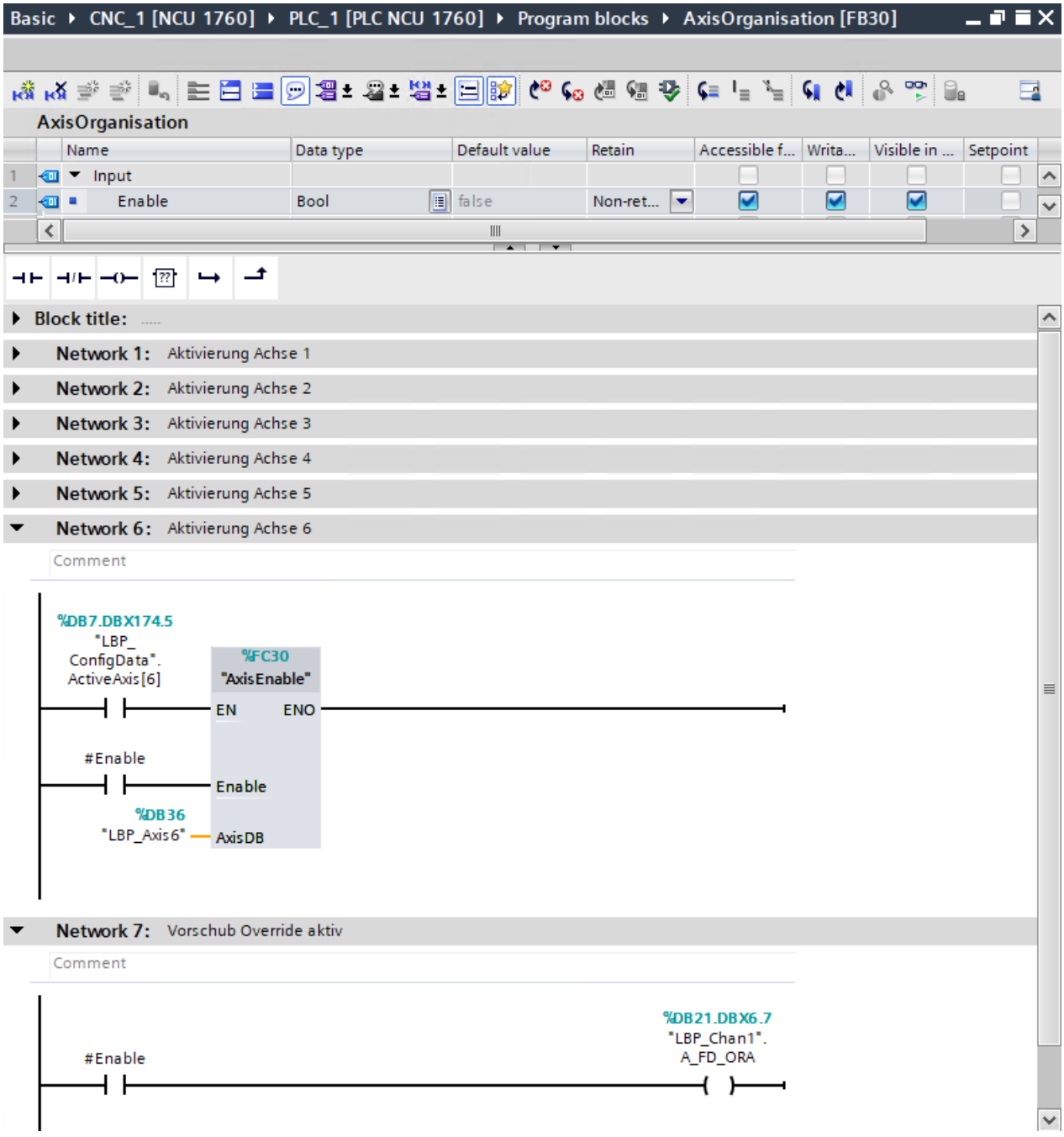


Figure 6-22 Sample program LAD: FB "AxisOrganisation", network for axis 6 and feedrate override opened

6.6.8 BagNckAlarm [FC31]

In the FC "BagNckAlarm", program the reaction to the tripping of the emergency stop or an interrupt.

Programming the function of the emergency stop button

1. Create a new FB, e.g. "BagNckAlarm", and open it in the editor.
2. Create a "Mode group reset" network with two NO contacts, one assignment, and enter the specified, symbolic variable names.
   If a reset has been tripped in channel 1 and it is active again, the mode group is reset.

Variable	Comment
"LBP_Chan1".A_Reset	A reset is tripped in channel 1 of the mode group.
"LBP_ConfigData".ActiveChan[1]	Channel 1 is active.
"LBP_ModeGroup".A_MGReset	Mode group is reset.

3. Create an "Emergency stop" network with one NC contact, one assignment, and enter the specified, symbolic variable names.
   Pressing the emergency stop button trips the NC function emergency stop.

Variable	Comment
"EStop"	NC contact: Value 0 fulfills the condition (emergency stop button pressed).
"LBP_NC".A_EMERGENCY	With value 1, emergency stop is active and all axes are braked.

4. Create an "Acknowledge emergency stop" network with two NO contacts, one assignment, and enter the specified, symbolic variable names.
   If the mode group is reset and the emergency stop button is not pressed, emergency stop is acknowledged.

Variable	Comment
"LBP_ModeGroup".A_MGReset	Mode group is reset
"EStop"	Emergency stop button not pressed
"LBP_NC".A_EMERGENCY_Ackn	Emergency stop is acknowledged. Machine is ready again.

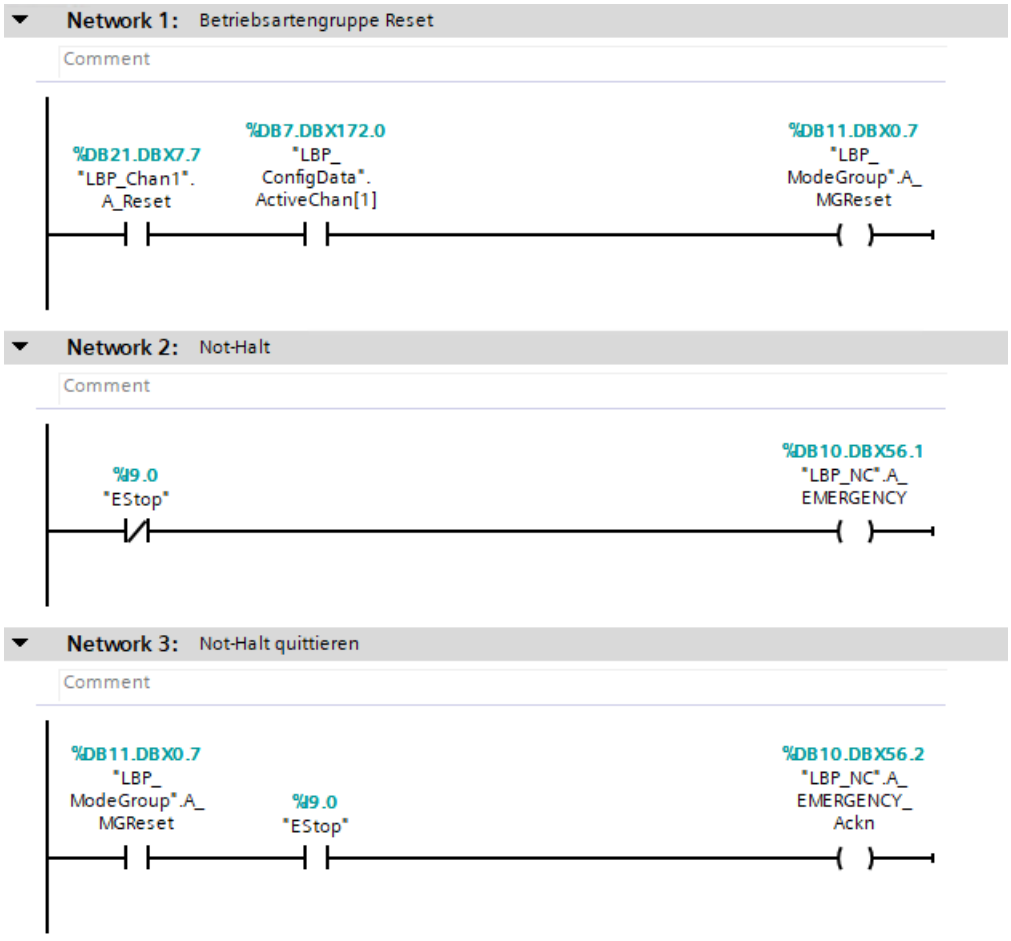


Figure 6-23 Sample program LAD: FC "BagNckAlarm", program emergency stop

6.6.9 Main [OB1]

The Main OB is executed after starting in cyclic mode.

Creating a simple Main OB

1. Double click the organization block "Main [OB1]" in the project navigator.
   The OB is opened in the Editor.
2. Insert the function "LBP_MainBP [FC2]" into the Editor with drag and drop. Die function allows cyclic mode of the NC/PLC interface.

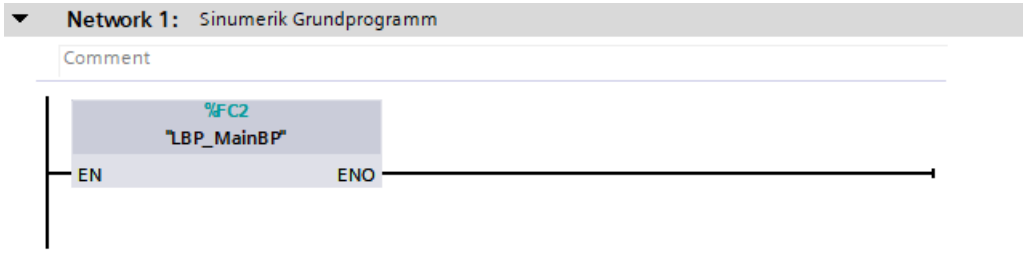


Figure 6-24 Sample program LAD main OB: "LBP_MainBP [FC2]"

3. Paste the function "LBP_MCPCtrlMilling [FC19]" into the Editor with drag and drop. With the function, you configure the transmission of signals between the NC/PLC interface and the machine control panel.
4. Configure the inputs/outputs of the block as follows. Keep the default settings of the other inputs/outputs.

Input/output	Value	Comment
BAGNo	B#16#1	Number of mode groups for signal transmission
ChanNo	B#16#1	Number of the channel
SpindleIFNo	B#16#4	Number of the machine axis. Axis 4 is used as a spindle in the example.
FeedHold	"LBP_AlarmMsgs".Chan[1].FDD[0]	Feed disable, channel 1
SpindleHold	"LBP_AlarmMsgs".Axis[4].FdStop[0]	Feedrate/spindle stop, axis 4

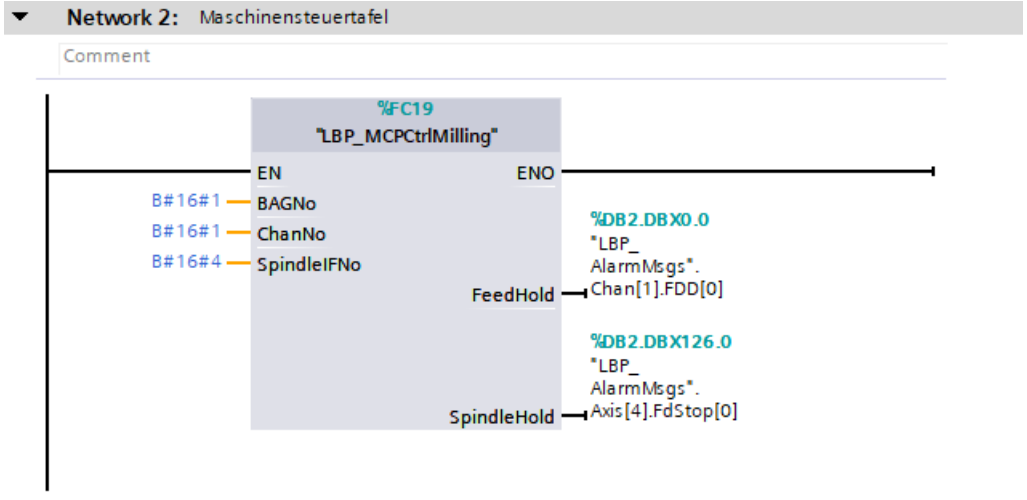


Figure 6-25 Sample program LAD main OB: "LBP_MCPCtrlMilling [FC19]"

5. **Real machine only:**
   Insert the function block "LBP_OpUnitComm [FB25000]" into the Editor with drag and drop. The block is used for communication with operator components via Industrial Ethernet (IE), e.g. machine control panels (MCP), handheld terminals (HT).

   Note

   This function block is **only** required for a **real machine**. An error message is displayed if the function block is present in the PLC program of the virtual machine.

6. When pasting the function block, create a new instance DB, e.g. "instLBP_OpUnitComm". The function block is inserted and the instance DB is created.
7. **Real machine with handheld terminal only:**
   Paste the function "LBP_Handwheels [FC25002]" into the Editor with drag and drop. The block transfers the handwheel signals from the PLC to the NCK.
8. Configure the inputs/outputs of the block as follows. Keep the default settings of the other inputs/outputs.

Input/output	Value	Comment
Comm	"instLBP_OpUnit-Comm"	Instance data of "LBP_OpUnitComm [FB25000]"

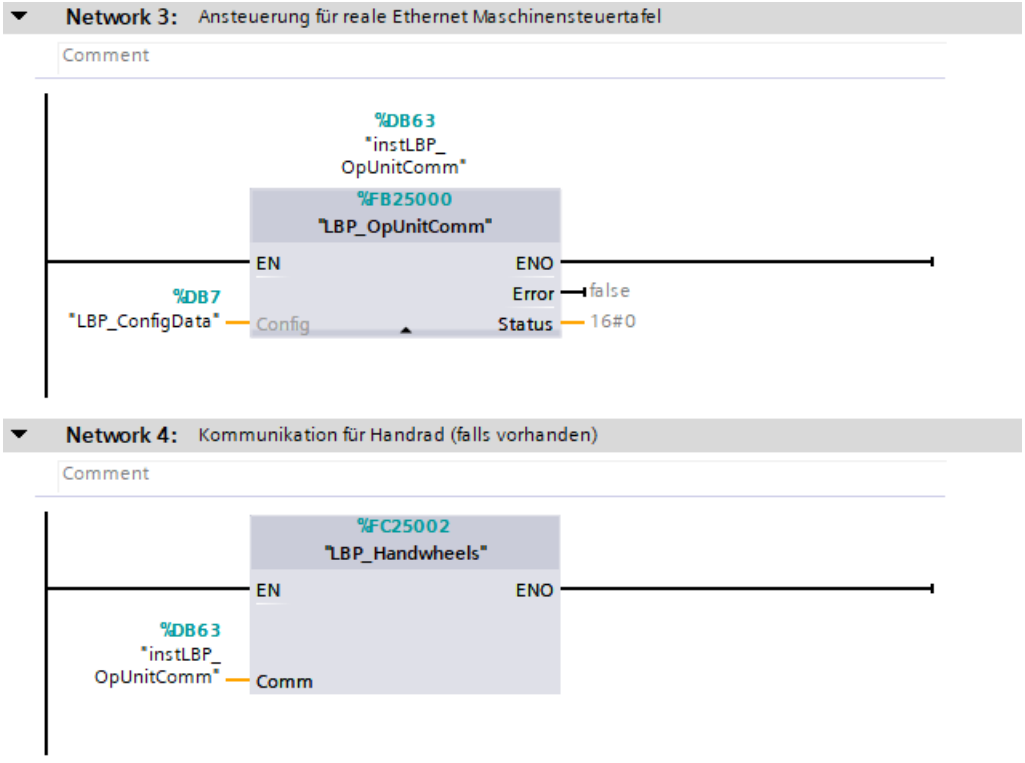


Figure 6-26 Sample program LAD main OB: Operator components (real machine only)

9. Paste the previously created function block "AxisOrganisation [FB30]" into the Editor with drag and drop. The block sets the axis enables. Leave the inputs/outputs in their default settings.

10. When pasting the function block, create a new instance DB, e.g. "instAxisOrganisation", and set "Enable" to "true".
The function block is inserted and the instance DB is created.

Input/output	Value	Comment
Enable	true	Axis enables

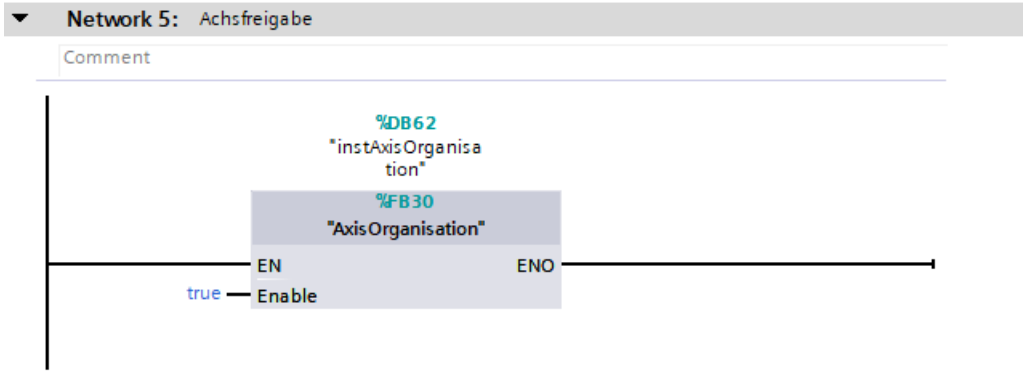


Figure 6-27 Sample program LAD main OB: "AxisOrganisation [FB30]"

11. Paste the previously created function "BagNckAlarm [FC31]" into the Editor with drag and drop. The function evaluates the emergency stop.

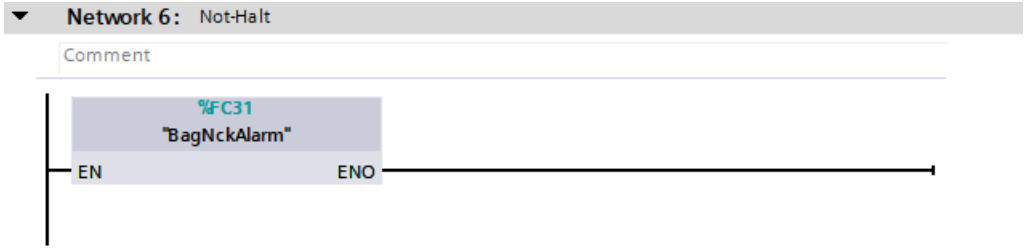


Figure 6-28 Sample program LAD main OB: "BagNckAlarm [FC31]"

12. Paste the function "LBP_GenerateAlarmMsgs [FC10]" into the Editor with drag and drop. This function evaluates the signals entered in "LBP_AlarmMsgs [DB2]" and writes alarms that have occurred to the PLC alarm buffer. The alarms are displayed and can be acknowledged via SINUMERIK Operate.
13. Configure the inputs/outputs of the function as follows. Keep the default settings of the other inputs/outputs.

Input/output	Value	Comment
ToUserIF	true	Signal transmission to user interface per cycle.
Ackn	"MCPIn".reset	Acknowledgment of error messages via the RESET button on the MCP.

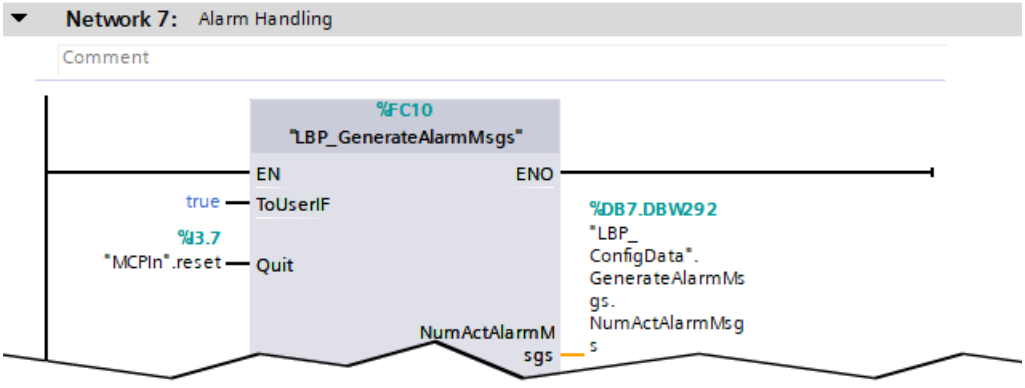


Figure 6-29 Sample program LAD main OB: "LBP_GenerateAlarmMsgs [FC10]"

Engineering NC (virtual machine) 7

7.1 Machine and setting data

Setting machine data

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

- The machine data (MD) is divided into the following areas:
  - General machine data
  - Channel-specific machine data
  - Axis-specific machine data
  - Parameters for the Control Unit
  - Parameter for the infeed
  - Drive parameters
- The setting data (SD) is divided into the following areas:
  - General setting data
  - Channel-specific setting data
  - Axis-specific setting data

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

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

The SINUMERIK Operate **Online Help** provides a context-related description of the machine data and setting data.

Effectiveness

The effectiveness of a machine data item specifies when the change becomes active:

po	The changed machine data require an "NCK Reset" to become effective.
re	The changed machine data must be activated by pressing the <RESET> key.
cf	The changed machine data must be activated by pressing the "Apply MD" softkey.
so	The changed machine data becomes active immediately.

Changes to the setting data always take effect **immediately**.

References

You will find a description of the machine data and setting data in the SINUMERIK ONE List Manual Machine data and parameters (SINUMERIK ONE document overview (www.siemens.com/sinumerik-one)).

7.2 Procedure when commissioning the NC

NC commissioning

We recommend the following sequence when commissioning the NC:

Sequence		Reference
①	Parameter sets of axis/spindle	• Velocities, setpoint/actual-value systems, closed-loop control (G2) • Spindles (S1)
②	Axis configuration	• Axes, coordinate systems, frames (K2) • Synchronous spindles (S3) • Rotary axes (R2) • Compensations (K3)
③	Parameterizing axis data:	Velocities, setpoint/actual-value systems, closed-loop control (G2)
	• Parameterizing the incremental-rotary measuring system	• Setpoint/actual-value system → Actual-value resolution
	• Parameterizing the incremental-linear measuring system	• Setpoint/actual-value system → Actual-value resolution
	• Parameterizing the absolute measuring system	• Setpoint/actual-value system → Actual-value resolution
	• Setpoint/actual-value channels	• Setpoint/actual-value system
	• Dynamic Stiffness Control (DSC)	• Tuning of the control
	• Rotary axes	• Rotary axes → (R2)
	• Positioning axes	• Positioning axes → (P2)
	• Position controller	• Closed-loop control
	• Speed setpoint matching	• Closed-loop control
	• Axis velocity matching	• Velocities
	• Axis monitoring functions (static)	• Axis monitoring, protection areas → (A3)
	• Axis monitoring functions (dynamic)	• Axis monitoring, protection areas → (A3)
④	Parameterizing the spindle data:	Spindles (S1)
	• Setpoint/actual-value channels	• Setpoint/actual-value system → (G2)
	• Measuring systems	• Setpoint/actual-value system → (G2)
	• Gear stages	• Gear stages for spindles and gear change change
	• Velocities and setpoint adaptation	• Gear stages for spindles and gear change change
	• Spindle positioning	• Spindle modes > Axis mode
	• Spindle synchronization	• Reference / synchronize
	• Monitoring	• Spindle monitoring
⑤	Referencing axis/spindle:	Reference point approach (R1)
	• Incremental measuring system	• Referencing with incremental measurement systems
	• Distance-coded reference marks	• Referencing with distance-coded reference marks
	• Absolute encoder homing	• Referencing with absolute encoders

Additional references

You will further information about the functions in the following documentation:

- A2, A3, G2, K2, R1, S1 in the Function Manual Basic Functions (www.siemens.com/sinumerik-one)
- P2, S3 in the Function Manual Axes and Spindles (www.siemens.com/sinumerik-one)
- K3 in the Function Manual Monitoring and Compensation (www.siemens.com/sinumerik-one)

Setting the technology

User views are lists of machine data and setting data that are compiled for a special application. In order to set all the technology-relevant data for a turning machine or milling machine on the control, the following user views are available to facilitate the commissioning:

- Setup_Milling
- Setup_Turning

The files on the SD card are stored under:

/user/sinumerik/hmi/template/user_views/param

Product announcement (www.siemens.com/sinumerik-one)

7.3 Configuring machine axes

7.3.1 Axis assignment

Introduction

Generally, a distinction is made between four types of 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**
  Special axes are all other channel axes that are not geometry axes. Unlike for geometry axes (Cartesian coordinate system), no geometric context is defined for special axes, neither between additional axes nor with respect to geometry axes.

Note

Geometry and special axes

A maximum of three channel axes can be declared as geometry axes. The geometry axes must be assigned to the channel axes in ascending order without any gaps. All channel axes that are not geometry axes are special axes.

Axis assignment

The assignment of geometry axes to channel axes and channel axes to machine axes, as well as the definition of the names of the different axis types is realized via machine data. The following diagram illustrates this relationship:

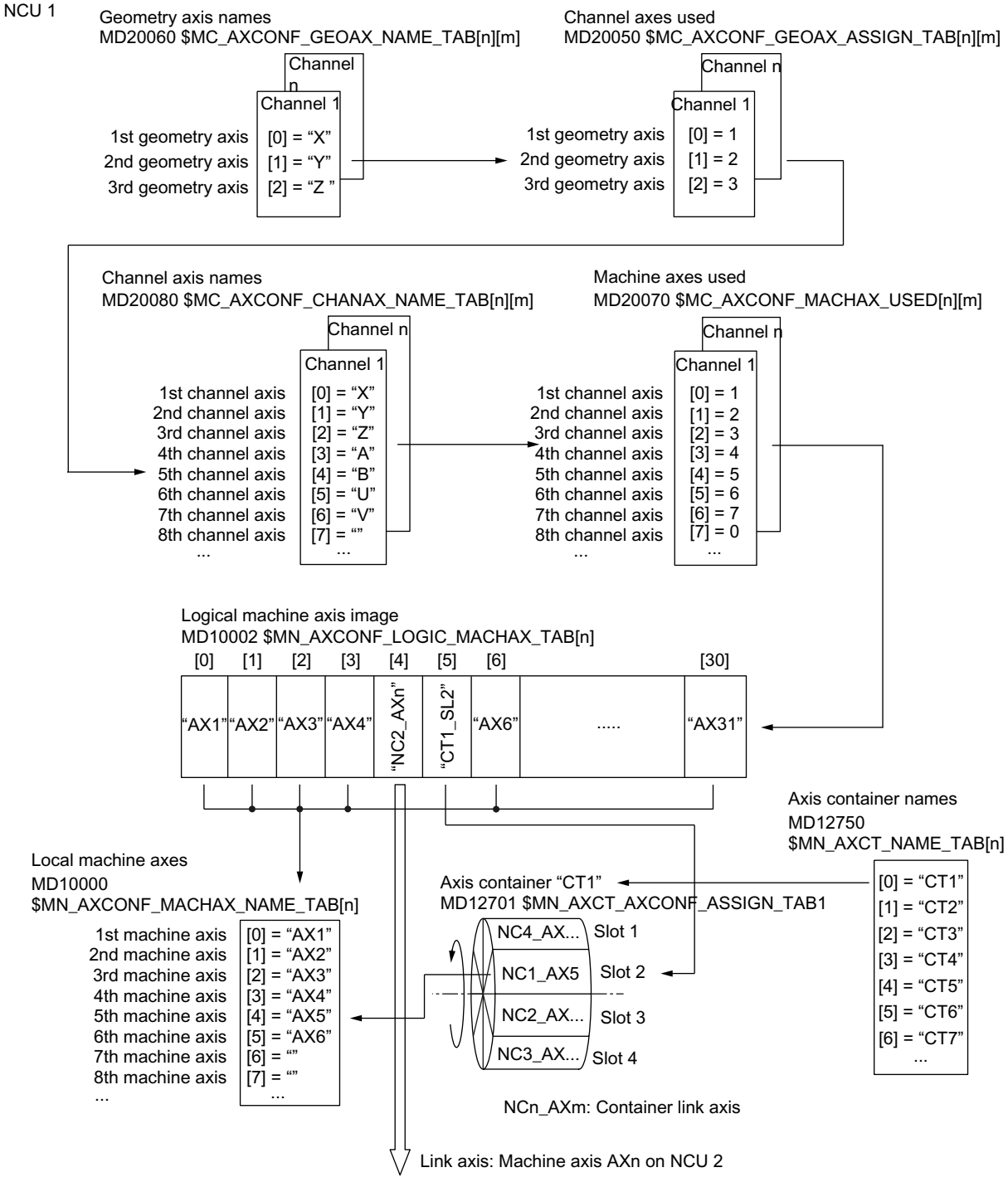


Figure 7-1 Axis assignment

7.3.2 Axis names

Machine axes

Each machine axis, channel axis and geometry axis is assigned an individual name that clearly identifies the axis. Machine axis names must be unambiguous for the entire NC. The name of the machine axes are defined via the following machine date:

MD10000 $MN_AXCONF_MACHAX_NAME_TAB [n] (machine axis name)

The specified names and the associated index are used in the following cases:

- 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 the PLC
- Display of axis-specific alarms
- Display in the actual-value system (machine-related)
- DRF handwheel function

Channel axes

The name of the channel axes are defined via the following machine date:

MD20080 $MC_AXCONF_CHANAX_NAME_TAB[n] (name of the channel axis in the channel)

Channel axis names must be unambiguous for the entire channel.

Geometry axes

The names of the geometry axes must be absolutely unique throughout the channel, and are defined using the following machine data:

MD20060 $MC_AXCONF_GEOAX_NAME_TAB [n] (geometry axis in the channel)

The names for channel and geometry axes are used in the part program for programming general traversing movements and to describe the workpiece contour.

- Path axes
- Synchronized axes
- Positioning axes
- Command axes
- Spindles
- Gantry axes
- Coupled axes
- Guide value coupling axes

7.4 Example of an axis configuration

7.4.1 Overview

For example, configure the axes of a 5-axis machine with three linear axes, two rotary axes, and one spindle. The axes are configured in the "Setup" operating area.

Requirement

To change the machine data, at least protection level 2 (service) or higher must be set in the "Setup" operating area.

How to configure the axes

1. Configure the number of axes (1 to 6) in the channel machine data.
2. Enter the names for the machine axes used in the general machine data.
3. Enter the names of the channel axes in the channel machine data.
4. Configure the axes used as linear or rotary axes in the axis machine data.
5. Configure an axis as a master spindle in the axis machine data.

See also

Assigning axis names (Page 104)

Spindle and axis types (Page 106)

First function test with the MCP (Page 114)

7.4.2 Assigning axis names

In the "Setup" operating area, configure the machine data for the number of axes used and the axis names. The modified machine data only take effect after an NC reset.

Requirement

The "Setup" operating area is open in SINUMERIK Operate.

Increasing the number of axes and assigning a channel

Increase the number of machine axes/spindles to 6 by entering additional axes in the corresponding index of the channel machine data 20070 [0...n].

1. In the "Setup" operating area, select "Machine data > Channel MD".
2. Enter the following values in the indices of the machine data 20070 [0...5].

Channel machine data				**CH1:CHAN**
20070 [0]	$MC_AXCONF_MACHAX_USED	1		PO
20070 [1]	$MC_AXCONF_MACHAX_USED	2		PO
20070 [2]	$MC_AXCONF_MACHAX_USED	3		PO
20070 [3]	$MC_AXCONF_MACHAX_USED	4		PO
20070 [4]	$MC_AXCONF_MACHAX_USED	5		PO
20070 [5]	$MC_AXCONF_MACHAX_USED	6		PO

3. Press the "Reset (po)" softkey and confirm the messages with "Yes ✓" to reset the NC data. The changed machine data are accepted.

Note

You can reset the NC data collectively for all changes at the end. All changed machine data then become effective.

After the NC reset, the axes are displayed with preassigned names. These are changed corresponding to the specifications.

Entering machine axis identifiers

Now change the axis identifiers according to the requirements of the machine tool manufacturer.

In this example, the following names and axis types are used for the machine axes:

MX1	Machine axis 1	Linear
MY1	Machine axis 2	Linear
MZ1	Machine axis 3	Linear
MSP1	Machine axis 4	Spindle
MB1	Machine axis 5	Rotary
MC1	Machine axis 6	Rotary

"JOG/REF" screen shows these names each time after the machine is switched on (POWER ON). Other names are displayed in the part program. One exception is if the axis is traversed to the reference position in the NC part program. Further exceptions are described in the NC part program manual.

How to enter the axis identifiers of the machine axes

The names are defined in the assigned **general machine data 10000 [0...n]**.

1. In the "Setup" operating area, select "Machine data > General MD".
2. Enter the following designations in the indices of the machine data 10000 [0...5].

General machine data				
10000 [0]	$MN_AXCONF_MACHAX_NAME_TAB	MX1		PO
10000 [1]	$MN_AXCONF_MACHAX_NAME_TAB	MY1		PO
10000 [2]	$MN_AXCONF_MACHAX_NAME_TAB	MZ1		PO
10000 [3]	$MN_AXCONF_MACHAX_NAME_TAB	MSP1		PO
10000 [4]	$MN_AXCONF_MACHAX_NAME_TAB	MB1		PO
10000 [5]	$MN_AXCONF_MACHAX_NAME_TAB	MC1		PO

Entering channel axis identifiers

The following naming convention is used for the part programming and the channel axes.

X1	Channel axis 1	Linear
Y1	Channel axis 2	Linear
Z1	Channel axis 3	Linear
SP1	Channel axis 4	Spindle
B	Channel axis 5	Rotary
C	Channel axis 6	Rotary

How to enter the axis identifiers of the channel axes

These names are defined in the assigned **channel machine data 20080 [0...]**.

1. In the "Setup" operating area, select "Machine data > Channel MD".
2. Enter the following designations in the indices of the machine data 20080 [0...5].

Channel machine data				
20080 [0]	$MC_AXCONF_CHANAX_NAME_TAB	X1		PO
20080 [1]	$MC_AXCONF_CHANAX_NAME_TAB	Y1		PO
20080 [2]	$MC_AXCONF_CHANAX_NAME_TAB	Z1		PO
20080 [3]	$MC_AXCONF_CHANAX_NAME_TAB	SP1		PO
20080 [4]	$MC_AXCONF_CHANAX_NAME_TAB	B		PO
20080 [5]	$MC_AXCONF_CHANAX_NAME_TAB	C		PO

3. Press the "Reset (po)" softkey and confirm the messages with "Yes ✓" to reset the NC data. The changed machine data are accepted.

7.4.3 Spindle and axis types

In the standard configuration all axes are created as linear axes. In the following section, you configure two axes as rotary axes and one axis as a spindle.

Requirement

The "Setup" operating area is open in SINUMERIK Operate.

Rotary axes and spindles

The axis machine data 30300, 30310 and 30320 are required to define an axis as a rotary axis. These settings are also requirements for the spindles. They are preassigned with 0 (linear axis) by default.

Note

One data record per axis

There is a machine data record for each axis in the axis machine data. This means that if you change the axis machine data, you must first select the corresponding axis data record with the "Axis +" or "Axis -" softkey.

How to configure a rotary axis

1. In the "Setup" operating area, select "Machine data > Axis MD".
2. Press the "Axis +" softkey to select the data record for the fourth axis (AX4).
3. Change the machine data to 1.
   After changing MD30300, alarm 4070 is displayed. This alarm indicates that the measuring system unit will be changed at the next NCK reset. The pre-selected linear measuring system unit is mm, and changes to degrees for rotary axes and spindles.

Axis machine data				**AX4:MSP1**
30300	$MA_IS_ROT_AX	1		PO
30310	$MA_ROT_IS_MODULO	1		PO
30320	$MA_DISPLAY_IS_MODULO	1		PO

4. Configure the axes AX5:MB1 and AX6:MC1 also as rotary axes.
   MB1 axis rotary axis configuration

Axis machine data				**AX5:MB1**
30300	$MA_IS_ROT_AX	1		PO
30310	$MA_ROT_IS_MODULO	1		PO
30320	$MA_DISPLAY_IS_MODULO	1		PO

MC1 axis rotary axis configuration

Axis machine data				**AX6:MC1**
30300	$MA_IS_ROT_AX	1		PO
30310	$MA_ROT_IS_MODULO	1		PO
30320	$MA_DISPLAY_IS_MODULO	1		PO

How to configure the rotary axis MSP1 as a spindle

After definition of the rotary axis, the SP axis is assigned as a spindle. This assignment is defined by **axis machine data 35000**. A value other than 0 (1 to 20) defines the axis as a spindle. The value depends on the number of spindles and the spindle configuration.

1. In the "Setup" operating area, select "Machine data > Axis MD".
2. Press the "Axis +" or "Axis -" softkey to select the data record for the fourth axis (AX4).
3. Configure the spindle in the axis machine data.

Axis machine data				**AX4:MSP1**
35000	$MA_SPIND_ASSIGN_TO_MACHAX	1		PO

Definition of the master spindle

The master spindle is defined by the channel machine data 20090. The value entered (1 to 20) is linked to the spindle defined in axis machine data 35000. The default channel machine data is 20090 = 1, therefore MSP1 is defined as the master spindle for the corresponding channel.

How to configure the master spindle

1. In the "Setup" operating area, select "Machine data > Channel MD".
2. Configure the master spindle in the channel machine data.

Channel machine data				**CH1:CHAN1**
20090	$MC_SPIN_DEF_MASTER_SPIN	1		PO

3. Press the "Reset (po)" softkey and confirm the messages with "Yes ✓" to reset the NC data. The changed machine data are accepted.

Checking the configuration

The finished machine configuration is displayed in the "Setup" operating area. This completes the basic machine configuration. The real drives are assigned to the axes in a further step. These are configured in the real machine.

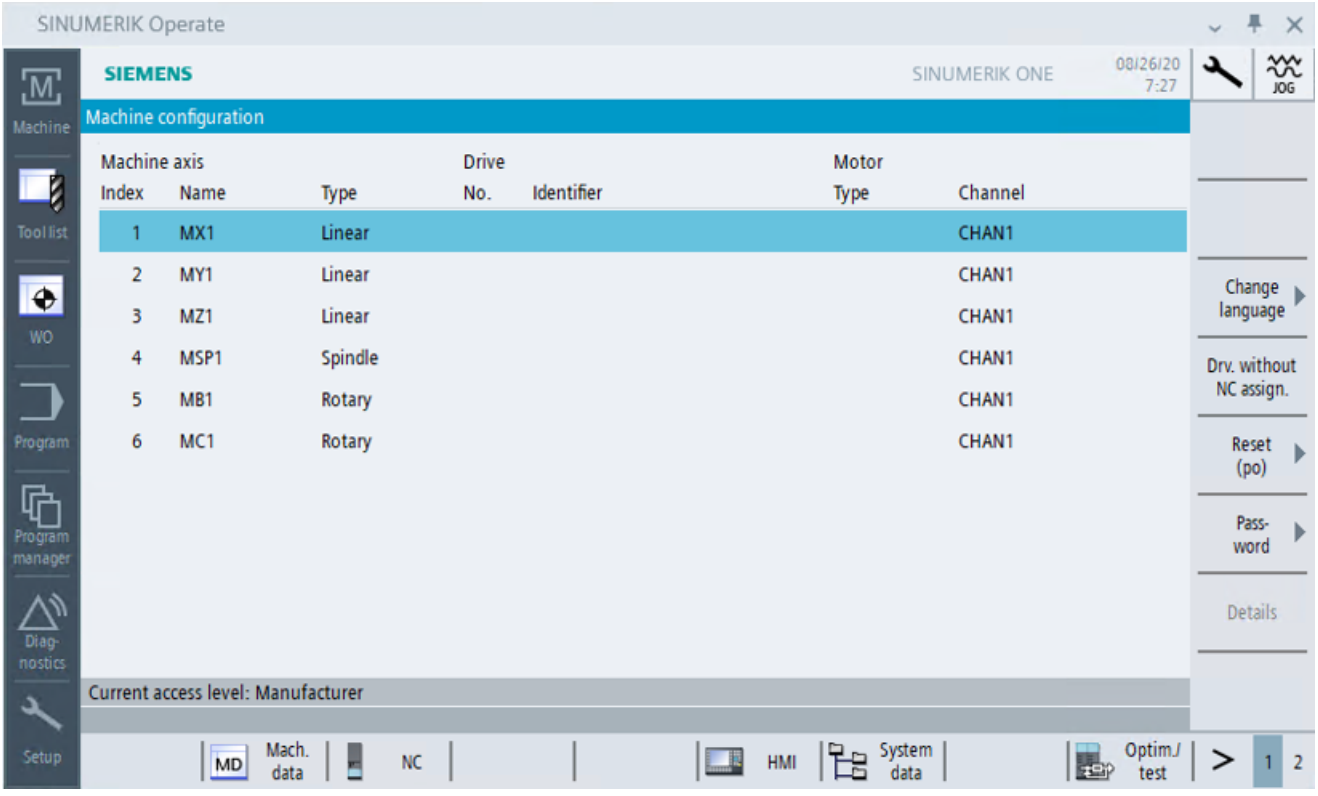


Figure 7-2 Machine configuration 3 linear axes, 2 rotary axes and 1 spindle

7.5 Machine data for an analog axis/spindle

Connection for encoder actual values

Precondition for connecting an actual value encoder is an axis with digital drive (SINAMICS axis), which only has one encoder. A Sensor Module, e.g. SMC30, is connected as 2nd encoder at the axis module, which is connected with the directly mounted spindle actual value encoder. The PROFIdrive telegram of the SINAMICS axis must be designed for two encoder actual values.

Functional restrictions:

- When operating an analog spindle or an analog axis, the drive has no speed control, and does not supply any status information; it simply involves an open-loop controlled axis.
- There is no setpoint telegram for the analog spindle; this means that the functionality based on the setpoint telegram is not available, e.g. DSC and torque feedforward control.
- The driver software simulates the "Drive ready" signal as being set.
- As drive parameters cannot be accessed, the associated functionality is restricted (e.g. spindle utilization display, automatic speed and position controller optimization). The missing values are shown in gray in the "Service Overview" dialog in the analog axis column: "This axis is not affected."

Connection for setpoints

The analog spindle is connected to interface X252 (only with SINUMERIK ONE PPU 1740). Depending on the operating mode, the following signals are output:

Spindle type	Signal name	Meaning
Bipolar spindle	AOUT	Analog output +/-10 V
	AGND	Analog output 0 V reference signal
	DOUT11	Controller enable
Unipolar spindle with separate enable and direction signals	AOUT	Analog output +10 V
	AGND	Analog output 0 V reference signal
	DOUT12	Negative direction of travel (remains set even if there is no controller enable)
Unipolar spindle with direction-dependent enable	AOUT	Analog output +10 V
	AGND	Analog output 0 V reference signal
	DOUT11	Controller enable and positive direction of travel
	DOUT12	Controller enable and negative direction of travel

The D/A conversion of the setpoint is realized with a 14-bit resolution.

Relevant machine data

The following machine data must be set for the analog axes/spindle:

- Activating the analog axis/spindle:
  MD30100 $MA_CTRLOUT_SEGMENT_NR = 0
  The analog axis/spindle for the setpoint output is activated by setting the local bus as bus segment.
- Select an operating mode:

MD30134 $MA_IS_UNIPOLAR_OUTPUT	
=0	bipolar output (+/-10 V)
=1	unipolar spindle with separate enable and direction signals
=2	Unipolar spindle with direction-dependent enable

- The rated output voltage must be adapted to the rated speed of the analog drive:
  MD32250 $MA_RATED_OUTVAL
  MD32260 $MA_RATED_VELO
- If the analog spindle is to be operated without an actual value encoder, then the value 0 must be entered as number of encoders:
  MD30200 $MA_NUM_ENCS = 0
- When using a directly mounted actual value encoder, PROFIBUS should be selected as the actual value sensing type:
  MD30240 $MA_ENC_TYPE = 1 or 4
- The actual value encoder must then be configured as 2nd encoder of a SINAMICS axis. To do this, the drive assignment of the actual value should be set the same as for the axis, where the SMC30 is to be connected at its axis module:
  MD30220[0] $MA_ENC_MODULE_NR[0] = MD30220[0] of the SINAMICS axis
- The input assignment of the actual value should be set to the input for the 2nd encoder at the SINAMICS axis module:
  MD30230[0] $MA_ENC_INPUT_NR[0] = 2
- Automatic drift compensation can be activated for a connected actual value encoder:
  MD36700 $MA_DRIFT_ENABLE
  MD36710 $MA_DRIFT_LIMIT
- A basic drift value is continuously entered as additional speed setpoint independent of whether there is an actual value encoder:
  MD36720 $MA_DRIFT_VALUE

Example

Example for 3 axes and one analog axis/spindle with actual value encoder (SMC30 as second encoder connected to the Y axis).

Axis machine data	X	Y	Z	SP	Meaning
MD30100 $MA_CTRLOUT_SEGMENT_NR	5	5	5	0	Bus segment
MD30110 $MA_CTRLOUT_MODULE_NR	1	2	3	1	Module assignment
MD30120 $MA_CTRLOUT_NR	1	1	1	1	Output assignment
MD30130 $MA_CTRLOUT_TYPE	1	1	1	1	Output type

Axis machine data	X	Y	Z	SP	Meaning
MD30134 $MA_IS_UNIPOLAR_OUTPUT	0	0	0	0	"0" means bipolar
MD30200 $MA_NUM_ENCS	1	1	1	1	Number of encoders
MD30220[0] $MA_ENC_MODULE_NR	1	2	3	2	SMC30 on the Y axis
MD30230[0] $MA_ENC_INPUT_NR	1	1	1	2	Input for second encoder
MD30240 $MA_ENC_TYPE	1/4	1/4	1/4	1/4	Encoder type

Axis machine data	SP	Meaning
MD32250 $MA_RATED_OUTVAL	80% of 10 V	Rated output voltage
MD32260 $MA_RATED_VELO	3000 (at 8 V)	Rated motor speed
MD36700 $MA_DRIFT_ENABLE	0	Automatic drift compensation
MD36710 $MA_DRIFT_LIMIT	0	Drift limit for automatic drift compensation
MD36720 $MA_DRIFT_VALUE	0	Basic drift value

7.6 Configuring ShopMill (optional)

Selection technology

You set the technology of the machine with the following channel machine data:

MD52200 $MCS_TECHNOLOGY	Technology
= 0	Universal - No specific configuration
= 1	Turning technology
= 2	Milling technology
= 3	Cylindrical grinding technology
= 4	Surface grinding technology

Technology extension:

MD52201 $MCS_TECHNOLOGY_EXTENSION	Technology extension
= 0	Universal - No specific configuration
= 1	Turning technology
= 2	Milling technology

Example:

Milling on a turning machine

MD52200 $MCS_TECHNOLOGY = 1

MD52201 $MCS_TECHNOLOGY_EXTENSION = 2

ShopTurn/ShopMill

Benefits

Machining operations such as drilling, centering, plunging or pocket milling are displayed as machining steps in a simple and clear manner. This makes part programs very compact and easy to read – even for complex machining operations. Associated sequences are automatically chained and can be assigned any position patterns.

This unique user-friendly programming allows you to achieve the shortest programming times, even for highly demanding machining tasks. The programming time is a crucial productivity factor for small series and single parts. ShopMill and ShopTurn machining step programming is unbeatable in these fields.

Functions:

- Multiple clamping of identical/different workpieces
- Manual machine
- Machining step programming



Software option

In order to use this function a license is required for the following option:

"ShopTurn/ShopMill" (6FC5800-0BP17-0YB0)

7.7 First function test with the MCP

After you have finished engineering the PLC and NC on the basis of the sample project, you can perform a first function test of the axes and spindle via the machine control panel in Create MyVirtual Machine.

Traverse axes via the machine control panel and testing the emergency stop

The machine root screen is displayed in the JOG operating area.



Figure 7-3 Machine root screen in JOG

1. The configured linear axes (MX1, MY1, MZ1) and rotary axes (MB1, MC1) are displayed in the actual value window with the current positions.
2. The active spindle S1 is configured as a master spindle.
3. Activate the enables for the spindle and feedrate.
4. Set the override switch for spindle and feedrate to 100%
5. Select the axis to be traversed. In the example, axis 1 is active. This corresponds to linear axis MX1.
6. Press the "-" and "+" buttons to traverse the axes.
7. Press the emergency stop button. The emergency stop is tripped and alarm 3000 is displayed. Emergency stop is deactivated by pressing again.
8. Press the "Reset" button to confirm the alarm. The alarm is deleted and the machine can be operated again.

The communication between PLC and NC is configured, and the axes can be traversed via the control panel and the emergency stop tripped.

7.8 Assigning axes to drives

7.8.1 Overview

The configured axes are still configured as simulation axes and have still not been assigned to a drive. At the real machine, configure the axis-drive assignment using a wizard if the drive devices are connected to SINUMERIK ONE. In a virtual machine, assign axes to the drives using machine data.

Axes and drives

Assign the axis to the drive as follows, corresponding to the configuring in the PLC project in the TIA Portal. The I/O addresses correspond to the configuring in the TIA Portal for the telegram configuration.

Axis	Drive No.	Drive		I/O address
MSP1	1	SERVO_3.3:3	Motor Module 3	4100
MX1	2	SERVO_3.3:4	Motor Module 4	4140
MY1	3	SERVO_3.3:5	Motor Module 5	4180
MZ1	4	SERVO_3.3:6	Double Motor Module 6 / 7	4220
MB1	5	SERVO_3.3:7		4260
MC1	6	SERVO_3.3:8	Motor Module 8	4300

As a result of the technical situation in the electrical cabinet (e.g. thermal dissipation at the real machine), it makes sense to assign spindle SP1 to Motor Module 3 and configure it as servo_3.3:3. The linear axes start at servo_3.3:4. This assignment is configured in the description of the axis-drive assignment.

7.8.2 Configuring axis references

Change the axis machine data for homing and defining the software limit switches and/or the axis velocities.

Requirement

- The "Setup" operating area is open in SINUMERIK Operate.
- In the "Setup" operating area, "Machine data > Axis MD" is selected.

Note

One data set per axis

There is a machine data set for each axis in the axis machine data. This means that if you change the axis machine data, you must first select the corresponding axis data set using softkey "Axis +" or "Axis -".

Axis machine data for homing

You define homing using the following axis machine data MD34000, MD34200 and MD34210.

1. Change the following machine data corresponding to the table for the three linear axes MX1, MY1, MZ1.

Axis machine data		**AX1:MX1; AX2:MY1; AX3:MZ1**		
34000	$MA_REFP_CAM_IS_ACTIVE	1		re
34200[0]	$MA_ENC_REFP_MODE	1		po
34210[0]	$MA_ENC_REFP_STATE	0		im

2. Change the following machine data corresponding to the table for spindle MSP1.

Axis machine data		**AX4:SP1**		
34000	$MA_REFP_CAM_IS_ACTIVE	0		re
34200[0]	$MA_ENC_REFP_MODE	1		po
34200[1]	$MA_ENC_REFP_MODE	1		po
34210[0]	$MA_ENC_REFP_STATE	0		im
34210[1]	$MA_ENC_REFP_STATE	0		im

3. Change the following machine data corresponding to the table for the two rotary axes MB1, MC1

Axis machine data		**AX5:MB1; AX6:MC1**		
34000	$MA_REFP_CAM_IS_ACTIVE	1		re
34200[0]	$MA_ENC_REFP_MODE	0		po
34210[0]	$MA_ENC_REFP_STATE	2		im

4. Press the "Reset (po)" softkey and confirm the messages with "Yes ✓" to reset the NC data. The changed machine data are applied.

Axis machine data for the software limit switches

You define the software limit switches for the traversing range of the axes using the following axis machine data MD36100 and MD36110. Typical values for a standard milling machine are used.

1. Change the following machine data corresponding to the table for linear axis MX1.

Axis machine data				**AX1:MX1**
36100	$MA_POS_LIMIT_MINUS	-750	mm	cf
36110	$MA_POS_LIMIT_PLUS	750	mm	cf

2. Change the following machine data corresponding to the table for linear axis MY1.

Axis machine data				**AX2:MY1**
36100	$MA_POS_LIMIT_MINUS	-300	mm	cf
36110	$MA_POS_LIMIT_PLUS	300	mm	cf

3. Change the following machine data corresponding to the table for linear axis MZ1.

Axis machine data				**AX3:MZ1**
36100	$MA_POS_LIMIT_MINUS	0	mm	cf
36110	$MA_POS_LIMIT_PLUS	650	mm	cf

4. Press the "Reset (po)" softkey and confirm the messages with "Yes ✓" to reset the NC data. The changed machine data are applied.

Axis machine data for axis velocity and rapid traverse

For real operation, define the machine data for the maximum axis velocities and rapid traverse. Leave the default values for the example.

List of relevant axis machine data for linear axes:

- MD32010 $MA_JOG_VELO_RAPID

List of relevant axis machine data for a spindle:

- MD32000 $MA_MAX_AX_VELO
- MD32010 $MA_JOG_VELO_RAPID
- MD35100 $MA_SPIND_VELO_LIMIT
- MD35110[0] and MD35110[1] $MA_GEAR_STEP_MAX_VELO
- MD35130[0] and MD35130[1] $MA_GEAR_STEP_MAX_VELO_LIMIT
- MD36200[0] MD36200[1] $MA_AX_VELO_LIMIT

List of relevant axis machine data for rotary axis axes:

- MD32000 $MA_MAX_AX_VELO
- MD32010 $MA_JOG_VELO_RAPID
- MD32020 $MA_JOG_VELO
- MD36200[0] and MD36200[1] $MA_AX_VELO_LIMIT

7.8.3 Configuring the encoder and setpoint output

To use as real axis (assign the drive), assign the axis to a drive module (MD30110[0] $MA_CTRLOUT_MODULE_NR). In addition, define the encoder type, number and the setpoint output for the relevant axes. Assign the encoder to the same drive module (MD30220[0] $MA_ENC_MODULE_NR).

Configuring the module number and encoder for linear axes

As example, configure a rotary encoder at linear axes MX1, MY1 and MZ1.

This is how you configure linear axis MX1

1. Change the following machine data corresponding to the table for linear axis MX1. The axis is assigned module number 2 (SERVO_3.3:4). An absolute rotary encoder is used. Index [0] stands for the first encoder.

Axis machine data				**AX1:MX1**
30110[0]	$MA_CTRLOUT_MODULE_NR	2		po
30130[0]	$MA_CTRLOUT_TYPE	1		po
30220[0]	$MA_ENC_MODULE_NR	2		po
30240[0]	$MA_ENC_TYPE	4		po

2. Keep the default values for the encoder resolution.
3. Click on softkey "Drive parameters" to adapt the drive parameters of linear axis MX1.
4. Check whether drive parameter p408[0] matches the encoder resolution in the axis machine data.

This is how you configure linear axis MY1

1. Change the following machine data corresponding to the table for linear axes MY1. The axis is assigned module number 3 (SERVO_3.3:5). An absolute rotary encoder is used.

Axis machine data				**AX2:MY1**
30110[0]	$MA_CTRLOUT_MODULE_NR	3		po
30130[0]	$MA_CTRLOUT_TYPE	1		po
30220[0]	$MA_ENC_MODULE_NR	3		po
30240[0]	$MA_ENC_TYPE	4		po

2. Keep the default values for the encoder resolution.
3. Click on softkey "Drive parameters" to adapt the drive parameters of linear axis MY1.
4. Check whether drive parameter p408[0] matches the encoder resolution in the axis machine data.

This is how you configure linear axis MZ1

1. Change the following machine data corresponding to the table for linear axes MZ1. The axis is assigned module number 4 (SERVO_3.3:6). An absolute rotary encoder is used.

Axis machine data				**AX3:MZ1**
30110[0]	$MA_CTRLOUT_MODULE_NR	4		po
30130[0]	$MA_CTRLOUT_TYPE	1		po
30220[0]	$MA_ENC_MODULE_NR	4		po
30240[0]	$MA_ENC_TYPE	4		po

2. Based on the description for linear axis MY1, check whether the encoder resolution and the drive parameters match.

Configuring the module number and encoder for the spindle

For spindle MSP1, configure two rotary encoders and adapt the encoder resolution.

This is how you configure spindle MSP1

1. Change the following machine data corresponding to the table for spindle MSP1. The spindle is assigned module number 1 (SERVO_3.3:3). Two rotary encoders are used.

Axis machine data				**AX4:MSP1**
30110[0]	$MA_CTRLOUT_MODULE_NR	1		po
30130[0]	$MA_CTRLOUT_TYPE	1		po
30200	$MA_NUM_ENCS	2		po
30220[0;1]	$MA_ENC_MODULE_NR	1		po
30240[0]	$MA_ENC_TYPE	1		po
30240[1]	$MA_ENC_TYPE	1		po
31020[1]	$MA_ENC_RESOL	1024		po
36400	$MA_CONTOUR_TOL	10	°	cf

2. Click on softkey "Drive parameters" to adapt the drive parameters of the spindle.
3. For parameter p408[1], enter the encoder resolutions 1024.

Configuring the module number and encoder for rotary axes

For the two rotary axes, configure a rotary encoder for each and adapt the encoder resolution.

This is how you configure rotary axis MB1

1. Change the following machine data corresponding to the table for rotary axis MB1. The rotary axis is assigned module number 5 (SERVO_3.3:7).

Axis machine data				**AX5:MB1**
30110[0]	$MA_CTRLOUT_MODULE_NR	5		po
30130[0]	$MA_CTRLOUT_TYPE	1		po
30220[0]	$MA_ENC_MODULE_NR	5		po
31020[0]	$MA_ENC_RESOL	512		po

2. Click on softkey "Drive parameters" to adapt the drive parameters of the rotary axis.
3. For parameter p408[0], enter the encoder resolutions 512.

This is how you configure rotary axis MC1

1. Change the following machine data corresponding to the table for rotary axis MC1. The rotary axis is assigned module number 6 (SERVO_3.3:8).

Axis machine data				**AX6:MC1**
30110[0]	$MA_CTRLOUT_MODULE_NR	6		po
30130[0]	$MA_CTRLOUT_TYPE	1		po
30220[0]	$MA_ENC_MODULE_NR	6		po
31020[0]	$MA_ENC_RESOL	512		po

2. Click on softkey "Drive parameters" to adapt the drive parameters of the rotary axis.
3. For parameter p408[0], enter the encoder resolutions 512.

Saving changes

Save the changes to the machine data and drive devices in the project.

1. In area "Drive parameters", select the following softkeys "Save/reset > Save > Drive device". The changes to all drive parameters are saved.
2. Switch to area "Axis MD".
3. Press the "Reset (po)" softkey and confirm the messages with "Yes ✓" to reset the NC data. The changed machine data are applied.
4. Save the machine project.

After the reset, the axes are displayed with the assigned drives.

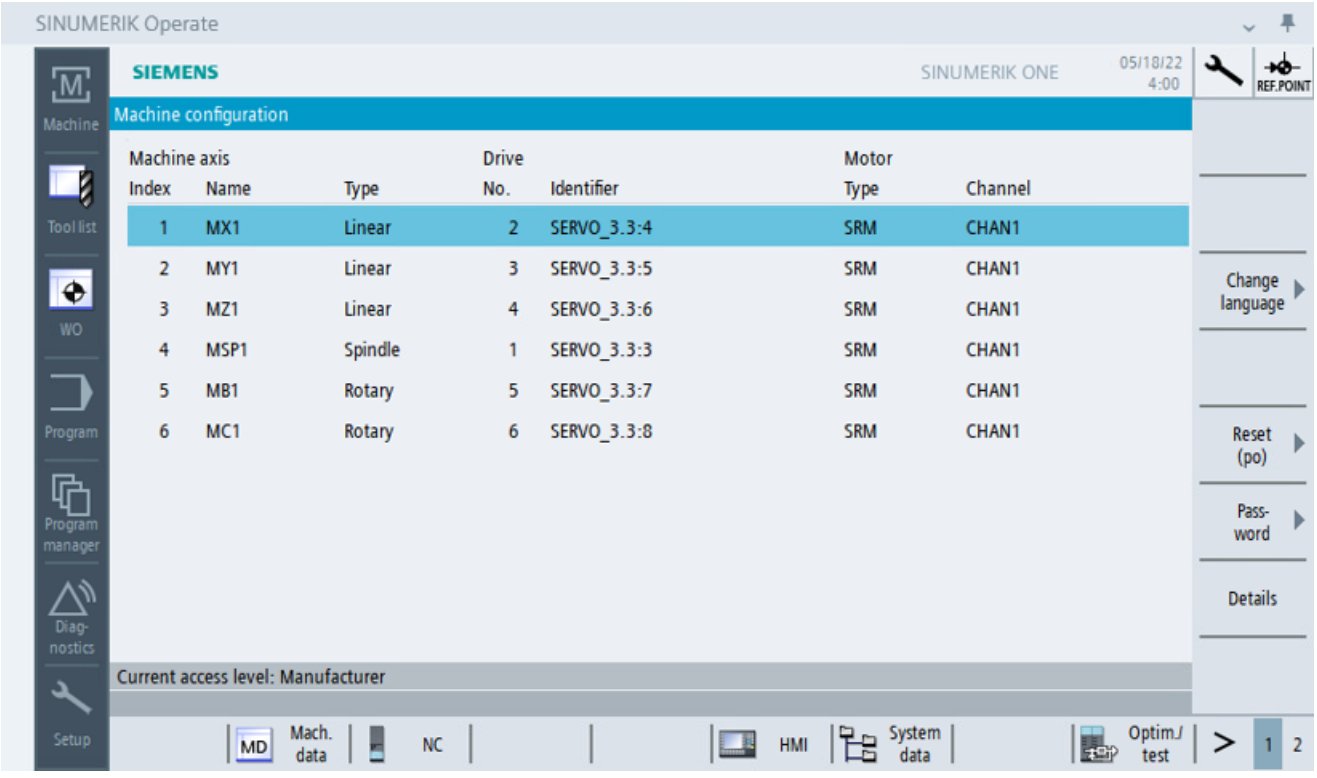


Figure 7-4 Machine configuration: Axes are assigned to the drives

7.8.4 Configuring mechanical properties

In "Mechanical properties", configure the axis type, gearbox ratio and spindle pitch, for example. This data is used for the simulation of the mechanical system and is basically used to determine the values of the load encoder. The load encoder supplies the axis values of a direct measuring system. In order that the encoder values for the configured second rotary encoder are correctly determined, configure the axis type of the spindle.

Configuring the axis type for the spindle

1. In Create MyVirtual Machine, switch to "Mechanical properties".
2. In line MSP1 / SERVO_3.3:3, change the axis type to "Rotary".

Mechanical properties

Servo selection	Axis type	Load gear numerator	Load gear denominator
MSP1 / SERVO_3.3:3	Rotary	1	1
MX1 / SERVO_3.3:4	Ball screw drive	1	1
MY1 / SERVO_3.3:5	Ball screw drive	1	1
MZ1 / SERVO_3.3:6	Ball screw drive	1	1
MB1 / SERVO_3.3:7	Ball screw drive	1	1
MC1 / SERVO_3.3:8	Ball screw drive	1	1

Figure 7-5 Configuring the axis type for spindle SP1 to "Rotary" when using a second encoder.

3. Confirm with "Activate".
4. Save the machine project.

Engineering HMI (virtual machine) 8

8.1 HMI commissioning: Overview

When using a standard HMI SINUMERIK Operate, separate commissioning of the HMI is not necessary. A standard HMI software is automatically prepared and installed via the selection of the CNC software with Create MyVirtual Machine or on starting the SINUMERIK ONE. The machine can be fully operated via the standard HMI.

Additional references

If you want to expand or change the standard HMI, you will find further information in the following documentation.

- Commissioning Manual Final steps for commissioning
- SINUMERIK ONE Operating Manual/Online Help
- SINUMERIK Integrate Run MyScreens Programming Manual
- SINUMERIK Integrate Create MyHMI/3GL Programming Manual
- SINUMERIK Integrate Create MyHMI/PRO Programming Manual

Engineering Safety Integrated (virtual machine) 9

9.1 Introduction to Safety Integrated

The "Safety Integrated" safety solution combines various safety functions in the SINUMERIK control system:

- F-I/O are connected via the F-capable PLC of the SINUMERIK control system:
- F-blocks are programmed with F-logic using F-FBD or F-LAD editors
- Configurations and the F-library are handled in the same way as for SIMATIC F-CPUs
- Configuring using the Safety Administration Editor
- Controlling the safety functions integrated in the drive (via SINAMICS Integrated):
  - Safety Integrated Basic Functions
  - Safety Integrated Extended Functions

Create MyVirtual Machine supports a series of a safety functions and selected components of the acceptance test. More information for commissioning Safety Integrated is provided in the *Commissioning Manual SINUMERIK ONE Safety Integrated*.

9.2 Program structure of the safety program (S7-1500)

Representation of program structure

For structuring purposes, a safety program consists of one or two F-runtime groups.

Each F-runtime group contains:

- F-blocks that you create using FBD or LAD or that are inserted from the project library or global libraries
- F-blocks that are added automatically (F-system blocks F-SBs, automatically generated F-blocks, F-runtime DB, and F-I/O DBs)

The following diagram shows the schematic structure of a safety program and/or an F-runtime group for an F-CPU S7-1500.

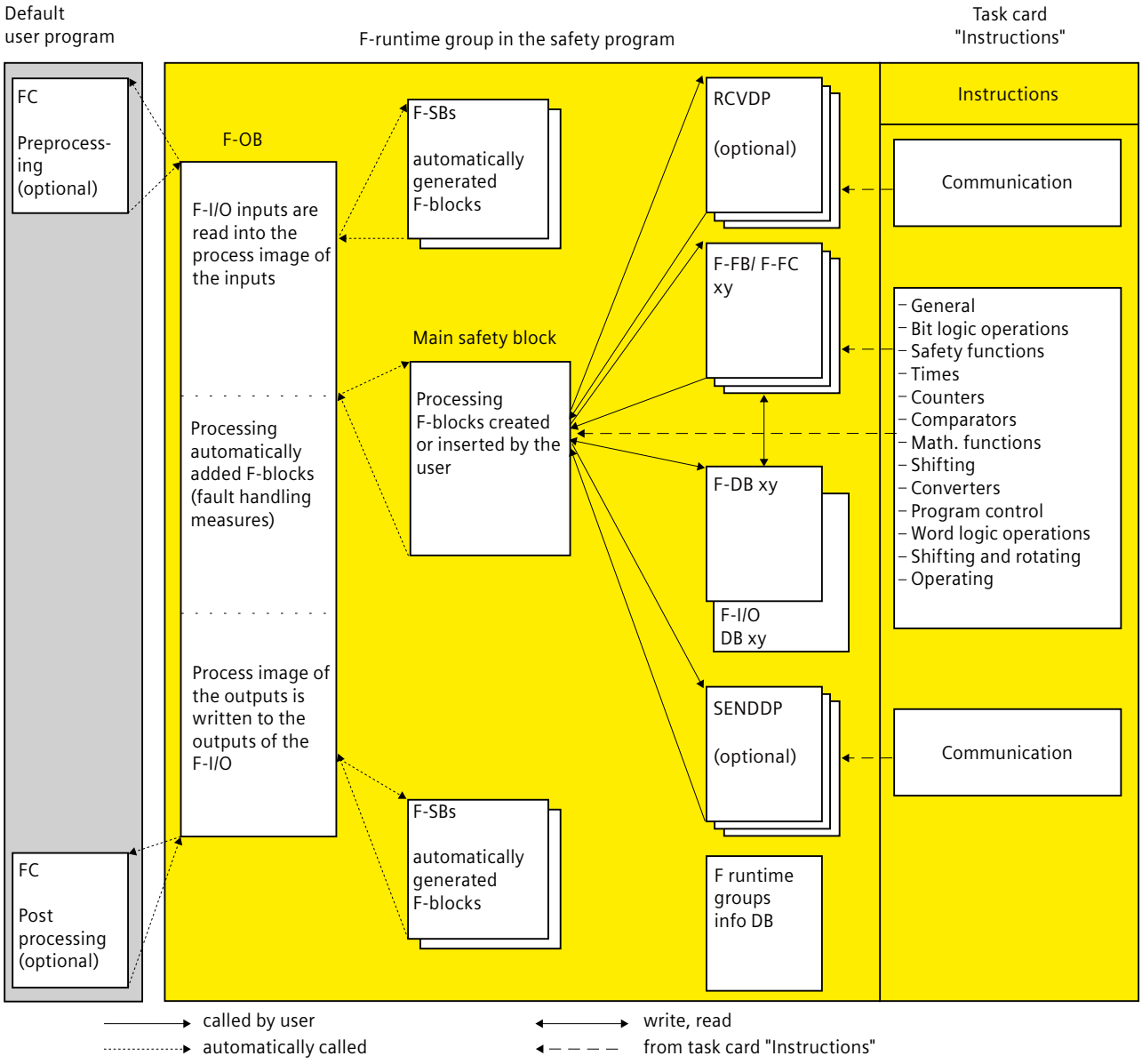


Figure 9-1 Schematic structure of a safety program and/or an F-runtime group for an F-CPU S7-1500

Main safety block

The main safety block is the first F-block of the safety program that you program yourself.

You must assign an F-runtime group to the main safety block.

The main safety block is called in an F-CPU S7-1500 using the F-OB assigned to the F-runtime group.

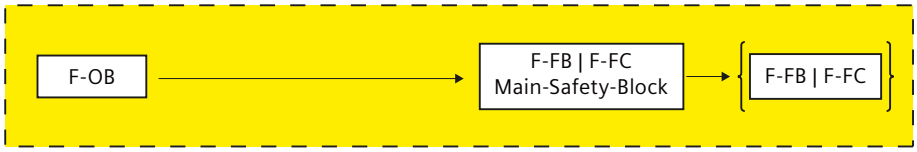


Figure 9-2 Calling the main safety block

F-runtime groups

To improve handling, a safety program consists of one or two "F-runtime groups". An F-runtime group is a logical construct of several related F-blocks that is formed internally by the F-system.

An F-runtime group consists of the following:

- An F-OB which calls the main safety block
- A main safety block (an F-FB/F-FC that you assign to the F-OB)
- Any additional F-FBs or F-FCs that you program using FBD or LAD and call from the main safety block
- One or more F-DBs, as needed
- F-I/O DBs
- F-runtime group information DB
- F-blocks from the project library or global libraries
- F-system blocks F-SBs
- Automatically generated F-blocks

Structuring the safety program in two F-runtime groups

You can divide your safety program into two F-runtime groups. By having parts of the safety program (one F-runtime group) run in a faster priority class, you achieve faster safety circuits with shorter response times.

I/O

10

10.1 I/O

I/O devices are external devices which are connected to the NCU. I/O modules establish the connection between NCU and the process.

- Digital input/output modules
- Analog input/output modules
- Drives
- Simulator modules

I/O simulation virtual machine

In Create MyVirtual Machine, you use the onboard I/O simulation or integrate external simulators via the open interface to test the machine configuration.

Upgrading a PLC project 11

11.1 General information about upgrading projects

When opening the SINUMERIK project from version < V17 of the TIA Portal, you are prompted to upgrade the project. This means that you can continue to use the project in the current version. For SINUMERIK projects with TIA Portal V17, you only have to perform a device replacement to version V6.20.

Note

CNC SW and TIA Portal project version

Before downloading, check the version of the TIA Portal project and CNC SW. The versions must be compatible, e.g. CNC SW V6.15 and SINUMERIK ONE STEP 7 Toolbox V17 with hardware and basic PLC program V6.15.

As of version CNC SW 6.13 and SINUMERIK ONE STEP 7 Toolbox V16, cross-version compatibility between CNC software and TIA Portal projects or DSF archives is guaranteed. Existing TIA Portal projects or DSF archives can also be loaded or read into an NCU with newer CNC SW versions.

Examples:

- An existing TIA Portal project with older configuration can be loaded into an NCU with a newer CNC SW version.
- Existing DSF backup/setup archive, created with an older CNC SW version, can be read into an NCU with newer CNC SW version.

In the next chapter, you are given further information about upgrading SINUMERIK projects in the TIA Portal

See also

Upgrading to SINUMERIK ONE Toolbox V17 Update 10 (Page 134)

11.2 Upgrading to SINUMERIK ONE Toolbox V17 Update 10

11.2.1 Continued use of TIA Portal projects

In the current version, only TIA Portal projects with the SINUMERIK ONE STEP 7 Toolbox V16 with basic PLC program V6.13 can continue to be used. Available projects with older versions of the TIA Portal or of the basic PLC program must first be upgraded to this version.

Installed software requirements

- TIA Portal V17 Update 4
- SINUMERIK STEP 7 Toolbox V17 Update 10 includes:
  - SINUMERIK 840D sl STEP 7 Toolbox V17 Update 10
  - SINUMERIK ONE STEP 7 Toolbox V17 Update 10

Upgrading know-how protected blocks

Know-how protected blocks are bound to the version of the TIA Portal under which the know-how protection was set up. Therefore, they cannot be upgraded for safety reasons. Proceed as follows if you use know-how protected blocks in the project:

- Remove your own blocks before upgrading the know-how protection.
- For third-party blocks, use the appropriate new version of these blocks (e.g. new version of basic PLC program).

After the upgrade, you can set up the know-how protection again.

Using TIA Portal projects in V17 Update 4

To be able to use previous TIA Portal projects in the current version, proceed as follows:

- Upgrade the control and NX modules to firmware V6.20 using "Device replacement".
- After upgrading the hardware to V6.20, replace the existing basic PLC program in the project with the current version of the basic PLC program V6.20.
- You update instructions used in the project to the latest version of the TIA Portal.

See also

Upgrading hardware (Page 135)

Updating the basic PLC program and data types (Page 136)

Updating instructions in the project (Page 137)

11.2.2 Upgrading hardware

Replacing devices

To replace devices, proceed as follows:

1. Open the project in the TIA Portal. The project structure is adapted automatically and a message is displayed.
2. Highlight the NCU in the device view and select "Change device" in the context menu.
3. Select the new NCU in the displayed dialog. The compatibility information displayed is provided for reference only.

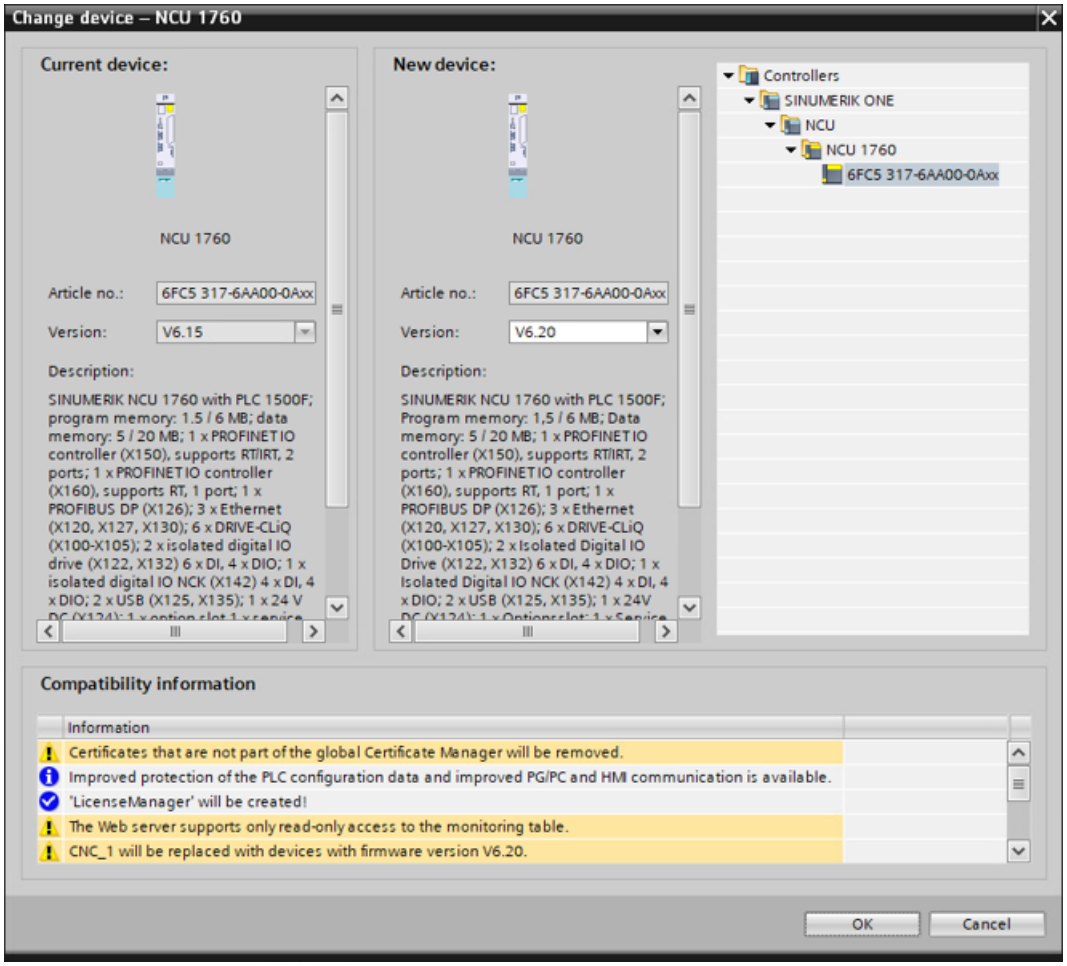


Figure 11-1 Replacement of device for new version

4. Confirm with "OK". The NCU and existing NX modules are upgraded to version V6.20.

Note

When replacing the device to Version V6.20 (PLC V2.9), the new functions for protection and PLC security are queried in the wizard. Observe additional information in the TIA Portal and in the SINUMERIK documentation.

In the next step, you upgrade the basic PLC program and the data types to version V6.20.

11.2.3 Updating the basic PLC program and data types

Upgrading the basic PLC program and data types

To upgrade the basic PLC program and the data types, proceed as follows:

1. Open the "Program blocks" folder in the project navigator.
2. Switch to task card "Libraries", and open library "SINUMERIK ONE PLC Basic Program V6.20". You use the variant for the basic PLC program and the data types with (**upgrade**) in the "Copy templates" folder.
   – SINUMERIK ONE PLC Basic program (upgrade)

   Note

   The folder (upgrade) does not contain the blocks that may contain application-related changes. These are the blocks "LBP_MFuncDecListConfig [DB75]", "LBP_ParamAlarmMsgs [DB5]" or "LBP_CallBackAuxFunc [FC12]". When updating the basic PLC program, the original version of these blocks is retained in your project and they are not overwritten.

3. Drag and drop the "Copy Templates > SINUMERIK ONE basic PLC Program (upgrade) > SINUMERIK ONE PLC BP" folder to the "Program Blocks" folder of your project.
   The basic PLC program is updated to the new version.
4. Drag and drop the "Copy Templates > SINUMERIK ONE Basic PLC Program (upgrade) > SINUMERIK ONE PLC BP data types" folder to the "PLC data types" folder of your project.
   The PLC data types are updated.
5. Save and compile the project.

The basic PLC program and the data types are up to date.

11.3 Updating instructions in the project

After upgrading the project from older versions (< V6.13), used instructions will not be automatically upgraded to the latest version of TIA Portal. When you compile the project, you receive the following error messages "Library version conflict for Serialize or Deserialize V2.1" if versions are not up-to-date. The current version used in the basic PLC program does not match the version of the instructions.

This is how you update the version of instructions

1. Open any function block in the editor, e.g. Main [OB1]. The program editor and the "Instructions" task card are shown.
2. Click on the "Update program in the current CPU" button in the "Instructions" task card. The instructions are automatically updated to the latest version.
   - Deserialize: V2.1
   - Serialize: V2.1

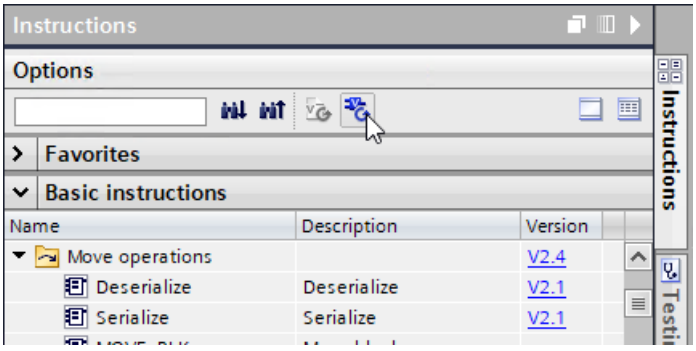


Figure 11-2 Updating instructions to the latest version TIA Portal

Alternatively, you can also set the version directly in the "Version" column to V2.1.

3. Save the project and compile the software. The project is compiled without error message.

Appendix

A

A.1 Communication and I/O

A.1.1 Communication connections

Various connections/protocols can be used for communication. The communications functions are based on the CP 1543-1 (see also the documentation references in the Note on NCU communications interfaces). An overview of the networking for the overall system and the possible communications connections, and the differences to the CP 1543-1 are displayed as follows.

Networking options

Generally, the following applies regarding connection configuration:

- Networking also possible via variable addressing (programming of T blocks).
- UDP/TCP connections are possible via configured and variable connections (programming of T blocks).
- RFC1006 (ISOonTCP) connections are only possible via configured connections.

The number and the types of possible communications connections are limited. Observe the following table.

Connection methods	Actual SINUMERIK	Virtual SINUMERIK
S7 connections (S7 protocol via RFC 1006)	128 S7 connections	Depending on S7DOS or SIMATIC NET license
ISOonTCP (RFC 1006)	Total number limited to 64 connections (ISOonTCP + TCP + UDP)	--
TCP connections		Total number limited to 64 connections (TCP + UDP)
UDP connections		
HMI connections (WinCC)	--	--
ISO connections (MAC-based without IP)	-- (Compiler signals error)	-- (Compiler signals error)
FDL connections	-- (PROFIBUS only)	-- (PROFIBUS only)
Fetch/Write (S5 protocol via ISOonTCP)	Total number limited to 16 connections (ISOonTCP + TCP)	--
Fetch/Write (S5 protocol via TCP)		16

A.1.2 Communication restrictions

The following points are not yet supported by the overall system for the communications connections.

- **Communication between machine tools**
  Only T blocks up to 2k in size (applicable for UDP connections only) can be used.
  Communication of interlinked (alongside one another and with one another) machine tools is only possible with restrictions due to the regulated size range.
  With greater data volumes, error code 8085 "The LEN parameter is larger than the highest permitted value." is issued upon call of the T block.
- **Communication connections**
  The number and the types of possible communications connections can only be used with restrictions. Refer to the table in the previous section Communications connections (Page 139).
- **Expansion of communications interfaces not possible**
  No external CMs or CPs can be connected.
- **Distributed numerical control I/O**
  Distributed NCK I/O (drives) is only supported at X150.
  Distributed NCK I/O (IOs) is supported at X150 and X126.
  Access from NCK to PROFINET/PROFIBUS I/O is only supported up to device number 255.
- **OPC UA**
  - The SINUMERIK OPC UA server (Access MyMachine / OPC UA) does not yet provide any access to PLC variables and can therefore only be used with restrictions.
  - Access to PLC variables is possible with the OPC UA server of the PLC.

A.1.3 I/O functionality

The following functions are currently supported by the overall system.

- **PLC drives**
  S7-Motion Control technology objects cannot be assigned to drive objects on SINAMICS Integrated or NX.
- **NCK I/O only available with restrictions**
  - Isochronous NCK drives such as SINAMICS Integrated or NX can be operated at the PROFIBUS DP Integrated interface (DRIVE-CLiQ).
  - Isochronous NCK drives such as CU320-2 PN can **only** be operated at the PROFINET PN1 interface (X150).
  - Isochronous NCK drives such as CU320-2 DP **cannot** be operated at the PROFIBUS DP1 interface.
  - NCK I/O peripherals such as ET200SP PN and PROFINET MCP with handwheel can be operated on the PROFINET PN1 interface (X150).
  - NCK I/O peripherals such as ET200SP DP or PROFIBUS MCP with handwheel can be operated on the PROFIBUS DP1 interface (X126) from NCU SW 6.14.
- **Limited operation of I/O and NCK drives**
  The supported connection options for the I/O are specified in the table.

	DP1 (X126) Interface	**DP Integrated Interface**	**PN1 (X150) Interface**	**PN2 (X160) Interface**
PLC I/O (e.g. ET200)	X	---	X	X
NCK I/O (e.g. ET200)	X*	---	X	---
Isochronous PLCs I/O (e.g. ET200)	X	---	X	---
Isochronous numerical control I/O (e.g. ET200)	X*	---	X	---
Isochronous PLCs + numerical controls I/O at the same interface	X*	---	X	---
Isochronous numerical control drives	---	X	X	---

	DP1 (X126) Interface	**DP Integrated Interface**	**PN1 (X150) Interface**	**PN2 (X160) Interface**
Isochronous NCK drives + isochronous PLC I/O at the same interface	---	---	X	---
Isochronous PLCs Drives (S7-Motion)	X	---	X	---

* as of NCU software 6.14

A.2 HMI

A.2.1 Restricted functions SINUMERIK ONE

The following functions are currently not supported by the overall system:

- **Several HMIs**
  The operation of multiple HMIs (SINUMERIK Operate) on one NCU is only possible with restrictions.
- **Evaluating diagnostic data in HMI**
  No diagnostics as with SI_DiagDB (SINUMERIK 840D sl) for SINUMERIK ONE F-operation.
- **Archives and topologies with multiple measuring systems**
  When reading in an archive, assignment of the topology is lost if the configurations are carried out with multiple measuring systems. You can adapt the topology assignment manually in SINUMERIK Operate after the import.
  You adapt the topology assignment in the following cases:
  - Import of a SINUMERIK 840D sl archive in a virtual SINUMERIK ONE.
  - Import of a virtual SINUMERIK ONE archive in a real SINUMERIK ONE.

The following functionalities can only be used with restrictions for the real SINUMERIK:

- **Archive creation with errors**
  Creation of a DSF archive is aborted if there is insufficient memory available on the storage medium. The non-specific message "Error in machine configuration" is displayed. In the event of this error occurring, first check the size of the available memory.

A.3 NCK

A.3.1 Differences regarding SINUMERIK 840D sl

The following functionalities of the NCK must be considered for SINUMERIK ONE:

- **MCP with handwheel via Industrial Ethernet (IE)**
  For transfer of the handwheel pulses from an IE-connected MCP on the NCK, the NCK machine data HANDWHEEL_SEGMENT must be specified with the value 6.

A.4 Standard telegram configuration of a SINUMERIK ONE

A.4.1 SINUMERIK-conformal telegram configuring

Rules for SINUMERIK-conformal telegram configuring of SINAMICS drives

To configure the data exchange between a SINUMERIK 828D, SINUMERIK ONE or SINUMERIK MC and SINAMICS S120 drives, the following rules must be observed for the PROFIBUS/PROFINET configuration of the drives:

- For SINAMICS drive devices (CU3xx) on PROFIBUS/PROFINET, the PROFIBUS/PROFINET configuration must be identical to the standard configuration of the telegrams of the drives on the integrated PROFIBUS (SINAMICS Integrated or NX) of a SINUMERIK 828D or SINUMERIK ONE with regard to the telegrams structure.
- The identical structure of the telegrams refers specifically to the sequence of telegrams for a drive (CU3xx). The telegrams must be configured in the following order:
  - Telegrams for SERVO or HLA drive objects
  - Telegram for the Control Unit drive object
  - Telegram for the infeed drive object
- The following rules must be observed for the telegrams of the individual drive objects:
  - The input and output address of a telegram must have the same value.
    Exception: User-specific telegrams that only have input or output values.
  - The input and output data of a telegram are generally transferred via the same slot. If two different slots are used for data exchange (for PROFIBUS or PROFIBUS Integrated), make sure that the input slot is defined first. The output slot must have the following slot number.

A.4.2 PROFIdrive telegrams for standard data

The I/O addresses of standard telegrams are compared to the following telegram configurations in the following:

- SINUMERIK ONE, from V6.14
- SINUMERIK 840D sl, from V4.94

Table A-1 SINAMICS Integrated: I/O addresses of PROFIdrive telegrams

Drive	Telegram type	I/O address (ONE)	I/O address (840D sl)	MD (ONE)
DriveAxis01	SIEMENS telegram 136	4100	4100	13050[0]
DriveAxis02	SIEMENS telegram 136	4140	4140	13050[1]
DriveAxis03	SIEMENS telegram 136	4180	4180	13050[2]
DriveAxis04	SIEMENS telegram 136	4220	4220	13050[3]
DriveAxis05	SIEMENS telegram 136	4260	4260	13050[4]

Drive	Telegram type	I/O address (ONE)	I/O address (840D sl)	MD (ONE)
DriveAxis06	SIEMENS telegram 136	4300	4300	13050[5]
DriveCU01	SIEMENS telegram 391	6500	6500	13120[0]
Infeed01	SIEMENS telegram 370	6514	6514	

Table A-2 NX on DRIVE-CLiQ socket X105; DP address 15: I/O addresses of PROFIdrive telegrams

Drive	Telegram type	I/O address (ONE)	I/O address (840D sl)	MD (ONE)
DriveAxis07	SIEMENS telegram 136	4340	4340	13050[6]
DriveAxis08	SIEMENS telegram 136	4380	4380	13050[7]
DriveAxis09	SIEMENS telegram 136	4420	4420	13050[8]
DriveAxis10	SIEMENS telegram 136	4460	4460	13050[9]
DriveAxis11	SIEMENS telegram 136	4500	4500	13050[10]
DriveAxis12	SIEMENS telegram 136	4540	4540	13050[11]
DriveCU02	SIEMENS telegram 390	6530	6530	
Infeed02	SIEMENS telegram 370	6534	6534	

Table A-3 NX on DRIVE-CLiQ socket X104; DP address 14: I/O addresses of PROFIdrive telegrams

Drive	Telegram type	I/O address (ONE)	I/O address (840D sl)	MD (ONE)
DriveAxis13	SIEMENS telegram 136	4580	4580	13050[12]
DriveAxis14	SIEMENS telegram 136	4620	4620	13050[13]
DriveAxis15	SIEMENS telegram 136	4660	4660	13050[14]
DriveAxis16	SIEMENS telegram 136	4700	4700	13050[15]
DriveAxis17	SIEMENS telegram 136	4740	4740	13050[16]
DriveAxis18	SIEMENS telegram 136	4780	4780	13050[17]
DriveCU03	SIEMENS telegram 390	6540	6560	
Infeed03	SIEMENS telegram 370	6544	6554	

Table A-4 NX on DRIVE-CLiQ socket X103; DP address 13: I/O addresses of PROFIdrive telegrams

Drive	Telegram type	I/O address (ONE)	I/O address (840D sl)	MD (ONE)
DriveAxis19	SIEMENS telegram 136	4820	4820	13050[18]
DriveAxis20	SIEMENS telegram 136	4860	4860	13050[19]
DriveAxis21	SIEMENS telegram 136	4900	4900	13050[20]
DriveAxis22	SIEMENS telegram 136	4940	4940	13050[21]
DriveAxis23	SIEMENS telegram 136	4980	4980	13050[22]
DriveAxis24	SIEMENS telegram 136	5020	5020	13050[23]
DriveCU04	SIEMENS telegram 390	6550	6590	
Infeed04	SIEMENS telegram 370	6554	6574	

Table A-5 NX on DRIVE-CLiQ socket X102; DP address 12: I/O addresses of PROFIdrive telegrams

Drive	Telegram type	I/O address (ONE)	I/O address (840D sl)	MD (ONE)
DriveAxis25	SIEMENS telegram 136	5060	5060	13050[24]
DriveAxis26	SIEMENS telegram 136	5100	5100	13050[25]
DriveAxis27	SIEMENS telegram 136	5140	5140	13050[26]
DriveAxis28	SIEMENS telegram 136	5180	5180	13050[27]
DriveAxis29	SIEMENS telegram 136	5220	5220	13050[28]
DriveAxis30	SIEMENS telegram 136	5260	5260	13050[29]
DriveCU05	SIEMENS telegram 390	6560	6620	
Infeed05	SIEMENS telegram 370	6564	6594	

Table A-6 NX on DRIVE-CLiQ socket X101; DP address 11: I/O addresses of PROFIdrive telegrams

Drive	Telegram type	I/O address (ONE)	I/O address (840D sl)	MD (ONE)
DriveAxis31	SIEMENS telegram 136	5300	5300	13050[30]
DriveAxis32	SIEMENS telegram 136	5340	5340	
DriveAxis33	SIEMENS telegram 136	5380	5380	
DriveAxis34	SIEMENS telegram 136	5420	5420	
DriveAxis35	SIEMENS telegram 136	5460	5460	
DriveAxis36	SIEMENS telegram 136	5500	5500	
DriveCU06	SIEMENS telegram 390	6570	6650	
Infeed06	SIEMENS telegram 370	6574	6614	

Table A-7 NX on DRIVE-CLiQ socket X100; DP address 10: I/O addresses of PROFIdrive telegrams

Drive	Telegram type	I/O address (ONE)	I/O address (840D sl)	MD (ONE)
DriveAxis37	SIEMENS telegram 136	5540	5540	
DriveAxis38	SIEMENS telegram 136	5580	5580	
DriveAxis39	SIEMENS telegram 136	5620	5620	
DriveAxis40	SIEMENS telegram 136	5660	5660	
DriveAxis41	SIEMENS telegram 136	5700	5700	
DriveAxis42	SIEMENS telegram 136	5740	5740	
DriveCU07	SIEMENS telegram 390	6580	6680	
Infeed07	SIEMENS telegram 370	6584	6634	

A.4.3 PROFIsafe/PROFIdrive telegrams for Safety Integrated (F-PLC)

The I/O addresses of safety-relevant telegrams are compared to the following telegram configurations in the following:

- SINUMERIK ONE, from V6.14
- SINUMERIK 840D sl, from V4.94

From the firmware versions of SINUMERIK ONE, the I/O addresses of SIEMENS telegram 903 no longer have to be entered in the machine data. The corresponding item in the 840D sl machine data is therefore not imported to the SINUMERIK ONE during the SINUMERIK archive migration.

Table A-8 SINAMICS Integrated: I/O addresses of PROFIsafe/PROFIdrive telegrams

Drive	Telegram type	I/O address (ONE)	I/O address (840D sl)	MD (ONE)
DriveAxis01	SIEMENS telegram 903	6700	1008	-
DriveAxis01	SIEMENS telegram 701	5800	5800	13374[0]
DriveAxis02	SIEMENS telegram 903	6716	992	-
DriveAxis02	SIEMENS telegram 701	5816	5816	13374[1]
DriveAxis03	SIEMENS telegram 903	6732	976	-
DriveAxis03	SIEMENS telegram 701	5832	5832	13374[2]
DriveAxis04	SIEMENS telegram 903	6748	960	-
DriveAxis04	SIEMENS telegram 701	5848	5848	13374[3]
DriveAxis05	SIEMENS telegram 903	6764	944	-
DriveAxis05	SIEMENS telegram 701	5864	5864	13374[4]
DriveAxis06	SIEMENS telegram 903	6780	928	-
DriveAxis06	SIEMENS telegram 701	5880	5880	13374[5]

Table A-9 NX on DRIVE-CLiQ socket X105; DP address 15: I/O addresses of PROFIsafe/PROFIdrive telegrams

Drive	Telegram type	I/O address (ONE)	I/O address (840D sl)	MD (ONE)
DriveAxis07	SIEMENS telegram 903	6796	912	-
DriveAxis07	SIEMENS telegram 701	5896	5896	13374[6]
DriveAxis08	SIEMENS telegram 903	6812	896	-
DriveAxis08	SIEMENS telegram 701	5912	5912	13374[7]
DriveAxis09	SIEMENS telegram 903	6828	880	-
DriveAxis09	SIEMENS telegram 701	5928	5928	13374[8]
DriveAxis10	SIEMENS telegram 903	6844	864	-
DriveAxis10	SIEMENS telegram 701	5944	5944	13374[9]
DriveAxis11	SIEMENS telegram 903	6860	848	-
DriveAxis11	SIEMENS telegram 701	5960	5960	13374[10]
DriveAxis12	SIEMENS telegram 903	6876	832	-
DriveAxis12	SIEMENS telegram 701	5976	5976	13374[11]

Table A-10 NX on DRIVE-CLiQ socket X104; DP address 14: I/O addresses of PROFIsafe/PROFIdrive telegrams

Drive	Telegram type	I/O address (ONE)	I/O address (840D sl)	MD (ONE)
DriveAxis13	SIEMENS telegram 903	6892	816	-
DriveAxis13	SIEMENS telegram 701	5992	5992	13374[12]
DriveAxis14	SIEMENS telegram 903	6908	800	-
DriveAxis14	SIEMENS telegram 701	6008	6008	13374[13]

Drive	Telegram type	I/O address (ONE)	I/O address (840D sl)	MD (ONE)
DriveAxis15	SIEMENS telegram 903	6924	784	-
DriveAxis15	SIEMENS telegram 701	6024	6024	13374[14]
DriveAxis16	SIEMENS telegram 903	6940	768	-
DriveAxis16	SIEMENS telegram 701	6040	6040	13374[15]
DriveAxis17	SIEMENS telegram 903	6956	752	-
DriveAxis17	SIEMENS telegram 701	6056	6056	13374[16]
DriveAxis18	SIEMENS telegram 903	6972	736	-
DriveAxis18	SIEMENS telegram 701	6072	6072	13374[17]

Table A-11 NX on DRIVE-CLiQ socket X103; DP address 13: I/O addresses of PROFIsafe/PROFIdrive telegrams

Drive	Telegram type	I/O address (ONE)	I/O address (840D sl)	MD (ONE)
DriveAxis19	SIEMENS telegram 903	6988	720	-
DriveAxis19	SIEMENS telegram 701	6088	6088	13374[18]
DriveAxis20	SIEMENS telegram 903	7004	704	-
DriveAxis20	SIEMENS telegram 701	6104	6104	13374[19]
DriveAxis21	SIEMENS telegram 903	7020	688	-
DriveAxis21	SIEMENS telegram 701	6120	6120	13374[20]
DriveAxis22	SIEMENS telegram 903	7036	672	-
DriveAxis22	SIEMENS telegram 701	6136	6136	13374[21]
DriveAxis23	SIEMENS telegram 903	7052	656	-
DriveAxis23	SIEMENS telegram 701	6152	6152	13374[22]
DriveAxis24	SIEMENS telegram 903	7068	640	-
DriveAxis24	SIEMENS telegram 701	6168	6168	13374[23]

Table A-12 NX on DRIVE-CLiQ socket X102; DP address 12: I/O addresses of PROFIsafe/PROFIdrive telegrams

Drive	Telegram type	I/O address (ONE)	I/O address (840D sl)	MD (ONE)
DriveAxis25	SIEMENS telegram 903	7084	624	-
DriveAxis25	SIEMENS telegram 701	6184	6184	13374[24]
DriveAxis26	SIEMENS telegram 903	7100	608	-
DriveAxis26	SIEMENS telegram 701	6200	6200	13374[25]
DriveAxis27	SIEMENS telegram 903	7116	592	-
DriveAxis27	SIEMENS telegram 701	6216	6216	13374[26]
DriveAxis28	SIEMENS telegram 903	7132	576	-
DriveAxis28	SIEMENS telegram 701	6232	6232	13374[27]
DriveAxis29	SIEMENS telegram 903	7148	560	-
DriveAxis29	SIEMENS telegram 701	6248	6248	13374[28]
DriveAxis30	SIEMENS telegram 903	7164	544	-
DriveAxis30	SIEMENS telegram 701	6264	6264	13374[29]

Table A-13 NX on DRIVE-CLiQ socket X101; DP address 11: I/O addresses of PROFIsafe/PROFIdrive telegrams

Drive	Telegram type	I/O address (ONE)	I/O address (840D sl)	MD (ONE)
DriveAxis31	SIEMENS telegram 903	7180	528	-
DriveAxis31	SIEMENS telegram 701	6280	6280	13374[30]
DriveAxis32	SIEMENS telegram 903	7196	512	-
DriveAxis32	SIEMENS telegram 701	6296	6296	
DriveAxis33	SIEMENS telegram 903	7212	496	-
DriveAxis33	SIEMENS telegram 701	6312	6312	
DriveAxis34	SIEMENS telegram 903	7228	480	-
DriveAxis34	SIEMENS telegram 701	6328	6328	
DriveAxis35	SIEMENS telegram 903	7244	464	-
DriveAxis35	SIEMENS telegram 701	6344	6344	
DriveAxis36	SIEMENS telegram 903	7260	448	-
DriveAxis36	SIEMENS telegram 701	6360	6360	

Table A-14 NX on DRIVE-CLiQ socket X100; DP address 10: I/O addresses of PROFIsafe/PROFIdrive telegrams

Drive	Telegram type	I/O address (ONE)	I/O address (840D sl)	MD (ONE)
DriveAxis37	SIEMENS telegram 903	7276	432	-
DriveAxis37	SIEMENS telegram 701	6376	6376	
DriveAxis38	SIEMENS telegram 903	7292	416	-
DriveAxis38	SIEMENS telegram 701	6392	6392	
DriveAxis39	SIEMENS telegram 903	7308	400	-
DriveAxis39	SIEMENS telegram 701	6408	6408	
DriveAxis40	SIEMENS telegram 903	7324	384	-
DriveAxis40	SIEMENS telegram 701	6424	6424	
DriveAxis41	SIEMENS telegram 903	7340	368	-
DriveAxis41	SIEMENS telegram 701	6440	6440	
DriveAxis42	SIEMENS telegram 903	7356	352	-
DriveAxis42	SIEMENS telegram 701	6456	6456	

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