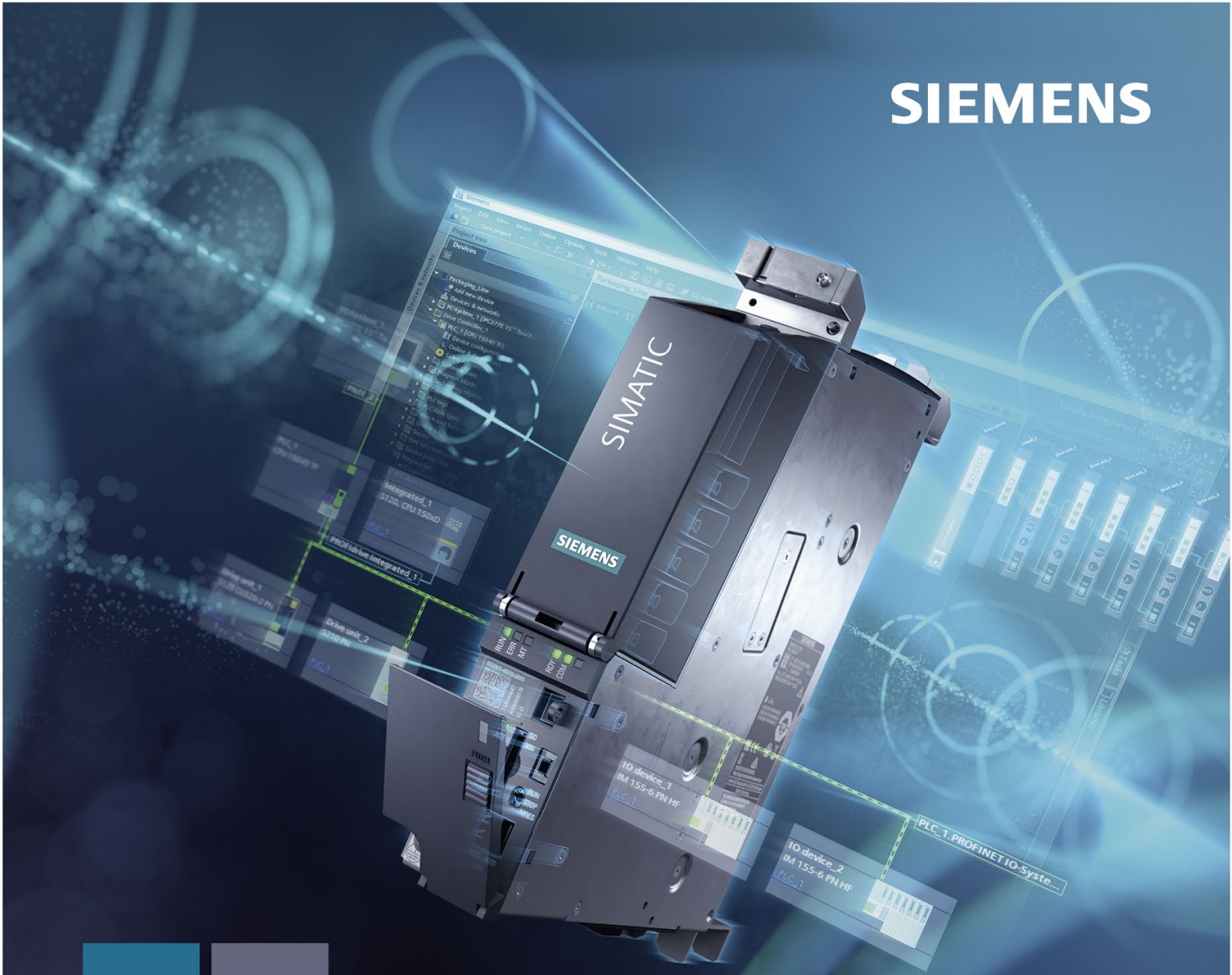
SIEMENS



Edition 11/2023

SYSTEM MANUAL

SIMATIC

S7-1500

SIMATIC Drive Controller

support.industry.siemens.com

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SIMATIC

SIMATIC Drive Controller

System Manual

Introduction 1
Safety information 2
New properties/functions 3
Industrial cybersecurity 4
System overview 5
Application planning 6
Installation 7
Connecting 8
Configuring 9
Basics of program execution 10
Protection 11
Flexible automation concepts 12
Commissioning 13
SIMATIC memory card 14
Maintenance 15
Test and service functions 16
Technical data 17
Information for users changing from SIMOTION D4x5-2 A
Accessories/spare parts B

11/2023
A5E46600094-AD

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.

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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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GERMANY

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Table of contents

1 Introduction 10

1.1 SIMATIC Drive Controller documentation guide 13
1.1.1 Information classes SIMATIC Drive Controller 13
1.1.2 SIMATIC Technical Documentation 14

2 Safety information 17

2.1 General safety information 17
2.1.1 Safety-relevant symbols 19

2.2 Residual risks of power drive systems 20

2.3 Unsafe operating states due to manipulation of software 21

3 New properties/functions 22

4 Industrial cybersecurity 24

4.1 Cybersecurity information 24

4.2 Security update notification 25

4.3 Basic information on industrial cybersecurity 25
4.3.1 Definition of industrial cybersecurity 25
4.3.2 Objectives of industrial cybersecurity 26

4.4 Integrated security concept and security strategies 26
4.4.1 Holistic "Defense in Depth" security concept 26
4.4.2 Security management 27

4.5 Operational environment and security assumptions 29
4.5.1 Intended use 29
4.5.2 Requirements for the operational application environment and security assumptions 30

4.6 Security properties of the devices 31

4.7 Secure operation of the system 31
4.7.1 Hardening measures 31
4.7.2 Secure configuration 32
4.7.3 Access control 32
4.7.4 Handling of sensitive data 32
4.7.5 Regular firmware updates 33
4.7.6 Notifications about security vulnerabilities (SIEMENS Security Advisories) 33
4.7.7 Data backup 34
4.7.8 Security checks 34
4.7.9 Secure decommissioning 34
4.7.9.1 Securely removing data 35
4.7.9.2 Recycling and disposal 36

4.8 Secure operation of the engineering software 37

4.9 Secure operation of CPUs ... 37
4.9.1 Secure configuration ... 37
4.9.2 User management and access control ... 37
4.9.2.1 Administration of user accounts ... 37
4.9.2.2 Assigning secure passwords ... 38
4.9.2.3 Password management ... 39
4.9.2.4 Setting protection levels ... 39
4.9.2.5 Certificate management ... 39
4.9.3 Protection functions ... 39
4.9.4 Web server ... 40
4.9.5 SINAMICS Integrated ... 40
4.9.6 Secure Communication/OPC UA ... 40
4.9.7 Sensitive data ... 41
4.9.8 Backups and data backups ... 41
4.9.9 Additional measures for network security ... 41
4.9.10 Remote access to CPU ... 42
4.9.10.1 Using a Web server ... 42
4.9.11 Recording Security events ... 42
4.9.12 Syslog messages ... 43
4.9.12.1 Transfer the syslog messages to a syslog server ... 45
4.9.12.2 Structure of the Syslog messages ... 49

4.10 Secure operation of SINAMICS Integrated ... 52
4.10.1 Write and know-how protection ... 53
4.10.1.1 Write and know-how protection for SINAMICS Integrated ... 53
4.10.1.2 Write and know-how protection for SINAMICS Startdrive ... 54
4.10.1.3 Know-how protection for SINAMICS Drive Control Chart ... 54
4.10.2 Scripting (Openness) ... 55
4.10.3 Using the memory card ... 55
4.10.4 Backing up and restoring data ... 55
4.10.4.1 Backing up data with SINAMICS Startdrive ... 56
4.10.4.2 Backing up data with STEP 7 Professional (TIA Portal) ... 56
4.10.4.3 Data backup/Further measures ... 57
4.10.4.4 Protecting backup files in the Windows file system ... 57
4.10.5 Communication services and used port numbers ... 57

4.11 Secure operation of interface modules ... 57

4.12 Secure operation of I/O modules ... 57

5 System overview ... 58

5.1 What is the SIMATIC Drive Controller? ... 58
5.1.1 Comparison of SIMATIC Drive Controller versions ... 58
5.1.2 Areas of application ... 60
5.1.3 Plant components and automation levels ... 65
5.1.4 Scalability ... 67
5.1.5 Overview of features ... 70

5.2 Configuration ... 71

5.3 SIMATIC Drive Controller functions ... 73
5.3.1 Safety ... 73
5.3.2 Security ... 77
5.3.3 Web server ... 81
5.3.4 Trace ... 82
5.3.5 Technology functions of the CPU ... 85
5.3.6 SINAMICS Integrated functions ... 91
5.4 Integrated interfaces for communication ... 94
5.5 DRIVE-CLiQ ... 95
5.6 Power supply ... 96
5.7 Software ... 97
5.7.1 TIA Portal ... 97
5.7.2 SINETPLAN ... 98
5.7.3 PRONETA ... 98
5.7.4 TIA Selection Tool ... 98
5.7.5 SIMATIC Automation Tool ... 99
5.7.6 SIMATIC S7 app ... 100
5.7.7 Industry Online Support app ... 100
6 Application planning ... 101
6.1 Installation location ... 101
6.2 Hardware and software requirements ... 103
6.3 Drive Controller-specific properties ... 104
6.3.1 Drive Controller-specific hardware properties ... 104
6.3.2 Drive Controller-specific properties of the CPU ... 104
6.3.3 Drive Controller-specific properties of SINAMICS Integrated ... 106
6.3.4 Drive Controller specific properties of the TIA Portal Openness API interface ... 108
6.4 Hardware configuration ... 109
6.5 Power supply ... 112
7 Installation ... 113
7.1 Installation notes ... 113
7.2 Mounting the SIMATIC Drive Controller ... 115
8 Connecting ... 117
8.1 Rules and regulations for operation ... 117
8.2 Additional rules and regulations for operation ... 120
8.2.1 Safety extra-low-voltage (SELV, PELV) for failsafe modules ... 120
8.2.2 Requirements of sensors and actuators for fail-safe modules ... 121
8.2.3 Capacitive crosstalk of digital input/output signals ... 123
8.3 Electrical configuration ... 124
8.4 Wiring rules ... 124
8.5 Connecting the supply voltage ... 125
8.6 PROFINET and PROFIBUS DP ... 127
8.7 Digital inputs and digital inputs/outputs X122, X132 and X142 ... 127

8.8 DRIVE-CLiQ interfaces X100 to X103 ... 130
8.9 Protective conductor and potential equalization, functional ground ... 131
8.10 Connecting cable shields ... 135
9 Configuring ... 137
9.1 Overview ... 137
9.2 Hardware/software requirements ... 138
9.3 Configuration procedure ... 139
9.4 Display in the TIA Portal ... 146
9.5 Configuration information ... 149
9.5.1 Notes on configuration software ... 149
9.5.2 Mixed operation of control modes for SINAMICS Integrated ... 151
9.5.3 Changing the current controller cycle time for SINAMICS Integrated ... 152
9.5.4 Determining the SINAMICS Integrated version ... 153
9.6 Address assignment ... 154
9.6.1 Addressing ... 154
9.7 Address space ... 155
9.7.1 Address space of the digital inputs and digital inputs/outputs ... 155
9.8 Process images and process image partitions ... 157
9.8.1 Process image - overview ... 157
9.8.2 Updating process image partitions in the user program ... 159
9.9 Configuration of digital inputs/outputs (X142) ... 160
9.9.1 Configuring the DI operating mode ... 162
9.9.2 Configuring the DQ operating mode ... 164
9.9.3 Configuring Timer DI operating mode ... 165
9.9.4 Configuring Timer DQ operating mode ... 170
9.9.5 Configuring Oversampling DI operating mode ... 177
9.9.6 Configuring Oversampling DQ operating mode ... 179
9.9.7 Configuring event/period measurement operating mode ... 181
9.9.8 Configuring Pulse width modulation (PWM) operating mode ... 188
9.9.9 Assignment of the control interface ... 191
9.9.10 Assignment of the feedback interface ... 192
9.9.11 Programming example ... 194
9.10 Configuring the digital inputs and digital inputs/outputs (X122/X132) ... 195
9.11 Configuring the clock system ... 197
9.11.1 Overview of isochronous mode ... 197
9.11.2 Configuring drives with SINAMICS Integrated isochronously ... 199
9.11.3 Configuring technology I/Os (X142) as isochronous ... 204
9.11.4 Configuring additional drives on PROFINET (X150) as isochronous ... 207
9.11.5 Configuring the PROFIBUS interface as isochronous ... 209
9.11.6 Setting the clock system ... 210
9.12 Configuring fail-safe technology CPU ... 218
10 Basics of program execution ... 222
10.1 Programming the CPU ... 222

10.2 Events and OBs ... 222
10.3 Asynchronous instructions ... 225
11 Protection ... 236
11.1 Overview of the protection functions ... 236
11.2 Protection of confidential configuration data ... 237
11.3 Local user management ... 237
11.3.1 Useful information on the local user administration and access control ... 237
11.3.2 Advantages of the local user administration and access control ... 240
11.3.3 From the access level to the function right of users ... 242
11.3.4 Information about compatibility ... 245
11.4 Configuring access protection for the CPU ... 247
11.5 Using the user program to set additional access protection ... 250
11.6 Know-how protection ... 251
11.7 Copy protection ... 254
11.8 Protection by locking the CPU ... 256
12 Flexible automation concepts ... 257
12.1 Standard machine projects ... 257
12.2 Configuration control (option handling) ... 261
12.3 TIA Portal Openness ... 263
13 Commissioning ... 264
13.1 Overview ... 264
13.2 Check before powering on for the first time ... 266
13.3 Commissioning procedure ... 266
13.3.1 Removing/plugging in a SIMATIC memory card ... 266
13.3.2 First power-on ... 269
13.3.3 Downloading a project to the device ... 270
13.4 Operating states of the CPU ... 271
13.4.1 Overview of operating modes: Startup, STOP, RUN ... 271
13.4.2 STARTUP operating state ... 272
13.4.3 STOP operating state ... 274
13.4.4 RUN operating state ... 275
13.4.5 Operating state transitions ... 276
13.5 SINAMICS Integrated operating states ... 277
13.6 Runtime licensing ... 278
13.7 CPU memory reset ... 281
13.7.1 Automatic memory reset ... 282
13.7.2 Manual memory reset ... 282
13.8 Configuring SIMATIC Drive Controller backup and restore ... 283
13.8.1 Backing up and restoring the CPU configuration ... 284
13.8.2 Backing up, restoring and deleting SINAMICS Integrated NVRAM data ... 288

13.9 Time synchronization ... 290
13.9.1 Time-of-day synchronization of the CPU ... 290
13.9.2 Time-of-day synchronization of SINAMICS drives ... 292
13.10 Identification and maintenance data ... 296
13.10.1 Reading out and entering I&M data ... 296
13.10.2 Record structure for I&M data ... 298
13.10.3 Example: Read out firmware version of the CPU with Get_IM_Data ... 300
13.11 Shared commissioning of projects ... 302
14 SIMATIC memory card ... 303
14.1 SIMATIC memory card – Overview ... 303
14.2 Setting the card type ... 310
14.3 Data transfer with SIMATIC memory cards ... 314
14.4 Service life of the SIMATIC memory card ... 316
15 Maintenance ... 317
15.1 Replacing system components ... 317
15.1.1 Replacing a defective SIMATIC Drive Controller ... 317
15.1.2 Replacing a defective SIMATIC memory card ... 318
15.1.3 Replacing a DRIVE-CLiQ component ... 319
15.2 SIMATIC Drive Controller firmware update ... 319
15.3 DRIVE-CLiQ component firmware update ... 327
15.4 System update SIMATIC Drive Controller ... 328
15.5 CPU reset to factory settings ... 329
15.6 SINAMICS Integrated reset to factory settings ... 332
15.7 Fault reactions with failsafe components ... 332
15.8 Temperature monitoring ... 335
15.9 Maintenance and repair ... 336
16 Test and service functions ... 337
16.1 Test functions ... 337
16.2 Reading/saving service data ... 343
16.3 Reading Open Source Software information ... 347
17 Technical data ... 349
17.1 Introduction ... 349
17.2 Standards and Approvals ... 349
17.3 Electromagnetic compatibility ... 351
17.4 Shipping and storage conditions ... 353
17.5 Mechanical and climatic ambient conditions ... 354
17.6 Information on insulation tests, protection class, degree of protection and rated voltage ... 356

A Information for users changing from SIMOTION D4x5-2 358
B Accessories/spare parts 361
Glossary 365
Index 379

Introduction

1

Purpose of the documentation

This documentation provides an overview of the SIMATIC Drive Controller family and important information on configuring, installing, wiring and commissioning.

Basic knowledge required

A basic knowledge of automation technology is required to understand the documentation.

Scope of the documentation

This documentation applies to all products from the SIMATIC Drive Controller product family.

Conventions

STEP 7: In this documentation, "STEP 7" is used as a synonym for all versions of the configuration and programming software "STEP 7 (TIA Portal)".

Please also observe notes marked as follows:

Note

A note contains important information on the product described in the documentation, on the handling of the product or on the section of the documentation to which particular attention should be paid.

Special information

Note

Important note for maintaining the operational safety of your plant

Plants with safety-related features are subject to special operational safety requirements on the part of the operator. The supplier is also obliged to comply with special product monitoring measures. For this reason, we inform you in personal notifications about product developments and features that are (or could be) relevant to the operation of plants from a safety perspective.

By subscribing to the corresponding notifications, you will ensure that you are always up-to-date and able to make changes to your system when necessary.

Log onto Industry Online Support. Follow the links below, and right-click on "email on update":

SIMATIC S7-1500/SIMATIC S7-1500F (https://support.industry.siemens.com/en/ww/de/ps/13716)

Distributed I/O (https://support.industry.siemens.com/cs/ww/en/ps/14029)

STEP 7 (TIA Portal) (https://support.industry.siemens.com/cs/ww/en/ps/14667)

SINAMICS S120 (https://support.industry.siemens.com/cs/ww/en/ps/13231)

SINAMICS Startdrive (https://support.industry.siemens.com/cs/ww/en/ps/13438)

Operator control and monitoring systems (https://support.industry.siemens.com/cs/ww/en/ps/14729)

Industrial communication (https://support.industry.siemens.com/cs/ww/en/ps/15247)

Safety systems – Safety Integrated (https://support.industry.siemens.com/cs/ww/en/ps/19902)

Note

When using F-CPUs in safety mode and fail-safe modules, note the description of the fail-safe system in the Programming and Operating Manual SIMATIC Safety - Configuring and Programming (https://support.industry.siemens.com/cs/ww/en/view/54110126).

Industry Mall

The Industry Mall is the catalog and order system of Siemens AG for automation and drive solutions on the basis of Totally Integrated Automation (TIA) and Totally Integrated Power (TIP).

You can find catalogs for all automation and drive products on the Internet (https://mall.industry.siemens.com).

Open-source software

Open-source software is used in the firmware of the SIMATIC Drive Controllers. The Open Source Software is provided free of charge. Siemens AG is liable for the product described, including the Open Source Software contained in it, pursuant to the conditions applicable to the product. Any and all liability is excluded:

- for use of the Open Source Software beyond the program sequence intended for the product by Siemens
- for defects caused by changes to the software

For legal reasons, Siemens AG is obliged to publish the original text of the license conditions and copyright notices. You can find it on the Internet in the FW downloads (https://support.industry.siemens.com/cs/de/en/view/109773914) and in the scope of supply of the SIMATIC Drive Controller for the firmware version that has been supplied (see the note on the type plate at the side).

In the case of SIMATIC Drive Controllers with HW function level FS 11 or higher, you can find this information on the device in readable form.
Instructions on how to read the information can be obtained from the lower, large QR code on the side of the nameplate of the SIMATIC Drive Controller and in the section Reading Open Source Software information (Page 347).

Note

Management of the license conditions and copyright notices of firmware updates

The license conditions and copyright notices in the scope of delivery can change as a result of firmware updates. In order to avoid license violations by the reseller and the buyer, if there are firmware updates, you must pass on the license conditions and copyright notices of the firmware update to the buyer (for example, by saving them to the SIMATIC Memory Card).

1.1 SIMATIC Drive Controller documentation guide

1.1.1 Information classes SIMATIC Drive Controller



The documentation for the SIMATIC Drive Controller is divided into three areas.

This arrangement enables you to access the specific content you require.

You can download the documentation free of charge from the Internet (https://support.industry.siemens.com/cs/ww/en/view/109742691).

Basic information



The System Manual describes in detail the configuration, installation, wiring and commissioning of the SIMATIC Drive Controllers.

The STEP 7 online help supports you in the configuration and programming.

Examples:

- SIMATIC Drive Controller System Manual
- Online help TIA Portal

Device information



Equipment manuals contain a compact description of the module-specific information, such as properties, wiring diagrams, characteristics and technical specifications.

Examples:

- SIMATIC Drive Controller CPU 1504D TF
- SIMATIC Drive Controller CPU 1507D TF

General information



The function manuals contain detailed descriptions on general topics relating to the SIMATIC Drive Controller and the S7-1500 automation system.

Examples:

- Function Manual Diagnostics
- Function Manual Communication
- Function Manual Motion Control
- Function Manual Web Server
- Function Manual Cycle and Response Times
- PROFINET Function Manual
- PROFIBUS Function Manual

Product Information on the SIMATIC Drive Controller

The Product Information contains changes and supplements to the SIMATIC Drive Controllers documentation. The Product Information takes precedence over the device and system manuals. You can find the latest Product Information on the SIMATIC Drive Controller on the Internet (https://support.industry.siemens.com/cs/ww/en/view/109772684).

Manual Collection S7-1500/ET 200MP

The Manual Collection contains the complete documentation on the SIMATIC S7-1500 automation system and the SIMATIC Drive Controller distributed I/O system ET 200MP gathered together in one file.

You can find the Manual Collection on the Internet.
(https://support.industry.siemens.com/cs/ww/en/view/86140384)

SIMATIC S7-1500 comparison list for programming languages

The comparison list contains an overview of which instructions and functions you can use for which controller families.

You can find the comparison list on the Internet.
(https://support.industry.siemens.com/cs/ww/en/view/86630375)

SINAMICS documentation

The SINAMICS documentation contains detailed descriptions of the SINAMICS S120 drive control and SINAMICS S210 servo drive systems.

You can find the documentation by entering the manual title in the search box on the Internet (https://support.industry.siemens.com/cs/ww/en/ps/13229/man).

The SINAMICS Technical Documentation
(https://support.industry.siemens.com/cs/ww/en/view/108993276) web page provides information on the following topics:

- Documentation overview
- Additional links for downloading documents
- Using documentation online (find and browse manual/information)

1.1.2 SIMATIC Technical Documentation

Additional SIMATIC documents will complete your information. You can find these documents and their use at the following links and QR codes.

The Industry Online Support gives you the option to get information on all topics. Application examples support you in solving your automation tasks.

Overview of the SIMATIC Technical Documentation

Here you will find an overview of the SIMATIC documentation available in Siemens Industry Online Support:



Industry Online Support International (https://support.industry.siemens.com/cs/ww/en/view/109742705)

Watch this short video to find out where you can find the overview directly in Siemens Industry Online Support and how to use Siemens Industry Online Support on your mobile device:



Quick introduction to the technical documentation of automation products per video (https://support.industry.siemens.com/cs/us/en/view/109780491)



YouTube video: Siemens Automation Products - Technical Documentation at a Glance (https://youtu.be/TwLSxxRQQsA)

Retention of the documentation

Retain the documentation for later use.

For documentation provided in digital form:

1. Download the associated documentation after receiving your product and before initial installation/commissioning. Use the following download options:
   - Industry Online Support International: (https://support.industry.siemens.com)

     The article number is used to assign the documentation to the product. The article number is specified on the product and on the packaging label. Products with new, non-compatible functions are provided with a new article number and documentation.
   - ID link:

     Your product may have an ID link. The ID link is a QR code with a frame and a black frame corner at the bottom right. The ID link takes you to the digital nameplate of your product. Scan the QR code on the product or on the packaging label with a smartphone camera, barcode scanner, or reader app. Call up the ID link.
2. Retain this version of the documentation.

Updating the documentation

The documentation of the product is updated in digital form. In particular in the case of function extensions, the new performance features are provided in an updated version.

1. Download the current version as described above via the Industry Online Support or the ID link.
2. Also retain this version of the documentation.

mySupport

With "mySupport" you can get the most out of your Industry Online Support.

Registration	You must register once to use the full functionality of "mySupport". After registration, you can create filters, favorites and tabs in your personal workspace.
Support requests	Your data is already filled out in support requests, and you can get an overview of your current requests at any time.
Documentation	In the Documentation area you can build your personal library.
Favorites	You can use the "Add to mySupport favorites" to flag especially interesting or frequently needed content. Under "Favorites", you will find a list of your flagged entries.
Recently viewed articles	The most recently viewed pages in mySupport are available under "Recently viewed articles".
CAx data	The CAx data area gives you access to the latest product data for your CAx or CAe system. You configure your own download package with a few clicks: • Product images, 2D dimension drawings, 3D models, internal circuit diagrams, EPLAN macro files • Manuals, characteristics, operating manuals, certificates • Product master data

You can find "mySupport" on the Internet. (https://support.industry.siemens.com/My/ww/en)

Application examples

The application examples support you with various tools and examples for solving your automation tasks. Solutions are shown in interplay with multiple components in the system - separated from the focus on individual products.

You can find the application examples on the Internet.
(https://support.industry.siemens.com/cs/ww/en/ps/ae)

Safety information 2

2.1 General safety information



⚠ WARNING

Electric shock and danger to life from other energy sources

Touching live parts can result in death or serious injury.

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

Follow the steps below to ensure safety:

1. Prepare for shutdown. Notify all those who will be affected by the procedure.
2. Disconnect the drive system and ensure it cannot be switched back on.
3. Wait until the discharge time specified on the warning labels has elapsed.
4. Check there is no voltage between any power connections or between 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 hazardous energy sources, such as compressed air, hydraulics and water. Put all energy sources in 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 with damaged devices

Improper handling of devices can result in damage.

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.

- Observe the limit values specified in the technical specifications during transport, storage, and operation.
- Do not use damaged devices.

⚠ WARNING

Unexpected movement of machines due to inactive safety functions

Safety functions that are inactive or that have not been adjusted accordingly can cause operational faults on machines that could lead to 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.

⚠ WARNING

Unexpected movement of machines caused by radio devices or cell phones

Using wireless devices or cell phones in the immediate vicinity of the components can cause the devices to malfunction. Malfunctions may impair the functional safety of machines and can therefore endanger people or lead to material damage.

- If you come closer than approx. 2 m to such components, switch off any radio devices or cell phones.
- Use the "SIEMENS Industry Online Support App" only on equipment that has been switched off.



⚠ WARNING

Interference from pacemakers and implants from electromagnetic fields (EMF)

Electromagnetic fields (EMF) are generated by the operation of electrical power equipment such as transformers, converters or motors.

People with pacemakers or implants are at a special risk in the immediate vicinity of these devices/systems.

- Ensure that the persons involved are the necessary distance away (minimum 2 m).

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



NOTICE

Device damage caused by electrical 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).

2.1.1 Safety-relevant symbols

The following table contains an explanation of the symbols located in your SIMATIC device, its packaging or the accompanying documentation.

Symbol	Meaning
	General warning sign **Caution/Notice** You must read the product documentation. The product documentation contains information about the potential risks and enable you to recognize risks and implement countermeasures.
	ESD symbol: Identifies electrostatic-sensitive devices (ESD)
	Read the information provided by the product documentation. ISO 7010 M002
	Ensure the device is only installed by electrically skilled person. IEC 60417 No. 6182
	Note that connected mains lines must be designed according to the expected minimum and maximum ambient temperature.
	Note that the device must be constructed and connected in accordance with EMC regulations.
	Note that a 230 V device can be exposed to electrical voltages which can be dangerous. ANSI Z535.2

Symbol	Meaning
	Note that a device of Protection Class III may only be supplied with a protective low voltage according to the standard SELV/PELV. IEC 60417-1-5180 "Class III equipment"
	Be aware that the device is only approved for the industrial field and only for indoor use.
	Note that an enclosure is required for installing the device. Enclosures are considered: • Standing control cabinet • Serial control cabinet • Terminal boxes • Wall enclosure

2.2 Residual risks of power drive systems

When performing the risk assessment for a machine or plant in accordance with the respective local regulations (e.g. EC Machinery Directive), the machine manufacturer or plant constructor must take into account the following residual risks associated with 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-rays, 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

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

2.3 Unsafe operating states due to manipulation of software

⚠ WARNING

Unsafe operating states due to software manipulation

Software manipulation, for example viruses, Trojans, and malware, can cause unsafe operating states in your plant which may result in death, serious injury, and material damage.

- Keep the software up-to-date.
- Integrate the automation and drive components into a holistic, state-of-the-art Industrial Security concept for the plant or machine.
- Consider all of the products used in your holistic Industrial Security concept.
- Use suitable protective measures such as virus scanners to protect the files on removable media from malware.
- Check all security settings when completing commissioning.
- Set up access protection for the CPU.
- Set up know-how protection for blocks (OB, FB, FC, global data blocks).
- Protect the drive from unauthorized changes by enabling the "Know-how protection" converter function.

New properties/functions

3

What's new in the SIMATIC Drive Controller System Manual, edition 11/2023 compared to edition 11/2022?

What's new?		What are the customer benefits?	Where can I find information?
New contents	Industrial cybersecurity	Due to the digitalization and increasing networking of machines and industrial plants, the risk of cyber attacks is also growing. Appropriate protective measures are therefore mandatory, particularly in the case of critical infrastructure facilities. The section contains the following information: • Basic information on the subject of industrial cybersecurity • Measures to protect individual components and the entire system against manipulation and unwanted access.	Section Industrial cybersecurity (Page 24)
	Syslog messages	The CPU stores syslog messages in a local cache (temporary storage). The messages can be forwarded to a syslog server.	Section Syslog messages (Page 43)
	Local user management	As of TIA Portal version V19 and FW version V3.1, the CPUs feature improved management of users, roles and CPU function rights (User Management & Access Control, UMAC). As of the above-named version, you manage all project users along with their rights (e.g. access rights) for all CPUs in the project. You do this in the editor for users and roles in the TIA Portal.	Section Local user management (Page 237)
	The following technology objects are provided with the SIMATIC Motion Interpreter: • Interpreter • Interpreter program • Interpreter mapping Motion Control Language (MCL) is supported.	• Sequential programming of technology and motion tasks takes place separately and independently of the cyclic user program of the CPU • Integrated extensions for technological tasks, e.g. path-synchronous actions • Simple and fast programming through configuration dialogs	Section Technology functions of the CPU (Page 85) S7-1500T Motion Control function manuals (https://support.industry.siemens.com/cs/ww/en/view/109751049)

What's new?		What are the customer benefits?	Where can I find information?
	The following SINAMICS functions are supported in addition for SINAMICS Integrated: • SINAMICS Technology Extension POLYGON (Polygonal Line) • SINAMICS Technology Extension SETPGEN (Setpoint Generator) Additional technology extension will be available soon	Extended areas of application: • Setpoint specification or adaptation (e.g. speed, torque) via a user-defined polygon function • Signal generator with predefined waveforms (sine, square, sawtooth)	Section Runtime licensing (Page 278)
Changed contents	Digital nameplate • Nameplates with QR code and ID Link (introduced earlier with HW function version FS 11)	• Simplified access to product data, manuals, declarations of conformity, certificates and other helpful information about your product. • Environmentally sustainable solution by eliminating product inserts (e.g. CD and product information in paper form)	SIMATIC Drive Controller Equipment Manual (https://support.industry.siemens.com/cs/ww/en/view/109766666), Nameplates section
	Open Source Software information • OSS information can be read from the CPU via a memory card (introduced earlier with HW function version FS 11)	• Environmentally sustainable solution by eliminating product inserts (e.g. CD and product information in paper form)	Section Reading Open Source Software information (Page 347)
	New SINAMICS Integrated firmware (new hotfix based on V5.2 SP3)	Optimizations and extended module spectrum (for example, SINAMICS S220 Motor Modules)	Product announcements for the SINAMICS S120 drive system (https://support.industry.siemens.com/cs/de/en/ps/13229/pm)
	The information in the product information on the SIMATIC Drive Controller, edition 03/2023, has been integrated into the System Manual and Equipment Manual.	Information in the documentation has been updated and is available centrally.	Various places in the SIMATIC Drive Controller System Manual and Equipment Manual

Industrial cybersecurity

4

Due to the digitalization and increasing networking of machines and industrial plants, the risk of cyber attacks is also growing. Appropriate protective measures are therefore mandatory, particularly in the case of critical infrastructure facilities.

In the first part of this section, you will find basic information on the subject of industrial cybersecurity. Subsequent sections describe recommended measures for protecting the entire system and individual components from manipulation and unwanted access.

Note

Security-relevant changes to software or devices are documented in the section New properties/functions (Page 22).

4.1 Cybersecurity information

Siemens provides products and solutions with industrial cybersecurity 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 cybersecurity 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 more information on protective industrial cybersecurity measures for implementation, please visit (https://www.siemens.com/global/en/products/automation/topic-areas/industrial-cybersecurity.html).

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 customers' exposure to cyber threats.

To stay informed about product updates at all times, subscribe to the Siemens Industrial Cybersecurity RSS Feed under (https://new.siemens.com/global/en/products/services/cert.html).

4.2 Security update notification

Observe the special information on maintaining the operational security of your plant in the section Introduction (Page 10).

Set up notification of security updates

To receive notifications about security updates, proceed as follows:

1. Register on mySiePortal (https://sieportal.siemens.com/en-ww/home).
2. Enter the keyword "Security" in the search engine.
3. Choose the "Search in Knowledge base" option.
4. Select the "Other types" option from the filter menu for "Type," and then choose "Download" and "Product note".
5. Select the document from which you want to create notifications.
6. For information on setting up email notification, watch the video Custom notifications and filters (https://cache.industry.siemens.com/dl/dl-media/691/90000691/att_1036866/v1/How-to_Videos-SIOS_EN/story_html5.html?lang=en).

4.3 Basic information on industrial cybersecurity

4.3.1 Definition of industrial cybersecurity

Industrial cybersecurity is generally understood to mean all measures to protect against the following threats:

- Loss of confidentiality due to unauthorized access to data
- Loss of integrity due to manipulation of data
- Loss of availability (e.g. due to the destruction of data or denial of service (DoS))

4.3.2 Objectives of industrial cybersecurity

The objectives of industrial cybersecurity are:

- Trouble-free operation and ensuring the availability of industrial plants and production processes
- Prevention of risks to people and production from cybersecurity attacks
- Protection of industrial communication against espionage and manipulation
- Protection of industrial automation systems and components against unauthorized access and data loss
- Provision of a practical and cost-effective concept for securing existing plants and devices without their own security functions
- Use of existing, open, and proven industrial security standards
- Compliance with legal requirements

An optimized and adapted security concept applies to automation and drive technology. The security measures must not impede or endanger production.

4.4 Integrated security concept and security strategies

4.4.1 Holistic "Defense in Depth" security concept

With Defense in Depth, Siemens provides a multi-layer security concept that offers industrial plants comprehensive and far-reaching protection in accordance with the recommendations of the IEC 62443 international standard.

Productivity and know-how are protected on 3 levels:

Plant security

Plant security uses various methods to secure the physical access of people to critical components. This starts with classic building access and extends to securing sensitive areas using access control (for example, code card, iris scan, fingerprint or access code).

Network security

Automation networks must be protected against unauthorized access. This is achieved through security measures on the product, but also those in the product-related environment.

System integrity

Targeted measures must be taken to protect existing know-how or to prevent unauthorized access to automation processes.

You can find more information on the following topics on the SIEMENS web page Industrial Cybersecurity (https://www.siemens.com/us/en/company/topic-areas/cybersecurity/industrial-security.html).

- Defense in Depth
- Plant security
- Network security
- System integrity

Also make use of the Download Center (https://www.siemens.com/us/en/company/topic-areas/cybersecurity/industrial-security/downloads.html) to obtain more information on industrial cybersecurity. The "Operational Guidelines", for example, provide recommendations on basic security measures for secure machine and plant operation in an industrial environment.

4.4.2 Security management

The ISO 27001 and IEC 62443 standards call for a comprehensive approach in IT and OT to protect against cyberattacks.

Responsibility for cybersecurity and IT security

Every operator of machinery and equipment is responsible for:

- Establishment of cybersecurity and IT security as an important criterion in the procurement and selection of machines and software applications.
- Use of suitable measures to protect production resources, data, and communication from manipulation and theft
- Provision of all necessary resources and training to employees to fully support these goals

For this purpose, suitable measures must be selected after a risk assessment and a cost-benefit analysis in order to protect material and intellectual property and prevent damage from occurring. These measures should be integrated into corporate processes and procedures, evaluated regularly, and firmly anchored in the corporate culture. In addition to protecting intellectual property, the protection of personal data must be ensured at all organizational units and levels.

Siemens will provide you with information and support. Subscribe to the RSS feed (https://www.siemens.com/cert) for vulnerabilities. Register on mySiePortal (https://sieportal.siemens.com/en-ww/home) and create filters to be notified when important information is published. Consider using Siemens Cybersecurity Services.

Responsibility in the digital supply chain

Cybersecurity should play a critical role in the evaluation and procurement process. The entire life cycle of a product should be considered to ensure protection against current and future risks. These include, for example, security updates throughout the product life cycle, including guidelines for secure disposal of the product.

Siemens plans and announces the release of security updates, discontinuation of products and cancellation of product support.

Employee awareness

Regular training in cybersecurity and continuous testing of training success are essential so that cybersecurity measures are internalized in processes and work instructions. This involves general training in the use of software and IT hardware for company communication and as work tools, e.g.:

- secure handling of USB devices
- encrypted communication
- use of VPN
- rules for passwords and use of access
- setting up two-factor authentication
- educating employees about the dangers posed by malware, phishing, social engineering, etc.

Furthermore, if applicable, production equipment and software training should always include the topic of cybersecurity.

Maintaining the security concept through updates

Keeping software up-to-date is essential, for example, to benefit from the following measures:

- Implementation of new security strategies, protocols and techniques
- Closing of security vulnerabilities
- Elimination of security vulnerabilities

To this end, it is necessary to keep a constant eye on the further development of protective measures and, if necessary, the expansion of requirements.

It is recommended to:

- Set up notifications for (security) updates
- Subscribe to information on vulnerabilities
- Monitor and implement the further development of the technology, especially in the area of cybersecurity

In short: Always keep technology and knowledge up to date.

Consideration of the risks posed by cyber attacks in the Threat and Risk Assessment (TRA)

Make an inventory of all software, hardware, and infrastructure devices, in order to identify risks to the location or organization. Incident response procedures must be incorporated into all IT and manufacturing processes. The choice of risk mitigation measures should be based on a cost-benefit analysis and classification of risks. This is followed by the introduction of cybersecurity rules and procedures and the training of personnel.

Living the concept

Technical solutions alone are not sufficient to effectively counter threats.

Cybersecurity must be part of the corporate culture and process landscape and must be internalized and lived by all employees.

Continuously monitoring the security situation

Continuous monitoring of the cybersecurity situation through:

- Setting anomaly references and creating allow and deny lists based on normal network communication and production machine behavior
- Establishment of an intrusion detection system (IDS) that generates alarms when unusual behavior occurs in the network
- Introduction of a Security Incident and Event Management (SIEM) system to collect, analyze, and evaluate events in real time to enable early countermeasures
- Measures regarding network security: e.g. network segmentation, firewalls, VPN, DMZ (demilitarized zones)

4.5 Operational environment and security assumptions

4.5.1 Intended use

SIMATIC products are intended for use in industry. If you plan to use the product in a different environment, check the conditions required for such use.

The product may be operated only by personnel qualified for the specific task in accordance with the relevant documentation, in particular its warning notices and safety information. 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.

Operational reliability and intended use

Observe the "Special information" section in Introduction (Page 10).

Area of application

Observe the section Areas of application (Page 60).

4.5.2 Requirements for the operational application environment and security assumptions

Siemens recommends the following security measures:

- Conducting a threat and risk assessment (as part of security management)
- Network security concepts
  - Network segmentation
  - Asset and network management
  - Network protection
  - Remote access
- Access control concepts (utilizing access control systems)
  - Physical protection
  - Physical enterprise security
  - Physical product security

Threat and Risk Assessment

Vulnerabilities and risks are identified, and countermeasures are proposed to ensure the security of the system, networks, and data.

Network security concepts

You can find information on network security in the white paper "Industrial Network Security Architecture", available from the Download Center (https://www.siemens.com/us/en/company/topic-areas/cybersecurity/industrial-security/downloads.html) on the Industrial Cybersecurity (https://www.siemens.com/us/en/company/topic-areas/cybersecurity/industrial-security.html) web page.

Access control concepts

Physical protection

In addition to closing off and/or monitoring entire production facilities, it may be necessary to physically secure cabinets or even individual components such as circuit breakers.

Physical enterprise security

Physical enterprise security can be ensured by the following measures:

- Closed off and monitored company premises
- Access control, locks/card readers, and/or security personnel
- Accompaniment of non-employees by company personnel
- Employees are trained on and embrace security processes within the company

Physical production security

Physical production security can be ensured through measures such as:

- Separate access control for critical areas, such as production areas.
- Installation of critical components in lockable cabinets/control rooms with monitoring and alarm capabilities. The cabinets/control rooms must be secured with a cylinder lock. Do not use simple locks, such as universal, triangular/square, or double-bit locks.
- Radio field planning to limit WLAN coverage areas, preventing them from extending beyond defined zones (e.g. factory floor).
- Guidelines that prohibit the use of external, insecure data storage media (such as USB flash drives) and IT devices (such as laptops) on systems.

4.6 Security properties of the devices

The security properties of the individual devices are listed in the Equipment Manuals.

4.7 Secure operation of the system

This section describes measures recommended by Siemens to protect your system from manipulation and unauthorized access.

4.7.1 Hardening measures

System hardening, also referred to simply as hardening, is the secure configuration of products or systems. The aim is to close vulnerabilities and take various measures to reduce the attack surfaces for cyberattacks.

Measures for system hardening include, for example:

- Secure configuration in which only software components and services actually needed for operation are installed or activated.
- Access control in which a restrictive user and rights management system is implemented.

4.7.2 Secure configuration

Secure configuration involves control over all software components, along with their interfaces, ports, and services.
Activated services and ports pose a risk.

- One possible risk is unauthorized access to the network.
- Another risk is unauthorized access to programs.

To minimize risks, only the necessary services should be activated for all automation components.

- Take into account all activated services (especially web servers, FTP, remote maintenance etc.) in the security concept.
- Consider the default states of ports and services in your security concept.

You can find an overview of all ports and services used in the Communication Function Manual (https://support.industry.siemens.com/cs/ww/en/view/59192925).

4.7.3 Access control

In addition to physical protection, also establish logical safeguards to control access to your system:

- Use a restrictive user and rights management system (e.g. for accessing TIA Portal)
- Observe the information regarding password management in the section Protection (Page 236) and in the STEP 7 online help (TIA Portal).

4.7.4 Handling of sensitive data

When storing your security-relevant data on your PC, independently ensure secure data storage.

Observe also the section Data worth protecting (Page 41).

4.7.5 Regular firmware updates

Note

Outdated firmware versions might not be monitored for security vulnerabilities.

- Always keep your system/products up to date to benefit from bug fixes and to minimize potential risks.
- Use email notifications to be automatically informed about firmware updates.

There are two ways of being automatically informed about firmware updates:

- Use "Enable notification" and "Add to mySupport favorites" functions, see the section Notification of security updates (Page 25) .
- Consult the firmware collection on SIOS. To do this, register in the download section on mySiePortal (https://sieportal.siemens.com/en-ww/home).

Observe also the basic cybersecurity information in the section Cybersecurity information (Page 24).

For more information, see also the section SIMATIC Drive Controller firmware update (Page 319).

4.7.6 Notifications about security vulnerabilities (SIEMENS Security Advisories)

A vulnerability is a security vulnerability in information security. It can pose a threat as it provides intruders with the opportunity to access system resources and manipulate or steal data.

SIEMENS ProductCERT

When Siemens identifies Vulnerabilities in their products, this is published in Security Advisories.

You can find the documents for SIMATIC on the following Siemens AG Web page: Siemens ProductCERT and Siemens CERT (https://new.siemens.com/global/en/products/services/cert.html?s=SIMATIC#SecurityPublications)

Enter "SIMATIC" in the search box "Search Security Advisories".

On this page, you will also find all necessary information on handling vulnerabilities:

- Contact persons for matters related to vulnerabilities
- Options for automated notifications regarding vulnerabilities
- Notifications are also possible in CSAF format
- Option to subscribe to RSS feeds and newsletters

- List of all current vulnerabilities and detailed information such as:
  - Description
  - Score according to Common Vulnerability Scoring System (CVSS)
  - Measures
  - Availability
  - Etc.
- Report possible vulnerabilities yourself at (https://new.siemens.com/global/en/products/services/cert.html#ContactInformation)

Set up an RSS feed to receive notifications about security-related topics.

4.7.7 Data backup

Secure your configuration and parameter settings so that you can quickly restore this data if needed.

4.7.8 Security checks

Security checks for data, files and archives serve to protect data integrity at the storage location and during file transfer from manipulation and transmission errors. This is often achieved using digital checksums that are provided alongside the data. Tools (such as SHA-256 or SHA-512) for calculating and verifying these checksums are provided in many systems and named according to their respective calculation methods.

- File Integrity Guidelines describe the prescribed procedure for integrity checks
- Integrity protection is a protection function for engineering data and firmware files
- Communication integrity means protecting communication against unauthorized manipulations to ensure high system availability. A central element in this regard is, for example, the use of digital checksums when accessing controllers. (Source: Industrial Cybersecurity web page (https://www.siemens.com/us/en/company/topic-areas/cybersecurity/industrial-security.html))

4.7.9 Secure decommissioning

In the following section, you will find information on how to properly decommission components of the SIMATIC Drive Controller. Decommissioning is necessary if the components have reached the end of their service life.

Decommissioning includes environmentally sound disposal and secure removal of all digital data of electronic components with storage medium.

4.7.9.1 Securely removing data

Before disposing of components of the SIMATIC Drive Controller, you should securely delete all data from the storage media of these components.

NOTICE
Data misuse resulting from non-secure deletion of data Incomplete or non-secure deletion of data from data memories can result in data misuse by third parties. For this reason, ensure secure deletion of data from all storage media before disposing of the product.

To remove all the data from the data memories of the SIMATIC Drive Controller, first reset the SINAMICS Integrated and then the CPU (PLC) to the factory settings. For this purpose, use the "Factory reset" function, which will reset the SINAMICS Integrated or the CPU (PLC), as the case may be, to the delivery state. The function deletes all information that was stored internally.

Deleting data

For secure deletion of data from the SIMATIC Drive Controller and the SIMATIC Memory Card, follow these steps in the order given:

1. Establish an online connection to the CPU (PLC) and to the SINAMICS Integrated.
2. Open the online and diagnostics view of SINAMICS Integrated from the project context.
3. In the dialog box, select "Backup/Restore > Reset to factory settings" and then the "Start" button. Click "OK" in response to the confirmation prompt.
4. Open the online and diagnostics view of CPU (PLC) from the project context.

5. In the dialog box, select "Functions > Reset to factory settings". Before resetting, select the options shown in the figure. Select the option "Format memory card" only if the entire contents of the SIMATIC Memory Card are to be deleted.

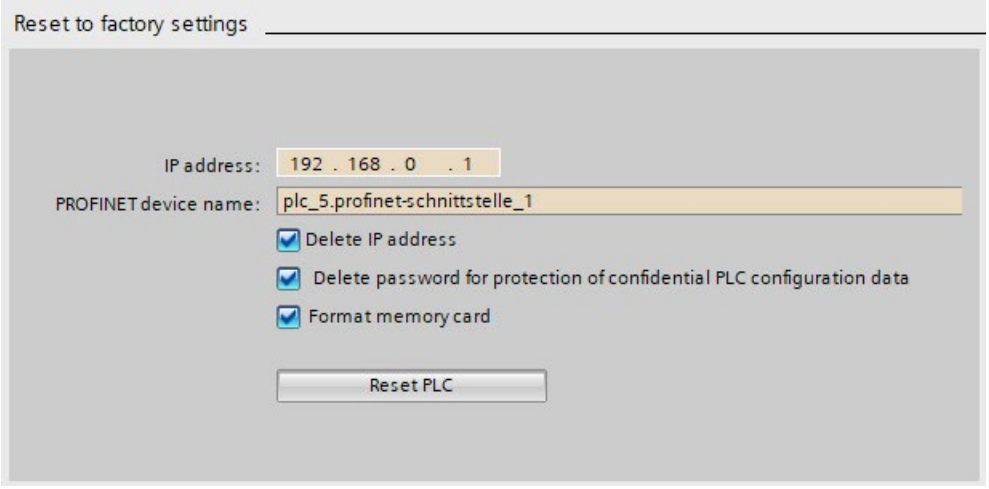


Figure 4-1 Restore factory settings

Note

The factory setting of the SINAMICS Integrated must always be restored first. If the CPU (PLC) is factory reset first, an online connection to the SINAMICS Integrated will not be possible due to the routing information being absent.

Detailed information on resetting to factory settings can be found in the following sections:

- CPU reset to factory settings (Page 329)
- SINAMICS Integrated reset to factory settings (Page 332)

Result: All the data that was still in the data memories of the SIMATIC Drive Controller and the SIMATIC Memory Card was deleted. You can now hand over the components for disposal.

Note

If you no longer plan to use the SIMATIC Memory Card after formatting it, destroy it before disposing of it.

A secure destruction method is to shred the card to such a degree that it cannot be reconstructed. For this, you can also use a waste disposal service that specializes in data storage medium destruction.

4.7.9.2 Recycling and disposal

For environmentally friendly recycling and disposal of your old equipment, contact a certified electronic waste disposal company and dispose of the equipment according to the applicable regulations in your country.

4.8 Secure operation of the engineering software

For more information on secure operation of the engineering software, refer to the TIA Portal online help.

4.9 Secure operation of CPUs

This section describes measures recommended by Siemens to protect your device from manipulation and unauthorized access.

4.9.1 Secure configuration

Information about ports, services and default states can be found in the Communication Function Manual (https://support.industry.siemens.com/cs/ww/en/view/59192925) and the SIMATIC Drive Controller Equipment Manual (https://support.industry.siemens.com/cs/ww/en/view/109766666).

4.9.2 User management and access control

4.9.2.1 Administration of user accounts

Creating and managing user accounts with appropriate usage rights is an important measure, as every active user represents a potential security risk.

Take the following security measures:

- Train your personnel in understanding their rights and password assignment
- Regularly check the user accounts

You can find information on creating and managing user accounts in the section Local user management (Page 237) and in the STEP 7 online help (TIA Portal).

4.9.2.2 Assigning secure passwords

Using non-secure passwords can easily lead to data misuse. Non-secure passwords can be easily guessed or decrypted.

- Therefore, always change the default passwords during commissioning and use different passwords for different functions and devices.
- When changing the password, do not use old passwords (or portions thereof) that were used in the past.
- Also, change passwords for functions you don't personally use to prevent misuse of such unused functions.
- Always keep your passwords confidential and ensure that only authorized individuals have access to the respective passwords.
- Exceed the required minimum password length and use a combination of lowercase letters, uppercase letters, numbers and special characters.

You can find information on assigning secure passwords in the STEP 7 online help (TIA Portal).

Overview of all components and functions with password protection

Components and functions with password protection	Comment
SIMATIC S7 app	See the section SIMATIC S7 app (Page 100)
CPU	See the Communication Function Manual (https://support.industry.siemens.com/cs/ww/en/view/59192925), section Secure Communication
OPC UA	See the Communication Function Manual (https://support.industry.siemens.com/cs/ww/en/view/59192925), section OPC UA Communication
SNMP Community-String (similar to a password)	See the Communication Function Manual (https://support.industry.siemens.com/cs/ww/en/view/59192925), section SNMP
Secure communication (with certificate protection)	See the Communication Function Manual (https://support.industry.siemens.com/cs/ww/en/view/59192925), section Secure Communication
Web server	See the Web Server Function Manual (https://support.industry.siemens.com/cs/ww/en/view/59193560)

4.9.2.3 Password management

- You can find comprehensive recommendations for assigning secure passwords in the Industrial Security Configuration Manual (https://support.industry.siemens.com/cs/de/de/view/108862708/en).
- Establishing guidelines for assigning passwords and the interval for password changes
- Settings can be made in the TIA Portal to check new or changed passwords for adherence to the guidelines. You can find more information in the Communication Function Manual (https://support.industry.siemens.com/cs/ww/en/view/59192925).
- Changing and resetting the password for protection of confidential configuration data.

  You can find a description of how to do the following in the Communication Function Manual (https://support.industry.siemens.com/cs/ww/en/view/59192925):

  - Change the password
  - Delete or reset the password
  - Assign the password via a SIMATIC Memory Card
- For user management and access control, use local user management (Page 237).
- Using a password provider: A password provider can be set up in STEP 7, see the section Know-how protection (Page 251).
- Alternatively, commercially available password management programs can be used.

4.9.2.4 Setting protection levels

Detailed information on setting up protection levels for the CPU and assigning user authorizations can be found in the section Configuring access protection for the CPU (Page 247) and the STEP 7 online help (TIA Portal).

4.9.2.5 Certificate management

You can find all the relevant information about "Certificate management" in the Communication Function Manual (https://support.industry.siemens.com/cs/ww/en/view/59192925).

4.9.3 Protection functions

Integrated protection functions of the CPU protect against unauthorized access.

You can find an overview of the protection functions supported by your CPU in the SIMATIC Drive Controller Equipment Manual (https://support.industry.siemens.com/cs/ww/en/view/109766666).

A description of the protection functions and their activation can be found in the section Protection (Page 236).

4.9.4 Web server

The CPUs of the SIMATIC Drive Controller have an integrated web server.

It comes with built-in security features:

- Access via the secure transmission protocol "HTTPS" using the CA-signed Web server certificate
- User authorization you can configure by means of user list
- Activation for specific interfaces

The functions are described in detail in the Web Server Function Manual (https://support.industry.siemens.com/cs/ww/en/view/59193560).

4.9.5 SINAMICS Integrated

The CPUs of the SIMATIC Drive Controller have an integrated SINAMICS S120 drive control (SINAMICS Integrated).

You can find more information on the security functions of SINAMICS Integrated in the section Secure operation of SINAMICS Integrated (Page 52).

4.9.6 Secure Communication/OPC UA

Additional protection is provided by the protection functions of the secure communication and OPC UA protocols.

Information on the Secure Communication and OPC UA protocols can be found in the Communication Function Manual (https://support.industry.siemens.com/cs/ww/en/view/59192925).

4.9.7 Sensitive data

Security-relevant and sensitive data can be protected through appropriate measures such as passwords and protection functions.
For certain data, protection is already essential and implemented within the system (e.g. certificate management in the TIA Portal).

Sensitive data	Comment	Where can I find more information?
Confidential configuration data (private keys, passwords/access data)	Protection by using a strong password	Communication Function Manual (https://support.industry.siemens.com/cs/ww/en/view/59192925), section Protection of confidential configuration data
User management data	-	STEP 7 online help
Configuration of CPUs and interface modules	Protection through PROFINET Security Class 1	PROFINET with STEP 7 Function Manual
Blocks (data blocks, logic blocks)	Know-how protection, copy protection, write protection	Section Protection (Page 236)
Data deemed sensitive by the operator	Backups, other configuration data, analysis data	Section Backing up and restoring the CPU configuration (Page 284)

4.9.8 Backups and data backups

Regular backups or data backups after successful installation should be part of a successful security concept. Whether for restoring a project if required, if the changes made do not yield the desired results, or for saving an installation in an emergency.

Options for backing up a STEP 7 project:

- Project backup via online backup, see article Online backup (https://support.industry.siemens.com/cs/us/en/view/109759862/91508694411)
- Project backup via the TIA Portal, see article What options are there in STEP 7 (TIA Portal) for backing up projects and what is the significance of the backup files of the projects? (https://support.industry.siemens.com/cs/us/en/view/92561565)

You can find more information in the section Backing up and restoring the CPU configuration (Page 284).

4.9.9 Additional measures for network security

The following measures additionally increase the protection against unauthorized access to functions and data of the CPU from external sources and via the network: You can find information on these topics in the section Other CPU protective measures in Overview of the protective functions (Page 236).

You can find information on network security and network components for protection from unauthorized access in the PROFINET Function Manual (https://support.industry.siemens.com/cs/ww/en/view/49948856), section Network security.

4.9.10 Remote access to CPU

4.9.10.1 Using a Web server

When using Web servers, traditional firewalls are no longer sufficient to protect modern networks.

You can find information on potential risks when using web servers in the Web Server Function Manual (https://support.industry.siemens.com/cs/ww/en/view/59193560).

4.9.11 Recording Security events

Syslog storage

Syslog stands for "System Logging Protocol," a standard for storing, transmitting and collecting log messages triggered by security events. Predefined events in a network device are collected as security events in the device (syslog client) and stored as syslog messages in the local cache.

A syslog server collects and categorizes syslog messages, which can then be analyzed and filtered and displayed in various ways. Additionally, notifications for critical events can be configured.

These security events for the CPU are collected in the CPU diagnostics buffer:

- Going online with the correct or incorrect password
- Manipulated CPU communication data detected
- Manipulated CPU data detected on memory card
- Manipulated firmware update file detected[1)]
- Changed protection level (access protection) downloaded to the CPU
- Password legitimization restricted or enabled (via an instruction).
- Online access to CPU denied due to the possible number of simultaneous access attempts being exceeded
- Timeout when an existing online connection is inactive
- Logging on to the Web server with the correct or incorrect password
- Creating a backup of the CPU[2)]
- Restoring the CPU configuration[2)]

[1)] Firmware update for CPU and SINAMICS Integrated and system update

[2)] The SINAMICS configuration is also backed up. You can find more information in the section Backing up and restoring the CPU configuration (Page 284).

The above-listed security events are also stored as syslog messages in the local cache of a CPU as of firmware version V3.1. You can find an overview of all syslog messages in the following Entry (https://support.industry.siemens.com/cs/ww/en/view/109823696).
The content of a syslog message is based on IEC 62443-3-3.

You can find more information in the section Syslog messages (Page 43).

Connection to a SIEM system

A SIEM system (Security Information and Event Management) analyzes security events in real time and can be installed, for example, on the syslog server.

4.9.12 Syslog messages

Using syslog messages

International standards and national regulations for the IT security of automation components require, for example, the ability to log safety-related events.
Syslog (System Logging) is an IETF standard protocol (RFC 5424) for the transfer of recorded events and meets this requirement. A CPU records the following events, for example:

- Security events
- Firmware updates
- Changes to the user program
- Changes to the configuration
- Changes to the operating state

The collecting of security-relevant events cannot be deactivated. Each CPU as of FW version V3.1 saves syslog messages in a local cache. By querying this cache, you can view the syslog messages and identify potential security risks.

The local cache of a CPU is organized as a ring buffer. If the storage limit of the cache is reached and additional security events occur, the oldest messages in the cache are overwritten.

If you want to access the local cache with the syslog messages, use the Web API of the web server (API method Syslog.Browse). You can find information on the procedure in the "Web server (https://support.industry.siemens.com/cs/us/en/view/59193560)" Function Manual.

You have the option of transferring the events collected by the CPU to a syslog server in the network.

Forwarding to a syslog server

From STEP 7 V19 and a CPU as of FW version V3.1, it is possible to transfer syslog messages to a server, e.g. SINEC INS. The syslog messages are transferred to the syslog server via the syslog protocol. The syslog server saves all syslog messages from its connected devices. Messages of system and network events are stored centrally in a storage location in the syslog server. At the syslog server interface, you can view the collected syslog messages and thereby determine the source of potential security risks or problems.

Syslog messages are sent to the syslog server via port 514 (UDP) or port 6514 (TLS over TCP) by default.

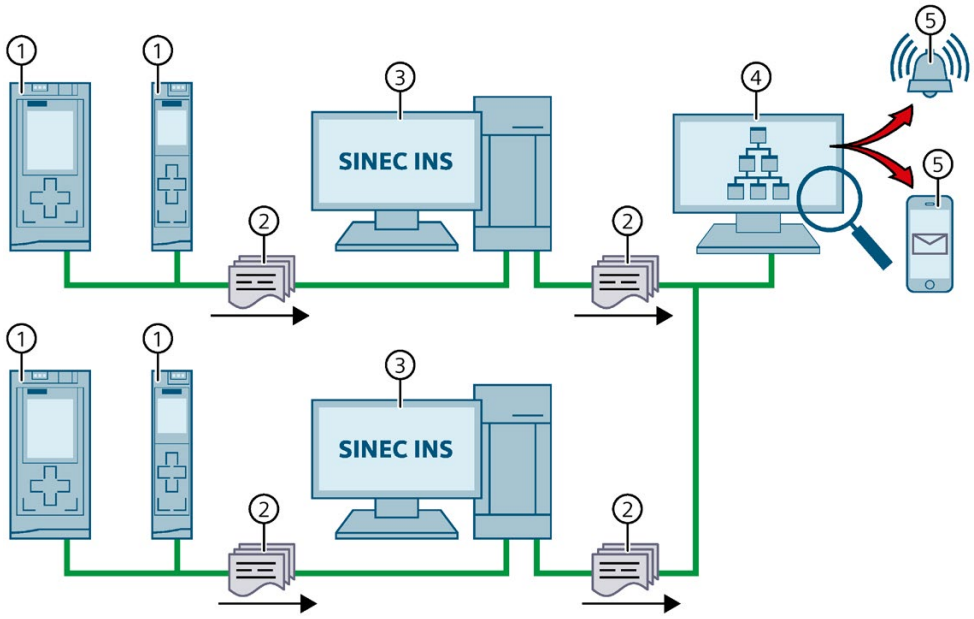
Note

If you are using UDP as the transport protocol, the data is transmitted unencrypted. Authentication is also omitted with UDP.

Processing in a Security Information and Event Management system (SIEM system)

In order to be able to accept the incoming syslog messages, a SIEM-system must understand the syslog protocol according to RFC 5424. Otherwise, the SIEM system cannot accept or process the incoming messages.

The SIEM system breaks down the incoming syslog messages into individual elements. These elements are assigned to their own event within the SIEM system. Within this event, it is analyzed whether there are connections between the individual syslog messages. In this way, the SIEM system detects possible attack vectors and, if necessary, informs the user, e.g. in the event of multiple attacks at several points in the system.



① CPUs
② Syslog messages
③ Syslog server, e.g. SINEC INS
④ SIEM system
⑤ Notify user

Figure 4-2 Forwarding and processing of syslog messages

More information

More information on network management with SINEC INS is available in the "SIMATIC NET: Network management SINEC INS V1.0 SP2" (https://support.industry.siemens.com/cs/us/en/view/109781023) manual.

You can find information on the structure of syslog messages in the Structure of the Syslog messages (Page 49) section.

4.9.12.1 Transfer the syslog messages to a syslog server

Requirements

If you want to transfer the syslog messages of a CPU to a syslog server, the following requirements must be met:

- STEP 7 as of version V19
- CPU as of FW version V3.1
- A project has been created in STEP 7
- The device or network view of STEP 7 is open

Procedure

To configure the CPU to transfer syslog messages to a syslog server, following these steps:

1. Select the required CPU in the device or network view of STEP 7.
2. In the Inspector window, navigate to "Properties > Protection & Security > Syslog > Syslog server".
3. In the "Connection to syslog server" area, select the "Enable transfer of syslog messages to a syslog server" option. The selection options below become editable.
4. Select one of the following options from the "Transport protocol" drop-down list:
   - "Transport Layer Security (TLS) - server and client authentication": Encrypted data transfer, syslog server and client (CPU) must authenticate themselves.
   - "Transport Layer Security (TLS) - only server authentication": Encrypted data transfer, only the syslog server needs to authenticate itself.
   - "UDP": Unencrypted data transfer, syslog server and client (CPU) do not need to authenticate themselves.

   In the next sections you can read how to select the certificates for authentication (logon) depending on the settings specified.
5. In the "Addresses of the syslog servers" column, enter a valid server address.
6. In the "Port" column, enter one of the following port numbers depending on the transport protocol used:
   - Standard TCP port for TLS: 6514
   - Standard UDP port: 514

Result: You have configured the transfer of syslog messages to a syslog server.

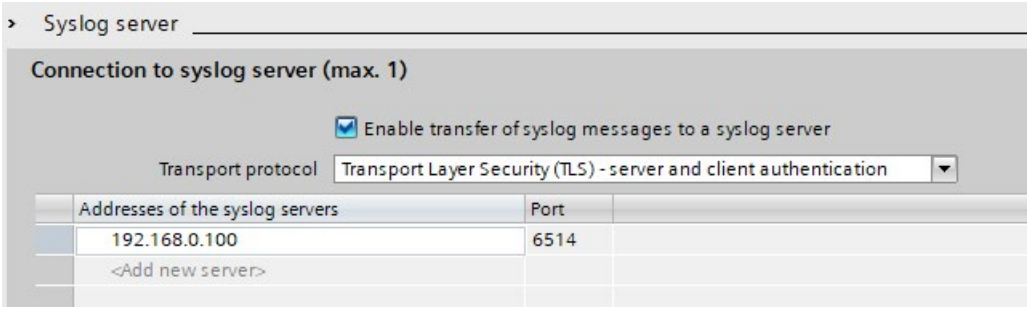
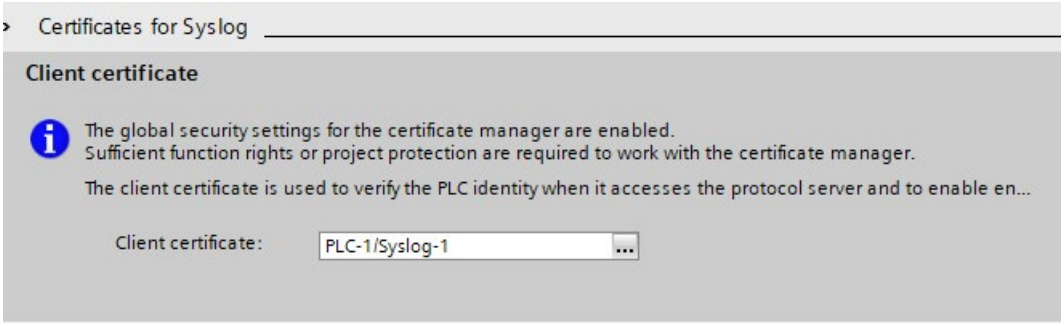


Figure 4-3 Transfer of syslog messages to a syslog server configured

Selecting the client certificate

STEP 7 provides the required client certificate for a CPU for the TLS transport protocol. If the certificate is managed within the CPU, you can either choose an existing certificate or create a new certificate. To do so, follow these steps:

1. Select the required CPU in the device or network view of STEP 7.
2. In the Inspector window, navigate to "Properties > Protection & Security > Syslog > Certificates for Syslog".
3. Select the appropriate certificate in the "Client certificate" field.



Selecting the server authentication

After selecting the TLS transport protocol, the configured syslog server must authenticate itself. This ensures that the CPU only connects to a trusted server. If you want to waive server authentication, activate the automatic acceptance of server certificates during runtime. To configure these settings, follow these steps:

1. Select the required CPU in the device or network view of STEP 7.
2. In the Inspector window, navigate to "Properties > Protection & Security > Syslog > Certificates for Syslog".

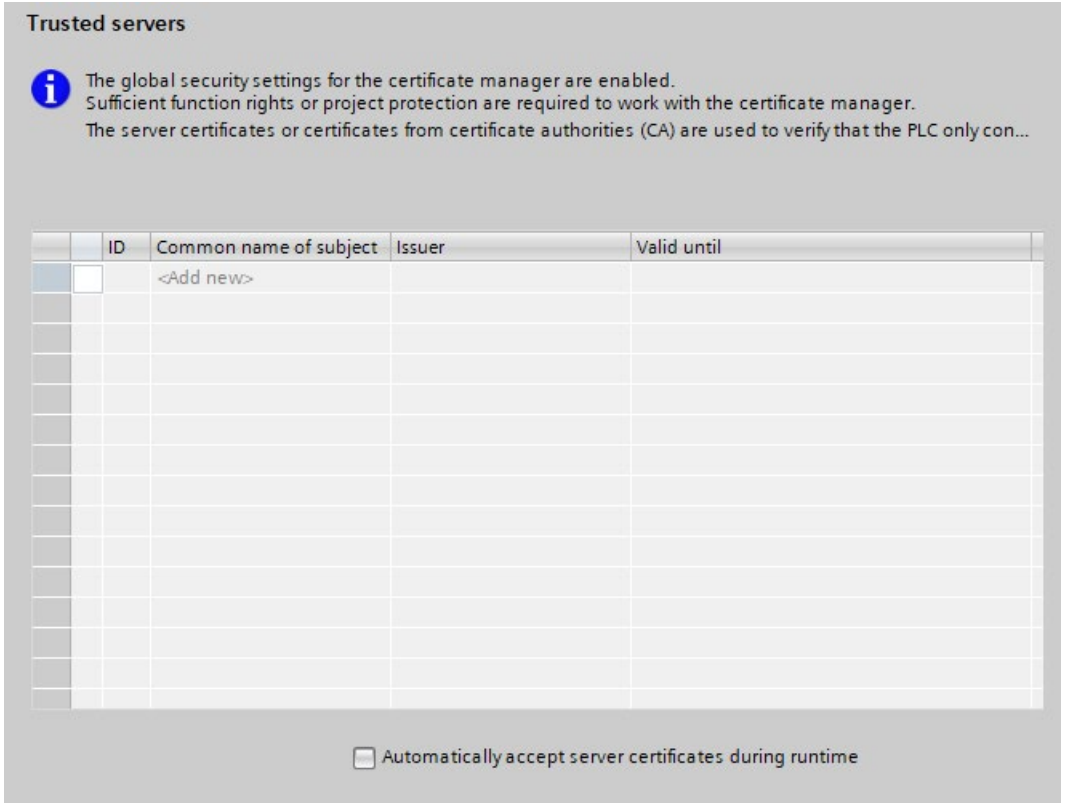
3. In the "Trusted servers" area, specify whether the connected syslog server is to be authenticated. In this case, it is necessary to complete the following information:
   - Add trusted server: Add a valid server certificate in the "Common name of subject" column.
   - Automatically accept certificates during runtime: Activate the "Automatically accept server certificates during runtime" option. Editing in the table is then not possible.

Note

No authentication with automatically accepted server certificates

If you enable the "Automatically accept server certificates during runtime" option, a server does not need to authenticate itself. This means that the CPU can also connect to unknown servers that could represent a security risk.

Only select this option during commissioning or in a protected environment.



Result: You have configured the server authentication.

4.9.12.2 Structure of the Syslog messages

A CPU collects syslog messages in a local cache. These syslog messages are structured according to the syslog protocol (RFC 5424) and consist of the following elements:

- HEADER
- STRUCTURED-DATA
- MSG (Message)

The following sections describe the structure and parameters of the individual elements.

Structure of the HEADER element

The header contains all the data required for further processing of the syslog message. A space separates the individual parts of the header (exception: No space between PRI and VERSION). A CPU transmits the following header in syslog messages, for example:

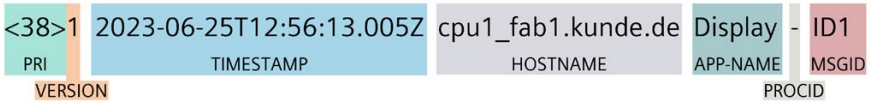


Figure 4-4 Example: HEADER of the syslog message of a CPU

The following table describes the parameters in the prescribed order.

Parameter	Description
PRI	PRI encodes the priority of the syslog message, divided into Severity (severity of the message) and Facility (origin of the message). The PRI value is formed as follows: • PRI = Facility x 8 + Severity Possible values: • Severity – 0 = Emergency: system is unusable – 1 = Alert: action must be taken immediately – 2 = Critical: critical conditions – 3 = Error: error conditions – 4 = Warning: warning conditions – 5 = Notice: normal but significant condition – 6 = Informational: informational messages – 7 = Debug: debug-level messages • Facility – 1 = User-level messages – 2 = Mail system – 3 = System daemons – 4 = Security/authorization messages – 5 = Messages generated internally by syslog – 6 = Line printer subsystem – 7 = Network news subsystem – 8 = UUCP subsystem – 9 = Clock daemon – 10 = Security/authorization messages – 11 = FTP daemon – 12 = NTP subsystem – 13 = Log audit – 14 = Log alert A CPU does not use all of the listed severity/facility values.
VERSION	Version number of the syslog specification.
TIMESTAMP	The device sends the time stamp in the format "2023-06-25T12:56:13.005Z" as UTC time without time zone and correction for daylight-saving/standard time.
HOSTNAME	Contains the name or IP address of the device or system from which the syslog message has been sent. IPv4 address according to RFC1035: Bytes in decimal representation: XXX.XXX.XXX.XXX IPv6 address according to RFC4291 Section 2.2 "-" is output if information is missing.
APP-NAME	Contains the component (device part or application) from which the message has been generated. "-" is output if information is missing.

Parameter	Description
PROCID	The process ID serves to clearly identify the individual processes, for example during analysis and troubleshooting. "-" is output if information is missing.
MSGID	ID to identify the message. "-" is output if information is missing.

Structure of the STRUCTURED-DATA element

STRUCTURED-DATA provides information in an interpretable and decomposable data format. The following applications are possible, for example:

- More information about the syslog message
- Application specific information

STRUCTURED-DATA can contain one or more elements (SD-ELEMENT). Each SD element must be enclosed in square brackets. If STRUCTURED-DATA consists of multiple SD elements, the individual SD elements are separated by a space.

Each SD-ELEMENT consists of its name (SD-ID) and one or more name-value pairs (SD-PARAM). Each name-value pair consists of a parameter name (PARAM-NAME) and the associated value (PARAM-VALUE). A space separates the individual components (SD-ID and SD-PARAM) within an SD element.

A CPU transmits the following SD ELEMENT in a syslog message, for example:

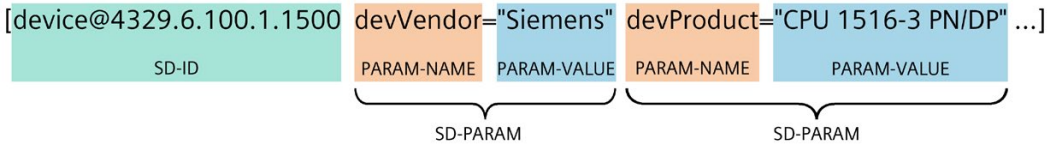


Figure 4-5 Example: SD ELEMENT of the syslog message of a CPU

Structure of the MSG element

In the MSG (MESSAGE) element, a CPU transmits the simplified name of the event in English. The following table shows what the content of a message of the MESSAGE element can look like.

MESSAGE	Description
SE_LOCAL_SUCCESSFUL_LOGON	The local logon has been successful (e.g. on the operator display of the CPU).

More information

You can read more information about the structure and transmission of syslog messages in the following RFCs (Request for Comments):

- The syslog protocol (RFC 5424) (https://tools.ietf.org/html/rfc5424)
- Transferring syslog messages via Transport Layer Security (RFC 5425) (https://tools.ietf.org/html/rfc5425)
- Transferring syslog messages via UDP (RFC 5426) (https://tools.ietf.org/html/rfc5426)

4.10 Secure operation of SINAMICS Integrated

Secure operation of drive systems

You can find information on industrial security for SINAMICS S, SINAMICS G and SINAMICS V20 drive systems and other products on the Internet (https://support.industry.siemens.com/cs/en/en/view/108862708).

Overview

The following overview presents the most important considerations for protection of SINAMICS Integrated from threats:

- Write and know-how protection
- Scripting (Openness)
- Using the memory card
- Backing up and restoring data
- Protecting backup files in the Windows file system
- Communication services and used port numbers

For a detailed description and detailed procedures, refer to the specified references and the SINAMICS documentation in the following sections.

Commissioning computer

Industrial security is based on the security of the commissioning computer. Read and comply with the general security measures in the following sections:

- Operational environment and security assumptions (Page 29)
- Secure operation of the engineering software

  You can find more information on secure operation of the engineering software in the TIA Portal online help.

4.10.1 Write and know-how protection

SINAMICS S120 converters provide you not only with "write protection" but also "know-how protection".
The know-how protection function is used generally to protect intellectual property. Machine manufacturers use know-how protection to protect their products from unauthorized use, changes or duplication.

⚠ WARNING

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

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

- Protect the parameter settings from unauthorized access.
- Control possible malfunctions through use of suitable measures (e.g. EMERGENCY STOP or EMERGENCY OFF).

4.10.1.1 Write and know-how protection for SINAMICS Integrated

You can use the write and know-how protection to protect parameter settings of the drive against unintended or unauthorized changes.

Write protection

Write protection prevents unauthorized or inadvertent changes to the drive settings.

Know-how protection

A machine manufacturer can use know-how protection to protect its confidential configuration and parameter assignment know-how from being read, changed or copied by unauthorized persons.

Note that the know-how protection does not act on all parameters and that the execution of some functions is not prevented.

More information

You can find more information on write and know-how protection on the Internet.

- SINAMICS S120 Drive Functions Function Manual, section Write and know-how protection (https://support.industry.siemens.com/cs/en/en/view/109781535)
- SINAMICS S120/S150 List Manual, section Parameters for write protection and know-how protection (https://support.industry.siemens.com/cs/en/en/view/109822659)

4.10.1.2 Write and know-how protection for SINAMICS Startdrive

You can use the TIA Portal option package SINAMICS Startdrive to commission SINAMICS drives.

You can use the write and know-how protection to protect the parameter assignment of your drive.

Write protection

You can activate the write protection in offline or online mode. In online mode, the write protection takes effect immediately after activation.

Recommendation: Activate the write protection in online mode.

When know-how protection is activated, it is possible to additionally activate write protection.

Know-how protection

To activate or configure the know-how protection, you must deactivate the write protection.

You can only activate and configure the know-how protection in online mode. Ensure that an online connection to SINAMICS Integrated exists before you call the configuration dialog for know-how protection.

More information

You can find more information on write and know-how protection in the SINAMICS S120 with Startdrive Commissioning Manual, sections Write protection and Know-how protection (https://support.industry.siemens.com/cs/ww/en/view/109781583).

4.10.1.3 Know-how protection for SINAMICS Drive Control Chart

SINAMICS Drive Control Chart (DCC) offers you a modular and scalable technology option that was developed mainly for drive-level, continuous closed-loop and open-loop control tasks within the drive.

Know-how protection

You use the know-how protection for DCC charts to protect confidential configuration know-how in the DCC chart from being read, changed or manipulated by unauthorized persons.

More information

You can find more information on know-how protection in the Configuring SINAMICS DCC Configuration Manual, section Know-how protection for DCC charts (https://support.industry.siemens.com/cs/en/en/view/109817626)

4.10.2 Scripting (Openness)

Scripts (Openness) are used to automate sequences in SINAMICS Startdrive. Accordingly, you must test scripts before using them on the machine.

⚠ WARNING

Danger from incorrect configurations of automated operating actions

The ability to use scripting to automate actions enables you to automate manual operating actions of the SINAMICS Startdrive. In this way you optimize the time spent on repeated configuration of projects and tasks.

The script creator and script user are both responsible for the operating actions implemented in scripts.

Incorrect configurations not identified by tests can cause serious bodily injury or death.

- Subject new or modified scripts to systematic testing to verify and validate them.
- Ensure that the content of a script is correct before executing it.
  Verify and validate the results of the script executions by tests on the machine.

Like DCC charts, scripts can be protected using know-how protection.

4.10.3 Using the memory card

Special care must be taken when using the memory card to prevent spread of malware or incorrect parameter settings.

Protect files stored on the memory card from malware through use of appropriate protective measures, such as virus scanners, access control and mechanical protection.

More information

You can find more information on using the memory card in the sections:

- Operational environment and security assumptions (Page 29)
- Protection by locking the CPU (Page 256)

4.10.4 Backing up and restoring data

Regular backups and data backups after successful installation are elements of a successful security concept.

4.10.4.1 Backing up data with SINAMICS Startdrive

To permanently save settings for SINAMICS Integrated, you have the following options in SINAMICS Startdrive:

- Saving settings in the project
- Saving settings (offline/online) retentively on the memory card

Saving settings in the project

For your backup, you can permanently save the settings you made in your Startdrive project.

Saving settings retentively

The settings made during parameter assignment of SINAMICS Integrated are saved in volatile memory. This means they are lost when the SIMATIC Drive Controller is switched off.

To save an online or offline configuration retentively, you must save the settings on the memory card.

More information

You can find more information on backing up data with SINAMICS Startdrive in the SINAMICS S120 with Startdrive Commissioning Manual, section Saving settings (https://support.industry.siemens.com/cs/ww/en/view/109781583).

4.10.4.2 Backing up data with STEP 7 Professional (TIA Portal)

With the STEP 7 Professional function "Backup from online device", you perform a complete backup of the current device state of the CPU.

This backup also includes the contents of the SIMATIC Memory Card and, thus, in the case of a SIMATIC Drive Controller, also the SINAMICS Integrated configuration.

If SINAMICS NVRAM data is to be included in the backup, you must back up this data on the SIMATIC Memory Card beforehand with p7775 = 1.

The backup is stored in the project tree in folder "Name of the CPU > Online backups". The backup is assigned the name of the CPU with the time and date of the backup.

If you have backed up the data at an earlier time, you can transfer the backup back to the device in an emergency.

More information

You can find more information on backing up data with STEP 7 in the section Backing up and restoring the CPU configuration (Page 284).

4.10.4.3 Data backup/Further measures

Recommendation: Additionally back up settings and configurations on a storage medium outside the SIMATIC Drive Controller, e.g. on a second memory card, PG/PC, hard disk or network drive.

Without a backup, your settings and configurations will be lost in the event of a device defect.

4.10.4.4 Protecting backup files in the Windows file system

If you generate backup files of charts or projects with Windows tools, you must likewise use Windows tools to protect these files from unauthorized access with secure passwords. The Startdrive configuration itself is integrity-protected.

4.10.5 Communication services and used port numbers

SINAMICS Integrated has no dedicated Ethernet interfaces.

With respect to communication services, take into account that the SINAMICS Startdrive communication uses S7 connections and port 102. In so doing, communication is forwarded internally from the CPU interface to SINAMICS Integrated.

4.11 Secure operation of interface modules

You can find device-specific security information and information on interface modules in the respective system manuals and operating instructions, e.g.:

- SIMATIC S7-1500/ET 200MP System Manual (https://support.industry.siemens.com/cs/ww/en/view/59191792)
- SIMATIC ET 200SP System Manual (https://support.industry.siemens.com/cs/ww/en/view/58649293)

4.12 Secure operation of I/O modules

Device-specific security information and information on I/O modules can be found in the respective equipment manual.

System overview

5

5.1 What is the SIMATIC Drive Controller?

SIMATIC Drive Controller

The SIMATIC Drive Controller is a drive-based controller in the SIMATIC S7-1500 range.

A SIMATIC Drive Controller combines the following functionalities in a SINAMICS S120 Booksize Compact enclosure:

- Failsafe SIMATIC S7-1500 technology CPU with integrated technology I/Os
- SINAMICS S120 automatic speed control

The two components are termed "CPU" and "SINAMICS Integrated" in this documentation.

The integrated SINAMICS S120 automatic speed control is based on a CU320-2 control unit and can control:

- A max. of 6 servo drives; or
- A max. of 6 drives with vector control; or
- A max. of 12 drives with U/f control

Two failsafe technology CPUs with graded performance are available. Safety Integrated at the CPU and drive end allow use in failsafe applications.

The SIMATIC Drive Controller supports communication over PROFINET and PROFIBUS DP.

5.1.1 Comparison of SIMATIC Drive Controller versions

SIMATIC Drive Controller performance classes

The SIMATIC Drive Controller contains a failsafe CPU from the SIMATIC S7-1500 family and SINAMICS S120 automatic speed control. Two performance classes are available.

Table 5- 1 Overview of performance classes

Performance class	SIMATIC Drive Controller	Article number
Small to mid-range applications	CPU 1504D TF	6ES7615-4DF10-0AB0
High-performance applications	CPU 1507D TF	6ES7615-7DF10-0AB0

Performance features of the CPUs

The SIMATIC Drive Controller s differ in terms of the integrated CPU. The CPUs can be used for lower and mid-range applications all the way to the high-end range of machine and plant automation. The following table shows key performance features of the SIMATIC Drive Controller.

Table 5- 2 Overview of SIMATIC Drive Controller performance features

Feature	1504D TF	1507D TF
Code work memory, max.	4 MB	15 MB
Data work memory, max.	6 MB	40 MB
Retentive data area (including timers, counters, bit memories)	768 KB	768 KB
Load memory/mass storage, max.	32 GB (with SIMATIC Memory Card)	32 GB (with SIMATIC Memory Card)
I/O address area, max.	32/32 KB	32/32 KB
Integrated interfaces	1 x PROFINET IO IRT (3-port switch) 1 x PROFINET IO RT 1 x PROFINET basic services (1000 Mbps) 1 x PROFIBUS DP 2 x USB 3.0[1] 4 x DRIVE-CLiQ	1 x PROFINET IO IRT (3-port switch) 1 x PROFINET IO RT 1 x PROFINET basic services (1000 Mbps) 1 x PROFIBUS DP 2 x USB 3.0[1] 4 x DRIVE-CLiQ
SINAMICS Integrated	on basis of CU320-2	on basis of CU320-2
Integrated inputs and outputs (onboard I/O)	CPU: 8 DI/DQ SINAMICS Integrated: 12 DI, 8 DI/DQ	CPU: 8 DI/DQ SINAMICS Integrated: 12 DI, 8 DI/DQ
Configuration control	X	X
CPU Web server	X	X
Isochronous mode[3]	PROFINET IO with IRT (X150) PROFIBUS DP (X126) SINAMICS Integrated Technology I/Os (X142)	PROFINET IO with IRT (X150) PROFIBUS DP (X126) SINAMICS Integrated Technology I/Os (X142)
Minimum cycle[5)]	500 µs	250 µs
Technology Integrated	CPU: • Motion control • PID control Onboard I/O: • Event/period duration measurement • Pulse width modulation (PWM) • Timer DI/DQ • Oversampling DI/DQ	CPU: • Motion control • PID control Onboard I/O: • Event/period duration measurement • Pulse width modulation (PWM) • Timer DI/DQ • Oversampling DI/DQ
Number of positioning axes	Typical[2]: 12 Maximum: 40	Typical[2]: 55 Maximum: 160
Motion Control resources[4]	3,200	12 800
Extended Motion Control resources[4]	160	420
Security Integrated	X	X
Integrated system diagnostics	X	X

Feature	1504D TF	1507D TF
Integrated safety functionality	X	X
Degree of protection	IP 20	IP 20

[1] Non-functional, no connection permitted

[2] With 4 ms servo/IPO cycle and 35% CPU load from motion control

[3] Besides the MC-Servo, only PROFINET interface X150 can also be operated isochronously with the clock system of SINAMICS Integrated and the X142 technology I/Os.
Isochronous coupling of PROFIBUS interface X126 with other clock systems is not possible. Additional drive systems must therefore be connected over the PROFINET interface (for details, see section Setting the clock system (Page 210)).

[4] For information on technology object resource requirements, see Technology functions of the CPU (Page 85) and S7-1500T Motion Control function manuals. (https://support.industry.siemens.com/cs/ww/en/view/109751049)

[5] Minimum supported cycle for PROFINET, SINAMICS Integrated, Technology I/Os (X142) and Servo/IPO. The use of clock pulses < 500 µs is only possible for CPU 1507D TF and is subject to restrictions (for details see section Setting the clock system (Page 210)).

5.1.2 Areas of application

The scalability of the SIMATIC Drive Controllers through several performance classes offers the required flexibility and scalability for a wide range of Motion Control applications in machine and plant engineering.

The SIMATIC Drive Controller have a wide range of communication interfaces, for example for implementing modular machine concepts and connecting HMI and I/O systems.

As the communication interfaces are available in all performance classes, you select the SIMATIC Drive Controller on the basis of CPU and Motion Control performance only.

The integrated technology CPU provides additional functions to the standard Motion Control and technology functions in the S7-1500 CPUs, such as:

- Extended synchronous operation and cam functionalities
- Kinematics functions
- Cross-PLC synchronous operation

The digital onboard I/O offer additional integrated technology functions, for example:

- Measuring inputs for fast, accurate and event-dependent acquisition of actual positions
- Outputs for output cams and cam tracks for position-dependent generation of switching signals

The failsafe design of the integrated technology CPU allows you to implement applications for safety systems. This enables seamless integration of machine safety into the SIMATIC Drive Controller. You use one system for both your standard and failsafe automation at the same time. This offers:

- Economics benefits
- Reliability
- Potential savings for hardware, engineering tasks and storage costs

You can expand the drive configuration limits of the SIMATIC Drive Controller over PROFINET, for example with SINAMICS S120 control unit CU320-2.

Applications and areas of application

The integration of an S7-1500TF CPU and automatic speed control (SINAMICS Integrated) into a device makes a small, compact design possible. With graded performance and interface configuration, SIMATIC Drive Controller are optimized for production machines and plants with Motion Control.

SIMATIC Drive Controller are used in applications with the SINAMICS S120 drive family, for example, because:

- A highly dynamic, flexible multi-drive system is required:
  - Broad performance range
  - Comprehensive range of motors (including linear drive, external drives, etc.)
  - Comprehensive range of control processes (servo, vector, U/f)
  - SINAMICS Technology Extensions
- Controlled supply/regeneration is required:
  - To avoid unwanted line harmonics
  - For a high level of ruggedness in the context of network fluctuations
  - For energy recovery in brake mode

SIMATIC Drive Controller are also used where:

- Safety solutions for the protection of people and machines are necessary
- A compact, space-saving design is required
- High performance for Motion Control and rapid I/O is required
- Modular machine concepts with rapid isochronous mode are required

Typical areas of application:

- Multi-axis machines (for example printing and paper machines)
- High-performance applications with short machine clocks (for example packaging machinery and handling applications)
- Compact machines in which there is limited room for the controller and drive system (for example control cabinets in the machine base)
- Distributed control and drive concepts
- Synchronization of multiple SIMATIC Drive Controller with cross-PLC synchronous operation
- Safe monitoring of motion

Example 1: Fast and flexible packaging

Automation task:

Development of a horizontal bagging machine with a speed of up to 120 packages per minute.

Feature:

The bagging machine allows the continuous packaging of individual solid products such as foodstuffs and commercial products. A quick changeover to new products must be possible. Scalability and cost efficiency is paramount in the automation solution.

Solution:

A SIMATIC Drive Controller uses the technology functions to control gear and cam synchronous operation for multiple axes. Necessary input and output signals such as print mark correction, slip compensation, distance detection and product detection are controlled by the integrated technology I/Os of the SIMATIC Drive Controller. Other inputs and outputs, for example for temperature acquisition, are available over the ET 200SP distributed I/O system.

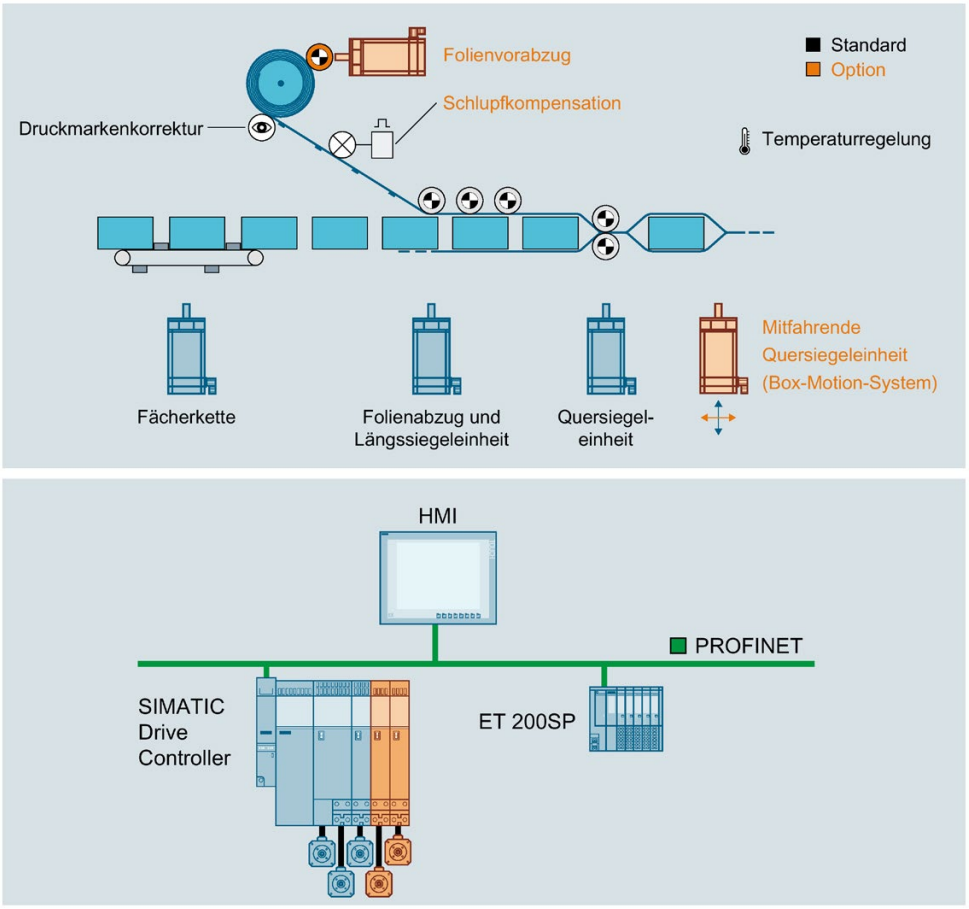


Figure 5-1 Example: Packaging machine with optional modules

Benefits

- High-performance solution for optimal product quality and high machine throughput
- Compact, scalable solution
- Format change at the touch of a button

Example 2: Printing machine

Automation task:

Development of a modular, fully automated printing machine with scalable performance to continue to ensure efficient production and cover a wide range of products in future.

Feature:

Modular solution, for example for winder/feed, printing mechanisms and drying. The individual machine modules are synchronized over a virtual leading axis.

Solution:

The modular solution is based on multiple machine modules, each of which is implemented with a SIMATIC Drive Controller and if necessary additional SINAMICS S120 CU320-2. Cross-PLC synchronous operation on the basis of PROFINET IO with IRT is used for synchronization of the axes.

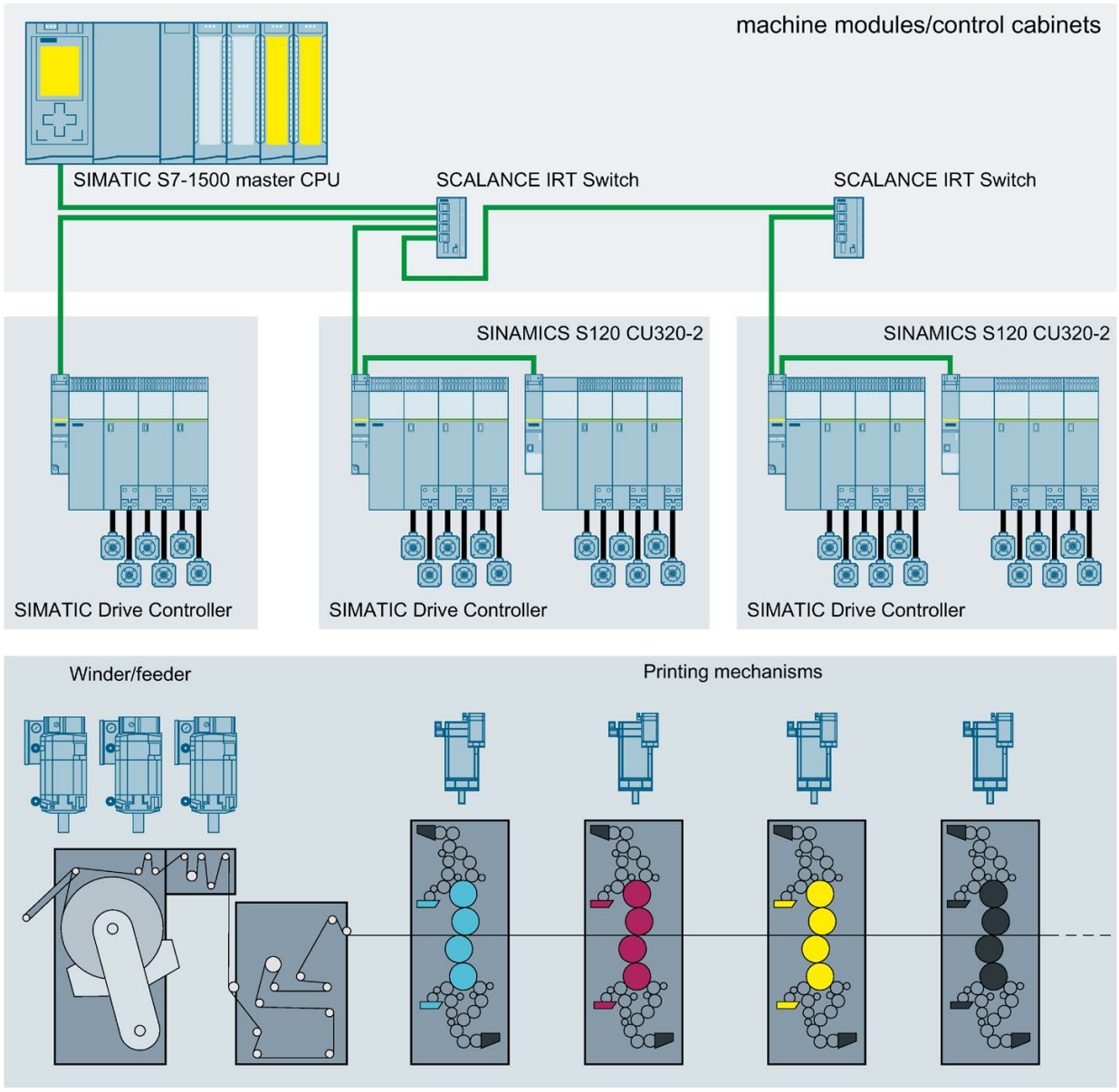


Figure 5-2 Example: Printing machine

Benefits

- Short machine setup times
- Scalable solution covers a wide performance range
- Perfect synchronous operation across modules ensures the best possible product quality high throughput

Advantages and customer benefits

The use of SIMATIC Drive Controllers offers the following advantages:

- Only one device for standard, safety and comprehensive Motion Control automation including automatic speed control
- Comprehensive range of interfaces, integrated bottom to top performance range
- Onboard technology I/Os save on additional hardware
- Eight digital outputs configurable as high-speed outputs; for ultra-short output delays and maximum switching accuracy
- Simple handling with lower cabling and installation costs
- Simple configuration in the STEP 7 hardware configuration
- Simple and efficient commissioning and optimization of drives using the engineering tool SINAMICS Startdrive in the TIA Portal
- Automatic alignment of the technological variables via the technology objects between controller and drive; reduced engineering, commissioning and service times
- Central data management with a memory card (SIMATIC Memory Card) for controller and drive
- Central license handling in the TIA Portal for CPU and SINAMICS Integrated

5.1.3 Plant components and automation levels

Plant components and automation levels

SIMATIC Drive Controller are used in particular in production automation and Motion Control applications for smaller to high-end machines. The combination of SIMATIC S7-1500 CPU and integrated SINAMICS S120 automatic speed control offers powerful and flexible automation solutions that cover all ranges of Motion Control applications:

- The process signals are connected to the central master computer via fieldbus.
- The SIMATIC Drive Controller is integrated consistently in the various automation levels through communication standards.
- The SIMATIC Drive Controller controls SINAMICS Integrated over the integrated drive and the axis group over the comprehensive range of SINAMICS S120 power units (Line Modules and Motor Modules).
- Motors with a DRIVE-CLiQ interface facilitate commissioning and diagnostics.
- You connect motors without a DRIVE-CLiQ interface, for example external motors or motors for retrofit applications, over Sensor Modules Cabinet-Mounted (SMC) or Sensor Modules External (SME). Terminal Modules (TM) are terminal expansions over DRIVE-CLiQ – for example for drive digital or analog inputs and outputs.
- The F-CPU integrated in the SIMATIC Drive Controller ensure failsafe processes.

- Technology I/Os are already integrated in the SIMATIC Drive Controller . If required, you can expand the SIMATIC Drive Controller with technology modules in the ET 200MP and ET 200SP distributed I/O systems.
- SIMATIC Drive Controller are intended for installation in a control cabinet with IP20 degree of protection

The schematic diagram below shows the key components of a system with SIMATIC Drive Controller from the management level to the control level and field level.

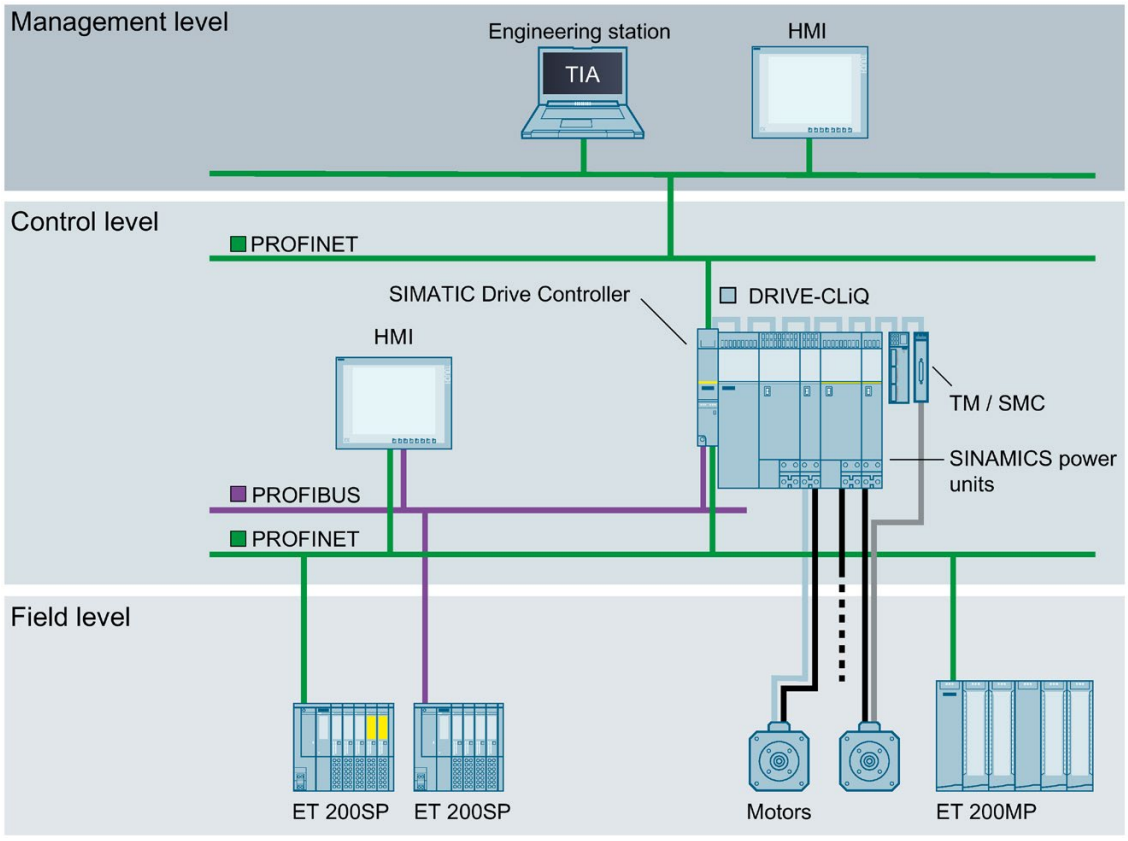


Figure 5-3 Example: SIMATIC Drive Controller at management, control and field level

5.1.4 Scalability

SIMATIC Drive Controller offer the required flexibility and performance for a wide range of controller applications in machine and plant engineering.

Scaling with performance class

To meet your machine and plant planning requirements, the SIMATIC Drive Controller can be scaled in terms of CPU and Motion Control performance and configuration limits (program and data memory and Motion Control resources).

The comprehensive networking options over PROFINET and PROFIBUS DP are the same for all versions. This means that you can scale simply by CPU performance – without affecting the available interfaces and thus your machine and plant topology.

Scaling with drive configuration limits

SINAMICS S120 automatic speed control is integrated in all versions of the SIMATIC Drive Controller. It can control.

- A max. of 6 servo drives; or
- A max. of 6 drives with vector control; or
- A max. of 12 drives with U/f control

You can expand the drive configuration limits of a SIMATIC Drive Controller, for example with SINAMICS S120 (CU320-2) or SINAMICS S210 (for example for individual drives). In this case, the CPU axis technology objects execute the Motion Control functions for the SINAMICS Integrated drives and drives connected externally. The maximum axis configuration limits are limited at the CPU side by the available Motion Control resources.

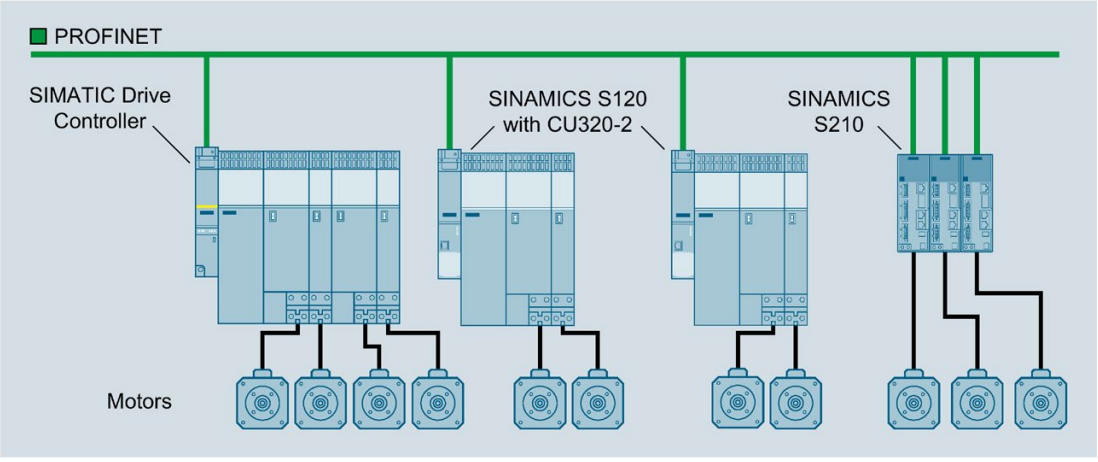


Figure 5-4 Example: Plant configuration with SIMATIC Drive Controller, SINAMICS S120 and SINAMICS S210

In principle, you can connect any drives that:

- Support the standardized profile for PROFIdrive drive technology
- Support the PROFIdrive frames possible with SIMATIC S7-1500

You can find additional information in the S7-1500T Motion Control function manuals (https://support.industry.siemens.com/cs/ww/en/view/109751049).

Note

Computing performance at the drive cannot be increased with a SIMOTION CX32-2 Controller Extension as with SIMOTION D4x5-2.

Scaling with modularization

Modular machine concepts offer many advantages, such as standardization, flexibility and scalability. A production line that consists of multiple machine modules each with a controller and drives requires synchronization of the drives.

SIMATIC Drive Controller have the cross-PLC synchronous operation functionality. Cross-PLC synchronous operation allows you to implement synchronous operation across devices. This enables you to:

- Implement more axes by distributing them across multiple controllers
- Implement modular machine concepts

In modular machine concepts, you can distribute the functionality between multiple machine modules, each with its own controller. You can distribute the master value source and synchronous axes between the various controllers. Coupling between the master axis/an external encoder and the following axis is isochronous via PROFINET IO with IRT. Control cycles for the axes are synchronized.

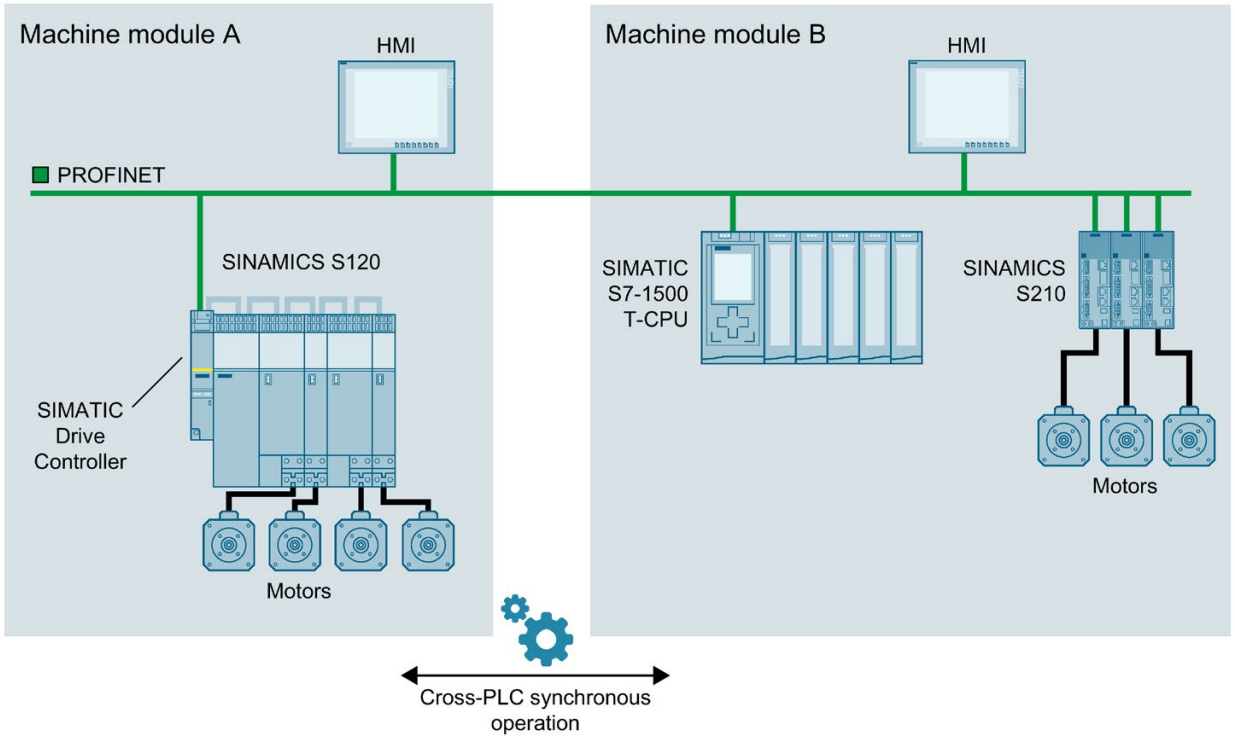


Figure 5-5 Example: Modular machine concept with SIMATIC Drive Controller and cross-PLC synchronous operation

Scaling with technology I/Os and technology modules

The integrated eight digital input/outputs (interface X142) provide configurable technology I/Os.

Of the integrated eight digital input/outputs of the SINAMICS Integrated (interface X122/132), you can also use eight digital inputs as measuring inputs.

To expand the integrated technology I/Os high-performance technology modules in the ET 200MP and ET 200SP distributed I/O systems, for example for additional measuring inputs and output cam outputs.

Information on technology objects for measurement sensing inputs and output cam outputs can be found in the section Technology functions of the CPU (Page 85).

5.1.5 Overview of features

SIMATIC Drive Controller

The SIMATIC Drive Controller combines a failsafe SIMATIC S7-1500 technology CPU with integrated technology I/Os and SINAMICS S120 automatic speed control in one compact enclosure. Performance grading, a range of interfaces, and technology functions are optimized for production machines and plants with Motion Control.

Important properties and functions

Optimized for production machinery

- Performance grading optimized for the demands of production machines and plants with Motion Control
- Comprehensive range of interfaces, integrated fieldbus interfaces from bottom to top performance range
- Technology I/Os onboard
- Eight digital outputs configurable as high-speed outputs; for ultra-short output delays and maximum switching accuracy

Communication standards

- PROFINET IO
- PROFIBUS DP
- DRIVE-CLiQ

Efficient engineering

- All features of a SIMATIC Drive Controller can be configured in TIA Portal
- Configuration of drive functions over SINAMICS Startdrive

Compact design

- Motion Control CPU and Drive control (SINAMICS Integrated)
- Compact size



Safety Integrated

- An F-CPU for failsafe and non-failsafe applications
- All F-parameters set in software

Simple handling

- Central data management with a memory card for control and drive
- Central license management

Technology Integrated

- Motion Control functionality supports the connection of drives with PROFIdrive capability
- Technology CPU with extended Motion Control functions
- Simple programming of motion processes with PLCopen Motion Control blocks
- Temperature controller
- PID control for continuous and discrete closed-loop control processes with Autotuning for easy commissioning and optimum control performance
- Seamless integration into TIA Portal for synchronous configuration and uniform operating concept
- TRACE support for effective commissioning, diagnostics and rapid optimization of drives and closed loop control

Figure 5-6 Overview of SIMATIC Drive Controller properties and functions

5.2 Configuration

Configuration

A system with SIMATIC Drive Controller comprises the following components:

- Power supply for SIMATIC Drive Controller and DRIVE-CLiQ components
- SIMATIC Drive Controller
- SINAMICS S120 power units:
  - Line Module
  - Motor Modules
- Sensor Modules (SMx)
- Terminal Modules (TM)
- Motors with/without DRIVE-CLiQ

Note

Use of SINAMICS S220 power units

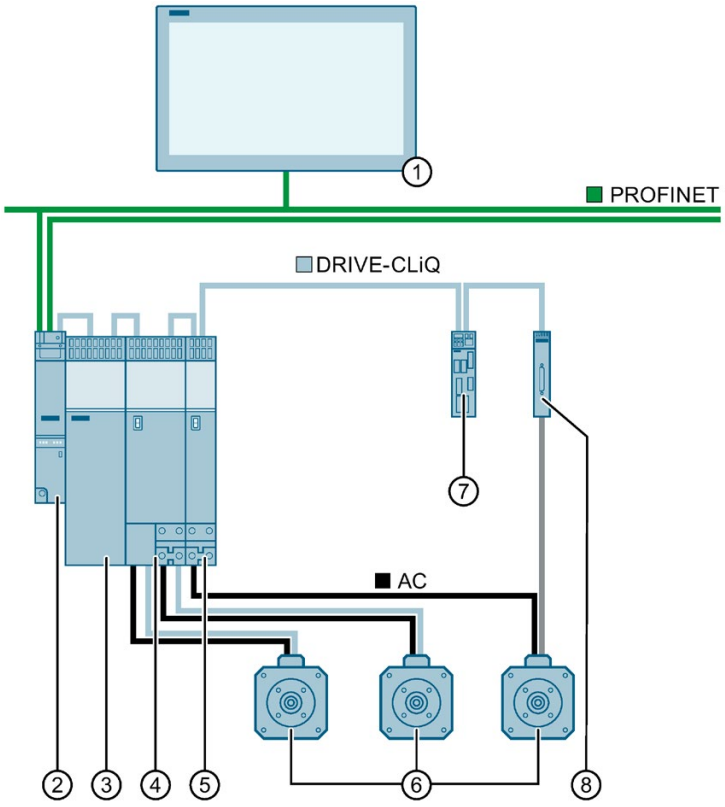
From SINAMICS firmware V5.2 SP3 HF10 onwards, the use of SINAMICS S220 power units at the integrated SINAMICS S120 drive control of the SIMATIC Drive Controller is also possible. For more information on the currently available module range as well as compatibility information for use with SINAMICS S120 drive controls, see the publications on the SINAMICS S120/S220 drive system, for example (https://support.industry.siemens.com/cs/ww/en/view/109806050)

WARNING

Danger to life due to unsuitable firmware version

Operation of the SINAMICS S220 Booksize component with an unsuitable firmware version can lead to unsafe operational states, for example, overheating of converter components, unexpected acceleration of a motor or malfunctioning of the safety functions.
Use firmware V5.2 SP3 HF10 or later.

Configuration example



① HMI device
② SIMATIC Drive Controller
③ Line Module
④ SINAMICS S120 Double Motor Module
⑤ SINAMICS S120 Single Motor Module
⑥ SIMOTICS S servo motor
⑦ SINAMICS Terminal Module
⑧ SINAMICS Sensor Module Cabinet-Mounted

Figure 5-7 Example: SIMATIC Drive Controller installation in a plant

5.3 SIMATIC Drive Controller functions

5.3.1 Safety

SIMATIC Safety Integrated of the integrated F-CPU

For failsafe operation of your plant, program the F-CPUs of the SIMATIC Drive Controller. Use the "STEP 7 Safety Advanced" of the TIA Portal for this purpose. In combination with the TIA Portal, the F-CPU offers optimal integration of failsafe systems into your engineering environment; one controller, one communication system and one engineering platform for standard and failsafe automation:

- Integration of safety technology
- Instructions approved by German Technical Inspectorate for frequently required safety applications
- Integration of safety functions up to SIL 3 in accordance with IEC 61508, SILCL 3 in accordance with IEC 62061 and/or PL e and Category 4 in accordance with ISO 13849-1
- Uniform engineering for standard and safety automation
- Simple documentation of safety-related changes via the F change history in STEP 7 Safety
- Support in the acceptance of the safety program and no renewed acceptance of the safety program after changes in the standard program

Advantages

SIMATIC Safety Integrated provides you with the following advantages:

- Engineering with SIMATIC STEP 7 Safety Advanced in the TIA Portal, same engineering and operating concept for standard and failsafe automation task
- Use of instructions approved by the German Technical Inspectorate from the system library Safety in the safety program, for example for protective door, emergency stop, monitored feedback loop circuit and user acknowledgment; saves time and reduces the error rate
- Simple connection of PROFIsafe devices via PROFINET and PROFIBUS
- Convenient configuration of the drive-side safety technology with SINAMICS Startdrive (with Startdrive Advanced including integrated safety acceptance test to facilitate the necessary documentation)
- Additional password protection for F-CPU and safety program for IT security
- Integration in integrated system diagnostics

SINAMICS Integrated safety functionality

SINAMICS Integrated of the SIMATIC Drive Controller supports the same Safety Integrated functions as SINAMICS S120 CU320-2:

- Safety Integrated Basic Functions
- Safety Integrated Extended Functions
- Safety Integrated Advanced Functions

One license is required for each axis to be operated with Safety Integrated Extended/Advanced Functions. You can find more information in Runtime licensing (Page 278).

The safety functions correspond to the functions pursuant to EN 61800-5-2 (if and to the extent that they are defined therein).

The maximum achievable safety class of the SINAMICS Integrated safety functions is SIL 2 according to IEC 61508 or PL d according to ISO 13849-1.

SIMATIC Safe Kinematics

The movement of predefined Kinematics with up to 12 interpolating axes in a multi-dimensional space can be securely monitored with SIMATIC Safe Kinematics. The following monitoring functions are available for this purpose:

- Safe velocity monitoring
- Safe zone monitoring
- Safe orientation monitoring

SIMATIC Safe Kinematics is a TIA Portal option package and is post-installed as Setup in TIA Portal.

Hardware requirements:

SIMATIC Drive Controller CPU 1507D TF from firmware version V2.9 onwards

Engineering requirements:

- SIMATIC STEP 7 Professional V17 or higher
- STEP 7 Safety Advanced from V17 or higher

Runtime requirements:

- SINAMICS Safety Integrated Advanced Functions for every monitored axis: from firmware V5.2 onwards (SINAMICS Integrated); from firmware V5.1 onwards (for connected Control Units).
- SIMATIC Safe Kinematics from V17 onwards

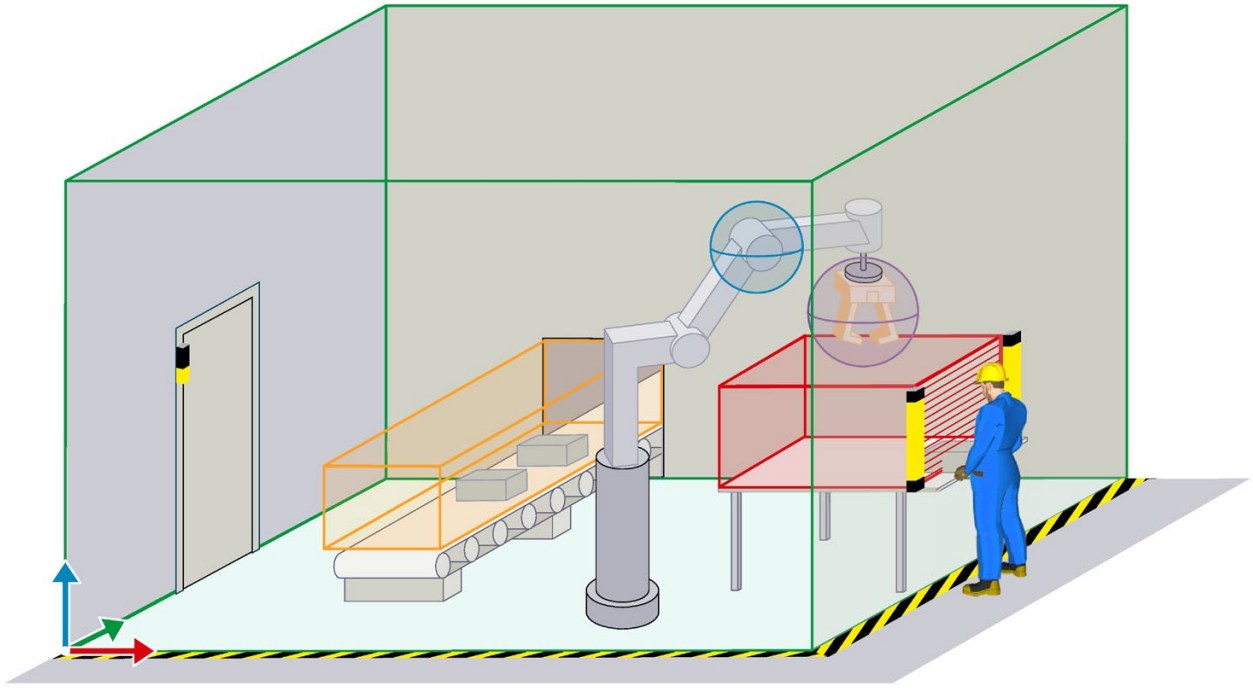
Safe Kinematics protects the machine operator by providing functionally safe monitoring of the movement of multi-axis kinematics equipment, for example:

- Industrial robots
- Handling systems for production machines and machine tools
- Cranes

With SIMATIC Safe Kinematics, you can program safe monitoring functions for kinematics in the framework of SIMATIC Safety Integrated. You can program the user-defined, fail-safe reactions when monitored limits are violated depending on the application, for example, a safe stop reaction.

Example: Production cell with safe zone monitoring

In a production cell, injuries to the machine operator must be prevented through the kinematic movement. To that end, areas are defined in the workspace (workspace zones), which are monitored for collision with all the moving parts of an industrial robot (kinematic zones). As long as a sufficient distance can be maintained between the machine operator and the robot, the robot may continue to move. Only when the machine operator reaches into the transfer zone (transgression of light curtain) and the robot is in the zone immediately before the transfer zone at the same time does this zone become the protected zone. The robot stops its movements.



Workspace zones:

- Work zone
- Signal zone
- Protection zone

Kinematics zones:

- Segment zone
- Tool zone

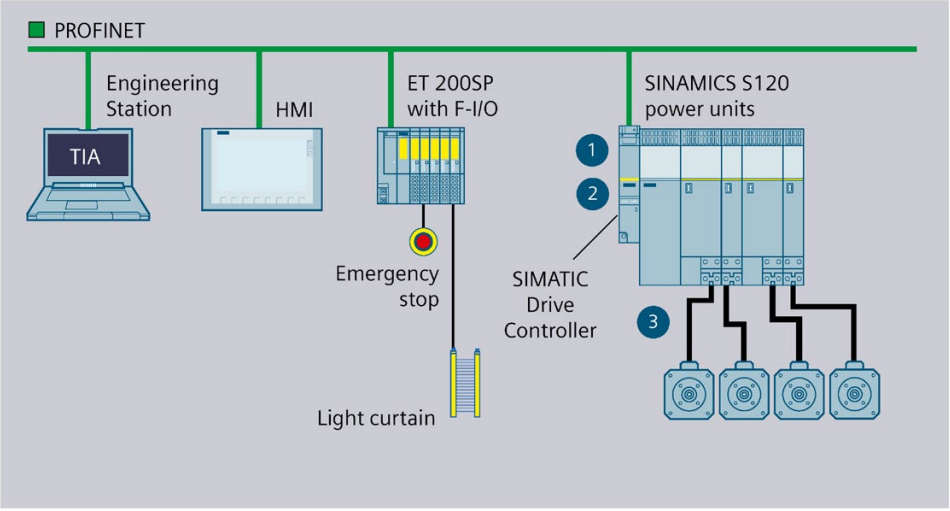
Figure 5-8 Example: Production cell with safe zone monitoring from SIMATIC Safe Kinematics

Feature:

The simple geometric forms cuboid and sphere, as well as point, represent zones in the workspace. The fixed workspace zones describe the environment of a kinematics system. The movable kinematics zones surround parts of a kinematics system. Safe zone monitoring checks all activated workspace zones (work zones, signal zones, protection zones) for collision with all activated kinematics zones (segment zones, tool zones).

Solution:

Use of a SIMATIC Drive Controller with SINAMICS S120 and fail-safe modules in the distributed I/O system ET 200SP on the PROFINET IO.



① Handling/robot application
② Safety program with Safe Kinematics blocks for monitoring kinematics
③ Reliable control commands for the drives and reliable state information
Safe position values from the drives

The ET 200SP F-modules provide the connections for emergency stop and monitoring the light curtain at the transfer area. A handling and robot application and a safety program with Safe Kinematics blocks (F-FBs) run in the CPU of the SIMATIC Drive Controller. Programming is done in the TIA Portal. SINAMICS Integrated determines the safe positions of the individual axes of the robot. The safe positions are sent to the CPU of the SIMATIC Drive Controller over PROFIsafe. SIMATIC Safe Kinematics calculates the velocities and positions in the workspace. If a limit is violated, the programmed stop reaction is triggered and transferred to the axes over PROFIsafe.

Additional information

You can find a detailed description of F-CPU configuration and programming in the SIMATIC Safety – Configuring and Programming (https://support.industry.siemens.com/cs/ww/en/view/54110126) programming and operating manual.

You can find a detailed description of the SINAMICS S120 Safety Integrated functions in the SINAMICS S120 Drive Functions (https://support.industry.siemens.com/cs/us/en/view/109781535) function manual and the SINAMICS S120 Safety Integrated (https://support.industry.siemens.com/cs/ww/en/view/109781722) function manual.

More information on SIMATIC Safe Kinematics is available

- in the S7-1500 Safe Kinematics (https://support.industry.siemens.com/cs/ww/en/view/109817533) Function Manual
- on the SIMATIC Safe Kinematics overview page (https://support.industry.siemens.com/cs/ww/en/view/109793052)

5.3.2 Security

Security means the protection of technical systems against sabotage, espionage and human error.

Protection functions of the integrated TF-CPU

For the setup of secure networks, the SIMATIC Drive Controller provides an integrated security concept:

Table 5- 3 Overview of the protection functions of the integrated TF-CPU

Protection function	Description
Protection of confidential configuration data	Protection of confidential CPU configuration data
Integrity protection	The CPUs come with an integrity protection function as standard. This helps detect any manipulations: • In the engineering data on the SIMATIC Memory Card; see also information on the integrity protection of the SIMATIC Memory Card as of CPU FW version V3.1 in the next section. • At the engineering data during data transfer between TIA Portal and CPU • At the engineering data during data transfer between HMI system and CPU • At the encrypted firmware
Know-how protection	Protection against unauthorized access and modifications to algorithms by means of password protection
Copy protection	Protection against duplication of programs by linking individual blocks to the serial number of the original memory card on the SIMATIC Memory Card

Protection function	Description
Local user management (as of FW version V3.1)	Improved management of users, roles, and CPU function rights (User Management & Access Control, UMAC). You can use the local user management to manage all project users with their rights (for example, access rights) in the editor for users and roles of the project in the TIA Portal.
Access protection (up to FW version V3.0)	Protection against unauthorized configuration changes using authorization levels
CPU lock	Protection against unauthorized access by locking the bottom cover with a seal or a lock

Integrity protection of the SIMATIC Memory Card, CPU FW Version V3.1 or higher

For CPUs as of FW version V3.1, the integrity protection of the SIMATIC Memory Card depends on the password for the protection of confidential configuration data that you assigned when configuring the CPU. This results in the following changes in the handling of SIMATIC Memory Cards:

- Drag-and-drop a CPU to a card reader/USB memory:
  For CPUs as of FW version V3.1, you must enter the password of the CPU with which you want to use the SIMATIC Memory Card. If you enter an incorrect password, the CPU will not start startup when switched on and will report the contents of the SIMATIC memory card as faulty.
- Insert a CPU from a card reader/USB memory:
  In order to be able to check the integrity of the contained configuration in STEP 7, you must enter the password of the CPU from which the configuration was loaded. In this case, STEP 7 checks the data on the SIMATIC Memory Card and reports possible damage. Entering the password is optional. If you do not want to use the integrity check, you do not need to enter the password (restore project).

Access protection example

You can choose from four different access levels in the TIA Portal to restrict user access to functions and memory areas.



Figure 5-9 Access protection

If you only want to allow users access over HMI, for example, select the access level "HMI access" in the TIA Portal. Only HMI access and access to diagnostics data is then possible without entering a password.

Users can read and write tags over an HMI device with this access level.

Users **cannot**:

- Download blocks or the hardware configuration to the CPU
- Upload blocks or the hardware configuration from the CPU to the PG/PC
- Run writing test functions
- Change the operating state from the PG/PC
- Run CPU firmware updates

Advantages and customer benefits of protection functions

The protection functions listed above protect your investments from unauthorized access and manipulation, helping to secure plant availability.

Secure Communication

There is an increasing need to transfer data to external computers in encrypted form via Intranet or public networks.

SIMATIC Drive Controller support the Internet PKI (RFC 5280) with STEP 7. This allows the configuration and operation of Secure Communication, for example:

- Hypertext Transfer Protocol Secure (HTTPS)
- Secure Open User Communication
- Secure Communication with OPC UA

A public key infrastructure (PKI) can issue, distribute and check digital certificates. For SIMATIC Drive Controller , you create certificates for various applications in the CPU properties in STEP 7, for example: TLS certificates for Secure Open User Communication, Web server certificates, and OPC UA certificates.

SIMATIC Drive Controller as of CPU firmware version V2.9 with STEP 7 and WinCC as of version V17 support innovative and standardized secure PG/PC and HMI communication - Secure PG/HMI communication for short.

Additional information

You can find introductory information on industrial cybersecurity and on secure operation and cybersecurity functions of the SIMATIC Drive Controller in the section Industrial cybersecurity (Page 24).

You can find more information on the described protection functions in the section Protection (Page 236) and in the STEP 7 online help.

Siemens products and solutions are only one element of a comprehensive industrial security concept. Please note the additional information on Industrial Security (https://www.siemens.com/industrialsecurity).

Note

Please also note the security information in the SINAMICS S120 documentation (https://support.industry.siemens.com/cs/ww/en/ps/13231/man).

5.3.3 Web server

The SIMATIC Drive Controller have an integrated Web server.

You can display the CPU status via a Web browser without installing additional software and to a limited extent control it. Graphic displays of process variables and user-defined websites facilitate information acquisition and the diagnosis of plant states.

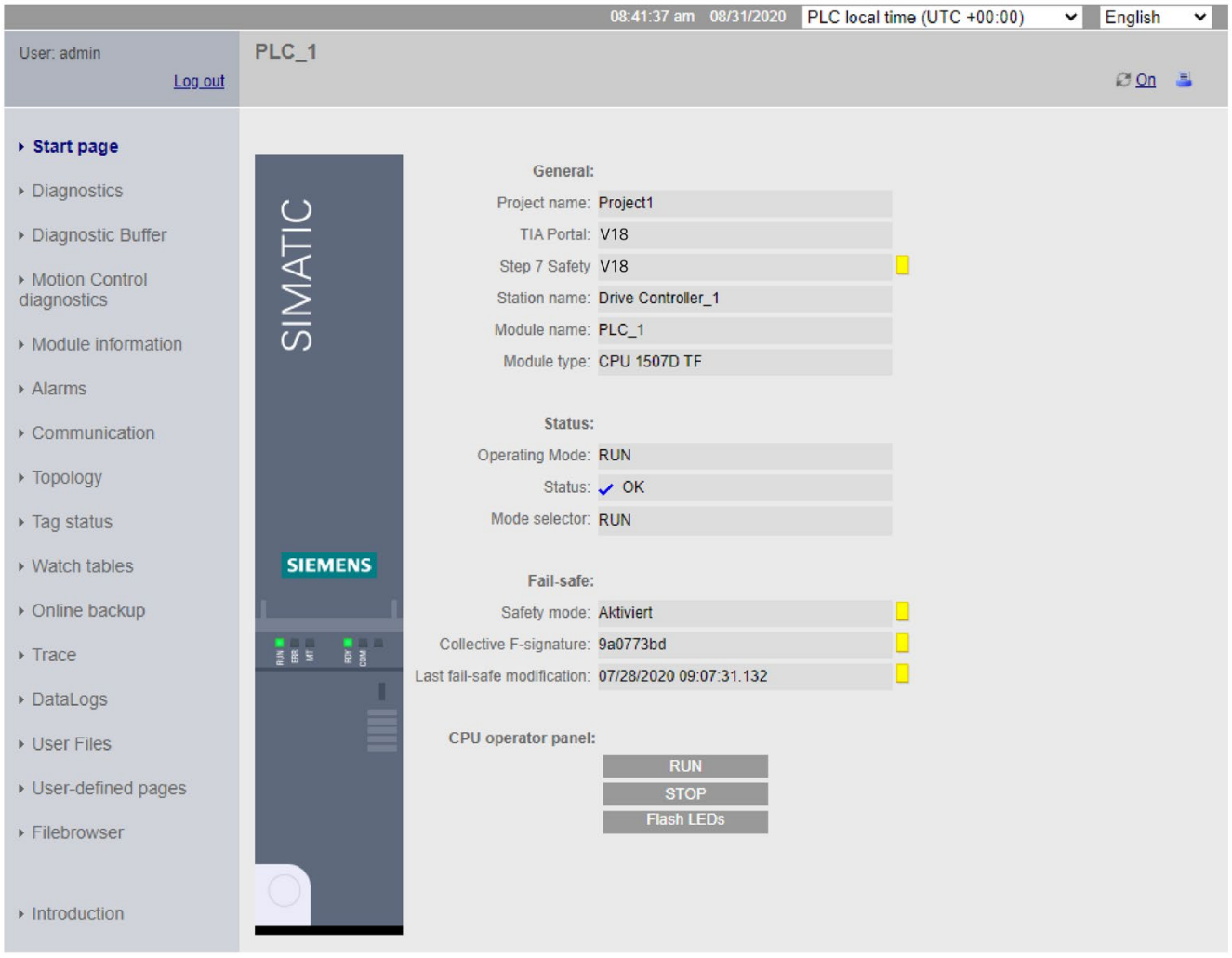


Figure 5-10 Home page web server

Note

SINAMICS Integrated of the SIMATIC Drive Controller does not have its own Web server.

Example: Web server facilitates commissioning and local diagnostics for standard machines

Automation task:

Implementation of a user interface for commissioning and calibrating test benches.

Feature:

When standard machines are commissioned, parameters often need to be set once for setup, for example in line with the place of installation or purpose. Examples of such parameters include machine runtime program parameters in the CPU.

The operator also requires easy access to the SIMATIC Drive Controller for rapid local diagnostics in the event of an error.

Solution:

Creation of user sites for the Web server of a SIMATIC Drive Controller. The customer can make the machine settings themselves over these websites without PG/PC, for example adjust the calibration parameters or change the formats.

In the event of an error, rapid initial diagnostics is possible over the integrated Web pages of the SIMATIC Drive Controller without the need for the engineering project.

Advantages and customer benefits

The Web server provides the following advantages:

- Access via Web browsers to a SIMATIC Drive Controller with plant-related operating data
- Display of service and diagnostics information over large distances
- Access restrictions for unauthorized users
- Firmware update of CPU and SINAMICS Integrated via remote access; see the section: Firmware update SIMATIC Drive Controller, under Procedure via the integrated Web server (Page 319)

Additional information

A detailed description of handling the Web server can be found in the SIMATIC S7-1500 Web Server Function Manual (https://support.industry.siemens.com/cs/ww/en/view/59193560).

5.3.4 Trace

The SIMATIC Drive Controller has an integrated Trace functionality for the effective commissioning and optimization of drives and controllers. The Trace function is available for the integrated CPU and SINAMICS Integrated.

The trace function records the following in line with the adjustable trigger conditions:

- CPU tags in the CPU Trace
- Drive parameters in the SINAMICS Integrated Trace

By visualizing the entire process with real-time Trace, you can identify sporadic events in the system during commissioning and service, for example.

Example: Signal response analysis

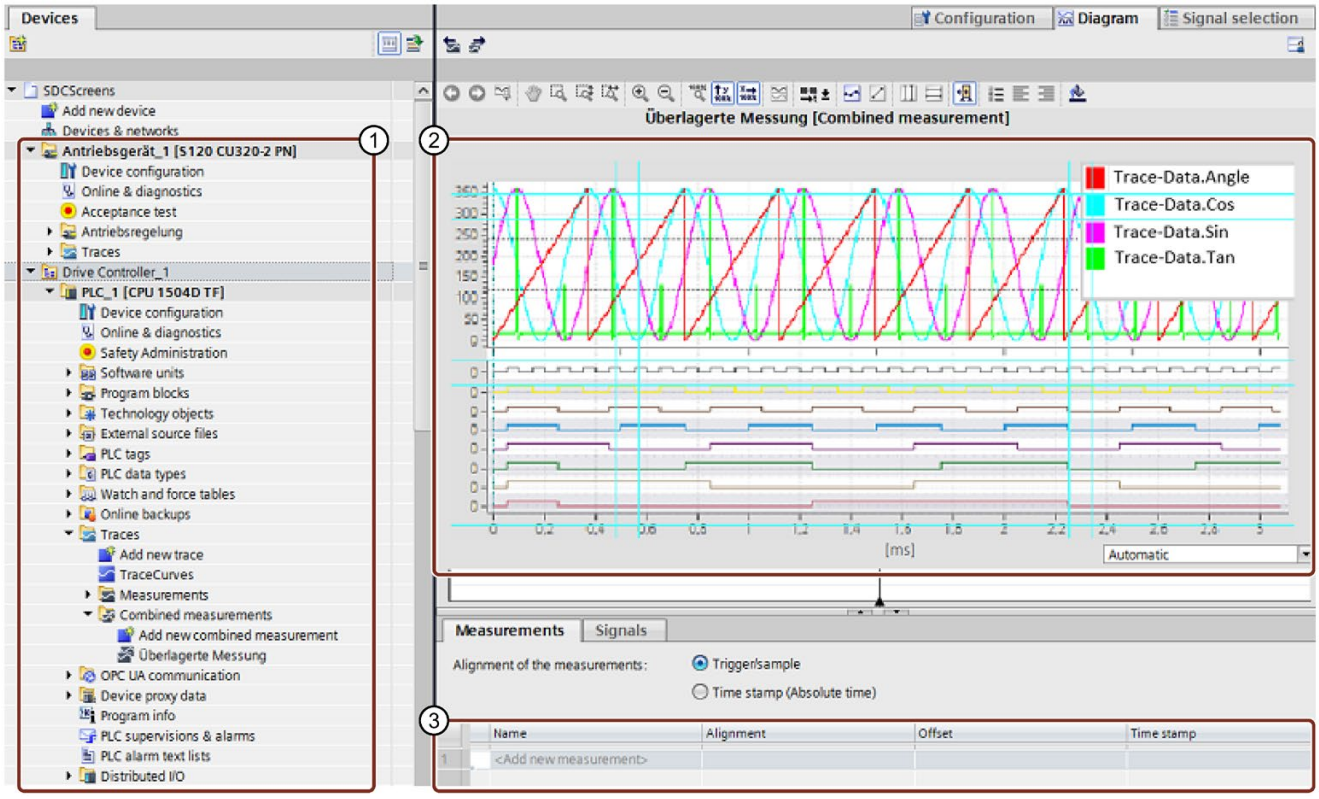
To analyze a specific signal response, you define the recording and trigger conditions for the signals for recording.

① The Trace function can be called in the project tree in the "Traces" folder:

- For the CPU, under the CPU of the SIMATIC Drive Controller
- For the SINAMICS Integrated, under the drive unit of the SIMATIC Drive Controller

The trend diagram ② displays the selected signals of a recording. Digital signals are displayed as bit track in the lower diagram.

The signal table ③ lists the signals of the selected measurement and provides setting options for specific properties.



① Trace recordings in the project tree
② Trend diagram
③ Signal table

Figure 5-11 Trace recording for the CPU

Example: Trace optimizes the commissioning of packaging machines

Automation task:

At what speed does a plant reach its maximum productivity? How do you quickly determine the optimum settings?

The packaging machine ensures quick and reliable packaging of ECG electrodes on a rotary table which is loaded and unloaded by a conveyor belt.

Feature:

After filling, the issue is the correct time for further transport of the packages electrodes. To this end, light barriers trace the position of the electrodes.

Solution:

The Trace function of a SIMATIC Drive Controller shows the exact sequence of selected signals over a short period of time. It helps the start-up engineer find the exact light barrier positions and the optimum speed for belts and the rotary table.

The trace recordings are supplied to the customer as part of the plant project. In the event of a fault, the customer can see whether changes to the basic settings have caused the fault.

The trace recordings in the CPU trace can also be stored as a "measurement" on the SIMATIC Memory Card; up to 999 trace recordings are available for evaluation.

Advantages

The Trace function provides the following advantages:

- A uniform standard for tag analysis that allows even sporadic errors to be located rapidly
- Cost-effective and easy evaluation as the signals are available in the CPU
- Monitoring of highly dynamic processes
- Cycle-by-cycle recording:
  - Of up to 16 different signals and up to 8 separate trace jobs in the CPU trace simultaneously
  - Of up to 8 different signals and up to 2 separate trace jobs in the SINAMICS Integrated trace simultaneously
- Storage of the CPU trace recordings in a separate memory area for easy localization of sporadic errors
- Various trigger options
- Various zoom and cursor measuring functions
- Storage of CPU trace recordings on the SIMATIC Memory Card
- Trace recordings can be evaluated on the SIMATIC Memory Card over SIMATIC Drive Controller Web servers
- Export of trace recordings, for example for user-specific processing

Project Trace

A project trace contains trace configurations of multiple CPUs. A project trace records the signals across CPUs if the CPUs are connected to each other via PROFINET.

A global trigger that can be activated by each CPU is used for synchronization. After receiving the global trigger, the CPUs with a valid project trace configuration start recording.

Additional information

You can find information on how to save trace recordings for the CPU without the TIA Portal in the section Data transfer with SIMATIC Memory Cards (Page 314).

A detailed description of the "Trace" function is available in the SIMATIC/SINAMICS Using the Trace and Logic Analyzer Function function manual (https://support.industry.siemens.com/cs/ww/en/view/64897128) and in the SINAMICS S120 with Startdrive commissioning manual (https://support.industry.siemens.com/cs/ww/en/view/109781583).

5.3.5 Technology functions of the CPU

The CPU of the SIMATIC Drive Controller has Motion Control technology objects and a modular S7-1500T CPU.

You can control PROFIdrive-capable drives with Motion Control instructions in accordance with PLCopen.

Motion Control technology objects

The following table shows the technology objects that support the SIMATIC Drive Controller. They occupy Motion Control resources or Extended Motion Control resources in the CPU.

Table 5- 4 Technology objects

Technology objects	Resource requirements per technology object
Speed axis	40
Positioning axis	80
Synchronous axis	160
External encoder	80
Measuring input	40
Output cam	20
Cam track	160
Cams (1000 points and 50 segments)	2*
Cams (10000 points and 50 segments)	20*
Kinematics	30*
Interpreter	60*
Leading axis substitute	3*

*They occupy Extended Motion Control resources in the CPU

Motion Control technology functions

The following table shows the technology functions supported by SIMATIC Drive Controller .

Table 5- 5 Motion Control technology functions

	SIMATIC Drive Controller technology functions
	Enable, disable technology objects
	Acknowledge alarms, restart technology object
	Reference technology objects, set reference point
	Halt axis
	Position axis absolutely
	Position axis relatively
	Move axis at set velocity/speed
	Move axis in jog mode
	Position axis overlapping
	Set alternative encoder as operationally active encoder
	Pause superimposed motions on the axis
	Halt and disable axis
	Enable/disable hardware limit switch
	Control bits of control word 1 and 2
	Save absolute encoder adjustment for device replacement
	Start one-time measuring
	Start cyclic measuring
	Abort active measuring
	Enable/disable output cam
	Enable/disable cam track
	Start gearing
	Start gearing with specified synchronous positions
	Start velocity synchronous operation
	Absolute shift of master value on the following axis
	Relative shift of master value on the following axis
	Absolute shift of following value on the following axis
	Relative shift of following value on the following axis
	Start camming
	Simulate synchronous operation
	Desynchronize gearing
	Desynchronize camming
	Specify additive master value
	Interpolate cam
	Read out slave value of a cam
	Read master value of a cam
	Copy calculated cam elements
	Specify motion setpoints
	Specify superimposed motion setpoints
	Enable and disable force/torque limit / fixed stop detection
	Specify additive torque
	Specify upper and lower torque limits

	SIMATIC Drive Controller technology functions
	Interrupt Motion Control of kinematics
	Continue Motion Control of kinematics
	Stop motion of kinematics
	Position kinematics with linear motion
	Position kinematics relatively with linear motion
	Position kinematics with circular motion
	Position kinematics relatively with circular motion
	Absolute travel of kinematics with synchronous "point-to-point" movement
	Relative travel of kinematics with synchronous "point-to-point" movement
	Start belt monitoring
	Set kinematics to simulation mode
	Define workspace zones
	Define kinematics zones
	Activate workspace zones
	Deactivate workspace zones
	Activate kinematics zones
	Deactivate kinematics zones
	Re-define tool
	Change active tool
	Redefine object coordinate systems
	Transform axis coordinates to Cartesian coordinates
	Transform Cartesian coordinates to axis coordinates

PID control

PID compact controllers are integrated as standard in all S7-1500 CPUs. In your application, the PID controller adjusts a physical setpoint and stabilizes it against interferences at the same time. You can use different PID controllers depending on your application. All controllers support the following functions:

- Manageable configuration screens
- Automatic determination of the controller parameters
- Commissioning screens with integrated Trace

Table 5- 6 PID controller versions

PID controller	Description
PID Compact	Continuous PID controller
PID 3step	Step controller for integrating actuators
PID Temp	Temperature controller for heating and cooling with two separate actuators

Technology function of the onboard I/O

The eight digital input/outputs of the SIMATIC Drive Controller provide the following technology function at the X142 interface:

Table 5- 7 Technology I/Os of the CPU at interface X142

Operating mode	Function	Application
DI	Digital input optional: Hardware interrupt upon rising and/or falling edge	Used as hardware limit switch, for example
DQ	Digital output	Used to control an indicator light, for example
Timer DI	Acquisition of the switching time of a digital input signal with up to two edges per cycle (OB91/OB6x)	Used as the input of a measuring input, for example
Timer DQ	Precise output of a digital output signal with up to two edges per cycle (OB91/OB6x)	Used as an output cam output, for example
Oversampling DI	Acquisition of 32 states of a digital input signal at equal intervals per cycle (OB91/OB6x)	Detection of short signal levels that are shorter than the position control cycle or isochronous mode interrupts. Used, for example, to detect a fast-traveling product with a proximity switch or light barrier
Oversampling DQ	Output of 32 states for a digital output signal at equal intervals per cycle (OB91/OB6x)	Output of short signal levels that are shorter than the position control cycle or isochronous mode interrupts. Used, for example, to control the output of short pulses or pulse trains, for example to control a glue valve for applying dots of glue.
Event/period duration measurement	Measurement of number of edges and period max. counting frequency 32 kHz	Simple speed measurement with shadow mask and light barrier: • Period measurement • Counter (rising edges)
Pulse width modulation (PWM)	Output of a selectable pulse-pause ratio with a configurable base frequency of: 1 kHz, 2 kHz, 4 kHz, 8 kHz, 16 kHz	Output of a signal with a defined period and variable on-load factor Used, for example, to control proportional valves and directional valves (energy savings through reduction in holding current).

High-speed outputs

For short pulses and maximum output accuracy, configure the digital outputs at interface X142 as high-speed outputs.

The digital outputs are then operated as rapid push/pull switches, which are switched alternately to 24 V DC and ground. This enables very steep edges and extremely short output delays.

Digital outputs as high-speed outputs are particularly suited to the operating modes timer DQ, oversampling DQ and pulse width modulation (PWM).

Note

Notes on interconnection

When you use the digital outputs at the X142 interface as high-speed outputs, the current-carrying capacity is reduced from 0.5 A to 0 4 A.
Please note also the information on input interconnection for high-speed outputs in the SIMATIC Drive Controller manual (https://support.industry.siemens.com/cs/ww/en/view/109768445).

Expansion of technology functions with technology modules

For solving technological tasks, powerful distributed technology modules are also available that operate largely autonomously and reduce the load on the CPU.

Table 5- 8 Technology modules ET 200SP and ET 200MP

Technology module	Article number	Description	Manual
ET 200SP Distributed I/O System			
TM Count 1x24 V	6ES7138- 6AA01-0BA0	Counter module 1 channel for 24 V incremental or pulse encoder, 3 DI, 2 DQ	ET 200SP TM Count 1x24V (https://support.industry.siemens.com/cs/ww/en/view/109768445)
TM PosInput 1	6ES7138-6BA01-0BA0	Module for count and position acquisition for RS-422 incremental encoder or SSI absolute encoder, 2 DI, 2 DQ	ET 200SP TM PosInput 1 (https://support.industry.siemens.com/cs/ww/en/view/109780353)
TM Timer DIDQ 10x24 V	6ES7138-6CG00-0BA0	Time-controlled digital inputs and digital outputs, 4 DI and 6 DQ with time stamp, count function, pulse width modulation, oversampling	ET 200SP TM Timer DIDQ 10x24 V (https://support.industry.siemens.com/cs/ww/en/view/95153951)
TM Pulse 2x24 V	6ES7138-6DB00-0BB1	Pulse width modulation and pulse output, 2 channels 2 A for proportional valves and DC motors	ET 200SP TM Pulse 2x24V (https://support.industry.siemens.com/cs/ww/en/view/109768441)

Technology module	Article number	Description	Manual
TM PTO 2x24V	6ES7138-6EB00-0BA0	Interface module for stepper drives, 2 channels pulse train output (PTO): 24 V, 2 DI and 1 DQ 24 V DC per channel	ET 200SP TM PTO 2x24V (https://support.industry.siemens.com/cs/en/en/view/109796316)
SIWAREX WP321 ST	7MH4138-6AA00-0BA0	Weighing electronics 1 channel Acquisition and processing of signals from weighing or force sensors with high precision	SIWAREX WP321 ST (https://support.industry.siemens.com/cs/ww/en/view/109770838)
SIWAREX WP351 HF	7MH4138-6BA00-0CU0	Weighing electronics 1 channel Calibration-capable weighing module for automatic dosing, filling, control and totalizing weighing scales	SIWAREX WP351 HF (https://support.industry.siemens.com/cs/de/en/view/109784492)
Additional technology modules	See (https://mall.industry.siemens.com/mall/en/WW/Catalog/Products/10225175)		
ET 200MP Distributed I/O System			
TM Count 2x24V	6ES7550-1AA01-0AB0	Counter module 2 channels for 24 V incremental or pulse encoder, 3 DI and 2 DQ per channel	S7-1500 TM Count 2x24 V (https://support.industry.siemens.com/cs/ww/en/view/109783960)
TM PosInput 2	6ES7551-1AB00-0AB0	Module for count and position acquisition for RS-422 incremental encoder or SSI absolute encoder, 2 channels, 2 DI and 2 DQ per channel	S7-1500 TM PosInput 2 (https://support.industry.siemens.com/cs/ww/en/view/109813005)
TM Timer DIDQ 16x24 V	6ES7552-1AA00-0AB0	Time-controlled digital inputs and digital outputs, max. 8 DI, 16 DQ, of which max. 16 with time stamp, count function, pulse width modulation, oversampling	ET 200MP/S7-1500 TM Timer DIDQ 16x24 V (https://support.industry.siemens.com/cs/ww/en/view/95153313)
TM PTO 4	6ES7553-1AA00-0AB0	Interface module for stepper drives, 4 channels, pulse train output (PTO): 24 V, 2 DI and 1 DQ 24 V DC per channel	S7-1500/ET 200MP TM PTO 4 (https://support.industry.siemens.com/cs/ww/en/view/109742067)
SIWAREX WP521 ST SIWAREX WP522 ST	7MH4 980-1AA01 7MH4 980-2AA01	Weighing electronics 1 channel (WP521 ST) or 2 channels (WP522 ST) Acquisition and processing of signals from weighing or force sensors with high precision	SIWAREX WP521/WP522 (https://support.industry.siemens.com/cs/ww/en/view/109742780)
Additional technology modules	See (https://mall.industry.siemens.com/mall/en/WW/Catalog/Products/10204242)		

Additional information

You can find additional information on the technology functions of the CPU in the S7-1500T Motion Control function manuals (https://support.industry.siemens.com/cs/ww/en/view/109751049).

5.3.6 SINAMICS Integrated functions

The automatic speed control integrated in SIMATIC Drive Controller is based on the automatic speed control of the SINAMICS S120 Control Unit CU320-2 (firmware version V5.x).

SINAMICS Integrated provides a functional subset of the SINAMICS S120 CU320-2 drive functions. You can find details at the end of the section under "Unsupported functions and components".

The integrated drive control supports the following:

- Servo control, for maximum dynamic response
- Vector control, for maximum torque accuracy
- U/f control

You can expand the drive configuration limits of the SIMATIC Drive Controllers via PROFINET IO IRT, for example with SINAMICS S120 Control Unit CU320-2.

Safety functionality of SINAMICS Integrated

SINAMICS Integrated of the SIMATIC Drive Controller supports the same Safety Integrated functions as SINAMICS S120 CU320-2:

- Safety Integrated Basic Functions
- Safety Integrated Extended Functions
- Safety Integrated Advanced Functions

The safety functions correspond to the functions pursuant to EN 61800-5-2 (if and to the extent that they are defined therein).

Supported SINAMICS functions requiring a license

SINAMICS Integrated only supports the following licensed functions and Technology Extensions (TEC) of a SINAMICS S120 CU320-2:

- Safety Integrated Extended Functions
- Safety Integrated Advanced Functions
- Detent torque compensation
- Advanced Position Control (APC)
- DCB Extension Library
- Advanced Synchronous Reluctance Control
- Controller Parameter Adaption
- Dynamic network support
- Line droop control
- Technology Extension VIBX (Vibration Extinction)
- Technology Extension SERVCOUP (Servo Coupling)
- Technology Extension DCDCCONV (DC-DC converter)

- Technology Extension RAILCTRL (Rail Control, under development)
- Technology Extension POLYGON (Polygonal Line)
- Technology Extension SETPGEN (Setpoint Generator)

PROFIdrive Integrated

Cyclic communication between CPU and SINAMICS Integrated is based on PROFIdrive mechanisms.

The communications services used for this are based on PROFIBUS DP and are processed over an internal, high-performance interface.

Unsupported functions and components

SINAMICS Integrated provides a functional subset of the SINAMICS S120 CU320-2 drive functions. The following functions/components are not supported by the integrated drive control of the SIMATIC Drive Controller:

- Free function blocks (FBLOCKS)
- SINAMICS Web server

  FW updates for SINAMICS Integrated can be carried out via the CPU web server (see Firmware Update SIMATIC Drive Controller section (Page 319)).
- SIMOTION-specific or SINUMERIK-specific DRIVE-CLiQ components (for example Terminal Module TM17, Hydraulic Drive HLA, Controller Extension CX32-2, Numeric Control Extensions NX10.3/NX15.3)
- Expansion boards, e.g. TB30, CBE20, CBE30-2
- Hardware and functions not supported by SINAMICS Startdrive, see (https://support.industry.siemens.com/cs/ww/en/view/109761180)

In addition, not all licensed functions and Technology Extensions (TEC) of a SINAMICS S120 CU320-2 are available to the SINAMICS Integrated. The High Output Frequency function, for example, is not available for high output frequencies > 550 Hz.

Note

Use of SINAMICS S120 CU320-2 Control Units

Additional CU320-2 Control Units on the SIMATIC Drive Controller offer the full range of functions, unlike SINAMICS Integrated.

Note

Use of SINAMICS S220 power units

From SINAMICS firmware V5.2 SP3 HF10 onwards, the use of SINAMICS S220 power units at the integrated SINAMICS S120 drive control of the SIMATIC Drive Controller is also possible. For more information on the currently available module range as well as compatibility information for use with SINAMICS S120 drive controls, see the publications on the SINAMICS S120/S220 drive system, for example (https://support.industry.siemens.com/cs/ww/en/view/109806050)

WARNING

Danger to life due to unsuitable firmware version

Operation of the SINAMICS S220 Booksize component with an unsuitable firmware version can lead to unsafe operational states, for example, overheating of converter components, unexpected acceleration of a motor or malfunctioning of the safety functions.
Use firmware V5.2 SP3 HF10 or later.

Use of "older" DRIVE-CLiQ components

Some "older" DRIVE-CLiQ components cannot be used with the SIMATIC Drive Controller or with SINAMICS S120 CU320-2.

Table 5- 9 DRIVE-CLiQ components that cannot be used with SIMATIC Drive Controller and SINAMICS S120 CU320-2

DRIVE-CLiQ components	Notes	Ending of the article no.
Single Motor Modules (SMM) Double Motor Modules (DMM)	6SL31* (all Motor Modules Booksize Compact 6SL34* can be used)	< 3
Line Modules (ALM/SLM)	6SL313* can generally be used: • All BLMs (6SL313*) • SLM (6SL313*) 5 and 10 kW	< 3
Chassis power units (Line Modules, Motor Modules, Power Modules)	• Line Modules: 6SL333* • Motor Modules: 6SL332* • Power Modules: 6SL331*	< 3
Sensor Modules Cabinet SMC30	-	< 2
Terminal Modules TM31/TM41	-	< 1
Sensor Module External SME20/25	-	< 3
Control Unit Adapter CUA31	-	< 1

If you use invalid components, then a topology error is reported, **F01360 Topology: Actual topology invalid**.

Additional information

You can find a description of the CPU and SINAMICS Integrated functions that require a license in the section Runtime licensing (Page 278).

You can find a detailed description of the functions of SINAMICS S120 CU320-2 in the SINAMICS S120 Drive Functions (https://support.industry.siemens.com/cs/us/en/view/109781535) function manual.

5.4 Integrated interfaces for communication

Interfaces for communication over PROFINET and PROFIBUS DP are integrated in the SIMATIC Drive Controller. The following communications options are available for your automation task:

Table 5- 10 SIMATIC Drive Controller communication options

Communication option	PN	DP
PG communication for commissioning, testing and diagnostics	X	X
HMI communication for operator control and monitoring	X	X
Open User Communication	X	-
Secure Open User Communication	X	-
Data exchange via OPC UA as server	X	-
Data exchange via OPC UA as client	X	-
Direct data exchange between IO controllers	X	-
Communication via Modbus TCP	X	-
Communication via UDP Multicast	X	-
Sending process alarms via e-mail	X	-
S7 communication	X	X
S7 routing	X	X
Web server of the CPU Data exchange via HTTP(S), for example for diagnostics	X	-
SNMP (Simple Network Management Protocol)	X	-
Time-of-day synchronization	X	X
Connection to the clock system of the technology I/Os X142 and to the SINAMICS Integrated	X	-

The SIMATIC Drive Controller also has two USB 3.0 ports (non-functional, no connection permitted).

Further information

You can find more information on communication options in the Communication Function Manual (https://support.industry.siemens.com/cs/ww/en/view/59192925).

5.5 DRIVE-CLiQ

SINAMICS Integrated has 4 DRIVE-CLiQ interfaces. For the 24 V DC supply of encoders and measuring systems, 450 mA are available for each DRIVE-CLiQ interface.

You can connect all components of SINAMICS Integrated including the motors and encoders over the common DRIVE-CLiQ interface.

DRIVE-CLiQ implements a high-performance point-to-point connection for internal drive communication between the various drive components.

The DRIVE-CLiQ interfaces of the SIMATIC Drive Controller are, for example, used for:

- Connecting the power units (Line Module, Motor Modules) to the automatic speed control of SINAMICS Integrated
- Connecting motors with DRIVE-CLiQ interface to the Motor Modules
- Connecting encoder systems over Sensor Modules Cabinet-Mounted (SMC) or Sensor Modules External (SME)
- Addition of drive I/Os using Terminal Modules (TM)

Over the DRIVE-CLiQ interface, SINAMICS Integrated detects all connected drive components after switch-on. During operation, cyclical drive-related data is exchanged with the drive components on an isochronous basis, for example parameters and diagnostics data.

Advantages and customer benefits

DRIVE-CLiQ provides the following advantages:

- Automatic detection of the connected components reduces commissioning work
- Standardized cables and connectors reduce the variety of different parts and cut storage costs.
- Consistent diagnostics through to the drive components
- Encoder evaluations for converting standard encoder signals to DRIVE-CLiQ are available for third-party motors or retrofit applications.

5.6 Power supply

SIMATIC Drive Controller supply

For the SIMATIC Drive Controller, use an external 24 V DC power supply, for example, from the SITOP range (https://mall.industry.siemens.com/mall/en/WW/Catalog/Products/10008864) (SITOP smart or SITOP modular).

Supply of the SINAMICS S120 drive modules

The SINAMICS S120 drive components are supplied over a SINAMICS Line Module. Line Modules generate direct voltage from the line voltage and supply energy to the Motor Modules through the DC link.

Optionally, Line Modules with controlled supply/regeneration ensure a constant DC-link voltage and high grid compatibility.

Motor Modules supply the motors with power from the DC link.

5.7 Software

5.7.1 TIA Portal

The SIMATIC Drive Controller are integrated in the Totally Integrated Automation portal. Engineering with TIA Portal offers:

- Configuration and programming
- Shared data management
- A uniform operating concept for control, visualization and drives

The TIA Portal simplifies integrated engineering in all configuration phases of a plant.

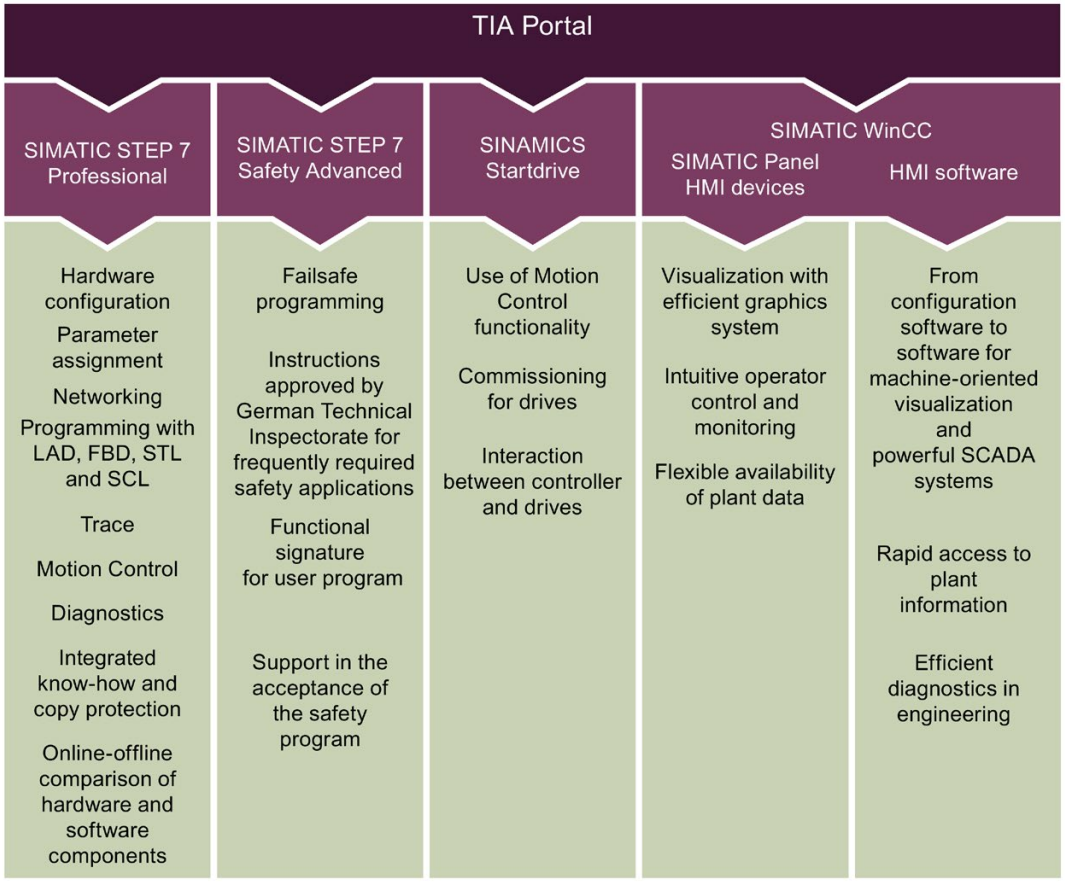


Figure 5-12 TIA Portal overview

5.7.2 SINETPLAN

SINETPLAN (https://www.siemens.com/sinetplan), the Siemens Network Planner, helps you plan automation systems and networks based on PROFINET. The tool facilitates the professional and predictive dimensioning of your PROFINET system right from the planning stage. SINETPLAN also assists with network optimization and helps you to make the best possible use of network resources and to plan for reserves. This allows you to avoid problems in commissioning and failures during productive operation even before planned use. This increases the availability of the production plant and helps improve operational safety.

The advantages at a glance:

- Network optimization thanks to port-specific calculation of the network load
- Increased production availability thanks to online scan and verification of existing systems
- Transparency before commissioning with the import and simulation of existing STEP 7 projects
- Efficiency through securing existing investments in the long term and the optimal use of resources

5.7.3 PRONETA

Siemens PRONETA (PROFINET network analysis) allows you to analyze the plant network during commissioning. PRONETA features two core functions:

- The topology overview independently scans PROFINET and all connected components.
- The IO check is a rapid test of the wiring and the module configuration of a plant.

Siemens PRONETA (https://support.industry.siemens.com/cs/ww/en/view/67460624) is available for free on the Internet.

5.7.4 TIA Selection Tool

The TIA Selection Tool allows you to select, configure and order devices for Totally Integrated Automation (TIA).
The TIA Selection Tool helps you select the right SIMATIC Drive Controller in line with:

- Axis quantity frameworks
- Axis technologies
- Control performance

With the TIA Selection Tool , you can generate a complete order list from your product selection or product configuration.

You can find the TIA Selection Tool on the Internet (https://www.siemens.com/tia-selection-tool).

5.7.5 SIMATIC Automation Tool

You use the SIMATIC Automation Tool (https://support.industry.siemens.com/cs/ww/en/view/98161300) to perform commissioning and maintenance activities simultaneously on various SIMATIC S7 stations as a bulk operation independent of the TIA Portal. The SIMATIC Automation Tool offers a wide range of functions:

- Browsing the network and creating a table showing the accessible devices in the network
- Flashing of device LEDs or HMI display to locate a device
- Loading addresses (IP, subnet, gateway) to a device
- Loading the PROFINET name (station name) to a device
- Switching a CPU to RUN or STOP mode
- Setting the time in a CPU to the current time of your PG/PC
- Downloading a new program to a CPU or an HMI device
- Downloading from CPU, downloading to CPU or deleting recipe data from a CPU
- Downloading from CPU or deleting data log data from a CPU
- Backup/restore of data in/from a backup file for CPUs and HMI devices
- Downloading service data from a CPU
- Reading the diagnostics buffer of a CPU
- CPU memory reset
- Resetting devices to factory settings
- Downloading a firmware update to the CPU

Note

When saving/restoring data to/from a backup file, the configuration of the SINAMICS Integrated is also saved/restored from the SIMATIC Memory Card.
NVRAM data must have been previously backed up to the SIMATIC Memory Card.
More information can be found in the section Configuring SIMATIC Drive Controller backup and restore (Page 283)

5.7.6 SIMATIC S7 app

With the SIMATIC S7 app, you can establish a secure connection via WLAN to SIMATIC S7-1500 and ET 200SP with, for example, the following functions:

- Detect up to 50 networked CPUs via HTTPS and establish a connection
- Change CPU operating mode (RUN/STOP)
- Read out CPU diagnostics information and send via e-mail
- Monitor and modify variables and tags
- High security through encrypted communication and encrypted profile data; password to start app and establish the connection

You can find more information about the SIMATIC S7 app on the Internet (https://new.siemens.com/global/en/produkte/software/mobile-apps/simatic2go.html).

5.7.7 Industry Online Support app

With the Industry Online Support app, you get access to documents and contributions for Siemens Industry products, for example

- FAQs
- Application examples
- Manuals
- Certificates
- Product announcements

Core functions of the app

- Scanning of product codes and EAN codes to directly display all the technical and graphical data (for example, CAx data) of the Siemens Industry product.
- Sending product information or entries via email so that the information can be further processed at the workstation.
- Sending Technical Support requests. Detailed information can be conveniently completed with the scan or photo function.
- Offline cache function to save favorites on the device. This will facilitate access to these contributions, products and conferences even without Internet access.
- Transferring PDF documents to an external library.

Download the Industry Online Support app (https://support.industry.siemens.com/sc/de/en/sc/2067)

Application planning

6

6.1 Installation location

Operating conditions

The SIMATIC Drive Controller is intended for installation in a control cabinet or in a device connection box.

- In these cases, the LEDs on the front of the device will remain visible and usable only during commissioning. Please take this into consideration for subsequent operation of the device.
- It is important to note that installation in a control cabinet or device connection box is essential for compliance with UL regulations.
- Protect the components from conductive contamination, for example by installing them in a control cabinet with degree of protection IP54 pursuant to IEC 60529 or NEMA 12.
  If the occurrence of conductive contamination can be ruled out, a correspondingly lower degree of protection for the control cabinet is permitted.
- The control cabinet or device connection box must satisfy the regulations regarding fire-protection housing.
- Ensure that all cables and leads that protrude externally are equipped with adequate strain relief.

Prohibition on use

The SIMATIC Drive Controller must not be used in the following environments without additional measures:

- In locations with a high degree of ionizing radiation
- In aggressive environments caused, for example, by
  - Dust formation
  - Corrosive vapors or gases
- In systems requiring special monitoring, for example
  - Elevators
  - Electrical equipment in particularly hazardous areas

An example of an additional measure for use of the SIMATIC Drive Controller is installation in enclosures.

Electromagnetic compatibility (EMC)

Electromagnetic compatibility (EMC) means that devices can operate satisfactorily without interfering with other devices and without interference from other devices. The EMC requirements for variable-speed drive systems (Power Drive System, PDS) are detailed in product standard IEC/EN 61800-3. A variable-speed drive system consists of SIMATIC Drive Controller, Line Module and Motor Module and the corresponding electric motors and encoders, including connecting cables. The machine powered is not part of the drive system.

Note

The same installation information regarding EMC applies to the SIMATIC Drive Controller as to SINAMICS S120 control units CU320-2.

The SINAMICS S120 power units are designed for use in the Second Environment. The Second Environment is understood as all non-residential locations. The main Second Environment locations are industrial zones supplied by the medium voltage network via their own transformers.

For compliance with the interference emission and immunity levels, follow the installation information in the SINAMICS S120 manuals.

You can find further information on this topic in the SINAMICS S120 Function Manuals (https://support.industry.siemens.com/cs/ww/en/ps/13231/man).

Use of wireless devices or mobile phones

Using wireless devices or cell phones in the immediate vicinity of the components can cause the devices to malfunction. The malfunctions can affect the functional safety of machinery and can therefore pose a risk to people or cause material damage.

- If you come closer to the components than c. 2 m, you switch off the wireless devices or mobile phones.
- Only use the "SIEMENS Industry Online Support App" on the device that is off.

Overvoltage protection

Please note the following information regarding overvoltage protection:

NOTICE
Damage to the device Inadequately dimensioned overvoltage protection can result in severe damage to the device. You should therefore ensure that the overvoltage protection is adequate.

Further information

You can find further information on the selection of the installation location, ambient conditions for operation, minimum spacing, etc. can be found in Installation (Page 113).

6.2 Hardware and software requirements

Introduction

Please note the following requirements for use of the SIMATIC Drive Controller in a SINAMICS drive system.

Hardware requirements

Table 6- 1 Hardware requirements

Component	Property/requirement
SIMATIC Drive Controller	The SIMATIC Drive Controller is available in various performance classes. • CPU 1504D TF (small to mid-range applications) • CPU 1507D TF (high-performance applications) What performance class you require depends on your specific automation and Motion Control solution requirements. You can find a summary of the main performance features of the Drive Controller in Comparison of SIMATIC Drive Controller versions (Page 58).
PROFINET PROFIBUS	Note the following requirements for operation of a SIMATIC Drive Controller as a bus device: **PROFINET** • The integrated PROFINET interface of the CPU is configured using STEP 7 (IP address and device name configured). • The CPU is connected to the subnet. See the PROFINET Function Manual (https://support.industry.siemens.com/cs/ww/en/view/49948856) For the rapid exchange of control data between the SIMATIC Drive Controller and drive components connected over PROFINET (for example SINAMICS S120, SINAMICS S210), the PROFINET IO network must be configured as isochronous. **PROFIBUS DP** • The integrated PROFIBUS interface of the CPU is configured using STEP 7 (node address and bus parameters configured). • The CPU is connected to the subnet. • The terminating resistors at the segment boundaries are on. See the PROFIBUS Function Manual (https://support.industry.siemens.com/cs/ww/en/view/59193579)
24 V DC power supply	Electronics power supply for the SIMATIC Drive Controller. Power supply units for the 24 V DC supply must supply safety extra-low voltage in accordance with IEC 61131-2 or IEC 61010-2-201. Devices from the SITOP family, for example, can be used. You can find information on the 24 V power supply specifications in Power supply (Page 112).
SINAMICS S120 system components	Please note the installation information in the SINAMICS S120 manuals and the "Rules for wiring with DRIVE-CLiQ" in the SINAMICS S120 Function Manual (https://support.industry.siemens.com/cs/ww/en/view/109781535).

Software requirements

Table 6- 2 Software requirements

Configuration in the TIA Portal	Requirement
Integrated SIMATIC S7-1500 CPU	SIMATIC STEP 7 Professional V16 or higher
	For programming the safety program of the F-CPU "STEP 7 Safety Advanced" from V16 onwards
SINAMICS Integrated	SINAMICS Startdrive Basic or Startdrive Advanced, V16 or higher Startdrive Advanced has additional engineering functions compared to Startdrive Basic such as a safety acceptance test. Note: It is not possible to configure SINAMICS Integrated with the STARTER configuration tool.

Information on the hardware and functions supported by SINAMICS Startdrive can be found at (https://support.industry.siemens.com/cs/ww/en/view/109761180)

Note

Licensing

The S7 controller and SINAMICS Integrated are licensed in the TIA Portal via STEP 7 Professional or Startdrive.

6.3 Drive Controller-specific properties

6.3.1 Drive Controller-specific hardware properties

The SIMATIC Drive Controller is part of the SINAMICS S120 drive system and the same installation conditions and installation rules as for SINAMICS S120 therefore apply.

The assembly conditions and assembly rules are available in the SINAMICS S120 manuals and in the EMC Installation Guideline (https://support.industry.siemens.com/cs/ww/en/view/60612658).

6.3.2 Drive Controller-specific properties of the CPU

The SIMATIC Drive Controller is optimized for automation solutions with Motion Control in which SINAMICS S120 high-performance converters are used.

With its extensive field bus interfaces, the SIMATIC Drive Controller is ideal for modular machine concepts.

Service functions

The SIMATIC Drive Controller does not have an integrated display. You can alternatively run service functions over the integrated Web server, for example. Using the FUNCT button, you can:

- Save service data on the SIMATIC Memory Card
- Set whether the SIMATIC Memory Card is to work as a program card (PROGRAM) or as a firmware update card (FWUPDATE)

S7-1500 I/O

The SIMATIC Drive Controller has no S7-1500 backplane bus. You can connect S7-1500 I/O modules over the distributed I/O system ET 200MP. Please note that CM/CP communication modules for PROFINET/PROFIBUS in particular cannot be used in the distributed I/O system ET 200MP, but only the communication modules for point-to-point connection (CM PtP). Alternatively, other I/O systems for the control cabinet (for example ET 200SP) or cabinet-free installation (for example ET 200pro, ET 200AL and ET 200eco PN) are available.

Time-based IO

The function blocks for the use of time-based IO (TIO instructions) are not supported by the digital input/outputs of the X142 interface.

Recommendation: For the timer DI/DQ, use the technology objects measuring input, output cam or cam track.

Device replacement

The SIMATIC Drive Controller supports a device replacement between SIMATIC Drive Controller CPUs of different performance classes and firmware versions as well as the device replacement with modular SIMATIC S7-1500 CPUs.

Device replacement with controllers of other designs (for example ET 200SP, ET 200pro) is not possible.

Clock system

The SIMATIC Drive Controller has four clock systems: A clock system for PROFINET, PROFIBUS, X142 I/Os and SINAMICS Integrated.

The clock system of the SINAMICS Integrated is always isochronous. This simplifies the configuration when using the S7-1500T Motion Control technology objects.

Drives without isochronous mode

There are applications where the drives do not require isochronous mode, for example:

- If the Motion Control functionality is implemented directly in the drive system (e.g. with the EPos basic positioner)
- If axis telegrams are used that do not require isochronous mode (e.g. PROFIdrive telegrams of application classes 1 and 3).

Since the SINAMICS Integrated is always isochronous, an OB servo or isochronous OB must be assigned to the process image.

Tip:

If you implement the Motion Control technology via the drive system and do not use any Motion Control technology objects in the CPU, you can force the automatic creation of the OB servo by inserting a cam.

Since a cam does not generate any relevant additional CPU load, this solution is more efficient than, for example, creating a virtual axis.

Additional information

You can find more information on the clock systems of the SIMATIC Drive Controller in the Configuring clock systems (Page 197) section.

6.3.3 Drive Controller-specific properties of SINAMICS Integrated

Supported functions

The automatic speed control integrated in the SIMATIC Drive Controller supports only a functional subset of the SINAMICS S120 CU320-2 drive functions. Free function blocks (FBLOCKS), for example, are not supported by SINAMICS Integrated. For details, see SINAMICS Integrated functions (Page 91).

Online functions with SINAMICS Integrated

SINAMICS Integrated is connected to the CPU over an internal PROFIdrive subnet. From the point of view of an external PROFINET/PROFIBUS interface, SINAMICS Integrated is connected to a lower-level network. Please therefore note the following aspects:

- Online functions with SINAMICS Integrated are only possible if the SIMATIC Drive Controller (CPU and SINAMICS Integrated) are configured in the TIA Portal and the network configuration has first been loaded to the CPU.
- If only Startdrive is installed (and not STEP 7 Professional), SINAMICS Integrated can be configured offline. Online functions are not possible. STEP 7 Professional and Startdrive need to be installed for this purpose.
- A subnet needs to be configured for the interface to which you are connecting the programming device. Routing to the SINAMICS Integrated is only possible if a subnet is configured.

In addition, it must be kept in mind that SINAMICS Startdrive can only establish an online connection to the SINAMICS Integrated or a SINAMICS S120 CU when the configured firmware version matches the firmware version of the device.

Device replacement

Device swapping is not possible, either between different firmware versions or with other SINAMICS S120 CUs.

Individual drive objects can only be copied and pasted:

- Between SINAMICS Integrated with the same firmware versions
- Between SINAMICS S120 CU320-2 with the same firmware versions
- Between SINAMICS S120 CU310-2 with the same firmware versions

SINAMICS Drive Control Chart (DCC)

SINAMICS Drive Control Chart (DCC) extends the functionality of SINAMICS Integrated by means of freely available control, calculation and logic blocks. SINAMICS DCC offers you the possibility to configure your own technological functions in the drive system using graphic configuration.

Requirements:

- SINAMICS DCC as of V17 (add-on package for Startdrive)
- CPU firmware version as of V2.9
- SINAMICS Integrated firmware version as of V5.2 SP3

To define the open-loop and closed-loop control functionality, you select multi-instance-capable Drive Control Blocks (DCB) from a library (DCB library) and graphically link them using drag-and-drop. The DCB libraries are divided into DCB Standard and DCB Extension.

The DCB standard library, which is included in the scope of delivery of SINAMICS DCC, comprises approx. 140 block types for the configuration of logic and technology functions. These can be calculated at different SINAMICS sampling times starting at 1 ms.

Additions to the DCB standard library can be made via DCB Extension libraries. A runtime license is required to use the blocks from DCB Extension libraries. For more information about the licenses, refer to the Runtime licensing (Page 278) section.

Note

Due to the system, the startup, download and RAM to ROM times are longer for the SINAMICS Integrated than for a SINAMICS S120 CU320-2.

Recommendation to minimize these times:

- Reduce the number of DCC charts to a minimum (e.g. use only for different sampling times).
- Use sub-charts.

Diagnostics

To evaluate diagnostics information of the SINAMICS Integrated, you can use, for example, the function block FB LAcycCom_ReadDriveMessagesDateTime (FB 30518) of the LAcycCom library.

With this function block, you can read active messages (alarms, errors and SI messages) from a drive object (DO) sorted by time (latest first). The information provided comprises the code, info, date and time of occurrence of the message. Additional information on the LAcycCom library is available here (https://support.industry.siemens.com/cs/ww/en/view/109479553).

The diagnostic information cannot be evaluated over the system diagnostics integrated in the SIMATIC S7-1500.

Restrictions

The following functions are not supported by SINAMICS Integrated:

- Upload to an empty project (see section Notes on the configuration software (Page 149))
- Reset via parameter p0972 (parameter does not exist)

  A warm restart (p0009 = 30, p0976 = 2, 3) is possible.
- Transfer of PROFIenergy commands to SINAMICS Integrated

  An energy management system for drives on the SINAMICS Integrated must be implemented using an application.
- Application library "SIMATIC Alarm Handling for SINAMICS Drives", LAlarmHdl_DriveAlarmsIOSystem (autonomous solution)

  The SINAMICS Integrated only supports the FB LAlarmHdl_AddSINADriveAlarms (modular approach). You can find details on alarm handling in this application example (https://support.industry.siemens.com/cs/ww/en/view/109761931).

You can find more information in the SINAMICS S120/S150 List Manual (https://support.industry.siemens.com/cs/de/de/view/109822659/en).
The list of drive parameters indicates which drive objects (function modules) are supported by SINAMICS Integrated (CU_I) or CU320-2 (CU_S120_DP and CU_S120_PN).

6.3.4 Drive Controller specific properties of the TIA Portal Openness API interface

You can use the TIA Portal Openness API interface to integrate the TIA Portal into your development environment and automate your engineering tasks.

Device-specific properties of the TIA Portal Openness API interface

The TIA Portal Openness API interface of the SIMATIC Drive Controller has the following device-specific properties:

- PROFIdrive Integrated for the cyclic communication between CPU and SINAMICS Integrated
- Onboard I/Os X142
- Setting for automatic time synchronization between CPU and SINAMICS drives

TIA Portal Openness Explorer

With the TIA Portal Openness Explorer, you can quickly get an overview of the attributes of the SIMATIC Drive Controller.

Additional information

You can find more information about Openness on TIA Portal Openness topic page (https://support.industry.siemens.com/cs/de/de/view/109792902/en).

You can find more information on the TIA Portal Openness Explorer on the Internet (https://support.industry.siemens.com/cs/de/de/view/109760816/en).

6.4 Hardware configuration

The SIMATIC Drive Controller controls SINAMICS Integrated over the integrated drive and the drive group over the comprehensive range of SINAMICS S120 power units (Line Modules and Motor Modules).

Hardware components

The basic configuration of a system with the SIMATIC Drive Controller comprises the following components:

- SIMATIC Drive Controller
  This includes the SIMATIC S7-1500 TF CPU and SINAMICS Integrated.
  The SIMATIC Drive Controller can alternatively control:
  - A max. of 6 servo drives; or
  - A max. of 6 drives with vector control; or
  - A max. of 12 drives with U/f control
- SINAMICS Line Module
  The Line Module generates the DC link from the network.
- SINAMICS Motor Modules
  Motor Modules are powered by the DC link and supply the connected motors.
- DRIVE-CLiQ components
  In SINAMICS S120, the individual components of the drive system communicate with each other over DRIVE-CLiQ. The SIMATIC Drive Controller has 4 DRIVE-CLiQ interfaces. Alongside the power components, encoder systems and special DRIVE-CLiQ I/O devices can also be connected over DRIVE-CLiQ.

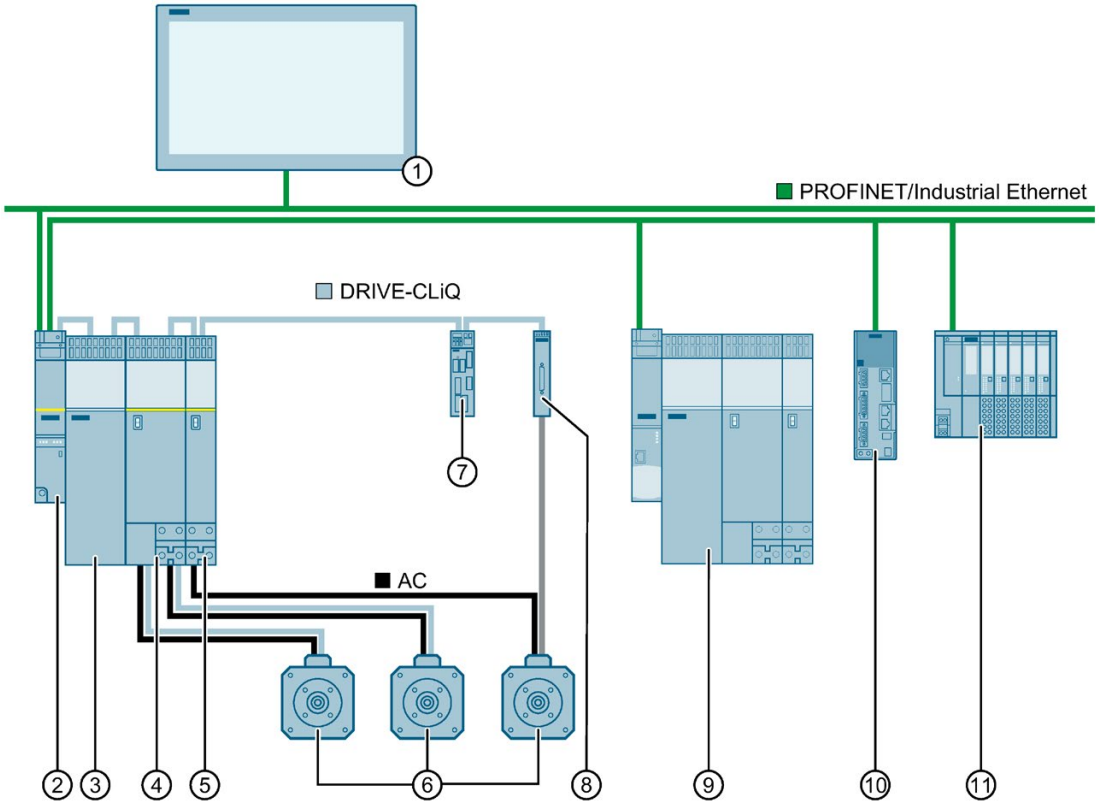
Hardware configuration

You can expand the drive configuration limits of a SIMATIC Drive Controller, for example with SINAMICS S120 Control Units (CU320-2) or SINAMICS S210 (for example for individual drives). Additional SINAMICS drive systems must be connected over PROFINET if they are operated isochronously with the servo clock with SINAMICS Integrated.

Computing performance at the drive cannot be increased with a SIMOTION CX32-2 Controller Extension as with SIMOTION D4x5-2.

Note

The PROFIBUS interface cannot be connected to other clock systems. If you expand the drive configuration limits with distributed drive systems, those systems must be connected over the PROFINET IO interface X150. Only PROFINET interface X150 can be connected to the clock system of SINAMICS Integrated and the X142 technology I/Os.



① HMI device
② SIMATIC Drive Controller
③ Line Module
④ SINAMICS S120 Double Motor Module
⑤ SINAMICS S120 Single Motor Module
⑥ SIMOTICS S servo motor
⑦ SINAMICS Terminal Module
⑧ SINAMICS Sensor Module SMC
⑨ SINAMICS S120 for up to six drives
⑩ SINAMICS S210 single-axis servo drive
⑪ ET 200SP I/O

Figure 6-1 Example: SIMATIC Drive Controller hardware configuration in a plant

See also

SINAMICS S120 Drive Functions function manual
(https://support.industry.siemens.com/cs/us/en/view/109781535)

6.5 Power supply

24 V power supply design

The SIMATIC Drive Controller is powered by an external 24 V supply (for example SITOP power supply).

The current consumption of the SIMATIC Drive Controller is:

- Without supply to interfaces and I/Os: Maximum 1.7 A
- With supply to interfaces and I/Os: Maximum 13.1 A

Table 6- 3 Permissible current load for SIMATIC Drive Controller interfaces

Interface	24 V
4 x DRIVE-CLiQ	4 x 450 mA
16 x digital output (permanent short-circuit proof)	16 x 500 mA

You can find an overview of the current consumption of SINAMICS components and recommendations for the selection of SITOP Power power supply units in the SINAMICS S120 Booksize Power Units manual.

Note

No electrical isolation

As ground potential and enclosure (PE) are connected over a low-impedance internal connection, please note the following:

- Suitably dimensioned equipotential bonding cables are required between the 24 V power supply and all grounded, physically separate devices.
- Insulation monitors are not permitted in the 24 V power supply.

Please also note the information in Connecting the supply voltage (Page 125).

Installation 7

7.1 Installation notes

Open components

These modules are open components. This means they may only be installed in housings, cabinets, or in electrical equipment rooms that can only be entered or accessed with a key or tool. Housings, cabinets, or electrical equipment rooms may only be accessed by trained or authorized personnel. An external fire-protection housing is required.



DANGER

Danger to life from energized parts

Death or serious injury will result if energized parts are touched.

Turn off and lock out all power supplying this device before working on this device.

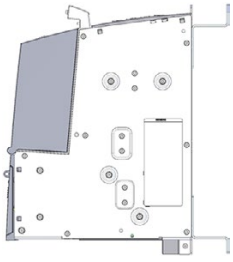
Protection from conductive contamination

The components must be protected from conductive contamination, for example by installing them in a control cabinet with degree of protection IP54 pursuant to IEC 60529 or NEMA 12.

If the occurrence of conductive contamination can be ruled out, a correspondingly lower degree of protection for the control cabinet is permitted.

Permitted mounting positions

The SIMATIC Drive Controller must be mounted vertically.



SIMATIC Drive Controller: Vertical mounting position

WARNING

Fire hazard due to overheating in the event of incorrect mounting position

Incorrect mounting positions cause overheating with a risk for personnel through smoke development and fire. This can also result in increased downtime and reduced service lives for devices / systems.

Install the SIMATIC Drive Controller only in vertical mounting position.

Distance for heat dissipation

The top and bottom of the SIMATIC Drive Controller must be at least the following distances from the enclosure wall:

80 mm

WARNING

Inadequate ventilation clearances pose risk of fire as a result of overheating

Inadequate ventilation clearances cause overheating with a risk for personnel through smoke development and fire. This can also result in increased downtime and reduced service lives for devices / systems.

Maintain a ventilation clearance of 80 mm above and below the SIMATIC Drive Controller.

EMC guidelines

The same installation information regarding EMC applies to the SIMATIC Drive Controller as to SINAMICS S120 control units CU320-2.
For further information, see SINAMICS S120 manuals and the EMC design guidelines (https://support.industry.siemens.com/cs/ww/en/view/60612658).

7.2 Mounting the SIMATIC Drive Controller

Requirement

The SIMATIC Drive Controller is fitted in a control cabinet together with the SINAMICS components.

Requirements for installing a SIMATIC Drive Controller:

- The control cabinet has been installed and wired.
- The SINAMICS components have been installed and wired.
- The components and tools required for installation are to hand.
- T10 screwdriver for the M3 screws in the spacer are to hand.
- For installation on the control cabinet wall: Tool for M6 screws

Designs

The SIMATIC Drive Controller is fitted to the wall of the control cabinet in one of the following ways:

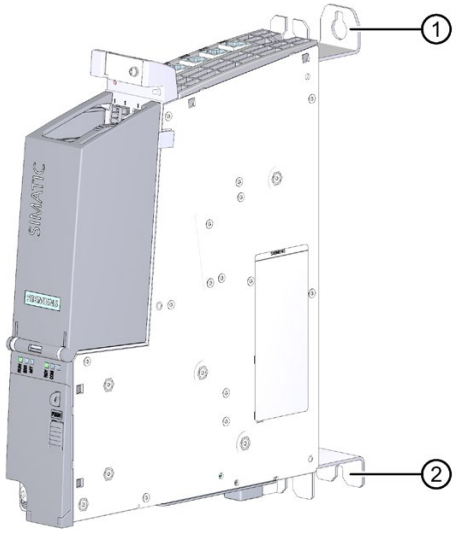
- Installation with spacer
- Installation without spacer

The SIMATIC Drive Controller is supplied with a spacer fitted.

The spacers increase the depth of the SIMATIC Drive Controller to 270 mm and allow flush installation with 270 mm-deep power units.

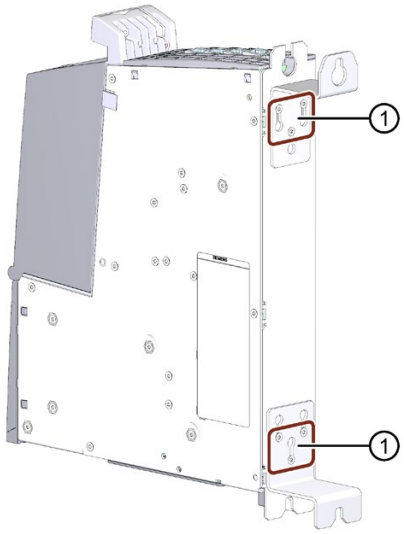
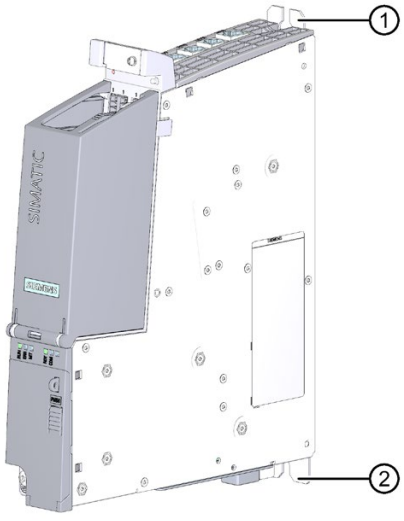
Installing SIMATIC Drive Controller with spacers

Proceed as follows:

1	Attach the SIMATIC Drive Controller to the control cabinet wall with one M6 screw each at ① and ②. Tightening torque: 6 Nm (53.1 lbf in)	

Installing SIMATIC Drive Controller without spacers

Proceed as follows:

1	Uninstalling the spacer: • Unscrew the M3 screws ① and remove the space. • Tighten the M3 screws ① again.	
2	Attach the SIMATIC Drive Controller to the control cabinet wall with one M6 screw each at ① and ②. Tightening torque: 6 Nm (53.1 lbf in)	

Note

If you install multiple SIMATIC Drive Controllers or SINAMICS S120 CU320-2 next to one another, use a grid size of 50 mm for the drilled holes horizontally to compensate for tolerances. A dimension drawing of the SIMATIC Drive Controller is available in the SIMATIC Drive Controller manual (https://support.industry.siemens.com/cs/ww/en/view/109766666).

Connecting

8

8.1 Rules and regulations for operation

General safety information

⚠ WARNING

Electric shock and danger to life from other energy sources

Touching live parts can result in death or serious injury.

- Work on electrical devices only if you are qualified for this job.
- Always observe the country-specific safety rules. Follow the steps below to ensure safety:

1. Prepare for shutdown. Notify all those who will be affected by the procedure.
2. Disconnect the drive system and ensure it cannot be switched back on.
3. Wait until the discharge time specified on the warning labels has elapsed.
4. Check there is no voltage between any power connections or between power connections and the protective conductor connection.
5. Check whether any auxiliary supply circuits are de-energized.
6. Ensure that the motors cannot move.
7. Identify all other hazardous energy sources, for example compressed air, hydraulic systems, or water. Put all energy sources in a safe state.
8. Check that the correct drive system is completely locked.

After you have completed the work, carry out the procedure in reverse to restore readiness for operation.

⚠ WARNING

Electric shock with damaged devices

Incorrect handling can damage devices. Hazardous voltages can be created at the housing or at exposed components if devices are damaged, and can cause death or serious injury if parts are touched.

- Ensure compliance with the limits specified in the technical data during transport, storage and operation.
- Never use damaged devices.

Specific application

Observe the safety and accident prevention regulations that are applicable to specific applications (for example the Machinery Directive).

EMERGENCY STOP devices

EMERGENCY STOP devices pursuant to IEC 60204 (corresponds to DIN VDE 0113) must remain effective in all operating modes of the plant or system.

Closed-loop control for secure operation

The following measures are also to be taken and adapted to your conditions for the secure operation of your plant:

- An EMERGENCY STOP concept in accordance with applicable engineering practice (for example European standards EN 60204, EN 418 and related standards).
- Additional measures for limiting axis limits (for example hardware limit switches).
- Devices and measures for protecting motors and power electronics in line with the SINAMICS design guidelines.

  We also recommend conducting a risk assessment in accordance with the essential safety requirements / Annex 1 to the EC Machinery Directive to identify hazards for the plant as a whole.

Excluding hazardous plant states

Hazardous operating states must not occur in the following situations:

- The plant restarts after a voltage dip or power failure.
- Bus communication is reestablished following a fault.
- An undefined system state occurs.

If a hazardous operating state occurs, force an EMERGENCY STOP.

An uncontrolled or undefined system startup must not occur after the EMERGENCY STOP device is unlocked.

External fuses/switches

Install the external fuses/switches in the proximity of the SIMATIC Drive Controller.

If fuses/switches are installed in the same control cabinet as the SIMATIC Drive Controller, for example, a unique assignment between fuses/switches and SIMATIC Drive Controller becomes a lot easier.

Line voltage

The points to note for line voltage are set out below:

- For fixed plants or systems without an all-pole mains disconnect switch, the building technology must include a mains disconnect device (all-pole).
- For load power supplies and power modules, the configured rated voltage range must correspond to the local line voltage.
- For all power circuits of the system, the fluctuation/deviation of line voltage from the rated value must be within the permitted tolerance.

You can find more information in the section Specifications for insulation tests, protection class, degree of protection, and rated voltage (Page 356).

24 V DC supply

The points to note for a 24 V DC supply are set out below:

- Power supply units for the 24 V DC supply must supply safety extra-low voltage (SELV or PELV) in accordance with IEC 61131-2 or IEC 61010-2-201.

Disconnecting 24 V plug-in connections

Note the safety information for use of the SIMATIC Drive Controller:

⚠ WARNING

Personal injury and damage to property can occur

Personal injury and property damage can occur if 24 V plug-in connections are disconnected under voltage.

Disconnection of 24 V plug-in connections is only permitted when the power is off.

Protection from external electrical effects

Below are the points to note for protection from electrical effects or faults:

- The system for discharging electromagnetic interference must be connected to a protective conductor with a sufficient cross-section for all plants with the SIMATIC Drive Controller.
- You must ensure that all supply, signal and bus cables are correctly laid and installed.
- For signal and bus lines, a cable break, wire break or a cross-circuit must not lead to undefined states in the plant or system.

Additional references

- For the configuration of a plant with SIMATIC ET 200 I/O (for example ET 200SP, ET 200MP, etc.), please see the ET 200 I/O systems (https://support.industry.siemens.com/cs/ww/en/ps/14029/man) manuals.
- We also recommend the EMC design guidelines / Basic system requirements (https://support.industry.siemens.com/cs/ww/en/view/60612658) configuration manual as a source of further information on EMC.

8.2 Additional rules and regulations for operation

8.2.1 Safety extra-low-voltage (SELV, PELV) for failsafe modules

Please note the following if you use distributed I/O (for example ET200SP) with failsafe modules:

WARNING

The failsafe components/modules must be operated with safety extra-low voltage (SELV, PELV).

You can find more information on safety extra-low voltage (SELV, PELV) in the data sheets of the applicable power supplies, for example.

The failsafe modules operate with the 24 V DC rated voltage. The tolerance range is 19.2 V DC to 28.8 V DC.

The failsafe motor starters operate with the 24 V DC rated voltage. The tolerance range is 20.4 V DC to 28.8 V DC.

Within the overvoltage range of 32 V DC to 36 V DC, the F-modules react in a failsafe manner and the inputs and outputs are passivated. For overvoltages greater than 36 V DC, the F-modules are permanently de-energized.

Use a power supply unit that does not exceed U_m = 36 V DC even in the event of a fault. For more on this, refer to the information in the data sheet on overvoltage protection in the case of an internal error, or implement appropriate measures to limit the voltage, for example use of an overvoltage protector.

All system components that can supply electrical energy in any form whatsoever must fulfill this condition.

Each additional circuit (24 V DC) used in the system must have safety extra-low voltage (SELV, PELV). Refer to the relevant data sheets or contact the manufacturer.

Please also note that sensors and actuators with an external power supply can also be connected to F-modules. Make sure that power is supplied to these components from safety extra-low voltage (SELV, PELV) as well. The process signal of a 24 V DC digital module may not exceed a fault voltage U_m even in the event of a fault.

WARNING

Even when a fault occurs, the permissible potential difference between the supply of the interface module (bus voltage) and the load voltage must not be exceeded.

An external direct electrical connection is one way to meet this requirement. This also prevents potential differences from causing voltage additions at the individual voltage sources, which could cause the fault voltage U_m to be exceeded.

Requirements for power supplies in the event of voltage interruption

Note

To ensure adherence to IEC 61131-2, only use power packs/power supply units (24 V DC) with a mains buffering time of at least 20 ms.

Please also note the requirements of the applicable standards regarding mains buffering time.

You can find information on the power supply components on the Internet.

8.2.2 Requirements of sensors and actuators for fail-safe modules

General requirements for sensors and actuators

Note the following important warning regarding safety-related use of sensors and actuators:

WARNING

Note that instrumentation with sensors and actuators bears a considerable **safety responsibility**. Also bear in mind that sensors and actuators generally do not have a service life of 20 years as defined in IEC 61508:2010 without considerable loss of safety.

The probability of hazardous faults and the rate of hazardous faults of safety functions must comply with an SIL-defined high limit. A listing of values achieved by F-modules in the technical specifications of the F-modules is available under "Fail-safe performance characteristics".

To achieve the respective safety class, suitably qualified sensors and actuators are necessary.

Additional sensor requirements

General rule: A single-channel sensor is sufficient to achieve SIL3/Cat.3/PLd. However, to achieve SIL3/Cat.3/PLd with a single-channel sensor, the sensor itself must be SIL3/Cat.3/PLd-capable; otherwise, the sensor must be connected via two channels to achieve this safety level.

To achieve Cat.4, sensors must be connected via two channels.

WARNING

In the case of fail-safe input modules, a "0" value is output to the F-CPU after detection of faults. You therefore need to make sure that the sensors are implemented in such a way as to ensure the reliable reaction of the safety program when the sensor is in the "0" state.

Example: In its safety program, an EMERGENCY-STOP sensor must achieve the shutdown of the respective actuator when it is in the "0" state (EMERGENCY-STOP button pressed).

Duration requirements for sensor signals

WARNING

Observe the following requirements for sensor signals:

- In order to ensure the correct detection of the sensor signals via fail-safe modules with inputs, you need to make sure that the sensor signals are output for a minimum duration.
- In order for pulses to be detected with certainty, the time between two signal changes (pulse duration) must be greater than the PROFIsafe monitoring time.

Safe detection of inputs through F-modules

The minimum duration of sensor signals for F-modules with inputs depends on the configured input delay, the parameters of the short circuit test of the sensor supplies, and the configured discrepancy behavior for 1oo2 evaluation. The duration of the signal must be greater than the maximum response time of the configured application. Information on calculating the maximum response time can be found in section "Response times" of the respective F-module.

The maximum permitted switching frequency of the sensor signals results from the minimum duration.

Additional requirements for actuators

The fail-safe output modules test the outputs at regular intervals. The F-module briefly switches off the activated outputs and, if necessary, switches on the deactivated outputs. You can assign the maximum duration of the test pulses (dark and light period) with parameters.

High-speed actuators may briefly drop out or be activated during this test. If your process does not tolerate this, set the pulse duration of the light or dark test correspondingly or use actuators that have sufficient lag.

⚠ WARNING

If the actuators switch voltages greater than 24 V DC (e.g. 230 V AC), the outputs of a fail-safe output module and the parts carrying a higher voltage must be electrically isolated (in accordance with IEC 60664-1).

This is generally the case for relays and contactors; particular attention must be paid to this requirement for semiconductor switching devices.

Technical specifications of sensors and actuators

Refer to the manuals of the fail-safe modules for technical specifications to assist you in selecting sensors and actuators.

8.2.3 Capacitive crosstalk of digital input/output signals

Readback errors may occur on the F-DQ modules if the fail-safe digital output signals and fail-safe digital input signals are routed through a single cable.

Cause: Capacitive crosstalk

During the bit pattern test of the outputs or the sensor supply of the inputs, the steep switching edge of the output drivers caused by the coupling capacitance of the line may result in crosstalk to other non-activated output or input channels. This may then lead to a response of the readback circuit in these channels. The module detects a cross circuit/short circuit and performs a safety-related shutdown.
Remedy:

- Separate cables for fail-safe DI modules and fail-safe DQ modules / non-fail-safe DQ modules
- Coupling relay or diodes in the outputs
- Disable the short-circuit test of the sensor supply if safety class requirements allow it.

Cause: magnetic crosstalk

Note that an inductive load connected to the F-DQ channels can induce coupling of a strong magnetic field.

Solution:

- Spatially disconnect the inductive loads or shield against the magnetic field.
- Configure the "Max. readback time dark test" to 50 ms or higher.

8.3 Electrical configuration

A system with the SIMATIC Drive Controller consists of several individual components. For a system configured with these components to meet the EMC and safety standards, certain design guidelines must be followed.

Grounding concept and radio interference suppression measures

The individual system components are attached to a metal cabinet panel.

In addition to the protective grounding of system components, special precautions must be taken to guarantee safe, error-free operation of the system. These measure include:

- Shielded signal lines
- Special equipotential bonding connections
- Isolation and shielding measures

Design guidelines

Take the following measures to achieve the best possible noise immunity for the complete system (controller, power unit and machine):

- Ensure a minimum distance of 200 mm between the signal lines and power cables.
- If necessary, signal and power cables may cross one another (if possible at an angle of 90°), but must never be laid close or parallel to one another.
- Only use cables approved by Siemens for the signal lines from and to the SIMATIC Drive Controller.
- Signal lines must not be routed close to strong external magnetic fields (for example motors or transformers).
- If signal lines cannot be routed a sufficient distance away, they must be installed in grounded (metal) cable ducts.

You can find further information on interference suppression measures and the connection of shielded cables in the EMC Design Guidelines configuration manual (https://support.industry.siemens.com/cs/ww/en/view/60612658).

See also

Protective conductor and potential equalization, functional ground (Page 131)

8.4 Wiring rules

Use suitable cables to connect a system to the SIMATIC Drive Controller . You can find wiring rules for the SIMATIC Drive Controller in "Wiring (Page 117)" under the relevant interface descriptions.

You can find the wiring rules and information on connection technology for SINAMICS components in the manuals of the SINAMICS components in question.

8.5 Connecting the supply voltage

24 V DC power supply

The SIMATIC Drive Controller is powered by an external 24 V DC power supply. Power supply units from the SITOP family, for example, can be used.

⚠ WARNING

Connection of an unsuitable power supply poses a danger to life from hazardous voltage

Configure the 24 V direct voltage as protective extra-low voltage.

A 24 V DC power supply to be connected to the interfaces must meet the requirements for a protective extra-low voltage (PELV) pursuant to UL 61010. A backup fuse that trips within 120 seconds in the event of a short-circuit at an ambient temperature of 0 °C must also be used.

When the power supply used comes primarily from OVC III circuits up to 600 V AC (line to neutral voltage), the contact distance for the fuse or circuit with single-fault safety must be 3.0 mm pursuant to UL 61010.

If using an external power supply, make sure that the shutdown rating of the fuse corresponds to the max. possible short-time short-circuit current of the power supply used.

Note

The ground potential and enclosure (PE) are connected over a low-impedance internal connection. Therefore, please note the following:

- Insulation monitors are not permitted in the 24 V power supply.
- If you are using external power supplies (for example SITOP), you must connect the ground potential to the protective conductor terminal (PELV).
- Suitably dimensioned potential equalization connections are required between the 24 V power supply and all grounded, physically separate devices. You can find information on potential equalization in Protective conductor and potential equalization, functional ground (Page 131).

Connecting the power supply

The supply voltage is supplied over a 4-pin connector at the front of the SIMATIC Drive Controller (behind the top cover).

Use rigid or flexible cables with a conductor cross-section as specified in the SIMATIC Drive Controller manual (https://support.industry.siemens.com/cs/ww/en/view/109766666) for wiring the power supply.

Tighten the connector using a flat-blade screwdriver.

The following special requirements apply to the connecting cables:

- The 24 V DC line must be approved for temperatures up to at least 75 °C.
- Select the permissible conductor cross-section according to the national regulations (NEC, VDE, etc.). The basis for this can be the output current of the 24 V DC supply or the overcurrent protection device used in the 24 V circuit. If the short-circuit current of the utilized 24 V power supply unit is greater than 50 A, an appropriate overcurrent protection device that limits the short-circuit current to this value must be used upstream of the product.
- The protective conductor connection must be designed with a minimum cross-section in accordance with EN 60204-1.
- Strip 7 mm from the cables for the connection to the 24 V DC connector.
- Adhere to the permissible bending radius of the cables.
- Lay all cables in such a way that no cables are crushed.
- Lay all cables so that they do not touch any abrasive edges.

Note

If power supplies with primary side supplies up to 600 V AC (voltage conductor to neutral conductor) are to be used, the transient voltages on the primary side of the power supply must be limited to 4000 V. Only connect the device to a 24 V DC power supply that meets the requirements of a safe extra-low voltage (PELV) according to UL 61010.

8.6 PROFINET and PROFIBUS DP

Connecting interfaces for communication

Connect the communication interfaces of the SIMATIC Drive Controller using standardized plug connectors.

Use preassembled connecting cables for the connection.

If you want to assemble the communication cables yourself, we recommend cables and RJ45 plug connectors from the Siemens FastConnect system.

Note

The X130 interface of the SIMATIC Drive Controller supports 10, 100 and 1000 Mbps.

For 1000 Mbps, you need 8-wire cables (4x2) and the 1000 Mbit version of the 180° FastConnect connector.

The 145° FastConnect connectors can only be used for Ethernet interface X130 with a max. of 100 Mbps.

8.7 Digital inputs and digital inputs/outputs X122, X132 and X142

The digital inputs and digital inputs/outputs at interfaces X122, X132 and X142 are designed for the connection of sensors and actuators.

The digital inputs and digital inputs/outputs at X122 and X132 interfaces are assigned to SINAMICS Integrated. Through configuration (frames 39x), you can also use the digital inputs and digital outputs (X122/X132) for the CPU.

The digital input/outputs at interface X142 are assigned to the CPU of the SIMATIC Drive Controller and that assignment is fixed.

Using the digital inputs and digital outputs

Digital inputs/digital outputs come in the following types:

- Digital inputs (DI)
- Bidirectional digital inputs/outputs (DI/DQ)

Bidirectional digital input/outputs can be configured channel-by-channel as digital input or digital output.

Assignment of the input/outputs to functions is freely configurable. Technology functions (for example measuring input and output cam) can also be assigned to the inputs/outputs.

Table 8- 1 Use

	X122, X132		**X142**
	DI0 to DI7, DI17, DI18, DI20, DI21	**DI/DQ 8 to 15**	**DI/DQ 0 to 7**
Electrical isolation	Isolated (ground reference M1 or M2)	Non-isolated (ground reference M)	Non-isolated (ground reference M)
Use as:			
Inputs/outputs assigned to the CPU	Yes[1)]	Yes[1)]	Yes
Inputs/outputs assigned to SINAMICS Integrated	Yes	Yes	No
Inputs of measuring input	No	Yes Measuring using central measuring input Measurement using PROFIdrive telegram	Yes Measuring using Timer DI
Cam outputs	No	Yes[1)] DQ can be used as cam output	Yes Timer DQ can be used as high-precision cam output
Oversampling DI	No	No	Yes
Oversampling DQ	No	No	Yes
Event/period duration measurement	No	No	Yes
Pulse width modulation PWM	No	No	Yes
Configuration:			
Assignment	Configurable channel-by-channel on the drive	Configurable channel-by-channel on the drive	Configurable channel-by-channel on the CPU

[1)] You can assign the inputs/outputs with frame 39x of the CPU (see also section Configuration of the digital inputs and digital inputs/outputs (X122/X132) (Page 195)).

Note

Shielded cables are required to ensure the best possible immunity of the digital inputs if they are being used as measuring inputs.

Power supply for X142 digital inputs/outputs

If you use the X142 digital inputs/outputs partly as inputs and partly as outputs (mixed operation), you need to supply the digital inputs over the same power supply as the SIMATIC Drive Controller (X124 module supply).

This restriction does not apply if you operate the X142 digital inputs/outputs exclusively as inputs or as outputs.

The X122/X132 digital inputs/outputs are not affected by this restriction.

Connection cables for digital inputs and digital outputs

Use rigid or flexible cables with a conductor cross-section as specified in the SIMATIC Drive Controller manual for wiring the inputs/outputs.

Note

Maximum permissible cable length

The maximum permissible cable length for the connection cable is 30 m.

Inductive loads

When you use the digital inputs in combination with inductive loads, you must ensure that the permissible voltage range of the digital inputs from -30 V to +30 V is not exceeded by the switching overvoltage of inductive loads.

You best avoid the overload by using auxiliary contacts at the contactor/relay for the digital inputs. If no auxiliary contacts are available, you must integrate an overvoltage protection. Protective wiring with overvoltage protection diode, or a diode combination with Zener diode are possible as overvoltage protection. RC elements and varistors are not suitable due to the residual voltages.

Overvoltage protection for signal lines

Overvoltage protection devices are required for lines of > 30 m. You are advised to use the following snubber to protect the 24 V signal lines from overvoltage:

Table 8- 2 Recommendations for overvoltage protection

Line	Overvoltage protection device
24 V signal lines	Manufacturer: Weidmüller article: MCZ OVP TAZ Article number: 844915 0000

Snubbers must always be positioned at the edge of the area to be protected, for example at the entry to the cabinet. All 24 V lines leaving the protected area must run through a snubber. You can find additional information on overvoltage protection in the SINAMICS S120 manual "Booksize Power Units (https://support.industry.siemens.com/cs/ww/en/view/109781351)".

Additional information

Additional information on the pin assignment of interfaces X122, X132, X142 can be found in the SIMATIC Drive Controller manual (https://support.industry.siemens.com/cs/ww/en/view/109766666).

8.8 DRIVE-CLiQ interfaces X100 to X103

Properties of the DRIVE-CLiQ interfaces

The SIMATIC Drive Controller has four DRIVE-CLiQ interfaces. The components of the SINAMICS S120 drive system including the motors and encoders are connected over the common DRIVE-CLiQ interface.

DRIVE-CLiQ has the following properties:

- Automatic recognition of the components by the SIMATIC Drive Controller
- Uniform interfaces on all components
- Consistent diagnostics down to the components
- Consistent service down to the components
- Each DRIVE-CLiQ interface has 24 V/450 mA for connecting encoders and measuring systems.

Note

The DRIVE-CLiQ cable with its 24 V supply is only used for the components that require it (for example motors with DRIVE-CLiQ interface).

Rules for DRIVE-CLiQ wiring

Rules apply for wiring components with DRIVE-CLiQ. A distinction is made between mandatory DRIVE-CLiQ rules that must be observed and recommended rules.

Further information

You can find further information on DRIVE-CLiQ wiring in the following manuals:

- SIMATIC Drive Controller (https://support.industry.siemens.com/cs/ww/en/view/109766666) manual
- SINAMICS S120 function manual (https://support.industry.siemens.com/cs/ww/en/view/109781535); section on Rules for wiring with DRIVE-CLiQ
- SINAMICS S120 Control Units and Supplementary System Components manual (https://support.industry.siemens.com/cs/ww/en/view/109782370)

8.9 Protective conductor and potential equalization, functional ground

Requirement

You have installed the SIMATIC Drive Controller in the control cabinet.

Please note the following safety instructions:



DANGER

Danger to life from live parts

Touching live parts can result in death or serious injury.

Always disconnect the plant and device from the power supply before commencing work.

Note

Compliance with machine and system functional safety, reliability and EMC requirements is only guaranteed with original SIEMENS cables.

Protective conductor connection

The SIMATIC Drive Controller and the SINAMICS S120 drive system are designed for use in control cabinets with protective conductor connections.

A connection for the protective conductor is available on the SIMATIC Drive Controller :

- Screw M5, Torx T25
- Tightening torque: 3 Nm (26.6 lbf in)

This connection is also used for the equipotential bonding conductor.

All plant and machine components are to be included in the protection concept. The drive line-up is to be installed on a common bare metal mounting plate ⑧ to ensure compliance with EMC limits. The connection provides a low-impedance connection to the mounting plate.

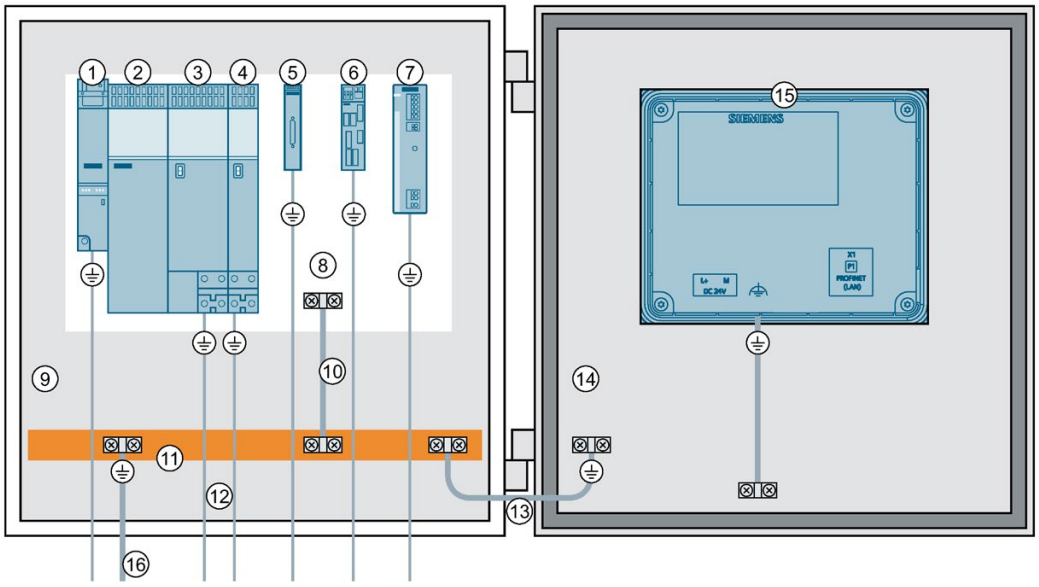
The mounting plate must be connected to the protective conductor connection of the control cabinet. This is done by establishing a connection ⑩ to the protective conductor bar ⑪. Connect the protective conductor bar ⑪ to the protective conductor ⑯.

The protective connection (PE connection) of the motors used must be over the motor cable ⑫.

For EMC reasons, the shield of the motor cable should be connected over a large surface area both at the Motor Module and at the motor.

Components that are **not** connected over a low-impedance connection, for example, control cabinet door ⑭ connected with hinges, also require a protective connection ⑬.

Example: Booksize axis group, consisting of SIMATIC Drive Controller, Line Module and Motor Modules.



① SIMATIC Drive Controller
② SINAMICS S120 Line Module
③ SINAMICS S120 Double Motor Module
④ SINAMICS S120 Single Motor Module
⑤ SINAMICS Sensor Module Cabinet-Mounted (SMC)
⑥ SINAMICS Terminal Module (TM)
⑦ Power supply, for example, SITOP
⑧ Mounting plate, metallic bright
⑨ Control cabinet
⑩ Protective conductor connection
⑪ Protective conductor bar
⑫ Motor cable
⑬ Flexible protective conductor
⑭ Control cabinet door
⑮ HMI device
⑯ Protective conductor

A mounting plate also acts as potential equalization surface. No additional equipotential bonding is therefore required within the drive line-up.

Dimension the protective conductor as follows:

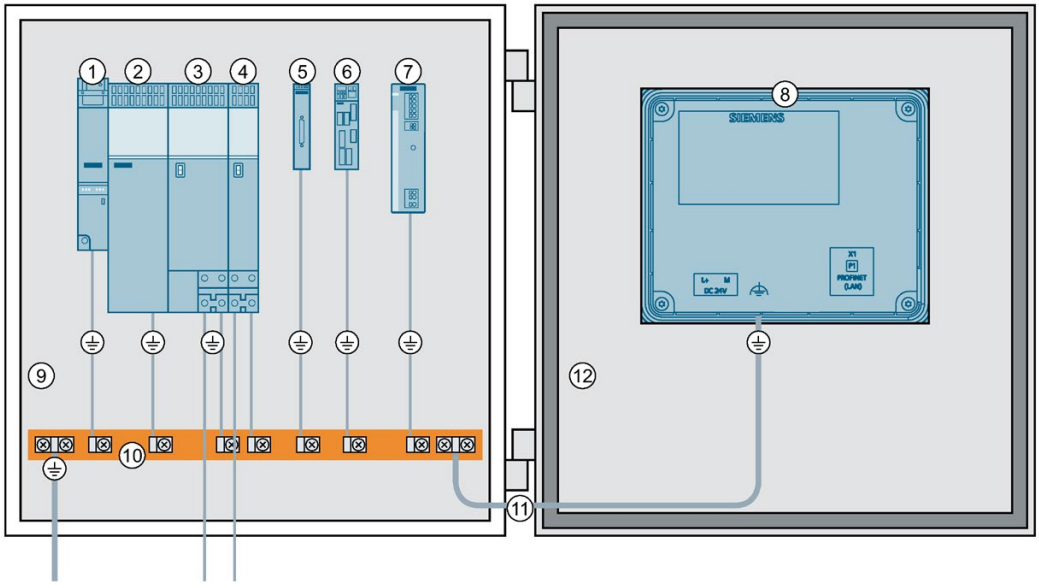
Table 8- 3 Cable cross-section for copper protective conductor

Cross-section of mains supply conductor	Cross-section of protective conductor
≤ 16 mm²	As mains supply conductor cross-section
> 16 mm² to ≤ 35 mm²	16 mm²
> 35 mm²	0.5 × mains supply conductor cross-section

For other materials, the cross-section of the protective conductor is to be increased so that it has at least the same conductance as copper.

Potential equalization

If there is no common bare metal mounting plate, you need different potential equalization that comes as close as possible to a cross-section in accordance with the "Cable cross-section for copper protective conductors" table, or at least with the same conductance.



① SIMATIC Drive Controller
② SINAMICS S120 Line Module
③ SINAMICS S120 Double Motor Module
④ SINAMICS S120 Single Motor Module
⑤ SINAMICS Sensor Module Cabinet-Mounted (SMC)
⑥ SINAMICS Terminal Module (TM)
⑦ Power supply, for example, SITOP
⑧ HMI device
⑨ Control cabinet
⑩ Functional ground bar
⑪ Flexible protective conductor
⑫ Control cabinet door

Note

The ground potential and enclosure (PE) for the SIMATIC Drive Controller are connected over a low-impedance internal connection.

WARNING

Electric shock without grounding

If there is no protective conductor connection or the connection is incorrectly implemented for devices with protection class I, high voltages can be present at open, exposed parts, which can result in death or serious injury if the parts are touched.

- Ground the device in compliance with the applicable regulations.

Communication connections

Equipotential-bonding cables are not required for fieldbus components within a control cabinet if they are configured as detailed above.

For communication connections between separate parts of a plant (for example devices in different control cabinets) and between buildings or parts of buildings, you must ensure potential equalization.

If data lines (PROFINET, PROFIBUS or DRIVE-CLiQ), for example, run through more than one control cabinet, potential equalization with a potential equalization conductor is required. Lay the equipotential bonding conductor together with the data line.

The following minimum cross-sections are required pursuant to IEC 60364-5-54:

- At least 6 mm² for copper
- At least 16 mm² for aluminum
- At least 50 mm² for steel

NOTICE

Disruption to data connection or device defect in the absence of equipotential bonding

Considerable leakage current can flow over the data line if no potential equalization is set up. Disruption to data connection or device defects are possible.

Lay an equipotential bonding conductor together with the data line.

Due to the maximum length of 100 m for PROFIBUS copper cables at 12 Mbps or for PROFINET copper cables, and aspects of electrical isolation, EMC protection and equipotential bonding, we recommend using fiber-optic cables for connections between buildings.

8.10 Connecting cable shields

Using shielded cables

The following options are available for the shield connection when using shielded cables:

- A shield connection using a shielding bus supplied separately
- Shield contact with shield contact element at the top of the SIMATIC Drive Controller enclosure.

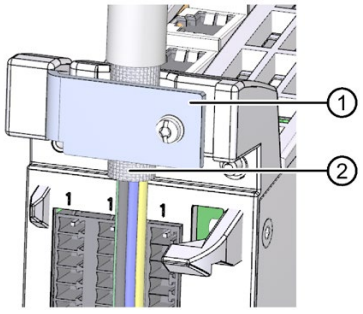
Using a shielding bus

Proceed as follows to use a shield bus:

1. Strip the cable shielding.
2. Attach the shield to a grounded shield bus after the point where the cable enters the cabinet.
3. Run the shielded cable as far as the module but do not establish a connection to the shield there.

Using a shield contact on the SIMATIC Drive Controller

1. Loosen the shield contact bracket ① far enough to create space under the bracket (M3 screw, Torx T10).
2. Strip the cable shielding and insert the cable.
3. Attach the retaining bracket so that the cable shield and cable ② are pressed against the shield support by the retaining bracket (tightening torque 0.8 Nm or 7.1 lbf in).



① Shield contact bracket
② Cable shield

Figure 8-1 Shield contact at the SIMATIC Drive Controller

WARNING

Unconnected cable shields cause electric shock

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

- Connect at least one end of cable shields and unused conductors of cables to the grounded enclosure potential.

Configuring

9

9.1 Overview

Overview

"**Configuring**" refers to all steps (configuration, parameter assignment and programming) required for creating an executable project in the TIA Portal.

You transfer the configuration (preset configuration) and mode of operation of the CPU and integrated automatic speed control SINAMICS Integrated to the SIMATIC Drive Controller by configuring, assigning the parameters of and connecting the individual hardware components. You perform the steps needed for this in the device and network views in the TIA Portal and in SINAMICS Startdrive (SINAMICS Integrated).

"**Configuring**" refers to arranging and networking devices and modules within the device or network view of the TIA Portal. The TIA Portal provides a graphic display of hardware components. It also shows the module racks, for example, for ET 200SP and ET 200MP I/O systems, and the drive line-up of SINAMICS Integrated.

During startup, the configured preset configuration is compared with the actual configuration of the system. Using parameter assignment, you can specify the response of the CPU to errors in the hardware configuration.

"**Parameter assignment**" means setting the properties of the components used (CPU, SINAMICS Integrated, I/O modules, etc.).

The TIA Portal compiles the hardware configuration (result of "configuring" and "parameter assignment") and loads it to the components.

"**Programming**" means creating the user programs. The TIA Portal provides high-performance programming editors for efficient engineering. You can, for example, create programs in structured control language (SCL), ladder logic (LAD), function block diagram (FBD) or statement list (STL).

9.2 Hardware/software requirements

Hardware requirements

The following requirements must be met for commissioning the SIMATIC Drive Controller:

- Your plant has been installed and wired.
- Your PG/PC has been connected to the SIMATIC Drive Controller over the PROFINET or PROFIBUS interface.

Software requirements

Table 9- 1 Required configuration software

Configuration in the TIA Portal	Requirement
Integrated SIMATIC S7-1500 CPU	SIMATIC STEP 7 Professional, V16 or higher
	For programming the safety program of the F-CPU "STEP 7 Safety Advanced" from V16 onwards
SINAMICS Integrated	SINAMICS Startdrive Basic or Startdrive Advanced, V16 or higher

Additional information

You can find an overview of the most important documents and links for the TIA Portal on the Internet (https://support.industry.siemens.com/cs/en/en/view/65601780).

You can find manuals, application examples and FAQs on Motion Control (https://support.industry.siemens.com/cs/ww/en/view/109751049) on the following topic page.

Note

Configuration without STEP 7/SINAMICS Startdrive

If you want to open projects that already contain a SIMATIC Drive Controller and a SINAMICS drive, you need STEP 7 **and** SINAMICS Startdrive.

Note

Connecting SINAMICS Integrated online

To connect SINAMICS Integrated online:

- You need STEP 7 Professional and SINAMICS Startdrive (V16 or higher).
- The hardware configuration must have been loaded to the SIMATIC Drive Controller.
- A subnet must be configured at the interface to which you are connecting your PC/PC.
- The configured SINAMICS firmware version must match the firmware version of the device.

For information on how to determine the firmware version of the device without SINAMICS Startdrive, refer to the section Determining the SINAMICS Integrated version (Page 153).

You can only configure the drive offline with SINAMICS Startdrive without STEP 7 Professional.

9.3 Configuration procedure

Proceed as follows to create a new project in the TIA Portal and add a SIMATIC Drive Controller:

Creating a project

1. Start TIA Portal.
2. Select the action "Start" > "Create new project" in the portal view.
3. Assign a name for the new project under "Project name".
4. Set the storage location with the "..." button.
5. If required, enter comments in the Comment field.
6. Click the "Create" button to create the project.

You have created the project and are currently in the portal view. To continue with the configuration, switch to the project view.

Adding a SIMATIC Drive Controller to the project

1. Select "Add new device" in the project tree.
2. In the "Add new device" dialog, select the device version you are using under "Controller" > "SIMATIC Drive Controller" and the firmware version of the device under "Version".
3. You use the "Open device view" checkbox to specify whether the hardware configuration view is to be opened once the device has been created. Keep the checkbox selected if you want to configure the CPU next.
4. Click OK to confirm the new device.

You have added the SIMATIC Drive Controller to the project and can now continue with configuration, parameter assignment and programming.

Display of the SIMATIC Drive Controller

When you add a SIMATIC Drive Controller to the project, by default:

- A "Drive Controller_n" group is generated
- Two devices are added to the group, for example:
  - PLC_n [CPU 1504D TF] and
  - Integrated_n [S120, CPU 150xD]

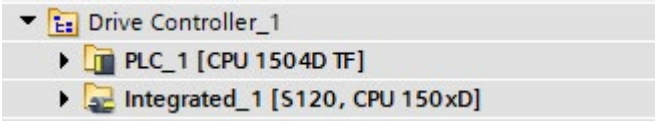


Figure 9-1 SIMATIC Drive Controller in the project tree, device collapsed

SINAMICS Integrated is only created if the following conditions are met:

- Startdrive is installed
- The option "Create including SINAMICS Integrated (Requirement: Startdrive is installed)" is activated, in the "Options" menu under "Settings" > "Hardware configuration" > "Device-specific settings".

Both devices are networked via the PROFIdrive Integrated_n subnet.

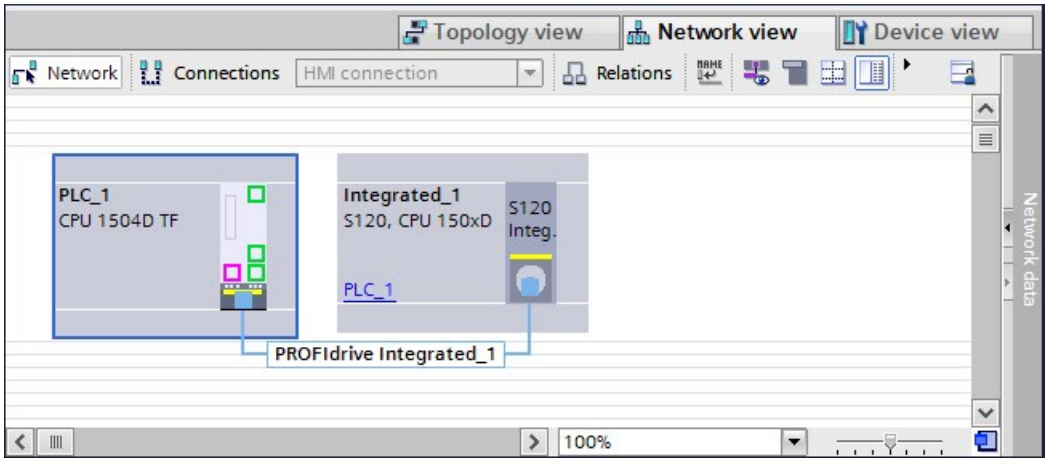


Figure 9-2 SIMATIC Drive Controller network view

When a new SIMATIC Drive Controller is created, all objects are assigned a uniform instance number (n).

CPU PLC_n and integrated automatic speed control Integrated_n are modeled as separate devices. You can also move the devices as required to other groups and delete the "Drive Controller" group. You can also add other devices to the "Drive Controller" group, for example a CU320-2 PN, if you require more than six servo drives.

Note

Adding SIMATIC Drive Controller directly to group

You can add the SIMATIC Drive Controller directly to a group folder in the project tree even if the group folder is a subfolder:

1. Select the required group.
2. Go to the menu bar or shortcut menu and select "Add" > "Device".

Creation options

The CPU and SINAMICS Integrated are by default created in a shared group folder in the project tree.

To change this behavior, activate or deactivate the relevant options for the SIMATIC Drive Controller in the "Options" menu under "Settings" -> "Hardware configuration" -> "Device-specific settings".

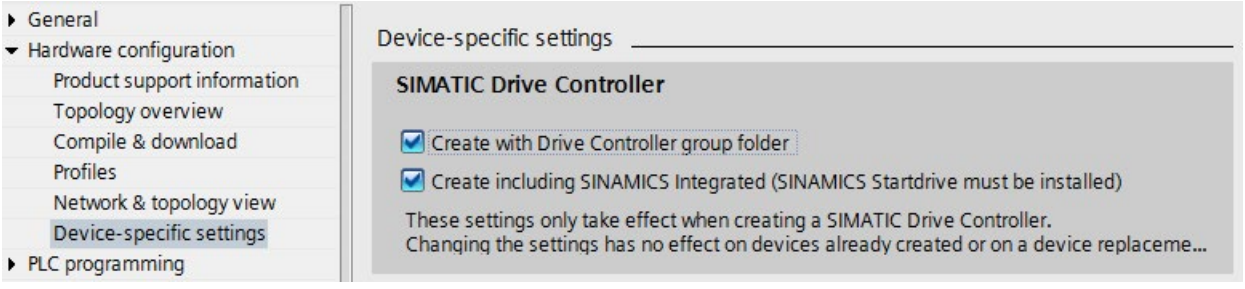


Figure 9-3 Creation options for creating a SIMATIC Drive Controller

The table below sets out the benefits of configuration with or without grouping.

Table 9- 2 Guide to grouping

With "Drive Controller" grouping	Without grouping or user-specific grouping
• Actions apply to all devices in a group, for example – Go online – Load to/from device – Copy • You can add additional devices to the group as required, for example – with CU320-2 – with I/O system	• Greater flexibility in project structure in the project tree, for example – by machine/plant modules – by CPUs and drives, in separate groups

If you want to create the SIMATIC Drive Controller **without the integrated drive**, deselect the "Including SINAMICS Integrated" option.

Deselecting this option can, for example, be useful in the following cases:

- You are copying a previously configured SINAMICS Integrated drive control from another project.
- The project is to be processed by another user without SINAMICS Startdrive.
- SINAMICS Integrated is not to be configured until later.
- SINAMICS Integrated is not being used, for example, because another drive system is being used.

"Drive Controller" group

For the "Drive Controller" group, you have a range of functions to choose from in the menu bar, toolbar and shortcut menu. With "Go online", for example, you can go online with all devices in the group.

The functionality supported by a given device depends on the device and state. For example, the function "Download to device" is supported by the SINAMICS Integrated but not by the CPU when there is an active online connection. The "Load preview" dialog provides relevant information and suggestions for actions for loading.

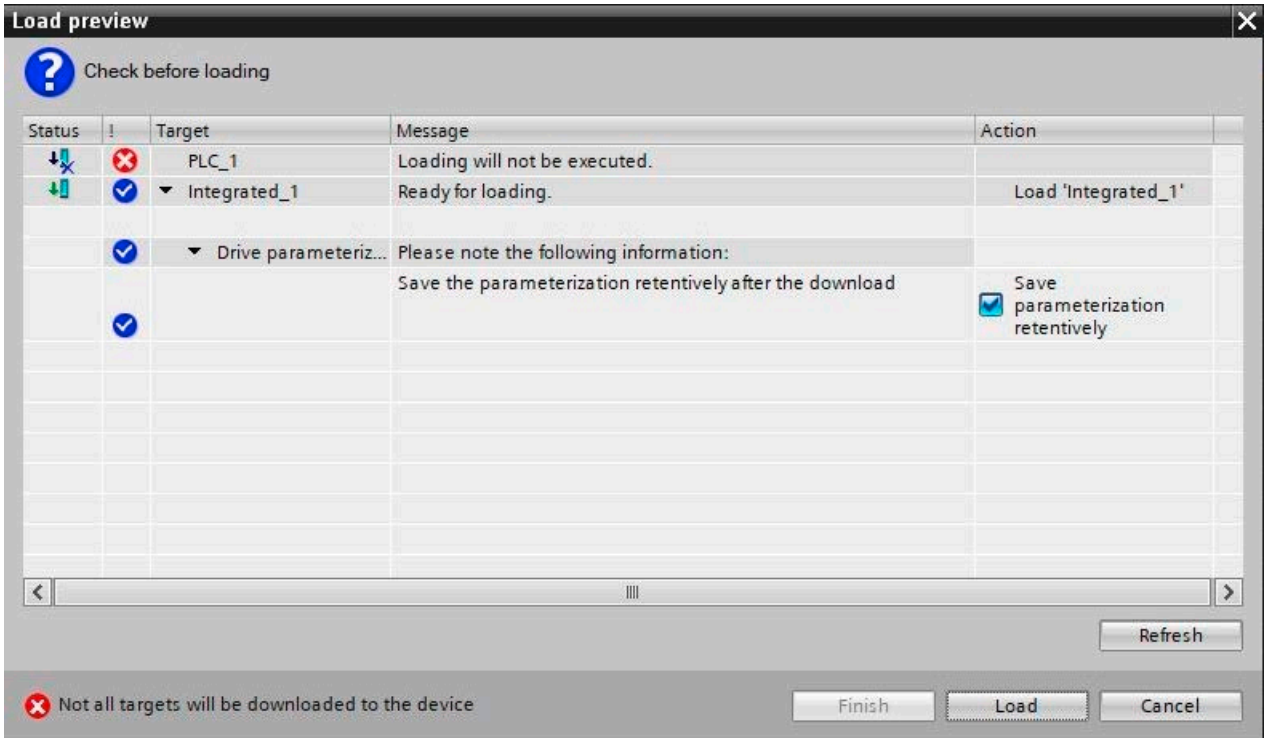


Figure 9-4 Load preview

Subsequently configuring SINAMICS Integrated

Requirements: STEP 7 Professional and SINAMICS Startdrive are installed.

Proceed as follows if your project only contains the CPU of a SIMATIC Drive Controller and you want to configure the missing SINAMICS Integrated.

1. Select "Add new device" in the project tree.
2. In the "Add new device" dialog, go to "Drives" > "Drives & starters" > "SINAMICS drives" > "SINAMICS S120 Integrated for SIMATIC" and select SINAMICS Integrated, and select the firmware version of the device under "Version".
3. Click OK to confirm.

Result: SINAMICS Integrated has been added to the project tree and can be networked with the CPU.

Subsequently configuring a CPU

Requirements: STEP 7 Professional and SINAMICS Startdrive are installed.

Proceed as follows if your project only contains a SINAMICS Integrated of a SIMATIC Drive Controller and you want to configure the missing CPU.

1. To ensure that only the CPU (without SINAMICS Integrated) is created, deselect the "Including SINAMICS Integrated" option under "Settings" > "Hardware configuration" > "Device-specific settings" in the "Options" menu. Also deselect the "Create Drive Controller with group folder" option if you do not want a group folder to be created. Alternatively, you will need to delete the components you do not require.
2. Select "Add new device" in the project tree.
3. In the "Add new device" dialog, select the relevant device version under "Controller" > "SIMATIC Drive Controller" and the firmware version of the device under "Version".
4. Click OK to confirm.

Result: The CPU has been added to the project tree and can be connected to the SINAMICS Integrated .

Replacing devices in STEP 7

The following section explains how to replace a SIMATIC S7-1500 CPU with a SIMATIC Drive Controller in an existing project or vice versa.

1. Select the device to be replaced in the project tree and right-click to open the shortcut menu.
2. Select the "Replace device..." option
3. Select the module you want to use in the right-hand column. The "Compatibility information" section indicates whether the devices to be replaced are compatible and whether or not and, if so, which configurations will be lost in the process.
4. Click "OK" to confirm.

When replacing devices, remember that the SIMATIC Drive Controller consists of two networked devices – a CPU and a SINAMICS Integrated.

Replacing a modular SIMATIC S7-1500 CPU with a SIMATIC Drive Controller (CPU)

If you replace a modular SIMATIC S7-1500 CPU with a SIMATIC Drive Controller, the configurations at the integrated PROFINET interfaces and at the integrated PROFIBUS interface are retained. In other words, the interfaces are mapped to an interface of the same type.

Configurations of the onboard I/O of S7-1500 compact CPUs are not applied. Please also note the compatibility information in the device replacement dialog.

Examples of alarms:

Message	**Explanation** **(Difference compared to modular SIMATIC S7-1500 CPUs)**
The 'CPU display' object is not supported in the new configuration and is removed.	Drive Controller has no display
The 'Virtual communication interface' object is not supported in the new configuration and is removed.	Drive Controller has no backplane bus, and communications processors (e.g. CP 1543-1) can therefore not be used. The communication interface required for this is removed.
'DI/DQ 8x24VDC' is created	Drive Controller has technology I/Os
'Port' is created	The PROFINET IO IRT interface for the Drive Controller has an additional third port
'PROFIdrive interface' is created	Drive Controller has a SINAMICS Integrated. The communication with the PLC takes place via a 'PROFIdrive interface'

The centralized I/O in the S7-1500 automation system is moved to the "unplugged modules" area. If required, copy the I/O to a distributed I/O ET 200MP system before device replacement.

A connected SINAMICS S120 CU320-2 remains connected – it is not swapped out for a SINAMICS Integrated. If you require a SINAMICS Integrated, you need to create it manually.

Replacing a SIMATIC Drive Controller (CPU) with a modular SIMATIC S7-1500 CPU

For the device replacement, PROFIdrive Integrated is removed and SINAMICS Integrated remains as a non-networked device in the project. You can connect SINAMICS Integrated to a SIMATIC Drive Controller CPU again at a later time.

If you no longer need SINAMICS Integrated, manually delete it from the configuration.

Configurations at interface X142 are not applied.

Note

Device replacement with other CPU classes (for example ET 200SP CPUs or ET 200pro CPUs) is not possible.

Replacing SINAMICS Integrated with SINAMICS S120 CU320-2 and vice versa

Device replacement is currently not supported

Changing the firmware version of the CPU

You change the firmware version of the SIMATIC Drive Controller CPU by replacing the device. Replace the CPU with a CPU with the preferred firmware version.

Changing the firmware version of the SINAMICS Integrated

You can only change the firmware version of the SINAMICS Integrated by deleting and reconfiguring the SINAMICS Integrated (see also paragraph above "Subsequently configuring SINAMICS Integrated ").

For additional information, refer to the following FAQ on the Internet (https://support.industry.siemens.com/cs/ww/en/view/109782271).

If you want to change the firmware version of connected SINAMICS S120 CUs, you must also start a new configuration with SINAMICS Startdrive .

Note

Firmware versions must match

SINAMICS Startdrive can only establish an online connection to SINAMICS Integrated or a SINAMICS S120 CU when the configured firmware version matches the firmware version of the device.

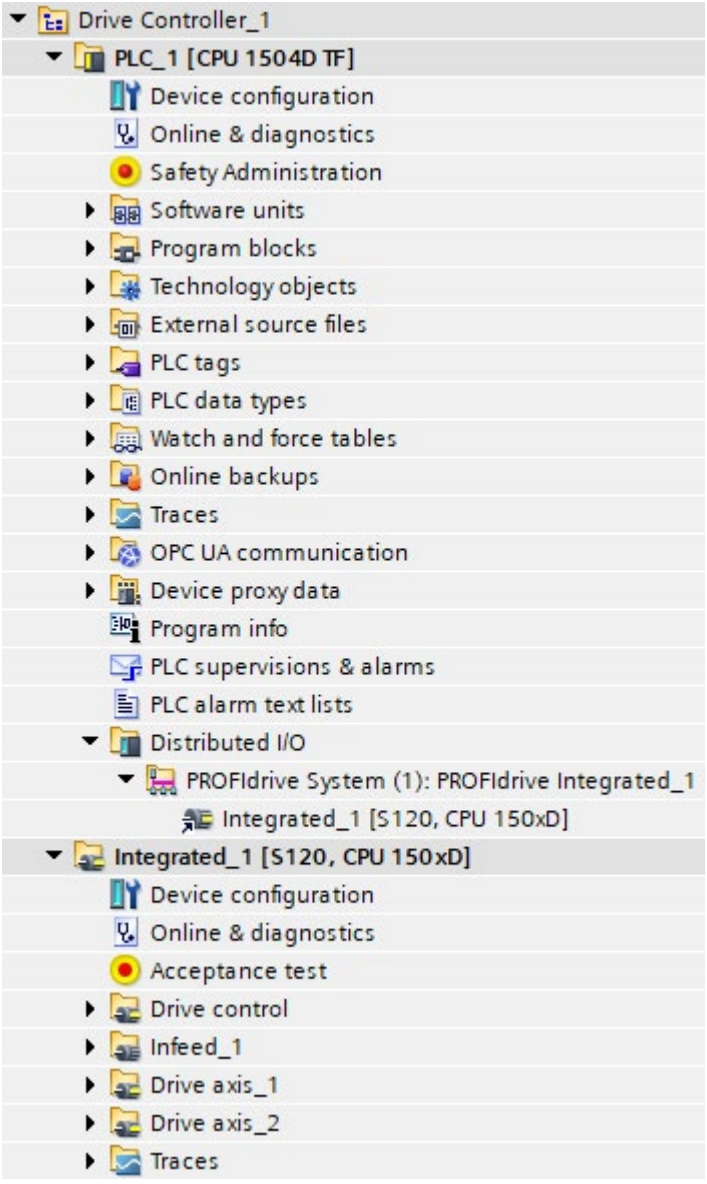
For information on how to determine the firmware version of the device, refer to the section Determining the SINAMICS Integrated version (Page 153).

9.4 Display in the TIA Portal

Project tree

In the project tree, STEP 7 creates the project tree for the SIMATIC Drive Controller . The project tree contains all elements and editors of the project.

Table 9- 3 Structure of the project tree



Under the "Drive Controller" group folder, you will find both the CPU and SINAMICS Integrated.

Under the "PLC" entry, you will find the device configuration and diagnostic options for the CPU, for example. You configure, assign parameters for and program the CPU with STEP 7 Professional.

Under the "Integrated" entry, you will find the device configuration and diagnostic options for integrated automatic speed control, for example. You configure and assign parameters for the SINAMICS Integrated with SINAMICS Startdrive.

Note

If there is no entry for SINAMICS Integrated, check whether SINAMICS Startdrive is correctly installed and whether the "Including SINAMICS Integrated" option is selected in the settings.

Finding associated device in the project tree

You can also assign the CPU and the associated SINAMICS Integrated in the project to other random groups.

To find the respective associated device, follow these steps in the project tree:

1. Below the CPU, for example, "PLC_1 [CPU 1504D TF]", select the "SINAMICS Integrated" (e.g. "Integrated_1 [S120, CPU 150xD]) under "Distributed I/O" > "PROFIdrive system".
2. Use the "Go to device" shortcut menu of the CPU to navigate to the associated SINAMICS Integrated.
3. To navigate from the SINAMICS Integrated to the associated CPU, select the SINAMICS Integrated , for example, "Integrated_1 [S120, CPU 150xD]".
4. Use the shortcut menu "Go to master I/O system" to return to the PROFIdrive system and thus to the associated CPU.

Network view

The network view displays the two components of the SIMATIC Drive Controller, for example:

- PLC_1 [CPU 1504D TF] and
- Integrated_1 [S120, CPU 150xD]

Different content is shown in the Inspector window depending on the selection in the network view:

- Select an interface ① to configure it
- Select the CPU ②□ to make CPU settings
- Select the SINAMICS Integrated ③ to make SINAMICS Integrated settings (for example frame settings)
- Select the PROFIdrive Integrated subnet ④ to set the bus cycle time (and thus indirectly the MC Servo clock) or couple the SINAMICS Integrated with another clock system (X142 technology I/Os or PROFINET interface X150).

You can copy/add/delete the components of the SIMATIC Drive Controller individually or together. If you subsequently configure a SINAMICS Integrated, you need to assign the SINAMICS Integrated manually to the master system to establish the PROFIdrive Integrated connection.

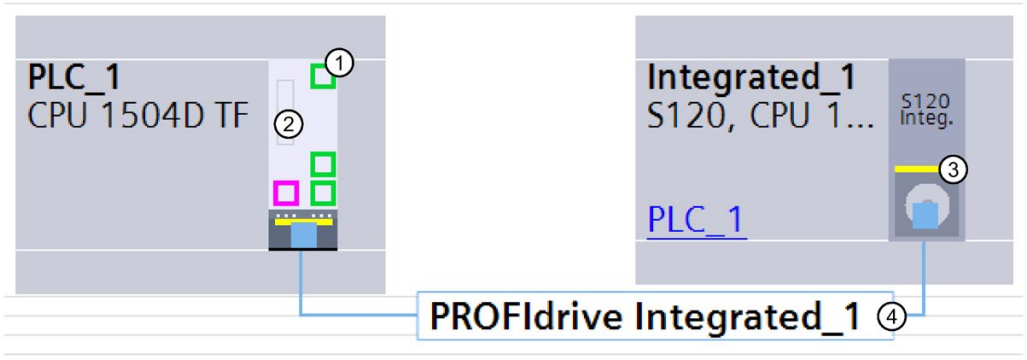


Figure 9-5 Display in the TIA Portal – network view

Topology view

As the topology view is irrelevant for the SINAMICS Integrated, only the CPU of the SIMATIC Drive Controller is displayed.

Device view

There is a separate device view for each of the two components of the SIMATIC Drive Controller.

- CPU device view: Parameter assignment of the CPU including communication interfaces
- SINAMICS Integrated device: Configuration of the SINAMICS S120 drive components (Line Modules, Motor Modules, motors, etc.), drive frames, etc.

You can switch between the two views simply and easily with a link.

As in the network view, different content is shown in the Inspector window depending on the selection in the device view.

9.5 Configuration information

9.5.1 Notes on configuration software

Routing

The PROFIdrive Integrated represents a lower-level network. A programming device connected over PROFINET/PROFIBUS uses routing to access the SINAMICS Integrated .

The following requirements must be met in order for you to set up an online connection with the SINAMICS Integrated:

- A subnet needs to be configured for the interface to which you are connecting the programming device. Routing to the SINAMICS Integrated is only possible if a subnet is configured.
- The configuration must be loaded to the CPU for CPU routing information to be available.

Accessible devices

As the SINAMICS Integrated is assigned to a lower-level network, you can only access the higher-level CPU – and not the SINAMICS Integrated – via "Accessible devices".

IP address of the PROFINET interfaces

With the SIMATIC Drive Controller, the IP addresses 192.168.215.240 to 192.168.215.255 are reserved for internal communication (subnet mask 255.255.255.240). When configuring the PROFINET interfaces (X150, X160, X130), you must ensure that the internal addresses are not located in their network. With IP, the network is defined by an AND connection of IP address and subnet mask.

Startdrive installation without STEP 7 Professional

If only Startdrive is installed, you can configure a SINAMICS Integrated "offline". Online functions are not possible because routing information is not available.

STARTER configuration tool

It is not possible to configure SINAMICS Integrated with the STARTER configuration tool.

Upload as a new station (as of TIA Portal V19)

Requirement: SIMATIC Drive Controller with loaded TIA Portal V19 project

If you upload the SIMATIC Drive Controller as a new station, the CPU is loaded. If a SINAMICS Integrated is configured, it is created as a proxy in the project. The proxy is represented as a "read only" object. It is not possible to upload SINAMICS Integrated to the proxy.

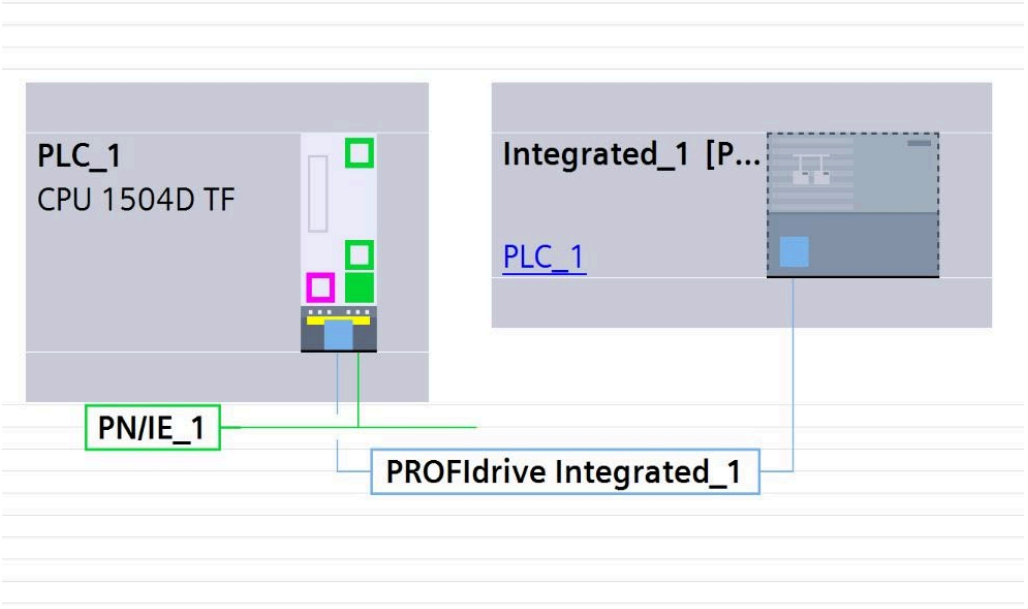


Figure 9-6 SIMATIC Drive Controller with SINAMICS Integrated as proxy

You may only use the upload for the following purposes:

- for diagnostics purposes.
- As a starting point for configuring trace data and then loading it into the CPU (e.g. for cross-project trace)
- To view the CPU configuration including the configured telegrams

Upload as new station (up to TIA Portal V18)

Requirement: You have only configured the CPU and not the SINAMICS Integrated.

The SIMATIC Drive Controller can be uploaded as a new station. Only the CPU is loaded.

Upload of the SINAMICS Integrated is not supported.

9.5.2 Mixed operation of control modes for SINAMICS Integrated

Mixed operation of control modes for SINAMICS Integrated

The mixed operation of servo control, vector control and U/f control is possible but is subject to restrictions.

Permissible:

- The mixed operation of servo control and U/f control
- The mixed operation of vector control and U/f control

Not permitted:

- The mixed operation of servo control and vector control

Note the following permissible drive quantities for mixed operation.

Mixed operation of servo control and U/f control

In mixed operation of servo control and U/f control, a drive takes up exactly as much computing power in servo control at 125 µs as two drives in U/f control at 500 µs. In combination with the servo control, a maximum of 11 drives is permitted (1 servo control plus 10 U/f controls).

Table 9- 4 Number of drives with mixed operation servo control

Number of drives in servo control at 125 µs and 62.5 µs current controller cycle times				**Number of drives in U/f control at 500 µs current controller cycle time**	
6	125 µs	3	62.5 µs	0	-
5	125 µs	-	-	2	500 µs
4	125 µs	2	62.5 µs	4	500 µs
3	125 µs	-	-	6	500 µs
2	125 µs	1	62.5 µs	8	500 µs
1	125 µs	-	-	10	500 µs
0	-	0	-	12	500 µs

Mixed operation of vector control and U/f control

In mixed operation of vector control and U/f control, a drive takes up exactly as much computing power in vector control at 250 µs as two drives in U/f control at 500 µs. In combination with the vector control, a maximum of 11 drives is permitted (1 vector control plus 10 U/f controls).

Table 9- 5 Number of drives with mixed operation vector control

Number of drives in vector control at 250 µs and 500 µs current controller cycle times				**Number of drives in U/f control at 500 µs current controller cycle time**	
6	500 µs	3	250 µs	0	-
5	500 µs	-	-	2	500 µs
4	500 µs	-	-	4	500 µs
3	500 µs	-	-	6	500 µs
2	500 µs	-	-	8	500 µs
1	500 µs	-	-	10	500 µs
0	-	0	-	12	500 µs

Note

In mixed operation of vector control and U/f control, the following drive constellations and current controller cycle times are **not** possible:

- 1 drive (vector control, 250 µs) and 8 drives (U/f control, 500 µs)
- 2 drives (vector control, 250 µs) and 4 drives (U/f control, 500 µs)

Additional information

For more information on the control types and on the system rules and possible sampling times, refer to the SINAMICS S120 Drive Functions function manual (https://support.industry.siemens.com/cs/de/en/view/109781535).

9.5.3 Changing the current controller cycle time for SINAMICS Integrated

Backlash on motion control functions

A change of the current controller cycle time p0115[0] ≠ 125 µs results in a re-initialization of the clock system.
Afterwards, the execution of Motion Control instructions and access to Motion DBs can result in programming errors that will put the CPU into the STOP operating state by default.

Solution:

You can prevent STOP of the CPU by configuring the programming error OB (OB 121).
You can then acknowledge any Motion Control alarms that occur with the Motion Control instruction "MC_Reset" ("Restart" parameter = TRUE).

Recommendations for action

Servo drives with current controller cycle time = 125 µs

It is best to use the standard sampling times p0112 = 3 (factory setting).
With this setting, the drives are operated with a current controller cycle time p0115[0] = 125 µs.

Servo drives with current controller cycle time ≠ 125 µs or vector drives

When current controller cycle times ≠ 125 µs are required for servo drives or when you are using vector drives, the Motion Control instructions and Motion DB access operations may only take place after a re-initialization of the clock system.
You can implement this behavior, for example, by programming a wait time in the startup OB (OB 100).
This is not possible with a delta download. In this case, configure OB 121 and use the MC_Reset instruction (parameter "Restart" = TRUE) to acknowledge any motion control alarms that occur.

Specifying the bus clock cycle

To prevent sign-of-life failures at the drives, the bus clock cycle must be an integer multiple of the current controller cycle time p0115[0].

9.5.4 Determining the SINAMICS Integrated version

The firmware version of the SINAMICS Integrated is displayed in SINAMICS Startdrive using the option "Online & diagnostics" followed by the secondary option "Diagnostics > General".
If an online connection to SINAMICS Integrated is not possible with Startdrive (in this context, also see the section Hardware-/software requirements (Page 138)), then you have the following alternatives for determining the SINAMICS Integrated firmware version on the device (from PLC firmware V3.0 onwards):

- in the TIA Portal in the CPU diagnostics using the option "Online & Diagnostics" and the secondary option "Diagnostics > General" under "Drive Controller information"
- in the CPU Web server on the web page "Diagnostics" in the "Identification" tab under "Drive Controller Info"
- in the exported diagnostic buffer of the CPU

9.6 Address assignment

9.6.1 Addressing

Introduction

The automation components and onboard I/O must have unique addresses so that they can be addressed. The following section explains the various address areas.

I/O address

I/O addresses (input/output addresses) are required in the user program to read inputs and set outputs.

STEP 7 automatically assigns input and output addresses when modules are configured. Each module uses a continuous range of input and/or output addresses corresponding to its volume of input and output data.

The same applies for the onboard I/O of the SIMATIC Drive Controller.

Module	Rack	Slot	I address	Q address	Type
PLC_1	0	1			CPU 1504D TF
DI/DQ 8x24VDC_1	0	1 X142	0...75	0...41	DI/DQ 8x24VDC
PROFINET Interface_1	0	1 X150			PROFINET interface
Port_1	0	1 X150 P1R			Port
Port_2	0	1 X150 P2R			Port
Port_3	0	1 X150 P3			Port
PROFINET Interface_2	0	1 X160			PROFINET interface
Port_1	0	1 X160 P1			Port
PROFINET Interface GBIT_3	0	1 X130			PROFINET interface GBIT
Port_1	0	1 X130 P1			Port
DP Interface_1	0	1 X126			DP interface
PROFIdrive Interface_1	0	1 PCIe			PROFIdrive interface

Figure 9-7 Automatic assignment of input/output addresses of interface X142 by STEP 7

STEP 7 assigns the address areas of the modules by default to the process image partition 0 ("Automatic updating"). This process image partition is updated in the main cycle of the CPU.

Note

If you have interconnected the X142 digital input/outputs with the technology object measuring input, output cam or cam track, isochronous mode and assignment to the process image partition OB servo are essential.

The setting is made automatically as soon as you interconnect a digital input or digital output with a corresponding technology object.

Device address (e.g., Ethernet address)

Device addresses are addresses of modules with interfaces to a subnet (e.g., IP address or PROFIBUS address). They are required to address the various devices on a subnet, for example, to download a user program.

Hardware identifier

STEP 7 automatically assigns a hardware identifier (HW identifier) for identification and addressing of modules and submodules. The HW identifier is used, for example, for diagnostics alarms or for instructions, to identify the faulty module or the addressed module.

In the "System constants" tab of the Inspector window, you will find all hardware identifiers and their symbolic names (of the hardware identifier) for the selected module.

Local~DP_Interface_1	Hw_Interface	60	PLC_1
Local~PROFIdrive_Interface_1	Hw_Interface	61	PLC_1
Local~PROFINET_Interface_1	Hw_Interface	64	PLC_1
Local~PROFINET_Interface_2	Hw_Interface	72	PLC_1
Local~PROFINET_Interface_GBIT_3	Hw_Interface	120	PLC_1
Local~DI_DQ_8x24VDC_1	Hw_SubModule	257	PLC_1
Local~PROFINET_Interface_1~Port_1	Hw_Interface	65	PLC_1
Local~PROFINET_Interface_1~Port_2	Hw_Interface	66	PLC_1
Local~PROFINET_Interface_1~Port_3	Hw_Interface	67	PLC_1
Local~PROFINET_Interface_2~Port_1	Hw_Interface	73	PLC_1
Local~PROFINET_Interface_GBIT_3~Port_1	Hw_Interface	121	PLC_1

Figure 9-8 Automatic identification and addressing of modules and submodules in STEP 7

9.7 Address space

9.7.1 Address space of the digital inputs and digital inputs/outputs

Address space of the digital inputs and digital inputs/outputs

The assignment of address space depends on which digital inputs and digital inputs/outputs are used:

- 8 DI/DQ at interface X142 (I/Os are assigned to the CPU)
- 12 DI, 8 DI/DQ at interface X122/X132 (I/Os are by default assigned to the SINAMICS Integrated)

Interface X142 (CPU)

The digital input/outputs of interface X142 are permanently assigned to the CPU.

Table 9- 6 Scope of the input/output data of the digital input/outputs of interface X142

I	76 bytes
Q	42 bytes

STEP 7 assigns the addresses automatically. You can change the addresses in the hardware configuration of STEP 7, that is, freely assign the start address. The addresses of the channels are derived from the start address.

You can find the addresses in the device view of the CPU under Device overview and in the Inspector window, on the General tab under I/O addresses.

You can find a description of the control and feedback interface of the digital input/outputs at interface X142 in Parameter assignment of digital input/outputs (X142) (Page 160).

Interfaces X122/X132 (SINAMICS Integrated)

The digital inputs and digital inputs/outputs are by default assigned to the drive (CU DO1). You can use frame interconnection so that these digital inputs and digital inputs/outputs can also be used by the CPU. To do so, you configure a frame 39x for automatic speed control.

Note

Telegram 393 is set by default during configuration of the SINAMICS Integrated.

Table 9- 7 Scope of input/output data of the digital inputs and digital inputs/outputs X122/X132

Frame	Inputs	Outputs	Use of Integrated/CU320-2
390	4 bytes	4 bytes	No measuring input; DI0 to DI7; DI/DQ8 to DI/DQ15
391	14 bytes	6 bytes	Two measuring inputs; DI0 to DI7; DI/DQ8 to DI/DQ15
392	30 bytes	6 bytes	Six measuring inputs; DI0 to DI7; DI/DQ8 to DI/DQ15
393	42 bytes	8 bytes	8 measuring inputs; DI0 to DI7; DI16, DI17, DI20, DI21, DI/DQ8 to DI/DQ15 (for CU310-2 also: DI18, DI19, DI22, DO16, AI0)
394	6 bytes	6 bytes	No measuring inputs; DI0 to DI7; DI16, DI17, DI20, DI21, DI/DQ8 to DI/DQ15 (for CU310-2 also: DI18, DI19, DI22, DO16, AI0)

You can find a description of the control and feedback interface of the frames in the SINAMICS S120/S150 List Manual (https://support.industry.siemens.com/cs/de/de/view/109822659/en), function diagram 2422 and 2495 to 2500. There, you will also find a description of other selectable telegrams that are not the focus with the SIMATIC Drive Controller (for example, telegram 395).

See also SINAMICS G/S FAQ: Configuration of standard frames in the TIA Portal (https://support.industry.siemens.com/cs/ww/en/view/82841762)

STEP 7 assigns the addresses automatically. You can change the addresses in the hardware configuration of STEP 7, that is, freely assign the start address. The addresses of the channels are derived from the start address.

You can, for example, find the assigned addresses:

- In the device view of the SINAMICS Integrated, in the Inspector window, on the General tag under frame configuration
- In the network view when you select the network; the addresses are then displayed under Address overview in the Inspector window

Programming example

You can find a programming example in the following FAQ on the Internet (https://support.industry.siemens.com/cs/ww/en/view/109782269).

9.8 Process images and process image partitions

9.8.1 Process image - overview

Process image input and process image output

The process image input and output is an image of the signal states. The CPU transfers the values from the input and output modules to the process image input and output. At the start of the cyclic program, the CPU transfers the process image output as a signal state to the output modules. The CPU then transfers the signal states of the input modules to the process image inputs.

Advantages of the process image

A process image accesses a consistent image of the process signals during cyclic program execution. If a signal state at an input module changes during program execution, the signal state is retained in the process image. The CPU does not update the process image until the next cycle.

Consistency of the process image

When the process image is updated, the SIMATIC Drive Controller accesses the data of each submodule as consistent data. This behavior is identical to the modular SIMATIC S7-1500 CPUs.

The maximum data width that is accessed as consistent data for each submodule depends on the IO system. For PROFINET IO, for example, this data width is 1024 bytes.

32 process image partitions

The CPU uses process image partitions to synchronize the updated inputs/outputs of specific modules with specific parts of the user program.

With the SIMATIC Drive Controller, the overall process image is subdivided into up to 32 process image partitions (PIP).

The CPU automatically updates PIP 0 (automatic update) in each program cycle and assigns it to OB 1.

You can assign other OBs to process image partitions PIP 1 to PIP 31 during configuration of the IO devices.

Before the start of the OB, the CPU writes the outputs of the assigned process image partition (PIPQ) straight to the peripheral outputs of the IO devices. The CPU then updates the assigned process image partition for inputs (PIPI) and reads in the process signals.

The figure below illustrates the updating of a process image partition.

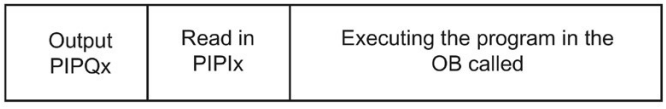


Figure 9-9 Updating a process image partition

Isochronous processing of the technology I/Os of interface X142

The operating modes timer DI, timer DQ, oversampling DI, oversampling DQ and event/period measurement require isochronous processing in OB91 (MC Servo) or OB6x (isochronous mode interrupt OBs). If you have configured one of those operating modes and have not set isochronous processing, this will result in an error when compiling the hardware configuration.

If you interconnect the technology I/Os with the technology object measuring input, output cam or cam track, isochronous mode and assignment to the process image partition OB servo are essential. The setting is made automatically as soon as you interconnect a technology I/O with a corresponding technology object.

9.8.2 Updating process image partitions in the user program

Requirements

Alternatively, you can also use the following instructions to update process images:

- "UPDAT_PI" instruction
- "UPDAT_PO" instruction

You will find the instructions in STEP 7 in the "Instructions" task card under "Extended instructions" in the "Process image" folder. You can call the instructions from any point in the user program.

Requirements for updating process image partitions with the "UPDAT_PI" and "UPDAT_PO" instructions:

- The process image partitions must not be assigned to any OB. This means the process image partitions are not automatically updated.

Note

Update of PIP 0

PIP 0 (automatic update) cannot be updated with the "UPDAT_PI" and "UPDAT_PO" instructions.

UPDAT_PI: Updates the process image partition of the inputs

With this instruction, you read the signal states from the input modules of the IO devices to the process image partition of the inputs (PIPI).

UPDAT_PO: Updates the process image partition of the outputs

With this instruction, you transfer the process image partition of the outputs of the IO devices to the output modules.

Direct I/O access to the inputs and outputs of the IO devices

You also have direct read and write access to the I/O as an alternative to access via the process image, should direct access be required for programming reasons. Direct (write) I/O access also writes to the process image. This prevents a subsequent output of the process image from again overwriting the value written by direct access.

Additional information

You can find more information on process image partitions in the Cycle and response times (https://support.industry.siemens.com/cs/ww/en/view/59193558) function manual.

9.9 Configuration of digital inputs/outputs (X142)

You configure the required digital input/outputs and operating modes over interface X142.

Overview of supported operating modes

You can configure the following operating modes for the individual channels of the X142 interface:

Table 9- 8 Overview of operating modes

Operating mode of X142 I/Os (8 channels)	**Functionality**	**Use with technology objects (TOs)**	**Use via I/O area (without TO)**	**Isochronous mode**
DI	Digital input • Input delay (1 µs/125 µs) • Hardware interrupt (optional) Hardware interrupt at rising and/or falling edge	• Hardware limit switch for positioning and synchronous axes • Reference mark • ...	No OB restrictions	Optional
DQ	Digital output	• Output cam • Cam track • ...	No OB restrictions	Optional
Timer DI	Acquisition of the switching time of a digital input signal with up to two edges per application cycle (e.g. for use as measurement sensing input)	Measuring input (OB 91 required)	OB 91/OB 6x required	Required
Timer DQ	Precisely timed output of a digital output signal with up to two edges per application cycle (e.g. for use as an output cam output)	• Output cam (OB 91 required) • Cam track (OB 91 required)	OB 91/OB 6x required	Required
Oversampling DI	Acquisition of 32 states of a digital input signal at equal intervals per application cycle	---	OB 91/OB 6x required	Required
Oversampling DQ	Output of 32 states of a digital output signal at equal intervals per application cycle	---	OB 91/OB 6x required	Required
Event/period duration measurement	Measurement of number of edges and period duration (e.g. for simple speed measurement with hole mask and light barrier)	---	OB 91/OB 6x required	Required
Pulse width modulation PWM	Output of a configurable pulse-pause ratio with a configurable frequency	---	No OB restrictions	Optional

Procedure

1. Select the Device configuration entry in the project tree under the CPU. The device view opens.
2. In the device view, click the DI/DQ 8x24VDC [X142] interface. You can now edit the configurable properties under Properties in the Inspector window.

Under Channel parameters, you can find an overview of all channels and your selected settings.

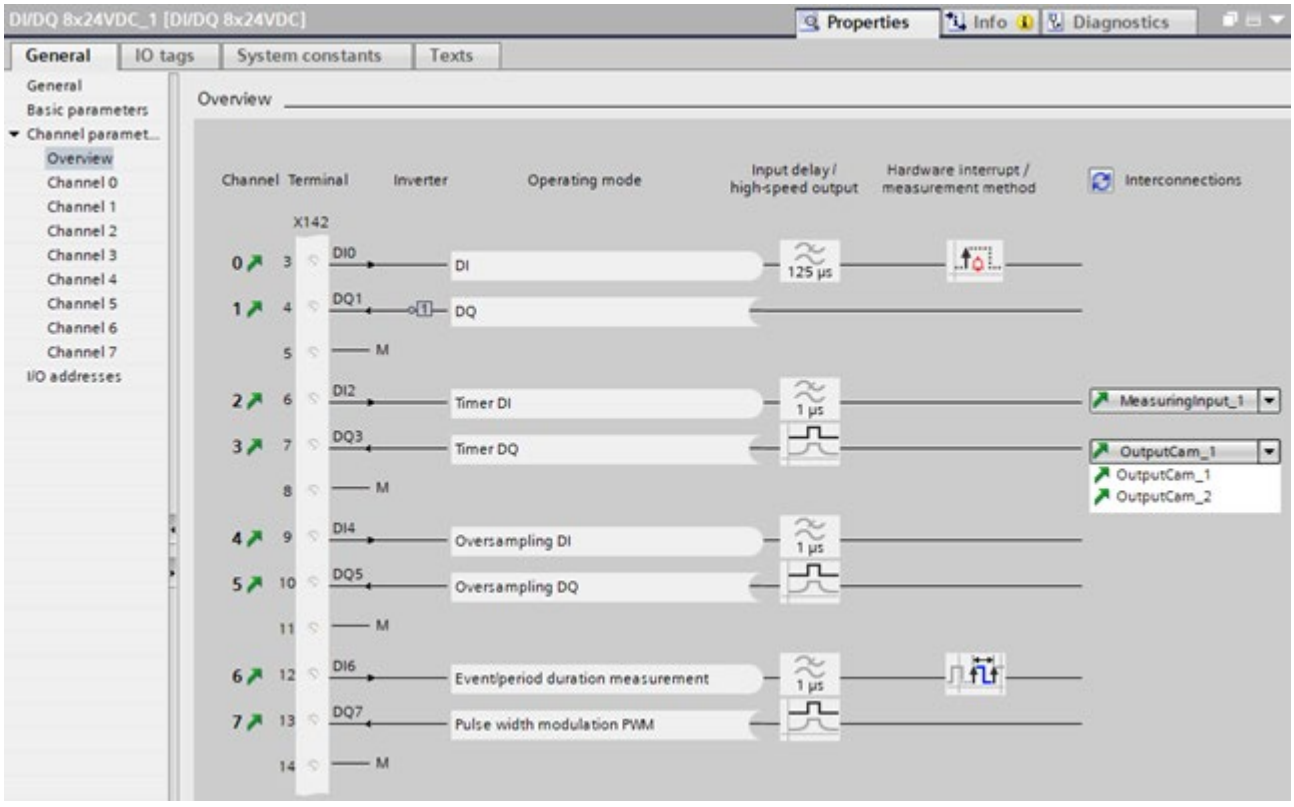


Figure 9-10 Channel parameters

Via links (arrow symbols) you will get to the parameter assignment of the respective channel or to the interconnected technology object.

Note

Multi-links

If you have linked a channel to several technology objects, you can select the link of the required technology object via the drop-down list.

You update the drop-down lists via the Refresh button next to "Interconnections". Updating may be required, for example, if changes were made to technology objects elsewhere in the project while the channel configuration was open.

9.9.1 Configuring the DI operating mode

DI operating mode

1. Select the operating mode DI for the required channel at interface X142.

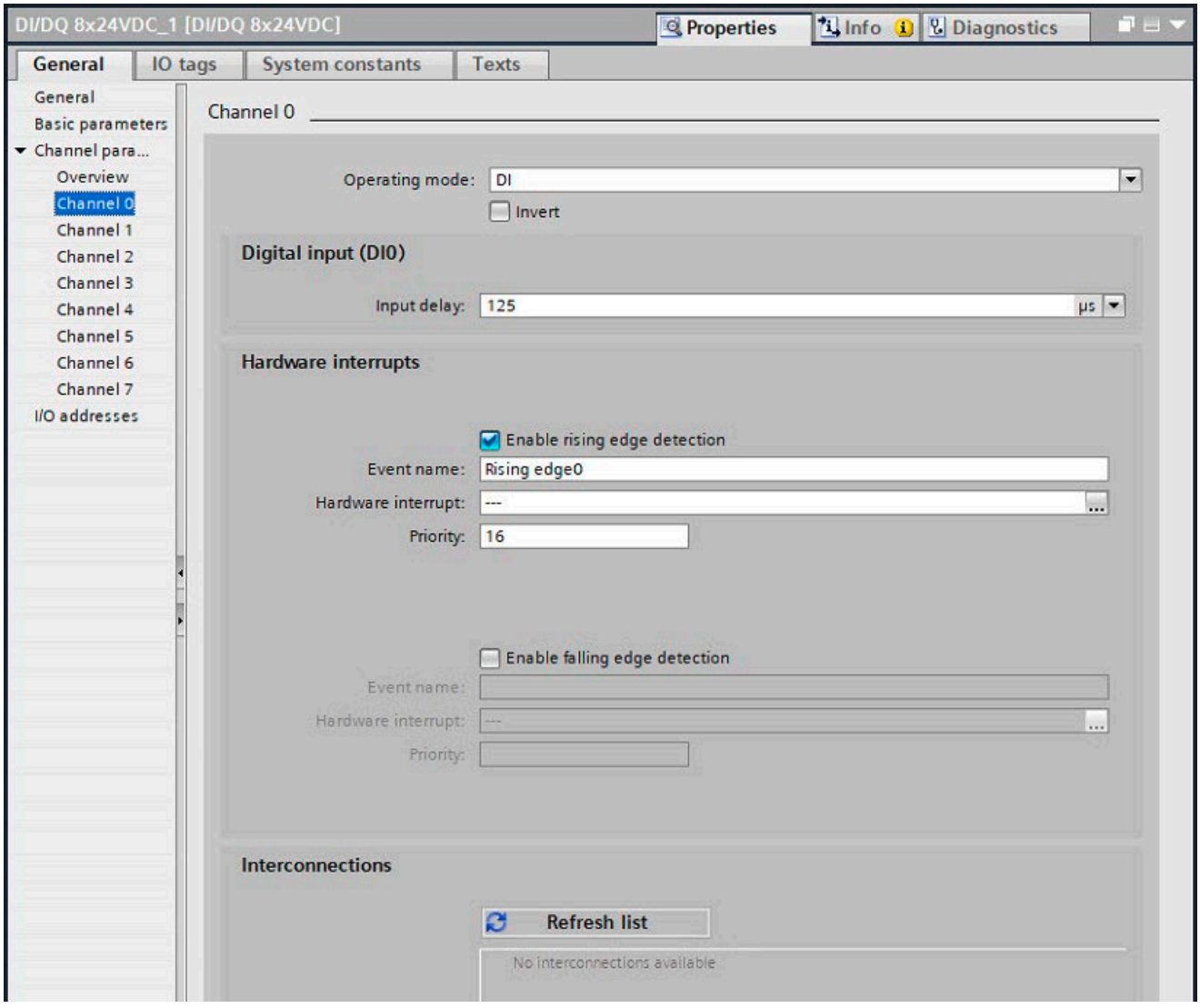


Figure 9-11 DI operating mode

Inversion

You can invert the 24 V signal to adjust it to your process. By default, the signal is not inverted.

Input delay

To suppress faults, you can set an input delay of 1 µs or 125 µs for the input filter of the digital inputs. Changes to the signal are only detected if they are constantly pending for longer than the set input delay time. When an input delay of 1 µs is set, the use of shielded cables is recommended for optimum interference immunity.

Hardware interrupts

In the Hardware interrupts section, you can assign a hardware interrupt to a rising and/or falling edge.

Interconnections

The technology objects that are interconnected with the channel are listed in the Interconnections area.

If technology objects are interconnected, you can reach the respective technology object through links (arrow icons).

Use the corresponding button to update the selection list. Updating may be required, for example, if changes have been made to technology objects elsewhere in the project while the channel configuration is open.

Further information

You can find more information on the DI operating mode in Assignment of the control interface (Page 191) and Assignment of the feedback interface (Page 192).

9.9.2 Configuring the DQ operating mode

DQ operating mode

1. Select the DQ operating mode for the required channel at interface X142.

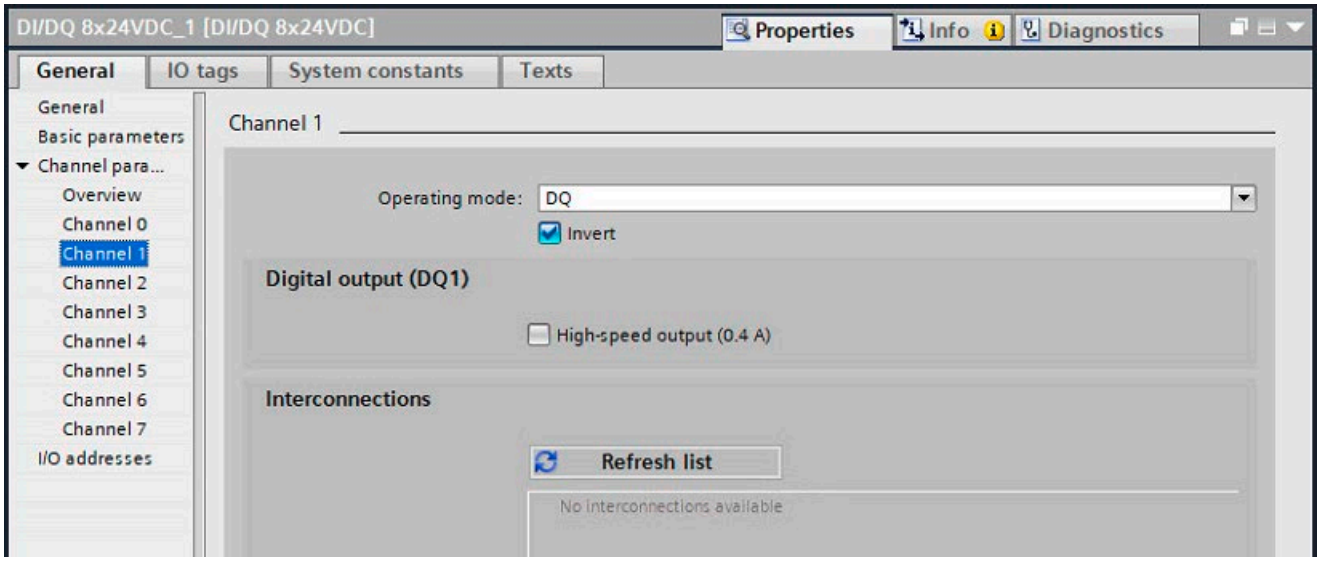


Figure 9-12 DQ operating mode

Inversion

You can invert the 24 V signal to adjust it to your process. By default, the signal is not inverted.

High-speed output (0.4 A)

If you select the high-speed output option, the digital output is switched alternately to 24 V DC and ground. Allows for extremely steep edges (output delay in the 1 µs range).

The rated load is reduced from 0.5 A to 0.4 A with this operating mode.

Interconnections

The technology objects that are interconnected with the channel are listed in the Interconnections area.

If technology objects are interconnected, you can reach the respective technology object through links (arrow icons).

Use the corresponding button to update the selection list. Updating may be required, for example, if changes have been made to technology objects elsewhere in the project while the channel configuration is open.

Further information

You can find more information on the DQ operating mode in Assignment of the control interface (Page 191) and Assignment of the feedback interface (Page 192).

9.9.3 Configuring Timer DI operating mode

Timer DI

Timer DI operating mode allows you to acquire the switching time of up to two edges per application cycle (for example OB 91, OB 6x), for example for use as a measuring output.

- Select the Timer DI operating mode for the required channel.

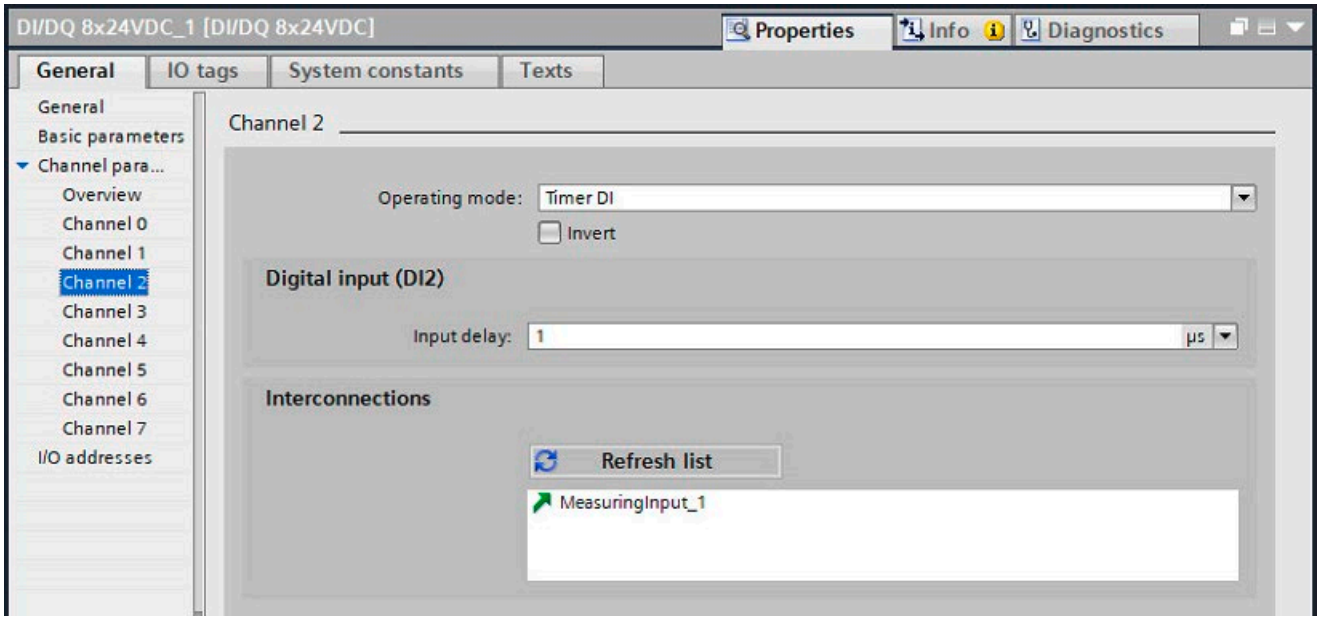


Figure 9-13 Operating mode: Timer DI

Inversion

You can invert the 24 V signal to adjust it to your process. By default, the signal is not inverted.

Input delay

To suppress faults, you can set an input delay of 1 µs or 125 µs for the input filter of the digital inputs. Changes to the signal are only detected if they are constantly pending for longer than the set input delay time.

To allow signals pending very briefly to be detected with timer DI (for example level of 100 µs), set an input delay of 1 µs.

When an input delay of 1 µs is set, the use of shielded cables is recommended for optimum interference immunity.

Interconnections

The technology objects that are interconnected with the channel are listed in the Interconnections area.

If technology objects are interconnected, you can reach the respective technology object through links (arrow icons).

Use the corresponding button to update the selection list. Updating may be required, for example, if changes have been made to technology objects elsewhere in the project while the channel configuration is open.

Assigning the measuring input technology object

The measuring input technology object must always be assigned to another technology object whose position is evaluated by the measuring input.

You can assign the measuring input technology object to the following technology objects:

- Synchronous axis
- Positioning axis
- External encoder

You can assign the measuring input technology object precisely one axis or one external encoder.

You can assign multiple measuring input technology objects to one axis or one external encoder.

Configuring the measuring input technology object

- Select the configuration of the measuring input in the Technology objects folder in the project tree.
- Configure the basic properties of the technology object in the Basic parameters configuration window.

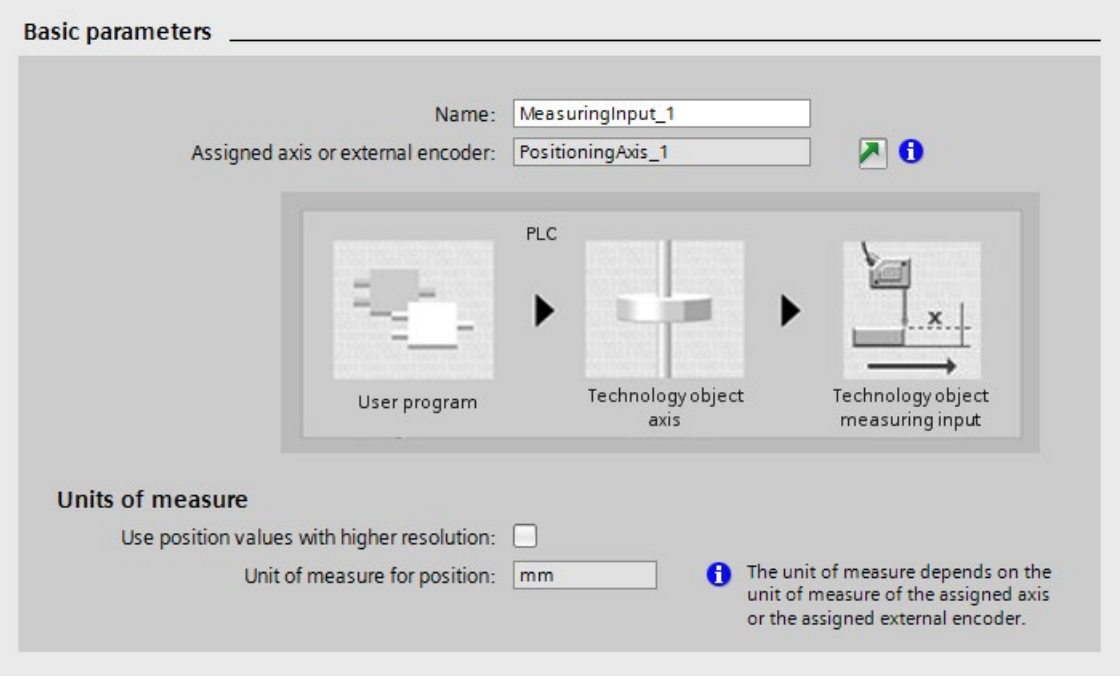


Figure 9-14 Basic parameters

Name

- Define the name of the measuring input in this field. The technology object is listed under this name in the project tree. The tags of the measuring input can be used in the user program under this name.

Assigned axis or external encoder

STEP 7 displays the axis or external encoder assigned to the measuring input. You can use the link to directly access the basic parameters of the higher-level technology object.

Unit of measurement

The unit of measure shown for the position of the measuring input corresponds to the unit of measure of the higher-level technology object.

Hardware interface

- In the Hardware interface configuration window, assign the Timer DI measuring input type and the selected channel to the technology object.

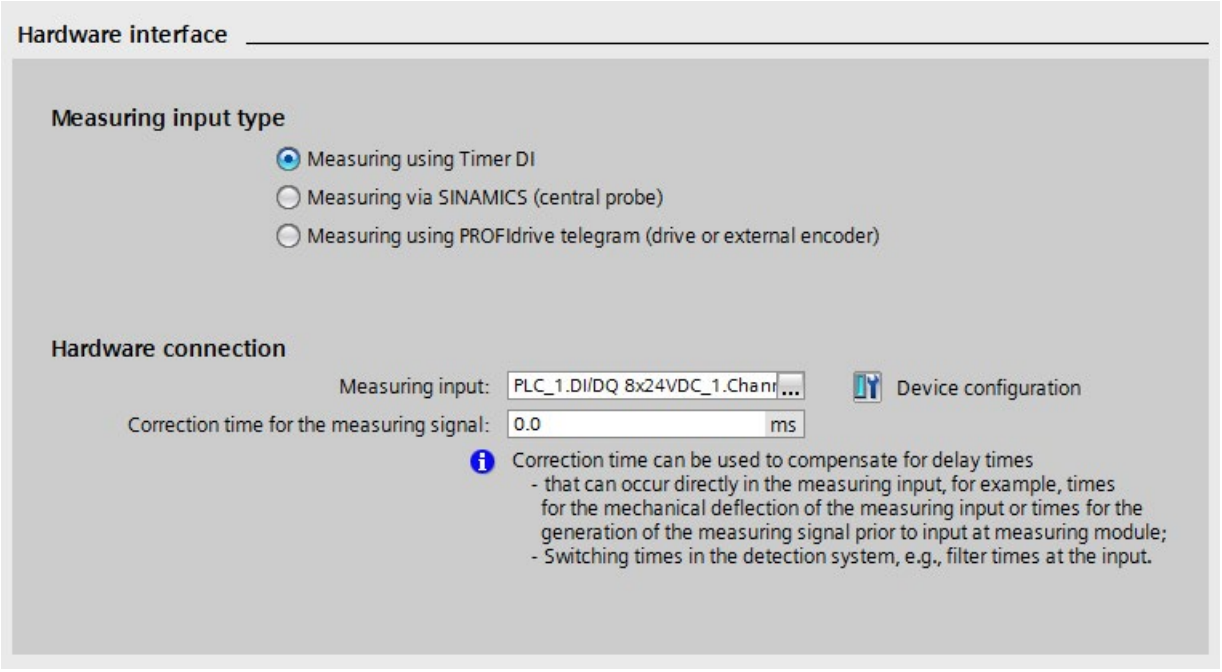


Figure 9-15 Hardware interface

Measuring input type: Measuring using Timer DI

- Select a measurement input for a measurement using a Timer DI. The selection box displays all channels that have been configured correctly.

Note

Extending the configuration limits

A maximum of eight timer DI can be configured at the X142 interface. If the timer DI at X142 are not sufficient for your needs, you can configure a further eight measuring inputs at interface X122/X132. You can also extend the configuration limits using time-based I/O modules:

- ET 200SP distributed I/O system: TM Timer DIDQ 10x24V (https://support.industry.siemens.com/cs/ww/en/view/95153951)
- ET 200MP distributed I/O system: TM Timer DIDQ 16x24V (https://support.industry.siemens.com/cs/ww/en/view/95153313)

Note

Unsupported instructions for X142

The function blocks for the use of time-based IO (TIO instructions) are not supported by the X142 interface.

Recommendation: Use the measuring input technology object for timer DI.

Adjustment for measuring range activation time

- To adjust the activation time defined in the system, enter an additional activation time in the Extended parameters configuration window.

Lost Edge Counter (LEC)

Timer DI support Lost Edge Counter. If more than two edges to be detected occur within one position control cycle, a measured value cannot be evaluated for the other edges to be detected. The LEC records the number of edges lost.

Which lost edges are recorded in the LEC depends on the mode set in the Motion Control instruction. For example, if you only want to measure rising edges, the LEC only records the rising edges not measured. The LEC can count and display a maximum of seven lost edges. The number of lost edges is displayed in the function block and in the technology data block.

Further information

You can find additional information on the following topics in the S7-1500T Motion Control function manuals (https://support.industry.siemens.com/cs/ww/en/view/109751049):

- Measuring input type: Timer DI
- Measuring input type: SINAMICS (central measuring input)
- Measuring input type: PROFIdrive telegram (drive or external encoder)
- Lost Edge Counter (LEC)

9.9.4 Configuring Timer DQ operating mode

Timer DQ

Timer DQ operating mode allows you to output up to two edges per application cycle (for example OB 91, OB 6x) at a specific time, for example, for use as a cam output.

1. Select the Timer DQ operating mode for the required channel.

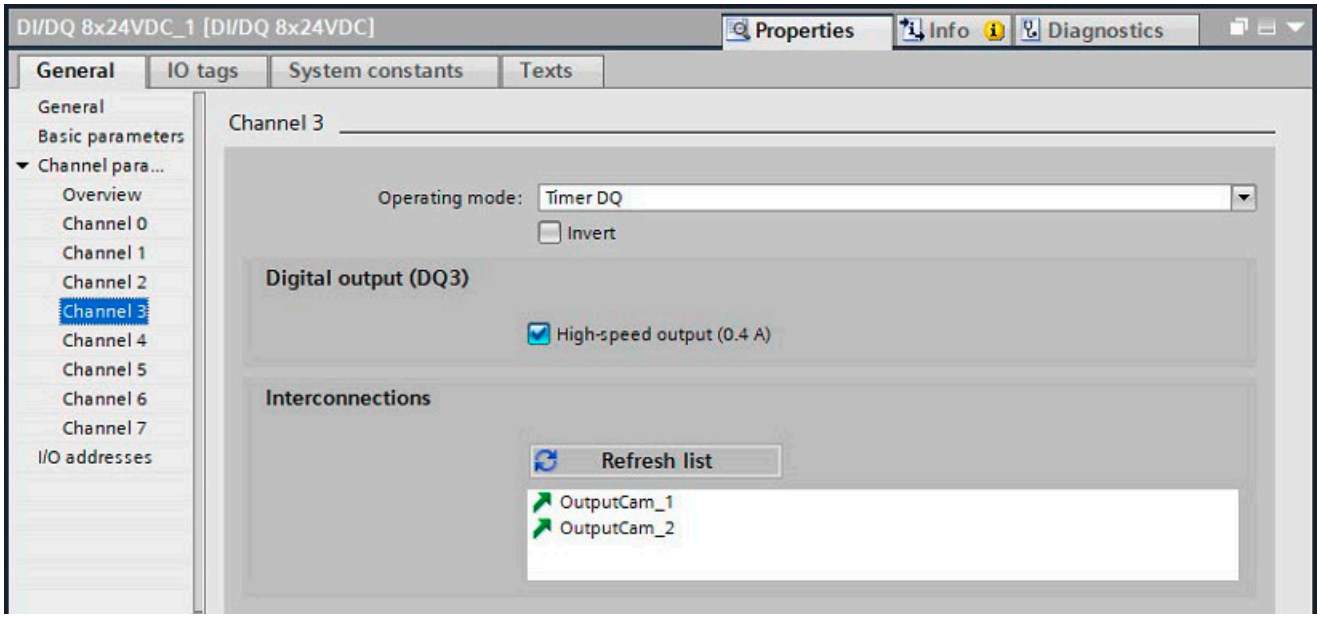


Figure 9-16 Mode of operation: Timer DQ

Inversion

You can invert the 24 V signal to adjust it to your process. By default, the signal is not inverted.

High-speed output (0.4 A)

If you select the high-speed output option, the digital output is switched alternately to 24 V DC and ground.

Advantages of the high-speed output:

- Extremely steep edges (output delay in the 1 µs range)
- Extremely high switching frequencies
- Maximum switching precision, for example, for use as a cam output

The rated load is reduced from 0.5 A to 0.4 A with this operating mode.

Interconnections

The technology objects that are interconnected with the channel are listed in the Interconnections area.

If technology objects are interconnected, you can reach the respective technology object through links (arrow icons).

Use the corresponding button to update the selection list. Updating may be required, for example, if changes have been made to technology objects elsewhere in the project while the channel configuration is open.

Assigning the output cam technology object

The output cam technology object must always be assigned to another technology object whose position is evaluated.

You can assign the output cam technology object to the following technology objects:

- Synchronous axis
- Positioning axis
- External encoder

You can assign exactly one axis or one external encoder to the output cam.

You can assign multiple output cams to one axis or one external encoder.

Configuring the output cam technology object

1. Select the configuration of the output cam in the Technology objects folder in the project tree.
2. Configure the basic properties of the technology object in the Basic parameters configuration window.

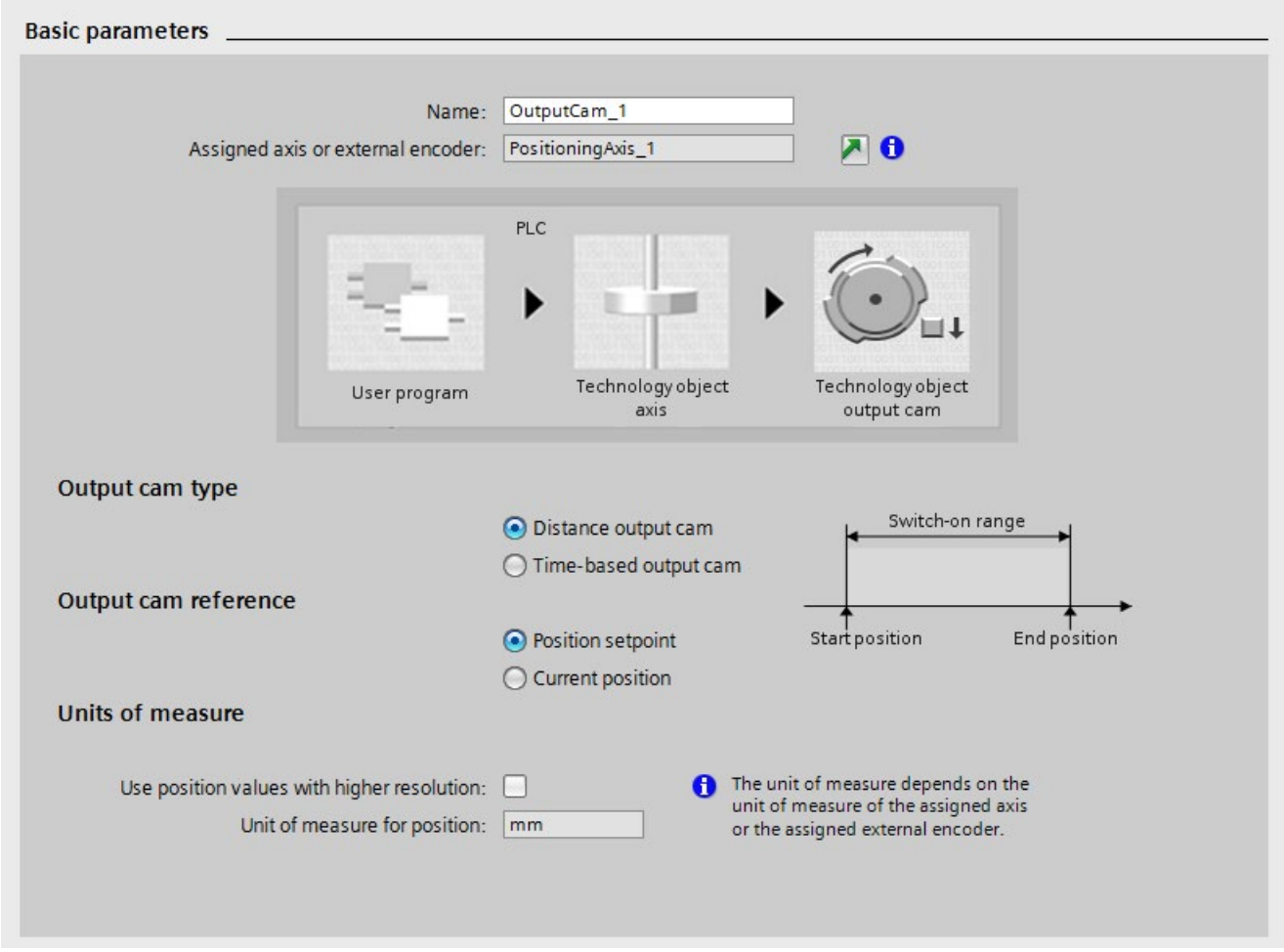


Figure 9-17 Basic parameters

Name

1. Define the name of the output cam in this field. The technology object is listed under this name in the project tree. The tags of the output cam can be used in the user program under this name.

Assigned axis or external encoder

STEP 7 displays the axis or external encoder assigned to the output cam. You can use the link to directly access the basic parameters of the higher-level technology object.

Output cam type

1. Select an output cam type on the basis of the required switching behavior:

- Position-based cam (position-dependent switch-on/switch-off)
- Time-based cam (position-dependent switch-on and position-independent or time-dependent switch-off)

Output cam reference

1. In this selection, configure whether the switching points of the output cams are to reference the actual position or the position setpoint.

Unit of measurement

The unit of measurement shown for the position of the output cam corresponds to the unit of measurement of the higher-level technology object.

When a time-based cam is selected as the output cam type, the unit of measurement for the switch-on duration and other times is also indicated. The unit of measurement for output cams is always ms.

Hardware interface

Select the type of cam output in the Hardware interface configuration window.

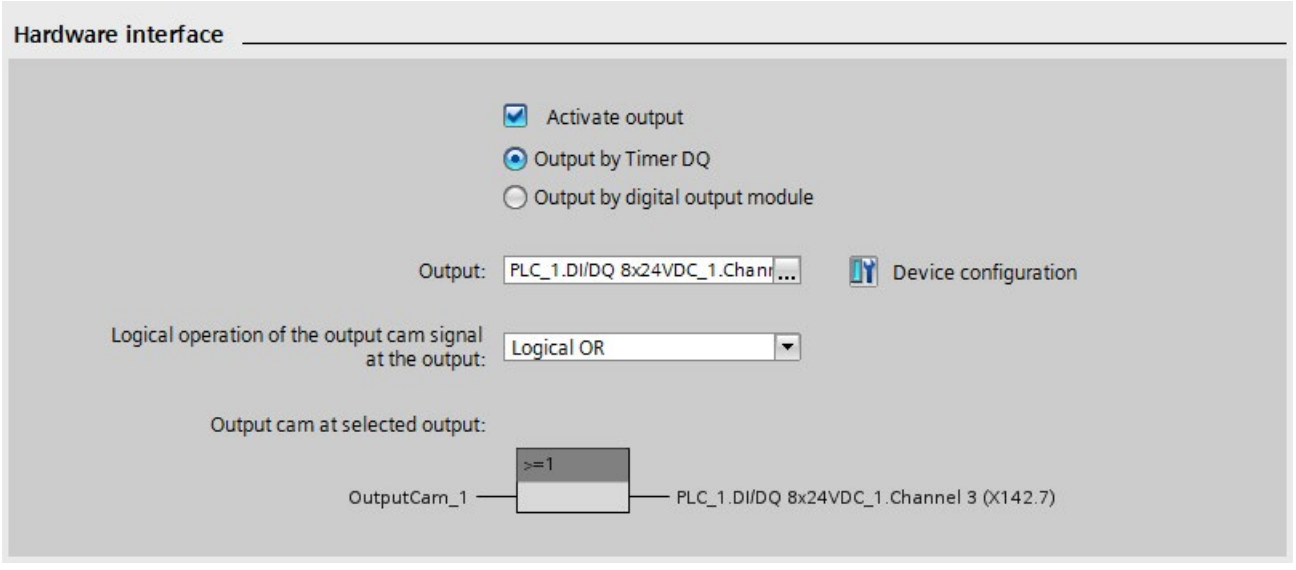


Figure 9-18 Hardware interface

1. Select whether you want to output the switching signals generated at the digital output.

- Activate output

  Select one of the following two output options for outputting the cam track:

  – Output via Timer DQ

    For output by Timer DQ, select a cam output in the Output field. The selection box displays all channels that have been configured correctly.

    Note

    Extending the configuration limits

    A maximum of eight timer DQ can be configured at the X142 interface. If the Timer DQ at X142 are not sufficient for your needs, you can increase the configuration limits with time-based IO modules:

    - ET 200SP distributed I/O system: TM Timer DIDQ 10x24V (https://support.industry.siemens.com/cs/ww/en/view/95153951)
    - ET 200MP distributed I/O system: TM Timer DIDQ 16x24V (https://support.industry.siemens.com/cs/ww/en/view/95153313)

    Note

    Unsupported instructions for the X142 interface

    The function blocks for the use of time-based IO (TIO instructions) are not supported by the X142 interface.

    Recommendation: For the timer DQ, use the output cam or cam track technology object.

  – Output by digital output module

    For output by a digital output module, select a digital output in the Output field. Only the digital outputs with previously defined PLC tags are displayed for selection.

    Note

    Output via the X122, X132 or X142 interface

    Also use the "Output by digital output module" setting in the following cases:

    - The output occurs at the X142 interface by a DQ instead of a Timer DQ.
    - The output occurs by a digital output of the X122 or X132 interface (configured telegram 39x required)

    In both cases you must define a PLC tag for the respective I/O address.

  You can assign several output cam technology objects to an output, linking the cam signal with a logical AND or logical OR at the output.

- Output deactivated
  When output is deactivated, the cam track is evaluated only in the software.

Extended parameters > Activation time

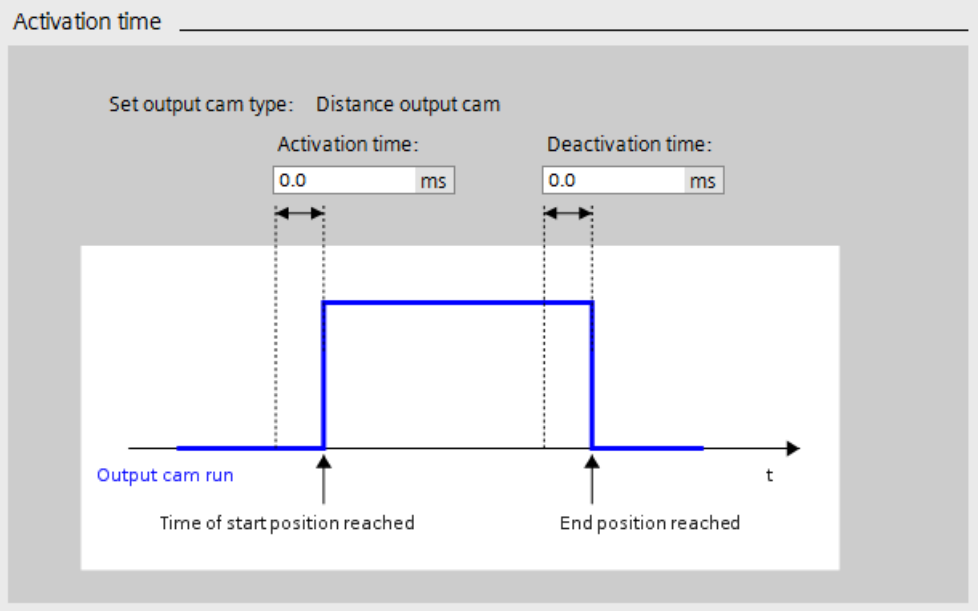


Figure 9-19 Activation time

The specified output cam type is indicated at the top of the Activation time configuration window.

1. For a time shift of the switch-on and switch-off times of the output cams, enter an activation time and a deactivation time.

Extended parameters Parameter > Hysteresis

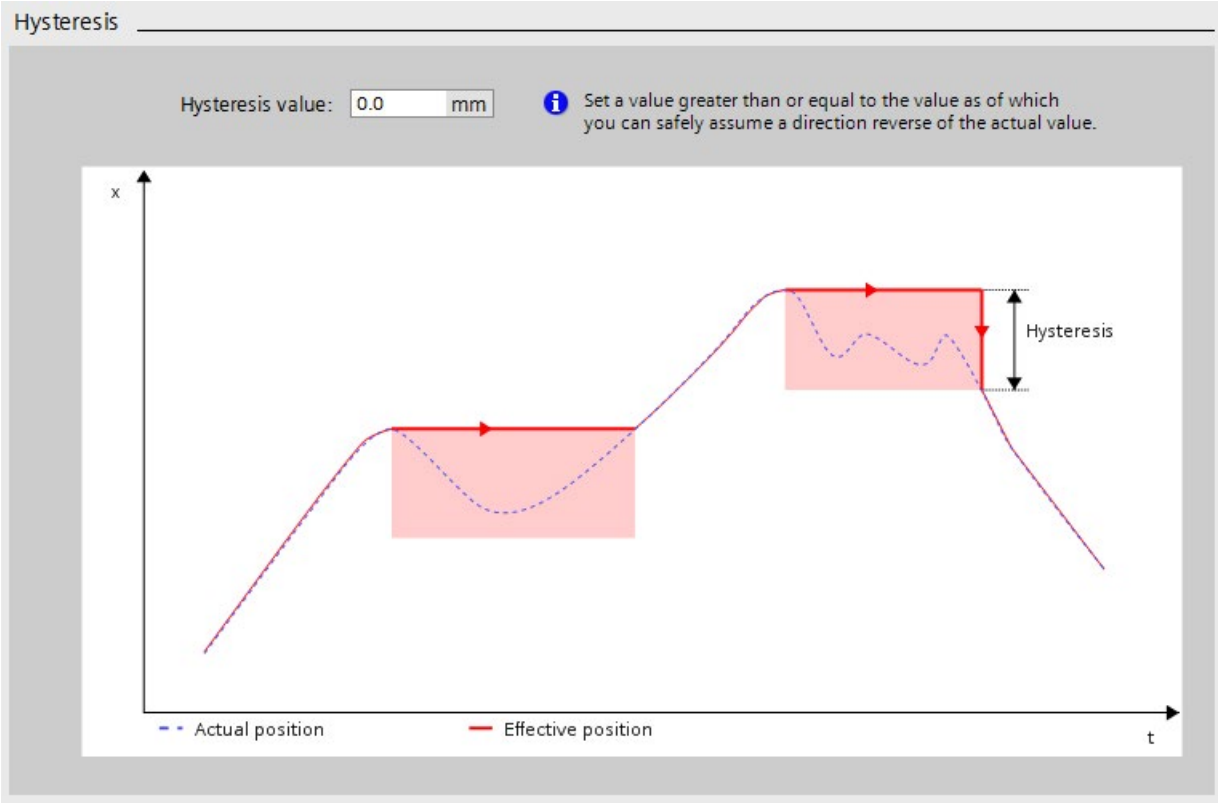


Figure 9-20 Hysteresis

1. To prevent unwanted changes in the switching state of the output cams of a cam track, enter a hysteresis value.

When using output cams that reference the actual position, it is advisable to enter a hysteresis value (> 0.0).

Cam track technology object

In addition to the output cam technology object already described, the cam track technology object is also available.

You can find a detailed description of how to configure the cam track technology object in the S7-1500T Motion Control function manuals (https://support.industry.siemens.com/cs/ww/en/view/109751049).

9.9.5 Configuring Oversampling DI operating mode

Oversampling DI

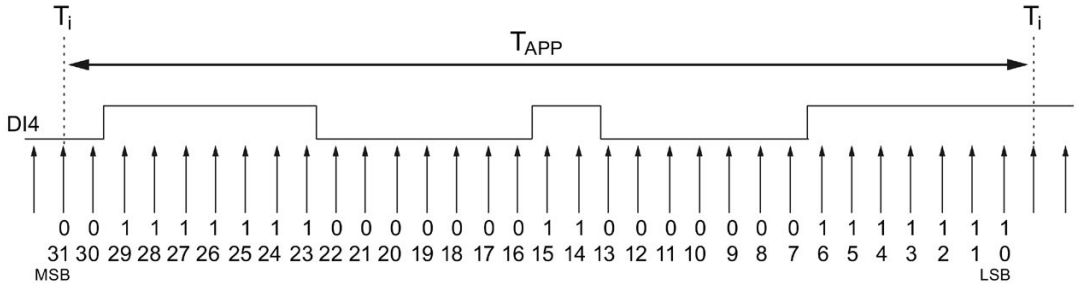
The Oversampling DI function detects 32 signal states of a given digital input at equal intervals per application cycle (for example OB 91, OB 6x). The 32 states are returned together as a 32-bit value in the feedback interface. The value is read in synchronously to Ti (actual value acquisition).

Note

Isochronous mode

Oversampling requires isochronous mode.

The figure below shows an example of Oversampling DI4:



T_{APP}	Application cycle
MSB	Most significant bit
LSB	Least significant bit

Figure 9-21 Oversampling DI

Configuring Oversampling DI

1. Select the Oversampling DI operating mode for the required channel.

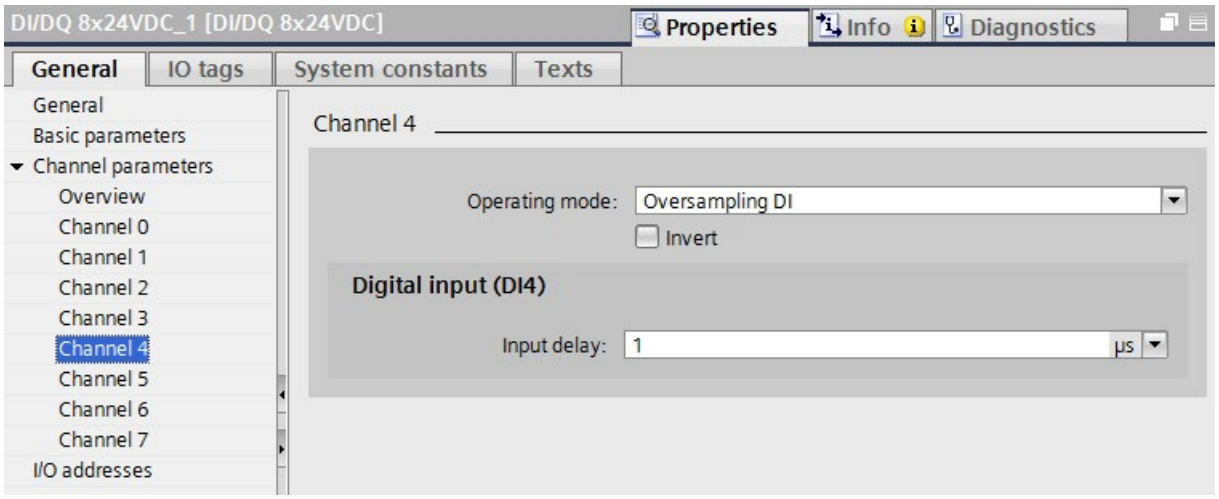


Figure 9-22 Oversampling DI

Note

Extending the configuration limits

A maximum of eight oversampling DI can be configured at the X142 interface. If the Oversampling DI at X142 are not sufficient for your needs, you can increase the configuration limits with time-based IO modules, for example:

- ET 200SP distributed I/O system: TM Timer DIDQ 10x24V (https://support.industry.siemens.com/cs/ww/en/view/95153951)
- ET 200MP distributed I/O system: TM Timer DIDQ 16x24V (https://support.industry.siemens.com/cs/ww/en/view/95153313)

Inversion

You can invert the 24 V signal to adjust it to your process. By default, the signal is not inverted.

Input delay

To suppress faults, you can set an input delay of 1 µs or 125 µs for the input filter of the digital inputs. Changes to the signal are only detected if they are constantly pending for longer than the set input delay time.

To allow signals pending very briefly to be detected by oversampling DI (for example level of 100 µs), set an input delay of 1 µs.

When an input delay of 1 µs is set, the use of shielded cables is recommended for optimum interference immunity.

Further information

You can find more information on the Oversampling DI operating mode in Assignment of the control interface (Page 191) and Assignment of the feedback interface (Page 192).

9.9.6 Configuring Oversampling DQ operating mode

Oversampling DQ

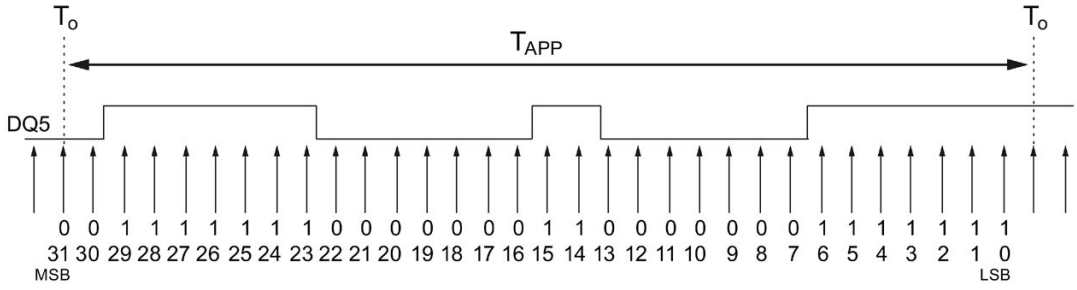
The Oversampling DQ function outputs 32 signal states at equal intervals per application cycle (for example OB 91, OB 6x). Up to 32 edges are therefore possible per application cycle at a given digital output. The 32 states are set over the control interface. The output occurs synchronously with time To (setpoint transfer).

Note

Isochronous mode

Oversampling requires isochronous mode.

The image below is an example of oversampling of DQ5:



TAPP	Application cycle
MSB	Most significant bit
LSB	Least significant bit

Figure 9-23 Oversampling DQ

Note

Output frequency with the Oversampling function

The combination of application cycle and the 32-bit string output must not result in an output frequency that exceeds the maximum switching frequency for the digital outputs.

Configuring an oversampling DQ

1. Select the operating mode Oversampling DQ for the required channel.

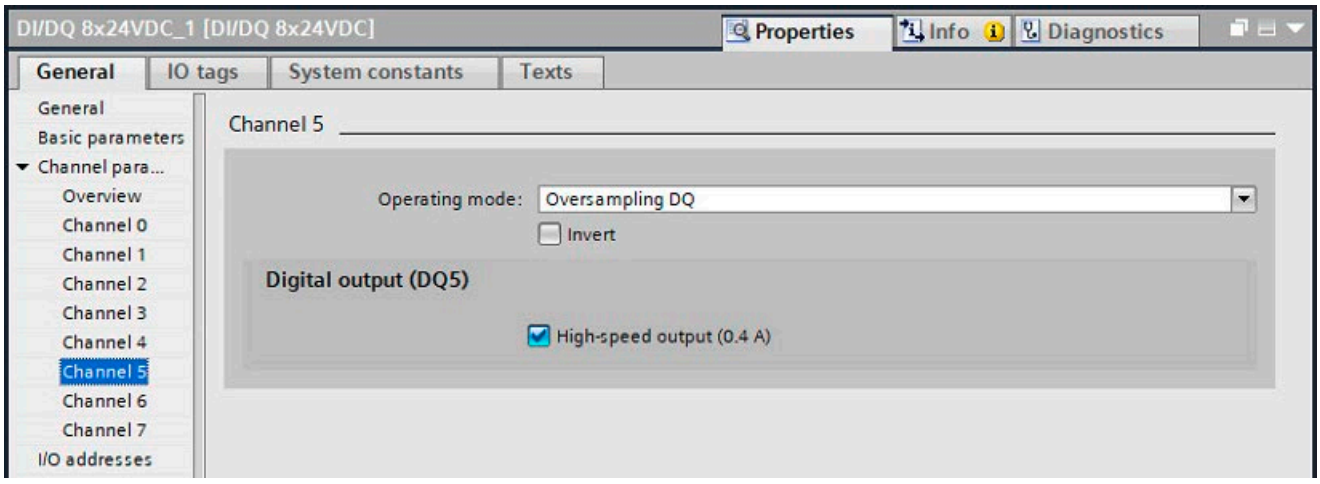


Figure 9-24 Oversampling DQ

Note

Extending the configuration limits

A maximum of eight oversampling DQ can be configured at the inputs/outputs of the X142 interface. If the oversampling DQ at X142 are not sufficient for your needs, you can increase the configuration limits with time-based IO modules, for example:

- ET 200SP distributed I/O system: TM Timer DIDQ 10x24V (https://support.industry.siemens.com/cs/ww/en/view/95153951)
- ET 200MP distributed I/O system: TM Timer DIDQ 16x24V (https://support.industry.siemens.com/cs/ww/en/view/95153313)

Inversion

You can invert the 24 V signal to adjust it to the process. By default, the signal is not inverted.

High-speed output (0.4 A)

If you select the high-speed output option, the digital output is switched alternately to 24 V DC and ground. Allows for extremely steep edges (output delay in the 1 µs range).

To allow signals pending very briefly to be output by oversampling DQ (for example level of 0.1 ms), you must operate the output as a high-speed output.

The rated load is reduced from 0.5 A to 0.4 A with this operating mode.

Further information

You can find more information on the Oversampling DQ operating mode in Assignment of the control interface (Page 191) and Assignment of the feedback interface (Page 192).

9.9.7 Configuring event/period measurement operating mode

Event/period duration measurement

In isochronous mode, you can use the event/period duration measurement operating mode to acquire the number of rising edges at the digital input and at the same time determine the period duration.

Note

Isochronous mode

The event/period duration measurement requires isochronous mode.

Event counter

With the event measurement, you count the number of rising edges at the digital input. The current count (16-bit value) is updated on the feedback interface with each application cycle (e.g. servo clock).

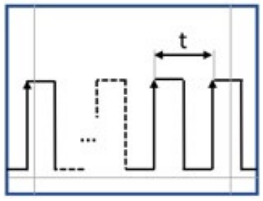
- The event counter is a rotary counter.
- An event counter overflow is not displayed.
- To determine the number of rising edges per application cycle, the difference between the current count and the previous count must be calculated by the application, taking into account any overflow.

Period duration measurement

Two methods are available for the period duration measurement.

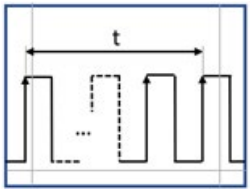
- "Single period" measurement method

  The period duration is determined based on the last period in a measuring cycle. This method provides the most current value.



- "Multiple periods" measurement method

  The period duration is determined based on all periods in a measuring cycle, whereby the measuring cycle length corresponds to one application cycle (e.g. servo clock). This method provides a more accurate measurement for short periods.



"Single period" measurement method

With this measurement method, you determine the period duration by counting the number of 41.67 ns increments between the last two incoming rising edges in the measuring cycle. The current count (32-bit value) is updated on the feedback interface with each application cycle (e.g. servo clock).

Period duration = 41.67 ns • N_{INC}

N_{INC}: Number of increments of 41.67 ns each (41.67 ns = 1/24 MHz)

Note

Always use the exact (not rounded) value for your calculations.

Since the last two incoming rising edges in the measuring cycle are used for the measurement, the "Single period" measurement method provides the most current value.

"Multiple periods" measurement method

Requirement:

- CPU firmware version V3.0 or higher
- Hardware function version FS 11 or higher

In this measurement method, the period duration is determined based on all periods in a measuring cycle, whereby the measuring cycle length corresponds to one application cycle (e.g. servo clock).
The number of 41.67 ns increments between the last rising edge of the last measuring cycle and the last rising edge of the current measuring cycle is counted.
The current count (32-bit value) is updated on the feedback interface with each application cycle (e.g. servo clock).

- The event counter and the period duration counter are circular counters.
- A counter overflow is not displayed.
- To determine the count, the difference between the current count and the previous count must be calculated by the application, taking into account any overflow.

$$\text{Periodendauer} = 41{,}67\ \text{ns} \bullet \frac{(N_{P(new)} - N_{P(old)})}{(N_{E(new)} - N_{E(old)})}$$

$N_{P(new)}$: Period duration counter, current (new) count

$N_{P(old)}$: Period duration counter, previous (old) count

$N_{E(new)}$: Event counter, current (new) count

$N_{E(old)}$: Event counter, previous (old) count

If current count < old count is true for the counters, then an overflow has occurred. In this case, the value 2^{16} must be added to the new count for the event counter, and the value 2^{32} must be added to the new count for the period duration counter. A maximum of one overflow is possible.

The "Multiple periods" measurement method yields a more accurate measurement.

- For short periods (i.e. a few 41.67 ns increments per period), in particular, the sampling jitter (1 increment) has less effect because the period duration is determined over many periods.
- Measured value fluctuations are averaged. For example, if rotational speeds are acquired using a slotted disk and fork light barrier, the tolerances of individual slots have less of an effect because the measurement is not based on a single period (of an individual slot).

Example 1: "Single period" measurement method

For an injection molding machine, the rotational speed of the extruder screw is to be determined using a simple encoder based on a rotating slotted disk.

The pulses are to be acquired on the SIMATIC Drive Controller using a digital input/output (X142) in the event/period duration measurement operating mode.

The rotational speed of the screw is determined from the time interval between 2 pulses.

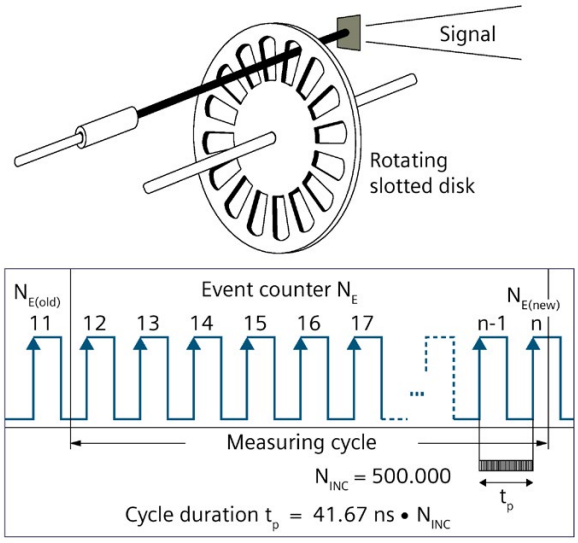


Figure 9-25 Simple encoder on a shaft, single period measurement method

In the "Single period" measurement method, the period duration is determined by counting the number of 41.67 ns increments between the last two incoming rising edges in the measuring cycle. The number of rising edges is additionally counted (circular counter).

Period duration t_P = 41.67 ns • N_{Inc}

If you know the number of pulses that the encoder generates per revolution of the extruder screw, you can calculate the speed at which the extruder screw turns.

Calculation example

N_S = 16 pulses are emitted per revolution of the extruder screw (N_S is also referred to as the number of pulses per revolution of the encoder).

The distance between 2 pulses is N_{Inc} = 500,000 counted 41.67 ns increments.
Thus, the rotational speed of the extruder screw is calculated as follows:

Period duration t_P = 41.67 ns • N_{Inc}

$$v = \frac{1}{t_p \bullet N_s} = \frac{1}{41{,}67\ \text{ns} \bullet 500.000 \bullet 16} = 3\frac{1}{\text{s}} = 180\frac{\text{U}}{\text{min}}$$

The period duration counter provides a 32-bit count value. This allows values up to FFFFFFFF (= 4,294,967,295 decimal) to be displayed. Thus, with a time base of 41.67 ns for N_S = 1, the minimum measurable speed is:

$$v = \frac{1}{t_p \bullet N_S} = \frac{1}{41{,}67\ ns \bullet\ 4.294.967.295 \bullet 1} = 0{,}00558\,\frac{1}{s} = 0{,}335\,\frac{U}{min}$$

The maximum measurable speed for encoders with passive deactivation (encoder output is open in inactive state) is the result of the maximum frequency of the input signals at the counter inputs of 32 kHz.

$$\text{Max. speed (when } N_S = 1) = \frac{\text{Max. frequency}}{N_S} = 32.000\,\frac{1}{s} = 1.920.000\,\frac{U}{min}$$

If the encoder generates 1 pulse per revolution (N_S = 1), this yields a maximum speed of 1,920,000 rpm.

If you use encoders that generate multiple pulses per revolution, you must reconsider the limit frequencies.

The table below shows a few examples.

Table 9- 9 Limits for various numbers of pulses per revolution N_S at a time base of 41.67 ns. (Encoder with passive deactivation)

N	Lower limit	Upper limit
1	0.3352 rpm	1,920,000 rpm
4	0.0838 rpm	960,000 rpm
8	0.0419 rpm	480,000 rpm
16	0.0209 rpm	120,000 rpm

Example 2: "Multiple periods" measurement method

With a machine, the speed of a shaft is to be determined via a single encoder based on a rotating slotted disc.

The pulses are to be acquired on the SIMATIC Drive Controller using a digital input/output (X142) in the event/period duration measurement operating mode.

Due to the accuracy requirements and high speed, the cycle duration is determined over multiple periods.

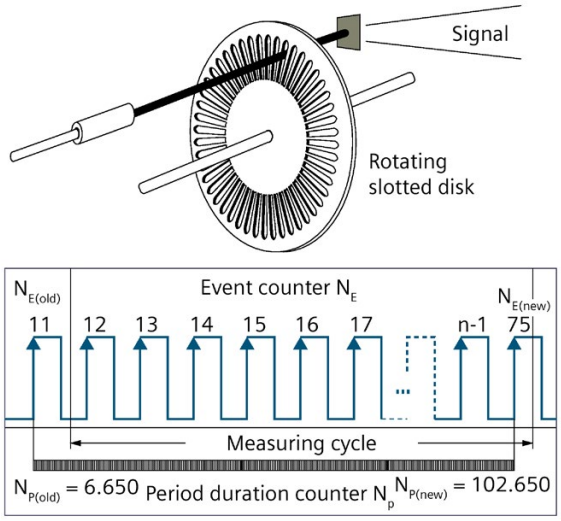


Figure 9-26 Simple encoder on a shaft, multiple periods measurement method

In the "Multiple periods" measurement method, the cycle duration is determined by counting the number of 41.67 ns increments between the last rising edge of the last measuring cycle and the last rising edge of the current measuring cycle with the period duration counter N_P. In addition, the number of rising edges N_E for the same period is determined.
The period duration is calculated based on the count values, taking into account counter overflows, as follows:

$$\text{Cycle duration } t_p = 41{,}67 \text{ ns} \bullet \frac{(N_{P(new)} - N_{P(old)})}{(N_{E(new)} - N_{E(old)})}$$

If you know the number of pulses emitted by the encoder per revolution of the shaft, you can calculate the speed at which the shaft rotates.

Calculation example

N_S = 48 pulses are emitted per revolution of the shaft (N_S is also referred to as the number of pulses per revolution of the encoder).

$$\text{Cycle duration} = 41{,}67 \text{ ns} \bullet \frac{(102.650 - 6.650)}{(75 - 11)} = 62{,}5 \text{ us}$$

Thus, the rotational speed of the shaft is calculated as follows:

$$v = \frac{1}{t_P \bullet N_S} = \frac{1}{62{,}5\ \text{us} \bullet 48} = 333{,}333\ \frac{1}{s} = 20.000\ \frac{U}{min}$$

Configuring event/period duration measurement

1. Select the required channel for the Event/period duration measurement operating mode.

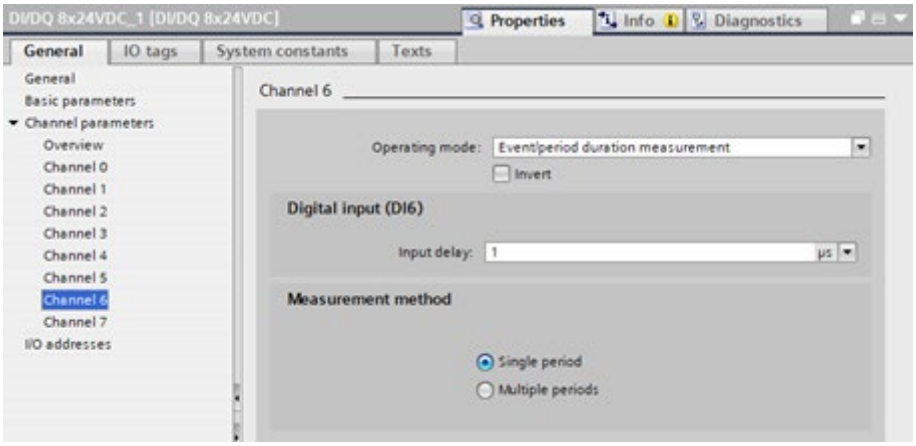


Figure 9-27 Event/period duration measurement

Inversion

You can invert the 24 V signal to adjust it to your process. By default, the signal is not inverted.

Input delay

To suppress faults, you can set an input delay of 1 µs or 125 µs for the input filter of the digital inputs. Changes to the signal are only detected if they are constantly pending for longer than the set input delay time.

To allow signals pending very briefly to be detected at high counting frequencies, you need to set an input delay of 1 µs.

When an input delay of 1 µs is set, the use of shielded cables is recommended for optimum interference immunity.

Measurement method

Depending on the selected measurement method, the period duration is determined based on the "last period" or "all periods" in a measuring cycle.

Note

"Multiple periods" measurement method when using unsupported hardware

If a SIMATIC Drive Controller does not meet the hardware function version (FS 11 or higher) requirement, the CPU remains in startup inhibit state.

Additional information

You can find more information on the Event/period duration measurement operating mode in Assignment of the control interface (Page 191) and Assignment of the feedback interface (Page 192).

9.9.8 Configuring Pulse width modulation (PWM) operating mode

Areas of application

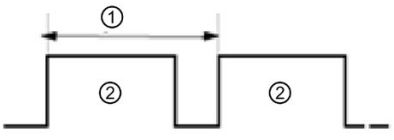
You can use pulse width modulation (PWM) to generate periodic pulses with a constant rated voltage and a variable pulse duration.

Possible applications for pulse width modulation (PWM):

- Control of proportional valves and directional valves
  - Energy savings as a result of a reduction in holding current or for controlling the valve position
- Heating control, for example, via an external additional power unit

Principle of operation

With pulse width modulation, a signal with defined time period and variable pulse duration is output at the digital output. You use pulse width modulation to vary the mean value of the output voltage. This allows you to control the load current or the power in line with the connected load. The pulse duration can be between 0 (no pulse, always off) and full-scale deflection (no pulse, always on).



① Period
② Pulse duration

Pulse width modulation (PWM) is based on the specification of a base frequency of 1, 2, 4, 8 or 16 kHz. You can alter the base frequency in terms of period and pulse-pause ratio over the control interface (32-bit value). The bit pattern is shown in each base period. The base period is defined on the basis of the base frequency. A "0" is LOW and a "1" is HIGH.

Examples

Base frequency: 1 kHz → Base period: 1 ms

1111 0000 0000 0000 1111 0000 0000 0000

Time period: 500 µs; 375 µs LOW; 125 µs HIGH

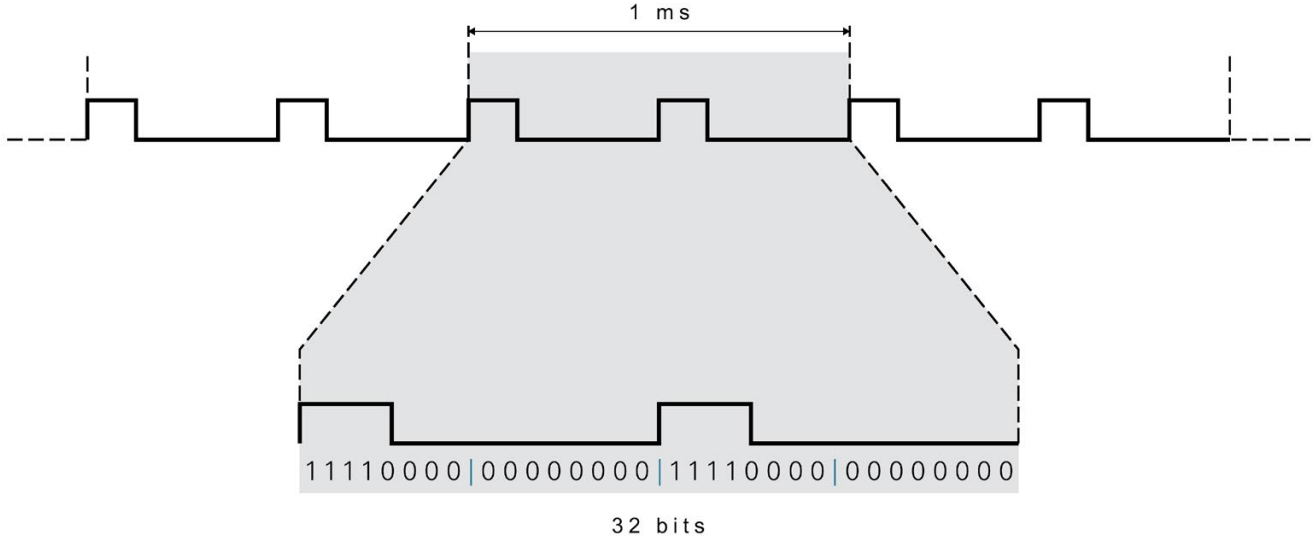


Figure 9-28 Pulse width modulation

Base frequency: 1 kHz

1111 1111 1111 1111 0000 0000 0000 0000

Time period: 1 ms; 500 µs LOW; 500 µs HIGH

1111 1111 0000 0000 0000 0000 0000 0000

Time period: 1 ms; 750 µs LOW; 250 µs HIGH

1111 0000 1111 0000 1111 0000 1111 0000

Time period: 250 µs; 125 µs LOW; 125 µs HIGH

Base frequency: 2 kHz

1010 1010 1010 1010 1010 1010 1010 1010

Time period: 31.25 µs; 15.625 µs LOW; 15.625 µs HIGH

Configuring Pulse width modulation PWM

To configure PWM operating mode, first define the required base frequency of pulse width modulation. You can configure the base frequency as 1, 2, 4, 8 or 16 kHz. The selected base frequency then applies to all channels of interface X142.

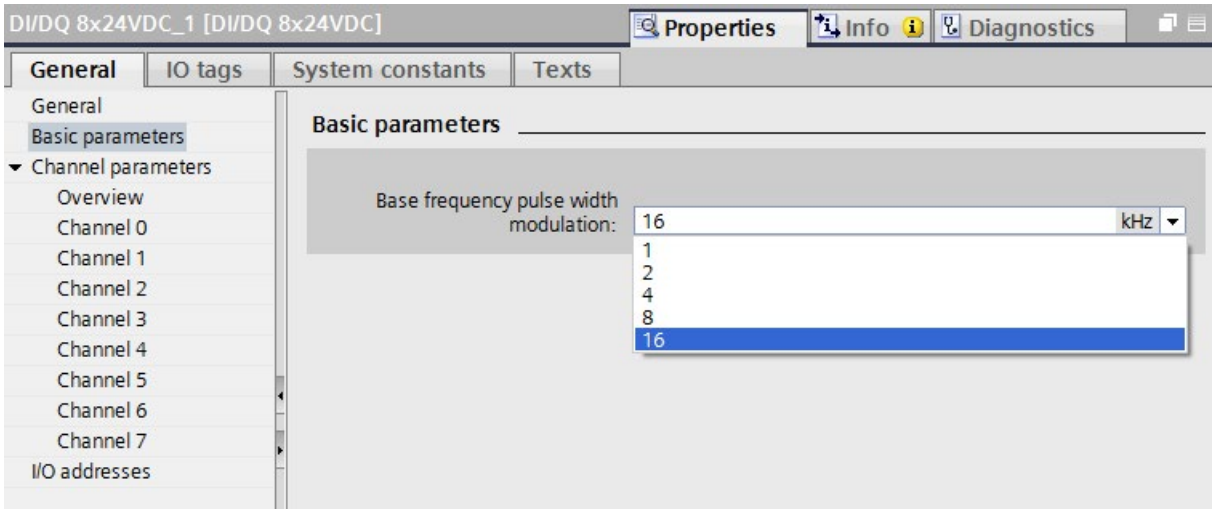


Figure 9-29 Base frequency of pulse width modulation

Now select the channels for PWM operating mode. If you want to configure very short pulses, enable the high-speed output function.

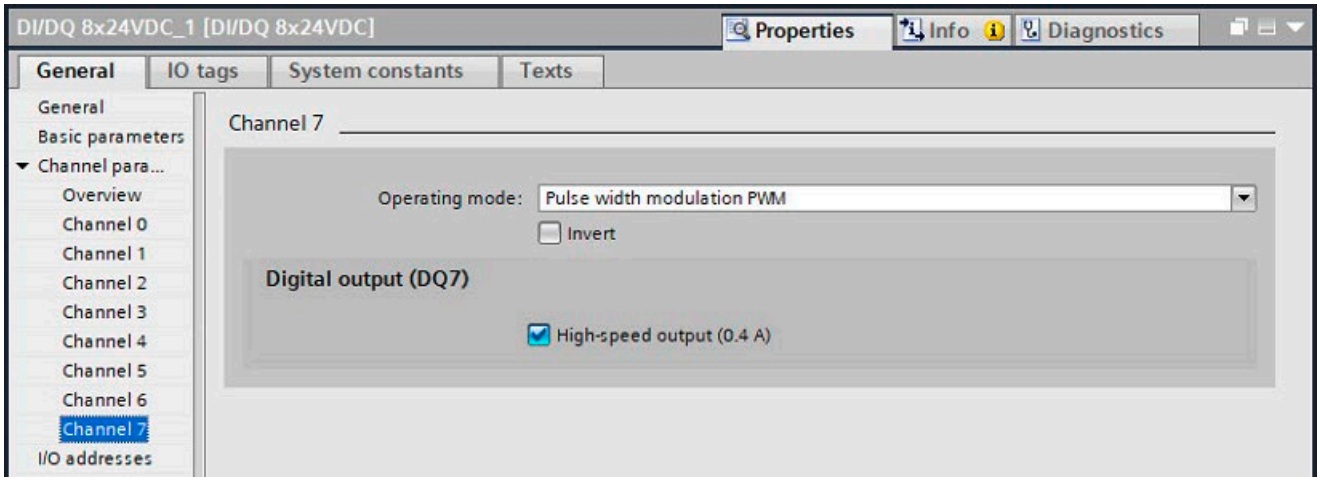


Figure 9-30 Pulse width modulation channel

The selected digital output is switched with the selected base frequency and the switching pattern from the control interface.

Inversion

You can invert the 24 V signal to adjust it to your process. By default, the signal is not inverted.

High-speed output (0.4 A)

If you select the high-speed output option, the digital output is switched alternately to 24 V DC and ground. Allows for extremely steep edges (output delay in the 1 µs range).

To allow signals pending very briefly to be output with pulse width modulation (for example, level duration of 0.1 ms), you must operate the output as a high-speed output.

The rated load is reduced from 0.5 A to 0.4 A with this operating mode.

Further information

You can find more information on the pulse width modulation operating mode in the sections Assignment of the control interface (Page 191) and Assignment of the feedback interface (Page 192).

9.9.9 Assignment of the control interface

Control interface

The user program uses the control interface to influence the behavior of the technology inputs and technology outputs at interface X142.

The following table shows the control interface assignment:

Table 9- 10 Assignment of the control interface

Offset from start address	Parameter	Meaning
Byte 0	SET_DQ (DQ0 to DQ7)	Set DQ (DQ0 to DQ7)
Byte 1 to 3	Reserved	Must not be used
Byte 4 to 7	TEC_OUT (DQ0)	Timer DQ: Byte 0, 1: OFF TIME (output time stamp for DQ reset) Byte 2, 3: ON TIME (output time stamp for setting DQ)
		Oversampling DQ: Byte 0 to 3: 32 states for oversampling
		Pulse width modulation (PWM): Byte 0 to 3: PWM bit pattern
Byte 8 to 11	TEC_OUT (DQ1)	See Byte 4 to 7
Byte 12 to 15	TEC_OUT (DQ2)	
Byte 16 to 19	TEC_OUT (DQ3)	
Byte 20 to 23	TEC_OUT (DQ4)	
Byte 24 to 27	TEC_OUT (DQ5)	
Byte 28 to 31	TEC_OUT (DQ6)	
Byte 32 to 35	TEC_OUT (DQ7)	

Offset from start address	Parameter		Meaning	
Byte 36	SEL (DI0, DI1)		SEL DI1	Bit 5 to 7: Edge selection for time stamp acquisition DI1 001 Rising edges only 010 Falling edges only 011 Rising and falling edges (in order of occurrence) 101 First rising, then falling edge 110 First falling, then rising edge 000, 100, 111 reserved
				Bit 4: Cyclical time stamp acquisition for DI1
			SEL DI0	Bit 0 to 3: see SEL DI1
Byte 37	SEL (DI2, DI3)		See byte 36	
Byte 38	SEL (DI4, DI5)			
Byte 39	SEL (DI6, DI7)			
Byte 40, 41	STW	MSL	Bit 12 to 15: Sign of life counter (master sign of life)	
		---	Bit 1 to 11: Reserved; bits must be set to 0	
		SYN	Bit 0: Synchronization of X142 interface with the user program	

9.9.10 Assignment of the feedback interface

Feedback interface

The user program receives current values and status information from the X142 interface technology I/Os over the feedback interface.

The following table shows the feedback interface assignment:

Table 9- 11 Assignment of the feedback interface

Offset from start address	Parameter	Meaning	
Byte 0	STS_DI (DI0 to DI7)	State DI (DI0 to DI7)	
Byte 1 to 3	Reserved	Must not be used	
Byte 4 to 7	TEC_IN (DI0)	Timer DI: Byte 0, 1: 2nd TIME/OFF TIME (second input time stamp) Byte 2, 3: 1st TIME/ON TIME (first input time stamp)	
		Oversampling DI: Byte 0 to 3: Oversampling value	
		Event/period duration measurement	Event measurement: Byte 0, 1: Reserved Byte 2, 3: Counter value
Byte 8 to 11	TEC_IN_EXT (DI0)		Time period measurement: Byte 0 to 3: Measured time period
Byte 12 to 15	TEC_IN (DI1)	See byte 4 to 11	
Byte 16 to 19	TEC_IN_EXT (DI1)		

Offset from start address	Parameter		Meaning
Byte 20 to 23	TEC_IN (DI2)		
Byte 24 to 27	TEC_IN_EXT (DI2)		
Byte 28 to 31	TEC_IN (DI3)		
Byte 32 to 35	TEC_IN_EXT (DI3)		
Byte 36 to 39	TEC_IN (DI4)		
Byte 40 to 43	TEC_IN_EXT (DI4)		
Byte 44 to 47	TEC_IN (DI5)		
Byte 48 to 51	TEC_IN_EXT (DI5)		
Byte 52 to 55	TEC_IN (DI6)		
Byte 56 to 59	TEC_IN_EXT (DI6)		
Byte 60 to 63	TEC_IN (DI7)		
Byte 64 to 67	TEC_IN_EXT (DI7)		
Byte 68	LEC (DI0, DI1)		Bit 4 to 6: Lost Edge Counter for DI1 Bit 0 to 2: Lost Edge Counter for DI0 Bit 3, 7: Reserved (must not be used)
Byte 69	LEC (DI2, DI3)		Bit 4 to 6: Lost Edge Counter for DI3 Bit 0 to 2: Lost Edge Counter for DI2 Bit 3, 7: Reserved (must not be used)
Byte 70	LEC (DI4, DI5)		Bit 4 to 6: Lost Edge Counter for DI5 Bit 0 to 2: Lost Edge Counter for DI4 Bit 3, 7: Reserved (must not be used)
Byte 71	LEC (DI6, DI6)		Bit 4 to 6: Lost Edge Counter for DI7 Bit 0 to 2: Lost Edge Counter for DI6 Bit 3, 7: Reserved (must not be used)
Byte 72	Reserved		Must not be used
Byte 73	Layout property		Specific value
Byte 74, 75	ZSW	SSL	Bit 12 to 15: Sign of life counter (slave sign of life)
		---	Bit 10, 11: Reserved (must not be used)
		SYNC	Bit 8: X142 interface is synchronized with user program
		Channel address	Bit 4 to 7 and 9: Number of the respective DI or DQ
		Channel mode	Bit 0 to 3: Operating mode of the respective DI or DQ

Substitute value behavior

If the CPU is in STOP, the digital outputs (irrespective of any inversion set) return "0" (LOW level) as a substitute value.

Reading back the terminal state

STS_DI (offset byte 0 of the feedback interface) represents the logical channel status, taking account of any inversion configured.

Digital inputs

With digital inputs (DI, Timer DI, oversampling DI, event/period measurement), the value corresponds to the logical state of the digital input.

Digital outputs

With digital outputs (DQ, Timer DQ, oversampling DQ, pulse width modulation PWM), the value corresponds to the actual terminal state of the digital output. If the terminal state deviates from the controlled state, there may be an output driver short-circuit or defect.

Note

STS_DI

Signals are only reliably acquired over STS_DI if the level is significantly longer than the input delay + acquisition cycle of the digital inputs/outputs (X142).

Example: If you operate the digital inputs/outputs (X142) as isochronous to the MC Servo in a cycle of 2 ms and a set input delay of 125 µs, the level duration must be > 2.125 ms.

9.9.11 Programming example

You can find a programming example for the use of the integrated digital inputs/outputs in the following FAQ on the Internet (https://support.industry.siemens.com/cs/ww/en/view/109782269).

9.10 Configuring the digital inputs and digital inputs/outputs (X122/X132)

The digital inputs and digital inputs/outputs (X122/X132) are assigned to SINAMICS Integrated. Through configuration (frames 39x), you can, however, also use the digital inputs and digital inputs/outputs (X122/X132) for the CPU. The following applies:

- A digital output is always only available exclusively to SINAMICS Integrated or to the CPU.
- If you use a digital input for the CPU, you can also interconnect the digital input at the drive end.

You can configure the digital inputs and digital inputs/outputs (X122/X132) channel by channel. To do so, go to the function view in the project tree under "Automatic speed control" > "Parameter assignment" and set the configuration under "Inputs/outputs".

Bidirectional inputs/outputs are configured in the following configuration mask.

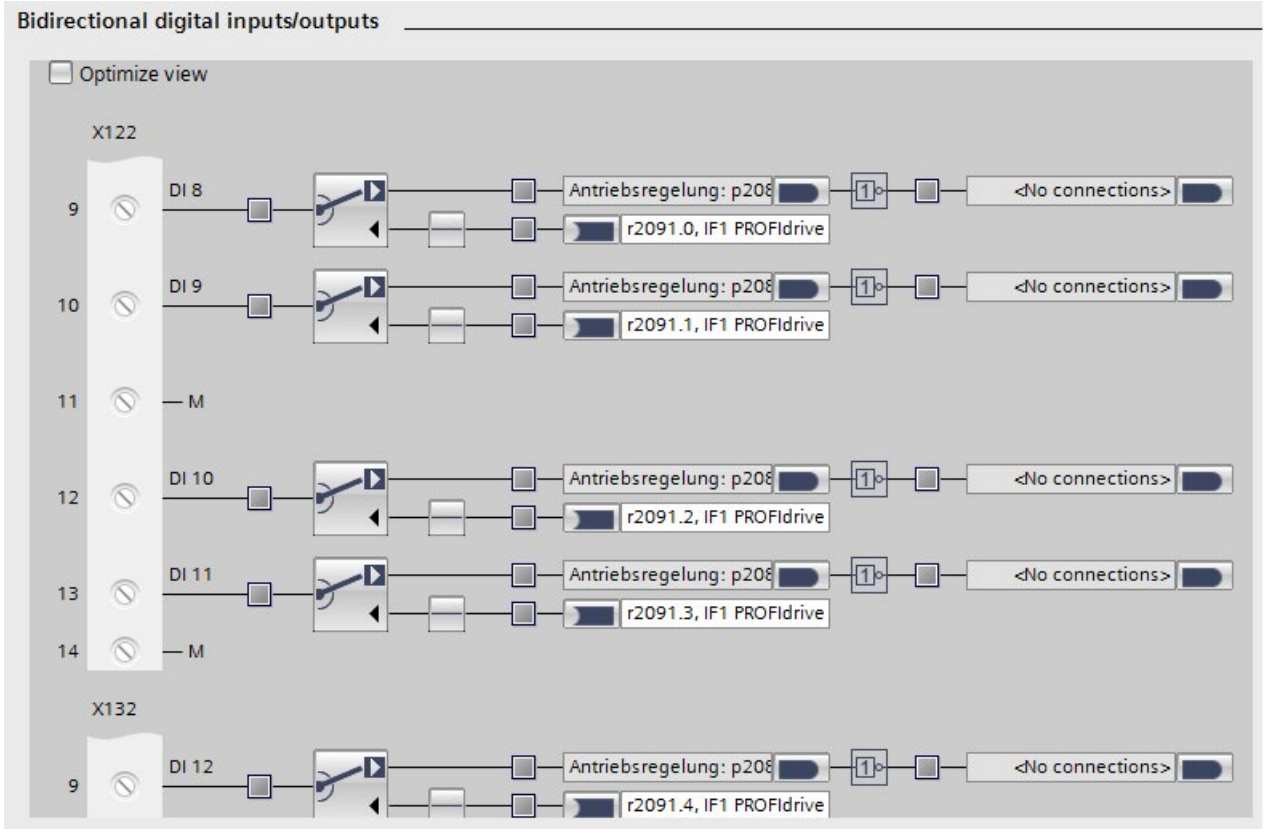


Figure 9-31 Bidirectional inputs/outputs

You can assign the SINAMICS digital inputs and digital inputs/outputs (X122/X132) using frame 39x of the PU. The status information of the digital inputs and digital outputs is then transferred at the PROFIdrive PZD sampling rate (p2048). The inputs/outputs are also sampled in the configured sampling time for the digital inputs and digital inputs/outputs (p0799). The application of the output values and return of the input values are therefore subject to dead times and jitter.

Note

Telegram 393 is set by default during configuration of the SINAMICS Integrated.

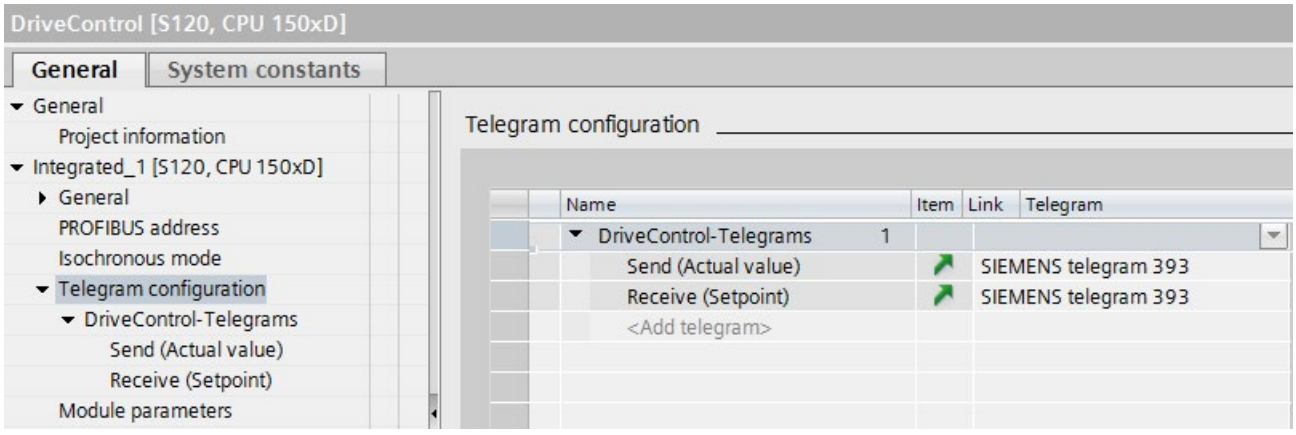


Figure 9-32 Configuration of frame 393 for automatic speed control

You can find further information on the various different frame types in Address space (Page 155).

Note

Interface X142

If you have particularly strict requirements for the digital input/outputs, use the digital input/outputs at interface X142. The digital inputs/outputs can be operated in isochronous mode and allow very short response times.

Programming example

You can find a programming example in the following FAQ on the Internet (https://support.industry.siemens.com/cs/ww/en/view/109782269).

9.11 Configuring the clock system

9.11.1 Overview of isochronous mode

Introduction

The SIMATIC Drive Controller supports isochronous mode for the following clock systems:

- PROFINET IO interface X150
- PROFIBUS DP interface X126
- Technology I/Os X142
- SINAMICS Integrated with PROFIdrive Integrated (always isochronous)

You can operate the clock systems separately or coupled on an isochronous basis.

Exception: Isochronous coupling of the PROFIBUS DP interface is not possible.

Independent isochronous mode

If you want to operate the clock systems separately in isochronous mode, configure a cycle time for each clock system and assign the clock systems to different process images, for example:

- SINAMICS Integrated → PIP OB Servo [OB 91]
- PROFIBUS DP interface X126 → PIP 1 of isochronous mode interrupt OB [OB 6x]

The clock systems are in this case not isochronous **to each other**.

Note

You cannot operate the X142 technology I/Os in isochronous mode separately from SINAMICS Integrated.

If you want to operate technology I/Os X142 and SINAMICS Integrated isochronously at the same time, the coupled isochronous mode must be set.

Coupled isochronous mode

In coupled isochronous mode, the relevant clock systems use a shared system clock.

The leading clock system provides its own system clock to the other clock systems.

The following table shows the possible combinations for coupled isochronous mode on the SIMATIC Drive Controller. The leading clock system for each combination is indicated.

Table 9- 12 Possible combinations for coupled isochronous mode

PROFINET IO interface X150	Technology I/Os X142 (local send clock)	SINAMICS Integrated (PROFIdrive Integrated)	PROFIBUS DP interface X126
X (leading)	X	X	-
X (leading)	-	X	-
X (leading)	X	-[1]	-
-	**X (leading)**	X	-

[1] SINAMICS Integrated is not configured.

You configure coupled isochronous mode in STEP 7; see Setting the clock system (Page 210).

Note

Isochronous coupling of the PROFIBUS interface with other clock systems is not possible.

If you want to expand the drive configuration limits with distributed drive systems, connect those distributed drive systems over the PROFINET IO interface X150. Only the PROFINET IO interface X150 can be connected isochronously alongside the MC Servo to the clock system of SINAMICS Integrated and the X142 technology I/Os.

9.11.2 Configuring drives with SINAMICS Integrated isochronously

Requirements

- STEP 7 , V16 or higher
- SINAMICS Startdrive , V16 or higher

Procedure

1. Add a SIMATIC Drive Controller to your project.
   The network view displays the components of a SIMATIC Drive Controller: SIMATIC S7-1500 CPU and SINAMICS Integrated, networked through PROFIdrive Integrated.

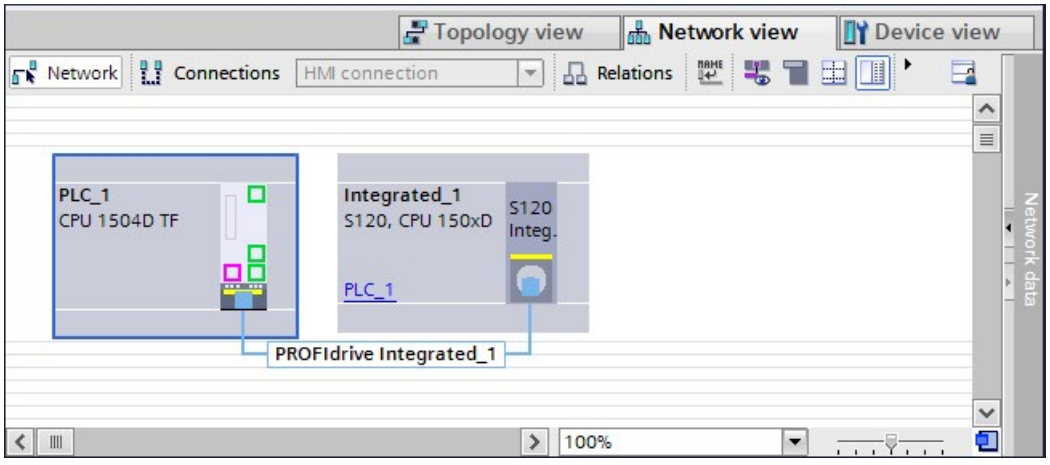


Figure 9-33 SIMATIC Drive Controller in the network view

2. Open the device view of SINAMICS Integrated. Configure the SINAMICS S120 drive system with its drive objects.
   You can find the relevant details in the SINAMICS S120 with Startdrive commissioning manual (https://support.industry.siemens.com/cs/ww/en/view/109781583).

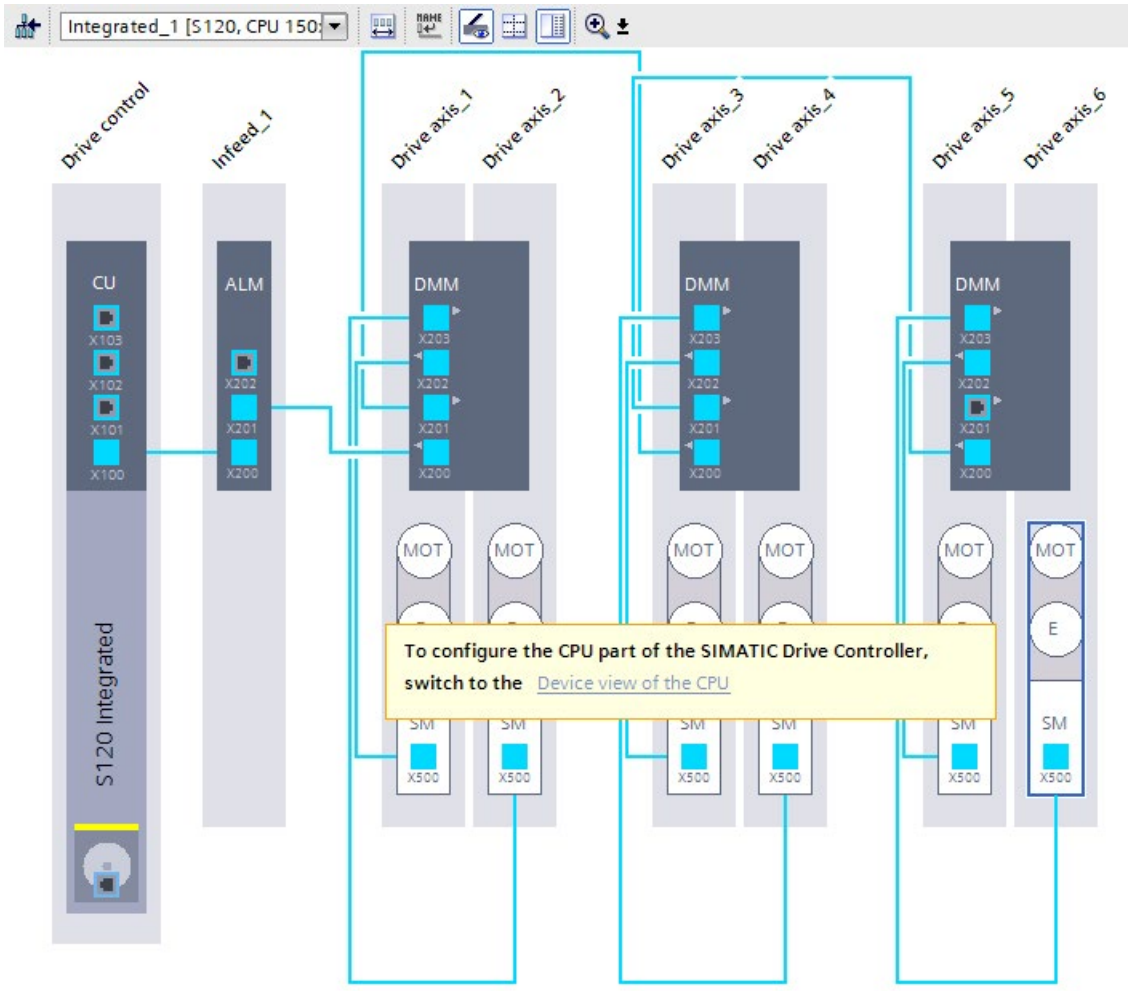


Figure 9-34 Configuring the SINAMICS S120 drive system

3. Select the drive control in the SINAMICS Integrated device view.
   Check the default PROFIdrive telegrams In the properties, under "Integrated_1" > "Telegram configuration" in the "General" tab. Make changes if required.
   The following default settings are made automatically:
   - Automatic speed control: Frame 393
   - Supply: Frame 370
   - Drive axes: Frame 105

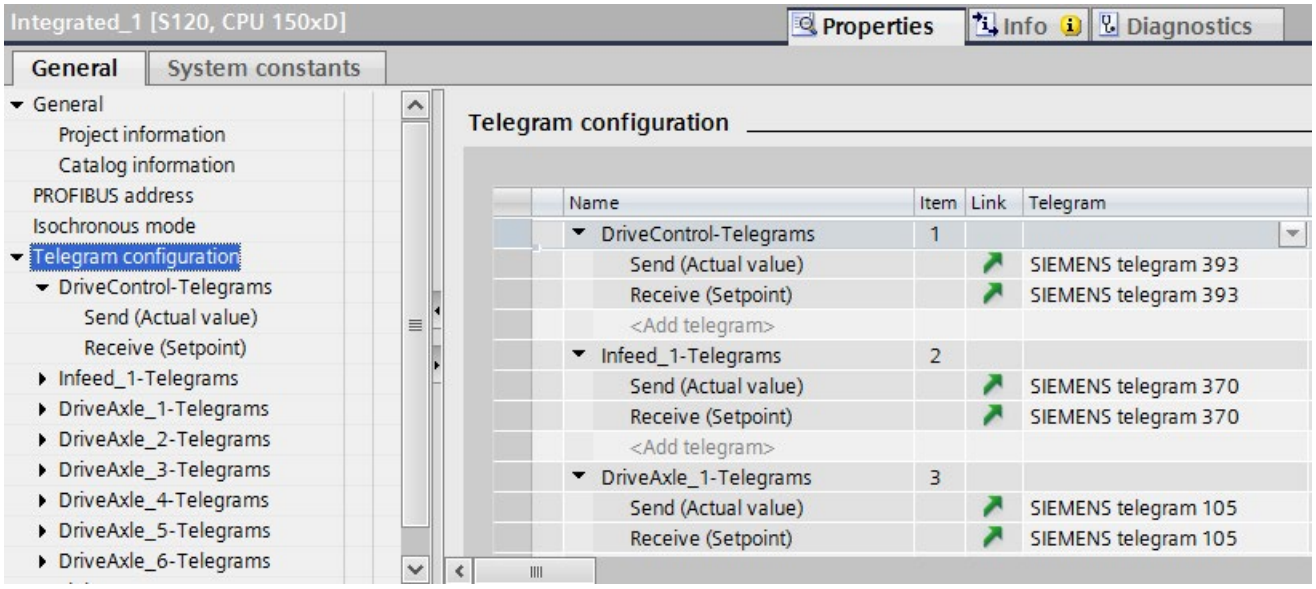


Figure 9-35 Configuring PROFIdrive frames

4. Create the axis technology objects. You create the axis technology objects under "Technology objects > Add new object" in the project tree.

5. Assign the configured drives to the axis technology objects.
   - Open the configuration of the technology object.
   - Navigate to "Hardware interface" > "Drive".
   - Select the "PROFIdrive" entry from the "Drive type" drop-down list.
   - Select the "Drive" entry from the "Data connection" drop-down list.
   - Select a SINAMICS Integrated drive axis from the "Drive" list.

   Only drives for which a suitable PROFIdrive frame has been configured are available for selection in the "Drive" list. You can find which PROFIdrive frames are supported by the SINAMICS Integrated in the S7-1500T Motion Control function manuals (https://support.industry.siemens.com/cs/ww/en/view/109751049).

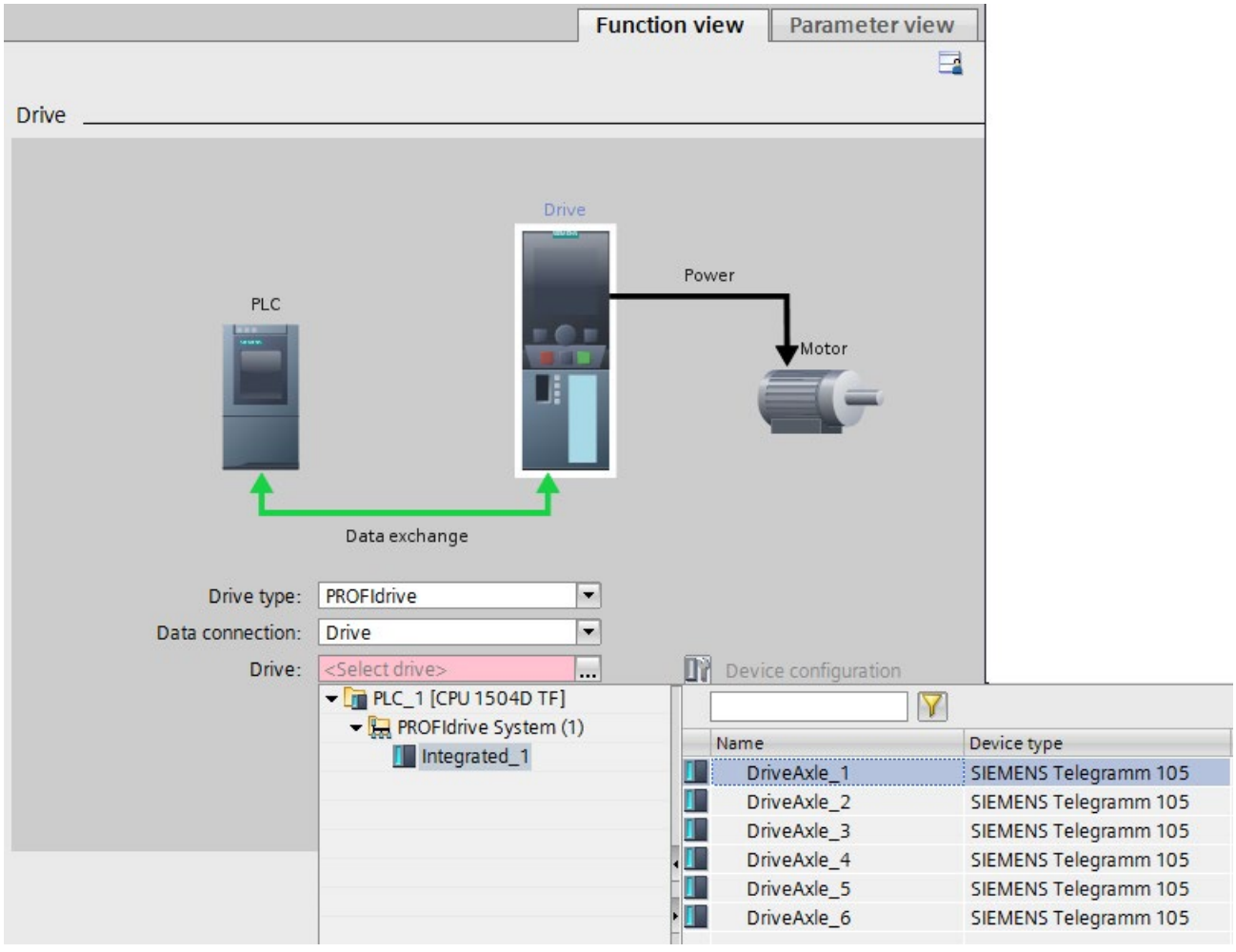


Figure 9-36 Assigning drives to the technology objects

The technology object is connected to the drive. When the drives are assigned to the axis technology objects, the following takes place:

- MC-Servo is created (if not already present)
- The TPA OB Servo is entered as the process image for all PROFIdrive telegrams

6. Once you have configured all axis technology objects, switch back to the drive configuration if necessary. You can use the "Device configuration" button.

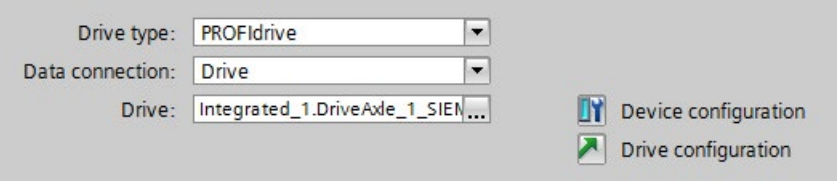


Figure 9-37 "Device configuration" button

Note

With SINAMICS Integrated, all frames must be operated in isochronous mode on OB Servo (OB 91) or isochronous mode interrupt OB (OB 6x). STEP 7 checks compliance with this rule when compiling the SIMATIC Drive Controller.

Exception: If you insert a SIMATIC Drive Controller in your project from the module catalog, "--- (none)" is entered as the organization block for the drive control. If you do not configure any other drive objects, you can also compile and download to the device without isochronous mode.

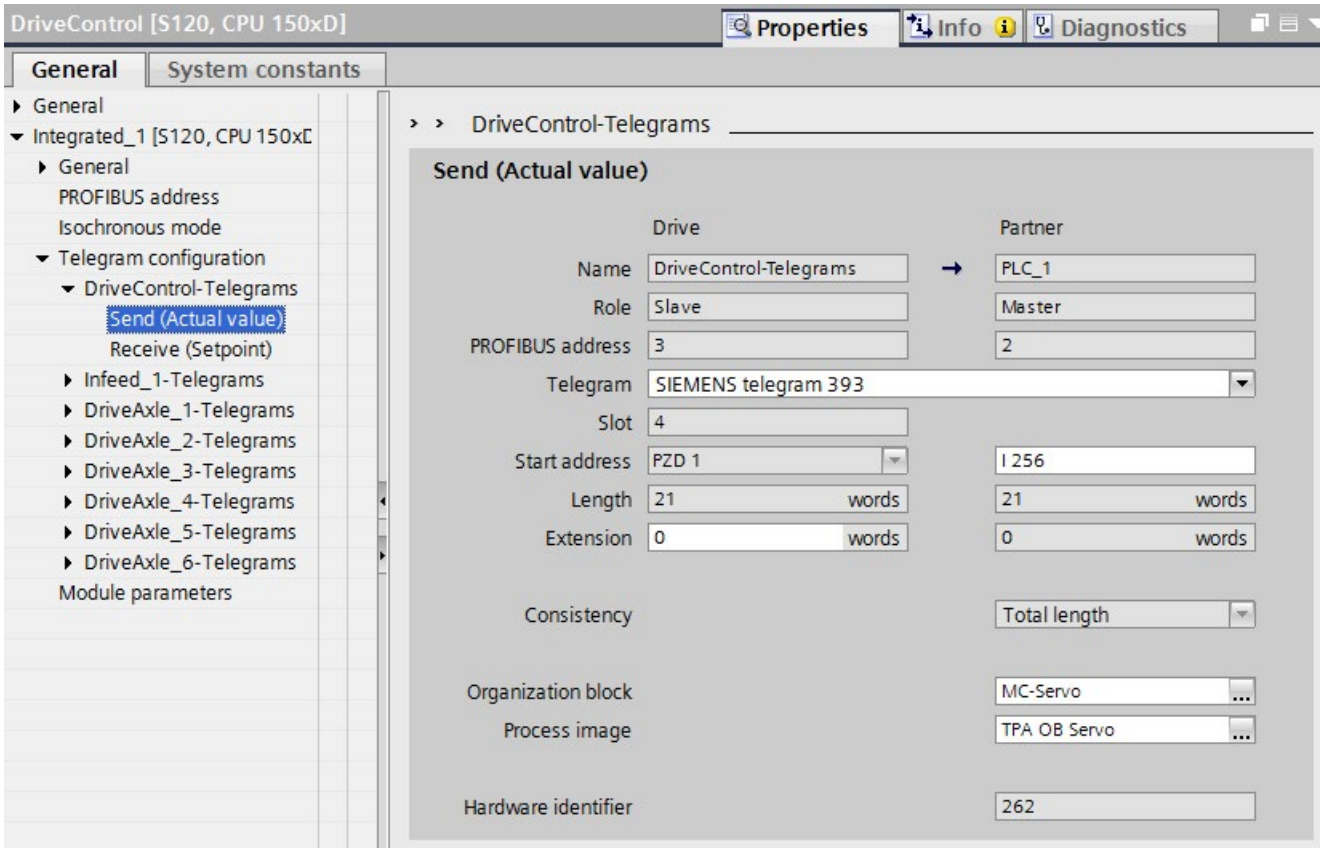


Figure 9-38 Configuring telegrams as isochronous

Setting the clock system for independent and coupled isochronous mode

You have configured SINAMICS Integrated as isochronous. Next, set the clock system.

Make the following settings in accordance with whether you are operating SINAMICS Integrated in independent or coupled isochronous mode:

- For independent isochronous mode:
  - Set the required cycle time.
  - Assign the "MC Servo" OB the clock system of SINAMICS Integrated.
- For coupled isochronous mode:
  - Assign the clock system of SINAMICS Integrated the leading clock system.
    You can find details of how to assign the leading clock system in Setting the clock system (Page 210).

9.11.3 Configuring technology I/Os (X142) as isochronous

Requirements

- STEP 7, V16 or higher
- SIMATIC Drive Controller has been configured.
- At least one axis technology object has been created at the CPU of the SIMATIC Drive Controller.
  See for example Configuring drives with SINAMICS Integrated isochronously (Page 199).

Procedure

1. Open the device view of the CPU.
2. Configure the operating modes of the technology I/Os in the CPU properties under "General" > "DI/DQ 8x24VDC[X142]" > "Channel parameters", for example, a timer DQ for later use as a cam output for channel 3.

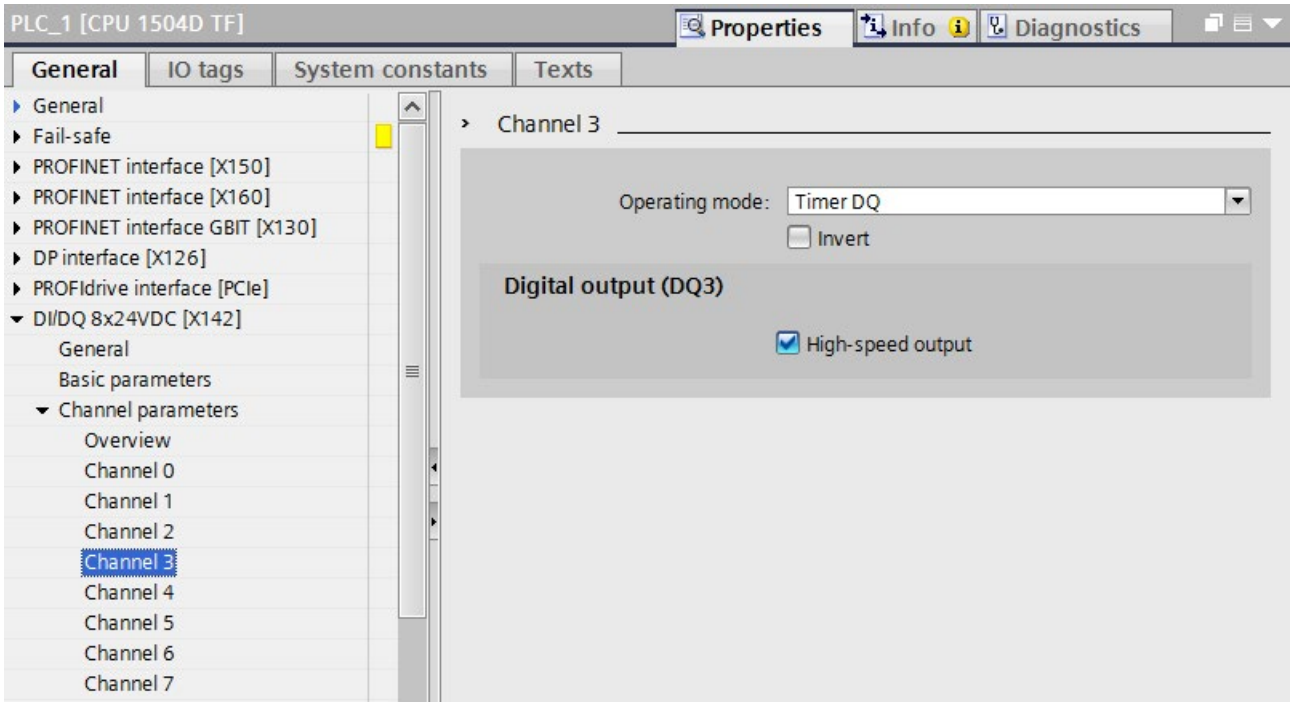


Figure 9-39 Setting the operating mode for technology I/O X142

3. In the project tree under the axis technology object, add an output cam technology object under "Output cam" > "Add new output cam".
4. Open the configuration of the output cam.
5. Under "Hardware interface", select the "Activate output" checkbox and the option "Output over Timer DQ".

6. Assign the configured output under "Output".

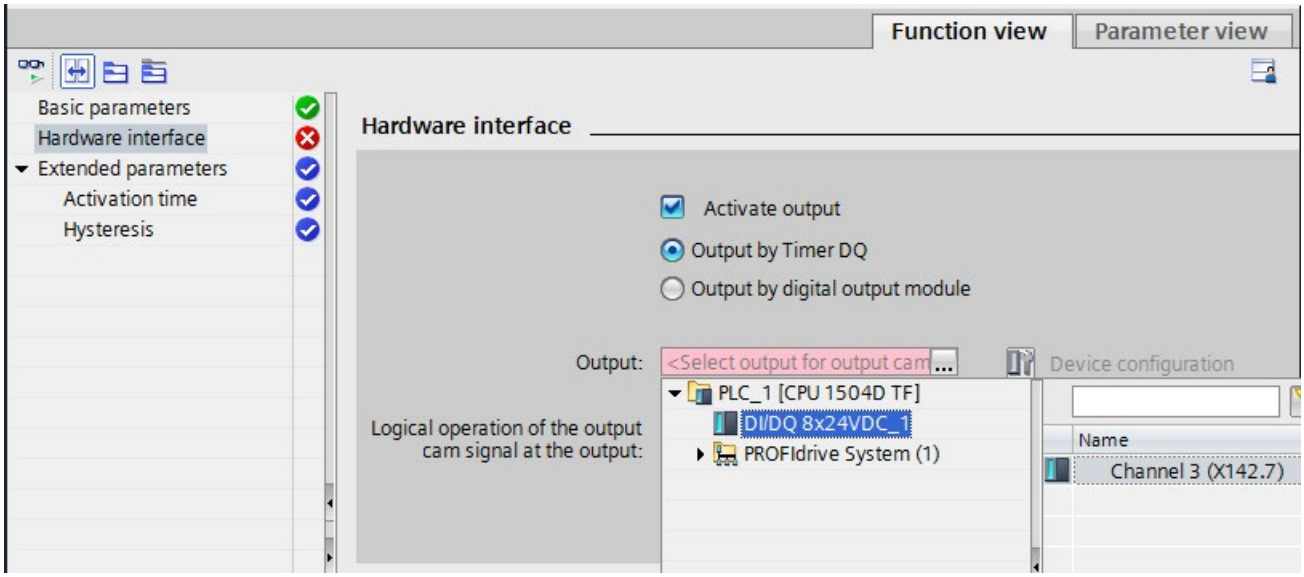


Figure 9-40 Assigning a channel to the output cam

7. Use the "Device configuration" button to switch back to the CPU settings and check the settings under "DI/DQ 8x24VDC [X142]" > "I/O addresses".

   The following settings must be configured for the input and output addresses:

   – "Isochronous mode" is enabled.
   – The organization block "MC Servo" is selected.
   – The process image "OB Servo PIP" is selected.

Automatic settings

Isochronous mode is mandatory for certain operating modes of the X142 technology I/O channels.

As soon as you set one of the following operating modes for a technology I/O channel, STEP 7 automatically selects the option "isochronous mode".

- Timer DI
- Timer DQ
- Oversampling DI
- Oversampling DQ
- Event/period measurement

If you assign an output cam, cam track or measuring input technology object to an X142 I/O, STEP 7 automatically sets the process image "OB Servo PIP".

In all other cases, you set the process image manually. If isochronous mode is mandatory for at least one technology I/O, you must set the process image of the "MC Servo" OB (OB91) or an isochronous mode interrupt OB (OB6x).

Setting the clock system

You have configured the technology I/Os as isochronous. Next, set the clock system.

Make the following settings in accordance with whether you are operating the X142 technology I/Os in independent or coupled isochronous mode:

- For independent isochronous mode or if the X142 technology I/Os are the leading clock system
  - Set the required cycle time.
  - Assign the "MC Servo" OB the clock system of the technology I/Os.

  Note

  You cannot operate the X142 technology I/Os in isochronous mode separately from SINAMICS Integrated. If you want to operate technology I/Os X142 and SINAMICS Integrated isochronously at the same time, the coupled isochronous mode must be set.

- For coupled isochronous mode:
  - Assign the leading clock system to the clock system of the technology I/Os.
    You can find details of how to assign the leading clock system in Setting the clock system (Page 210).

9.11.4 Configuring additional drives on PROFINET (X150) as isochronous

Requirement

- STEP 7, V16 or higher
- SINAMICS Startdrive, V16 or higher

You can import drives that are not integrated in the TIA Portal via Startdrive using GSD files (generic station description). To do so, install the drive in the "Options" menu as a device description file (GSD).

Adding a drive and frame to the device configuration

1. Add the required drive system in the network view, for example, SINAMICS S120 CU320-2 PN.
2. Open the device view of the drive system and configure the drive objects.
   You can find the relevant details in the SINAMICS S120 with Startdrive commissioning manual (https://support.industry.siemens.com/cs/ww/en/view/109781583).
3. Open the network view. Assign the drive system to the PROFINET interface [X150] of the CPU.
4. Open the topology view. Interconnect the port of the drive system as in the real configuration with the port of the CPU.

5. Configure the PROFIdrive frames for the drive axes, for example, frame 105.

Note

If you use a PROFINET IO drive system other than SINAMICS S120, adding and configuring may differ from the description in certain respects. The frame is automatically preassigned in line with the drive system.

Activating isochronous mode in the device configuration

You can operate PROFINET drives in isochronous or non-isochronous mode. Isochronous mode, however, increases the quality of the position control of the drive and is therefore recommended for drives such as SINAMICS S120.

Proceed as follows to activate isochronous mode for the drive:

1. Select the device view of the drive system.
2. In the properties window, select the tab "PROFINET Interface [X150]" > "Advanced options" > "Isochronous mode".
3. Select the "Isochronous mode" check box.
4. In the properties window, select the tab "PROFINET Interface [150]" > "Advanced options" > "Real-time settings" > "Synchronization".
5. Select "IRT" as the RT class.

Note

If you have configured a PROFIdrive frame at the drive that requires isochronous mode, STEP 7 automatically sets "Isochronous mode" and the RT class "IRT".

Configuring the CPU as sync master and setting the send clock

1. Select the device view of the CPU.
2. In the properties window, select the tab "PROFINET interface [X150]" > "Advanced options" > "Real-time settings" > "Synchronization".
3. Select "IRT" as the RT class if it has not already been set automatically.
4. Select "Sync master" from the "Synchronization role" drop-down list.
5. Click the "Domain settings" button.
6. Set the required send clock.

Selecting the drive in the configuration of the technology object

1. Add a new axis technology object.
2. Open the configuration "Hardware interface" > "Drive".

3. Select the "PROFIdrive" entry from the "Drive type" drop-down list.
4. Select a drive axis of the PROFINET drive unit from the "Drive" list.
   Only drives for which you have configured a suitable PROFIdrive frame are available for selection. You can find out which PROFIdrive frames are supported by the SIMATIC Drive Controller in the S7-1500T Motion Control function manuals (https://support.industry.siemens.com/cs/ww/en/view/109751049).

   Using the "Device configuration" button, you can switch to the drive device view, for example, to configure drives or set other PROFIdrive frames (for example 39x frame for the X122/X132 IOs of a CU320-2).

Setting the clock system

You have configured an external drive as isochronous on PROFINET using the example of the SINAMICS S120 CU320-2 PN. Next, set the clock system.

- Choose between independent and coupled isochronous mode.
- Set the required send clock.
- Assign the "MC Servo" OB the clock system of the PROFINET interface X150.

You can find more information in Setting the clock system (Page 210).

9.11.5 Configuring the PROFIBUS interface as isochronous

You can find out how to configure isochronous mode for distributed I/O on the PROFIBUS DP in the Isochronous Mode (https://support.industry.siemens.com/cs/ww/en/view/109755401) function manual.

Note

Isochronous coupling of the PROFIBUS interface with other clock systems is not possible.

If you want to expand the drive configuration limits with distributed drive systems, connect those distributed drive systems over the PROFINET IO interface X150. Only the PROFINET IO interface X150 can be connected isochronously alongside the MC Servo to the clock system of SINAMICS Integrated and the X142 technology I/Os.

9.11.6 Setting the clock system

The SIMATIC Drive Controller supports isochronous mode for the following clock systems:

- PROFINET IO interface X150
- PROFIBUS DP interface X126
- Technology I/Os X142
- SINAMICS Integrated with PROFIdrive Integrated (always isochronous)

You can operate the clock systems separately or coupled on an isochronous basis. Exception: Isochronous coupling of the PROFIBUS DP interface is not possible. You can find information on the combinations in which you can couple the clock systems in Overview of isochronous mode (Page 197).

You make the required settings in the relevant clock systems.

Once you have set and, if necessary, coupled the clock systems, you need to couple the OB servo with the clock system in which you wish to operate the drives / that is the leading clock system. Depending on the configuration, these settings are made by the system.

Use of clock cycles < 500 µs

You can only use clock cycles < 500 µs in the CPU 1507D TF with the following restrictions:

- Limited quantities are available.
- The vulnerability for level overflows increases, for example, with MC Servo [OB91] and MC Interpolator [OB92]. This may result in an involuntary STOP of the CPU, especially in case of additional loads caused by the user program, traces and large watch tables.
- A down-scaling from the application cycle of the MC-Servo [OB91] to the selected clock system, results in an additional load and should be avoided with small clocks.

You should, therefore, only use clock cycles < 500 µs in exceptional cases and test your application very intensely.

For small position controller clock cycles, you can also use the position controller in the drive (Dynamic Servo Control function, DSC). This allows for position controller clock cycles of 125 µs, for example.

Dynamic Servo Control (DSC)

In drives that support Dynamic Servo Control (DSC), you can optionally use the position controller in the drive.

If you use telegrams that support DSC, DSC is automatically enabled (setting "Position control in the drive (DSC enabled)" is enabled at the axis TO under control loop / Dynamic Servo Control (DSC)). The position controller in the drive is usually implemented with a rapid speed-control cycle. This improves the control quality of the drive.

For drives on the SINAMICS Integrated, the Siemens telegram 105 is sent with DSC by default.

Note

Isochronous mode is essential on the controller and on the drive side for the operation of DSC.

You can find further information in the S7-1500T Motion Control function manuals (https://support.industry.siemens.com/cs/ww/en/view/109751049).

SINAMICS Integrated clock system

Proceed as follows to set the clock system of the SINAMICS Integrated:

1. Switch to the network view.
2. Click on PROFIdrive Integrated in the network view.
3. Make the settings for the SINAMICS Integrated under "Constant bus cycle time". The SINAMICS Integrated is always isochronous (option is always selected).

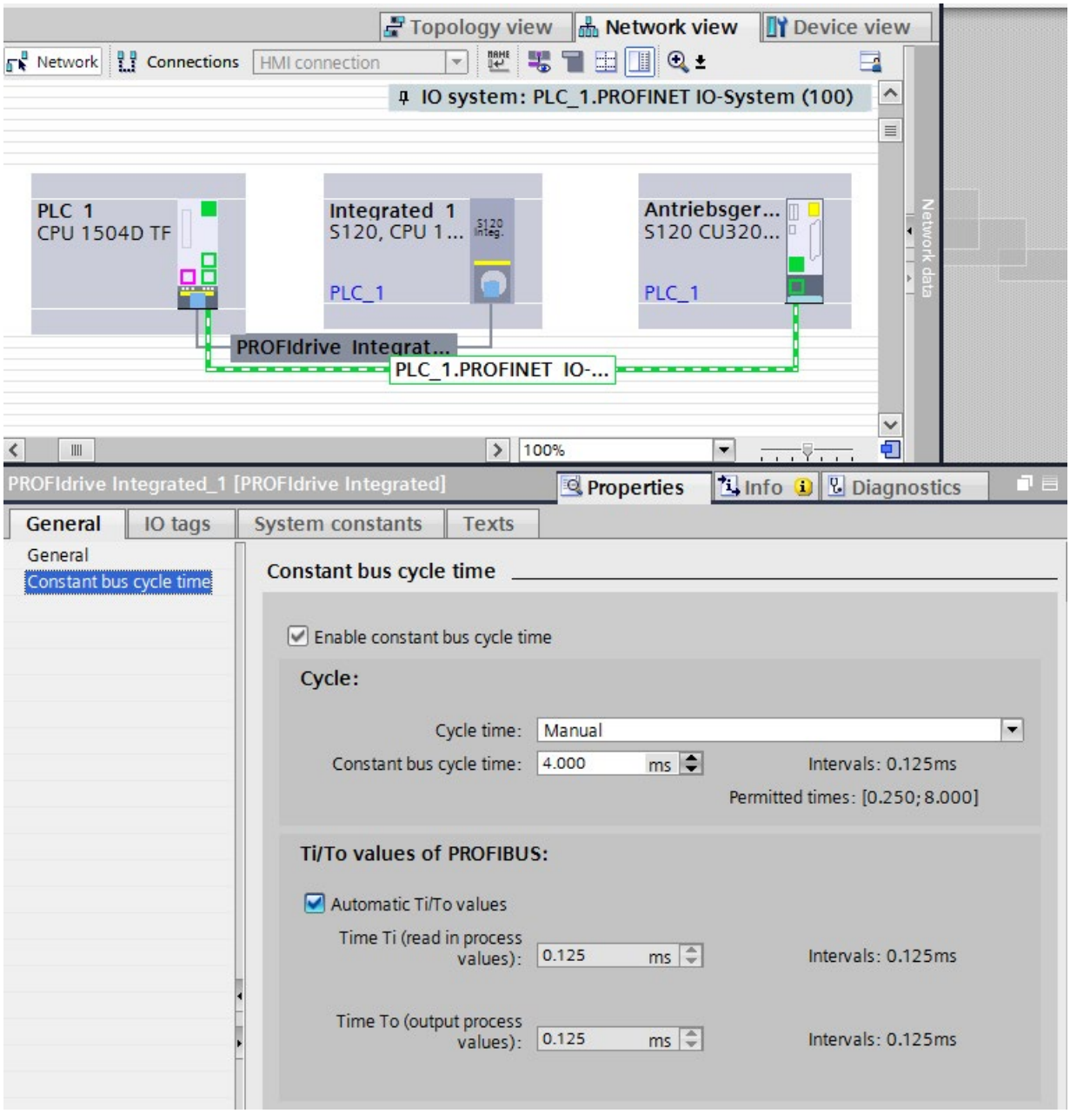


Figure 9-41 SINAMICS Integrated (PROFIdrive Integrated) clock system

Adjust other settings if required – for example times Ti/To for reading in/outputting data in isochronous mode.

Table 9- 13 Setting options for "Cycle time" in the SINAMICS Integrated clock system

Setting options	**Note**
Manual	With these settings, you operate the SINAMICS Integrated as an independent clock system.
Automatic minimum	
Use local send clock [X142]	With this setting, you operate the SINAMICS Integrated in isochronous mode coupled with the clock system of the X142 technology I/Os. Use this setting if you want to use the technology I/Os isochronously with the OB servo, for example, for measuring input or output cam applications. Please note the following: • You cannot operate the X142 technology I/Os in isochronous mode separately from SINAMICS Integrated. • If you want to operate technology I/Os X142 and SINAMICS Integrated isochronously at the same time, the coupled isochronous mode must be set. Consistency checks ensure that the setting is correct.
Using the send clock of the PROFINET interface [X150]	With this setting, you operate SINAMICS Integrated in isochronous mode coupled with PROFINET interface X150. SINAMICS Integrated uses the system clock of PROFINET interface X150. Use this setting if you need to operate the SIMATIC Drive Controller in isochronous mode at PROFINET IO interface X150, for example, for the connection of drives or for synchronous operation across PLC.

X142 technology I/Os clock system

Proceed as follows to set the clock system of the X142 technology I/Os:

1. In the device view of STEP 7, select the CPU of the SIMATIC Drive Controller.
2. Navigate to "Advanced configuration" > "Isochronous mode" in the properties of the CPU.
3. Select the required settings from the "Source of send clock" drop-down list in the "Isochronous mode for local modules" section.

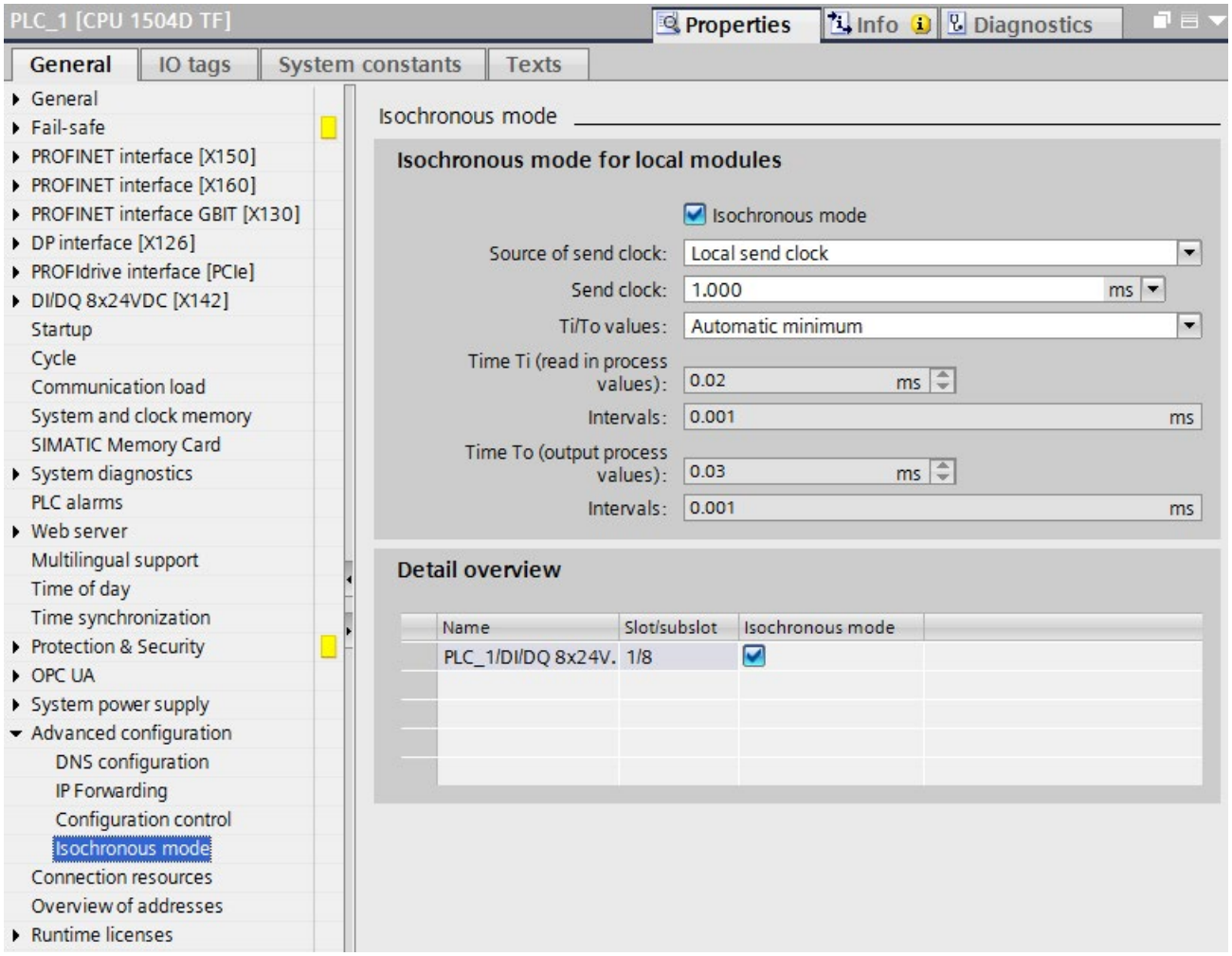


Figure 9-42 Technology I/O clock system

Table 9- 14 Setting options for "Source of send clock" in the clock system of the technology I/Os

Setting options	Note
Local send clock	With this setting, you operate the X142 technology I/Os as an independent clock system, or as the leading clock system if you couple the clock system of the SINAMICS Integrated.
Using the send clock of the PROFINET interface [X150]	With this setting, you operate X142 technology I/Os in isochronous mode coupled with PROFINET interface X150. The X142 technology I/Os use the system clock of PROFINET interface X150.

PROFINET IO interface X150 clock system

Proceed as follows to set the clock system of PROFINET interface X150:

1. Select the PROFINET IO system in the network view of STEP 7.
2. Make the settings for the send clock, etc. under "PROFINET subnet" > "Domain management" > "Sync domains".

In coupled isochronous mode with other clock systems, the clock system of the PROFINET interface is always leading.

You can find additional information on configuring isochronous mode on PROFINET IO in the Isochronous mode (https://support.industry.siemens.com/cs/ww/en/view/109755401) function manual.

PROFIBUS interface X126 clock system

You must follow the rules below during configuration if you want to operate the PROFIBUS DP interface in isochronous mode:

Table 9- 15 Rules for configuring isochronous mode for PROFIBUS DP interface

If ...	The configured cycle time of the PROFIBUS DP interface must...
A SINAMICS Integrated is configured	Be equal to or an integer multiple of the configured cycle time of the SINAMICS Integrated (PROFIdrive Integrated)
The X142 technology I/Os are operated in isochronous mode	Be equal to or an integer multiple of the configured cycle time of the X142 technology I/Os
The clock system of the PROFINET IO interface is coupled with one of the two clock systems.	Be equal to or an integer multiple of the configured cycle time of the PROFINET IO interface

Consistency checks ensure that the setting is correct.

Proceed as follows to set the clock system of the PROFIBUS interface:

1. Select the DP master system in the network view of STEP 7.
2. Make the settings for the DP cycle under "Constant bus cycle time".

Note

Isochronous coupling of the PROFIBUS interface with other clock systems is not possible.

If you want to expand the drive configuration limits with distributed drive systems, connect those distributed drive systems over the PROFINET IO interface X150. Only the PROFINET IO interface X150 can be connected isochronously alongside the MC Servo to the clock system of SINAMICS Integrated and the X142 technology I/Os.

Synchronizing MC Servo with clock system

Proceed as follows to synchronize the MC Servo with a clock system:

1. Open the "Program blocks" folder in the project tree.
2. Select the "MC Servo" organization block.
3. Select the "Properties" command in the shortcut menu.
4. Select the "Cycle time" entry in the area navigation.

5. The option "Synchronous to the bus" must be selected in the dialog box.
6. In the "Source of send clock" drop-down list, select the clock system to be synchronized with the OB MC-Servo.

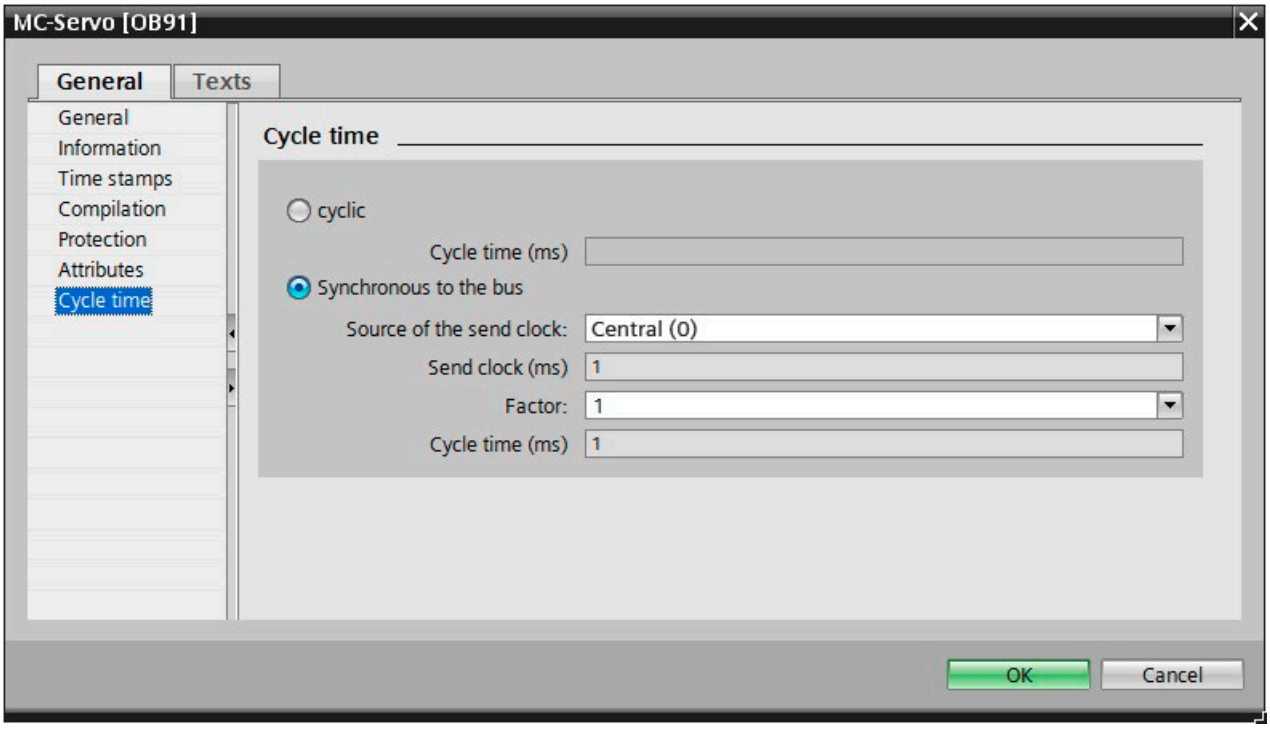


Figure 9-43 Synchronizing MC Servo with clock system

Table 9- 16 Setting options for synchronization with a clock system

Setting options[1)]	Note
PROFIdrive system (1)	With this setting, you synchronize MC Servo with the clock system of SINAMICS Integrated.
PROFINET IO system (100)	With this setting, you synchronize MC Servo with PROFINET interface X150.
Central (0)	With this setting, you synchronize MC Servo with the clock system of technology I/Os X142.
DP master system (2)	With this setting, you synchronize MC Servo with PROFIBUS interface X126.

1) The designations may vary depending on the names assigned.

For coupled isochronous mode, the leading clock system must always be selected.

If the leading clock system is not set as the source of the send clock in the case of a coupled clock system, then the leading clock system is automatically set when compiling the project data and a corresponding note is displayed.

Setting the application cycle

The application cycle of MC Servo is derived from the send clock and a configurable factor. The adjustable factors depend on the coupled clock system.

9.12 Configuring fail-safe technology CPU

The SIMATIC Drive Controller contains a fail-safe SIMATIC S7-1500 technology CPU with integrated technology I/Os.

Note the following information when you use the SIMATIC Drive Controller as fail-safe technology CPU.

Safety and standard mode

The fail-safe design of the integrated technology CPU allows you to implement applications for safety systems, for example, safety solutions for the protection of machines and people. This enables seamless integration of machine safety into the SIMATIC Drive Controller. You use one system for both your standard and fail-safe automation at the same time.

You can program the F-CPU of the SIMATIC Drive Controller for safety mode or standard mode.

For safety mode, a license for STEP 7 Safety needs to be installed. If no license for STEP 7 Safety is installed, you can only use the SIMATIC Drive Controller in standard mode.

Enabling/disabling the F-capability in STEP 7

By default, the F-capability is enabled for the SIMATIC Drive Controller in STEP 7.

If you wish to change the setting of the F-capability, follow these steps:

1. Highlight the F-CPU in the device view or network view and select the "Properties" tab in the Inspector window.
2. Select "Fail-safety" in the area navigation.
3. Enable/disable the F-capability using the corresponding button.
4. If you want to disable the F-capability, confirm the "Turning off the F-activation" dialog with "Yes".

Disabling F-capability with existing safety program

When you disable the F-capability for an F-CPU because you want to use the F-CPU as a standard CPU even though a safety program is installed, you must note the following:

- You need the password if a password was assigned to the safety program.
- The Safety Administration editor is deleted from the project tree.
- The F-OBs are deleted.
- All F-blocks are deleted.
- You can no longer use the F-I/O in safety mode with this F-CPU.
- For SINAMICS Integrated, you can no longer control the Safety Integrated functions via PROFIsafe but only via terminals.

Note

The routing of the PROFIsafe telegrams of a higher-level F-CPU (e.g. CPU 1518F-4 PN/DP) to the SINAMICS Integrated is not supported.

Support of PROFIsafe V2

The PROFINET IO interfaces X150 and X160 support PROFIsafe V2.

Network disconnector according to IEC61784-3-3 (PROFIsafe standard)

CPU 1504D TF and CPU 1507D TF provide network disconnection between the X150, X160 and X130 interfaces according to IEC61784-3-3.

The following behavior applies to these F-CPUs with regard to communication network disconnectors:

- There is an absolute network disconnection between the interfaces X150, X160 and X130 when no bridging is implemented on communication level 2.
- There is no network disconnection if the connection is established via ports of the same interface (with X150 interface: P1R, P2R and P3 ports).

Even when using a communication network disconnector according to IEC 61784-3-3-3 (PROFIsafe standard), you must still ensure that the individual disconnected networks are not connected by other standard components.

You can find more information in this FAQ (https://support.industry.siemens.com/cs/ww/en/view/109740240).

Standard CPUs are generally not network disconnectors according to IEC61784-3-3-3 (PROFIsafe standard).

PFD_{avg}, PFH values for F-CPUs

You can find the probability of failure values (PFD_{avg}, PFH values) for the SIMATIC Drive Controller in the SIMATIC Drive Controller manual (https://support.industry.siemens.com/cs/ww/en/view/109766666), section "Technical Specifications".

For more information and examples on the overall determination of the PFH value of control and drive systems, see also (https://support.industry.siemens.com/cs/ww/en/view/76254308)

Effects of the installation altitude on the availability

Observe the maximum installation altitude of the components used. Additional information can be found in the section Mechanical and climatic environmental conditions (Page 354).

The higher cosmic radiation present during operation at altitudes above 2000 m will also start to have an effect on the failure rate of electronic components (the so-called soft error rate). In rare cases, this may result in particular in a transition of the F-CPU into the safe state. However, the functional safety of the F-CPU remains fully intact.

Requirements for power supplies in the event of voltage interruption

Note the following information regarding the use of power supplies in safety mode.

Note

To ensure adherence to IEC 61131-2 and NAMUR Recommendation NE 21, only use power packs/power supply units (230 V AC → 24 V DC) with mains buffering times of at least 20 ms. Observe the relevant requirements in your product standards (e.g. 30 ms for "burners" pursuant to EN 298) as regards possible voltage interruptions. The latest up-to-date information on PS components is available on the Internet (https://mall.industry.siemens.com).

Note

Observe any application-specific requirements, for example, on mains buffering for power supply units/power packs.

Restrictions and special features for safety mode

Note the following restrictions and special features for safety mode:

Restriction with "CREAT_DB" and "DELETE_DB" instructions:

F-DBs can neither be created nor deleted.

Restriction with "READ_DBL" and "WRIT_DBL" instructions:

The destination address must not point to an F-DB.

Restriction when configuring the retentive behavior of F-data blocks:

The configuration of the retentive behavior of data blocks is not supported for F-DBs. This means that the actual values of the F-DBs are not retentive in the event of Power OFF/ON and Restart (STOP-RUN) of the F-CPU. The F-DBs receive the initial values from the load memory.

The "Retain" check box is grayed out for all tags in F-DBs.

Use of isochronous mode interrupt (F-)OBs:

If the sum of the isochronous mode interrupt OBs and the isochronous mode interrupt F-OBs used exceeds the number specified in the technical specifications of the SIMATIC Drive Controller, it is no longer possible to load the standard user program in RUN.

Safety-related shutdown of standard modules

The function "Safety-related shutdown of standard modules", as described in the FAQ (https://support.industry.siemens.com/cs/it/en/view/39198632), is only released up to a maximum installation altitude of 2000 m.

Web server

The following is displayed for the F-CPU on the start page of the Web server:

- Version of STEP 7 Safety with which the safety program was compiled.
- Safety mode activated/deactivated
- Collective F-signature
- Last fail-safe change

The "Fail-safe" tab on the "Diagnostics" Web page provides information about the F-runtime groups:

- Name of F-runtime group
- F-runtime groups signature
- Current cycle time
- Max. cycle time
- Current runtime
- Max. runtime

The following is displayed for each F-I/O on the "Module information" Web page in the "Safety" tab:

- F-parameter signature (with addresses)
- Safety mode
- F-monitoring time
- F-source address
- F-destination address

Write access to F-blocks is not permitted.

Note

Controlling fail-safe inputs/outputs can result in an F-CPU STOP.

Additional information

Information on the use of the SIMATIC Drive Controller in safety mode is available in the Programming and operating manual SIMATIC Safety - Configuring and Programming (https://support.industry.siemens.com/cs/ww/en/view/54110126).

Information on the interaction between the Safety functions in the drive and the S7-1500T CPU is available in the Function Manual S7-1500/S7-1500T Axis functions on the Motion Control topic page (https://support.industry.siemens.com/cs/ww/en/view/109751049).

Basics of program execution 10

10.1 Programming the CPU

Hardware and software requirements

Your PG/PC is connected to the SIMATIC Drive Controller over the PROFIBUS or PROFINET interface.

To configure and program the SIMATIC Drive Controller, you require:

- SIMATIC STEP 7 Professional, V16 or higher
- For programming the safety program of the F-CPU "STEP 7 Safety Advanced" as of V16
- For the configuration of the SINAMICS Integrated , the SINAMICS Startdrive option package as of V16 in the Basic or Advanced version. Startdrive Advanced has additional engineering functions compared to Startdrive Basic, such as a safety acceptance test.

Points to note

The function blocks for the use of time-based IO (TIO instructions) are not supported by the X142 interface. We therefore recommend using the technology objects measuring input, output cam or cam track for the timer DI/DQ.

10.2 Events and OBs

Response to triggers

The occurrence of a trigger results in the following reaction:

- If the event comes from an event source to which you have assigned an OB, this event triggers the execution of the assigned OB. The event enters the queue according to its priority.
- If the event comes from an event source to which you have not assigned an OB, the default system reaction is executed.

Note

Some event sources, such as startup, pull/plug, exist even if you do not configure them.

Triggers

The table below provides an overview of:

- possible event sources
- possible values for the OB priority
- possible OB numbers
- default system reaction
- Number of OBs

Table 10- 1 Triggers

Types of event sources	Possible priorities (default priority)	Possible OB numbers	Default system reaction [1]	Number of OBs
Startup [2]	1	100, ≥ 123	Ignore	0 to 100
Cyclic program [2]	1	1, ≥ 123	Ignore	0 to 100
Time-of-day interrupt [2]	2 to 24 (2)	10 to 17, ≥ 123	Not applicable	0 to 20
Time-delay interrupt [2]	2 to 24 (3)	20 to 23, ≥ 123	Not applicable	0 to 20
Cyclic interrupt [2]	2 to 24 (8 to 17, frequency dependent)	30 to 38, ≥ 123	Not applicable	0 to 20
Hardware interrupt [2]	2 to 26 (18)	40 to 47, ≥ 123	Ignore	0 to 50
Status interrupt	2 to 24 (4)	55	Ignore	0 or 1
Update interrupt	2 to 24 (4)	56	Ignore	0 or 1
Manufacturer-specific or profile-specific interrupt	2 to 24 (4)	57	Ignore	0 or 1
Isochronous mode interrupt	16 to 26 (21)	61 to 64, ≥ 123	Ignore	0 to 2
Time error [3]	22	80	Ignore	0 or 1
Maximum cycle time exceeded once			STOP	
Diagnostics interrupt	2 to 26 (5)	82	Ignore	0 or 1
Removal/insertion of modules	2 to 26 (6)	83	Ignore	0 or 1
Rack error	2 to 26 (6)	86	Ignore	0 or 1
MC servo [4]	17 to 26 (26)	91	Not applicable	0 or 1
MC pre-servo [4]	Corresponds to MC Servo priority	67	Not applicable	0 or 1
MC post-servo [4]	Corresponds to MC Servo priority	95	Not applicable	0 or 1
MC interpolator [4]	16 to 25 (24)	92	Not applicable	0 or 1
MC PreInterpolator [4]	Corresponds to MC Interpolator priority	68	Not applicable	0 or 1
MC LookAhead [4]	15 to 16 (15)	97	Not applicable	0 or 1
MC Transformation [4]	17 to 25 (25)	98	Not applicable	0 or 1

Types of event sources	Possible priorities (default priority)	Possible OB numbers	Default system reaction [1]	Number of OBs
Programming error (only for global error handling)	2 to 26 (7)	121	STOP	0 or 1
I/O access error (only for global error handling)	2 to 26 (7)	122	Ignore	0 or 1

1) If you have not configured the OB.

2) For these event sources, apart from the permanently assigned OB numbers (see column: possible OB numbers), you can also assign OB numbers from the range ≥ 123 in STEP 7.

3) If the maximum cycle time has been exceeded twice within a cycle, the CPU always switches to STOP regardless of whether you have configured OB80.

4) You can find more information on these event sources and the startup behavior in the S7-1500 Motion Control function manuals.

Assignment between event source and OBs

The type of OB determines where you make the assignment between OB and event source:

- With hardware interrupts and isochronous mode interrupts, the assignment is made during the configuration of the hardware or when the OB is created.
- For MC Servo, MC PreServo, MC PostServo, MC Interpolator and MC PreInterpolator, STEP 7 automatically assigns OBs 91/92 as soon as you add a technology object.
- For all other types of OB, the assignment is made when the OB is created, where applicable after you have configured the event source.

For hardware interrupts, you can change an assignment which has already been made during runtime with the instructions ATTACH and DETACH. In this case, only the actually effective assignment changes, and not the configured assignment. The configured assignment takes effect after loading, and upon each startup.

The CPU ignores hardware interrupts to which you did not assign an OB in your configuration or which occur after the DETACH instruction. The CPU does not check whether an OB is assigned to this event when an event arrives, but only prior to the actual processing of the hardware interrupt.

OB priority and runtime behavior

If you have assigned an OB to the event, the OB has the priority of the event. The CPUs of the SIMATIC Drive Controller support priorities 1 (lowest) to 26 (highest). The following items are essential to the execution of an event:

- Call and execution of the assigned OB
- The update of the process image partition of the assigned OB

The user program processes the OBs exclusively on a priority basis. This means the program processes the OB with the highest priority first when multiple OB requests occur at the same time. If an event occurs that has a higher priority than the currently active OB, this OB is interrupted. The user program processes events of the same priority in order of occurrence.

Note

Communication

The communication (e.g. test functions with the PG) always works with priority 15. To prevent extending the program runtime unnecessarily in time-critical applications, these OBs should not be interrupted by communication. Assign a priority > 15 for these OBs.

Additional information

Additional information on organization blocks is available in the STEP 7 online help.

10.3 Asynchronous instructions

Introduction

Program execution makes a distinction between synchronous and asynchronous instructions.

The "synchronous" and "asynchronous" properties relate to the temporal relationship between the call and execution of the instruction.

The following applies to synchronous instructions: When the call of a synchronous instruction is complete, execution of the instruction is also complete.

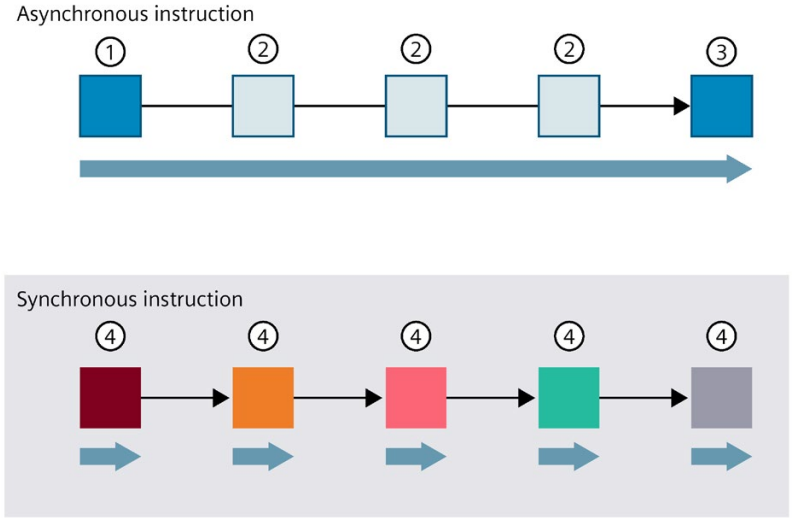
This is different in the case of asynchronous instructions: When the call of an asynchronous instruction is complete, execution of the asynchronous instruction is not necessarily complete yet. This means the execution of an asynchronous instruction can extend over multiple calls. The CPU processes asynchronous instructions in parallel with the cyclic user program. Asynchronous instructions generate jobs in the CPU for their processing.

Asynchronous instructions are usually Motion Control instructions or instructions for transferring data, e.g. data records for modules, communication data, or diagnostics data.

Difference between synchronous/asynchronous instructions

The figure below shows the difference between the processing of an asynchronous instruction and a synchronous instruction. In this figure the CPU calls the asynchronous instruction five times before its execution is complete, e.g. a data record has been completely transferred.

With a synchronous instruction, execution is completed upon each call.



① First call of the asynchronous instruction, start of execution
② Intermediate call of the asynchronous instruction, execution continues
③ Last call of the asynchronous instruction, completion of execution
④ The synchronous instruction is completely executed at each call
➡ Duration of complete execution

Figure 10-1 Difference between asynchronous and synchronous instructions

Parallel processing of asynchronous instruction jobs

A CPU can process several asynchronous instruction jobs in parallel. The CPU processes the jobs in parallel under the following conditions:

- Several asynchronous instruction jobs are called at the same time.
- The maximum number of simultaneously running jobs for the instruction is not exceeded.

The figure below shows the parallel processing of two jobs of the WRREC instruction. The two instructions are executed simultaneously for a certain duration.

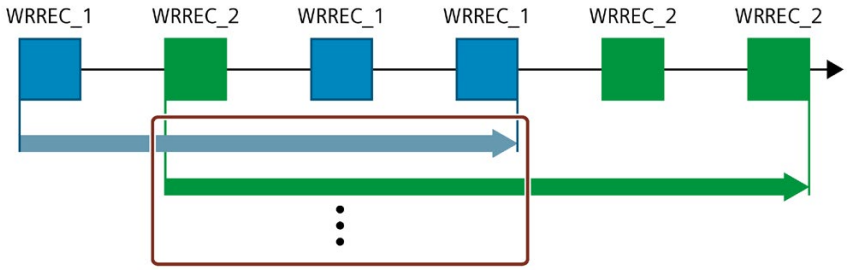


Figure 10-2 Parallel processing of the asynchronous instruction WRREC

Note

Dependencies between asynchronous instructions

The call sequence in the user program may differ from the processing sequence of the asynchronous instructions. This can lead to problems with dependencies between asynchronous instructions.

Remedy: To ensure correct timing of processing, use the status outputs of the asynchronous instructions in a sequencer. If an asynchronous instruction is finished and this is acknowledged via the parameter DONE, then only the next asynchronous instruction should start.

Example: For the RecipeImport and RecipeExport recipe functions, you need a CSV file for the recipe data. If you use the same CSV file for import and export, then the two asynchronous instructions are dependent on each other. In a sequencer, link the status of the DONE parameter of the RecipeImport instruction to the next step, where the RecipeExport will be executed. The link thus ensures correct processing.

Assignment of call to job of the instruction

To execute an instruction over multiple calls, the CPU must be able to uniquely relate a subsequent call to a running job of the instruction.

To relate a call to a job, the CPU uses one of the following two mechanisms, depending on the type of the instruction:

- Using the instance data block of the instruction (for "SFB" type)
- Using job-identifying input parameters of the instruction. These input parameters must match in each call during processing of the asynchronous instruction.

Example: A job of the "Create_DB" instruction is identified by input parameters LOW_LIMIT, UP_LIMIT, COUNT, ATTRIB and SRCBLK.

The following table shows which input parameters you use to identify which instruction.

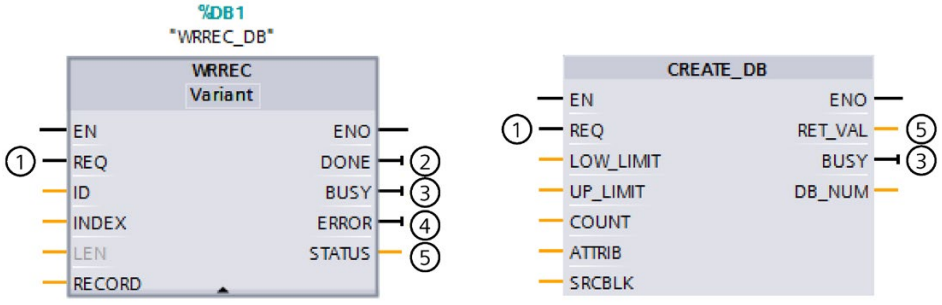
Table 10- 2 Asynchronous instructions Call to job assignment

Instruction	Job is identified by
DPSYC_FR	LADDR, GROUP, MODE
D_ACT_DP	LADDR
DPNRM_DG	LADDR
WR_DPARM	LADDR, RECNUM
WR_REC	LADDR, RECNUM
RD_REC	LADDR, RECNUM
CREATE_DB	LOW_LIMIT, UP_LIMIT, COUNT, ATTRIB, SRCBLK
READ_DBL	SRCBLK, DSTBLK
WRIT_DBL	SRCBLK, DSTBLK
RD_DPARA	LADDR, RECNUM
DP_TOPOL	DP_ID

Status of an asynchronous instruction

An asynchronous instruction shows its status via the block parameters STATUS/RET_VAL and BUSY. Many asynchronous instructions also use the block parameters DONE and ERROR.

The figure below shows the two asynchronous instructions WRREC and CREATE_DB.



① The input parameter REQ starts the job to execute the asynchronous instruction.

② The output parameter DONE indicates that the job was completed without error.

③ The output parameter BUSY indicates whether the job is currently being executed. When BUSY =1, a resource is allocated for the asynchronous instruction. When BUSY = 0, the resource is free.

④ The output parameter ERROR indicates that an error has occurred.

⑤ The output parameter STATUS/RET_VAL provides information on the status of the job execution. The output parameter STATUS/RET_VAL receives the error information after the occurrence of an error.

Figure 10-3 Block parameters of asynchronous instructions using the instructions WRREC and CREATE_DB as examples.

Summary

The table below provides you with an overview of the relationships described above. It shows in particular the possible values of the output parameters if execution of the instruction is not complete after a call.

Note

You must evaluate the relevant output parameters in your program after each call

Table 10- 3 Relationship between REQ, STATUS/RET_VAL, BUSY and DONE during a "running" job.

Seq. no. of the call	Type of call	REQ	STATUS/RET_VAL	BUSY	DONE	ERROR
1	First call	1	W#16#7001	1	0	0
			Error code (e.g. W#16#80C3 for lack of resources)	0	0	1
2 to (n - 1)	Intermediate call	Not relevant	W#16#7002	1	0	0
n	Last call	Not relevant	W#16#0000, if no errors have occurred.	0	1	0
			Error code if errors occurred.	0	0	1

Use of resources

Asynchronous instructions use resources in the CPU during their execution. The resources are limited depending on the type of CPU and instruction. The CPU can simultaneously process only a maximum number of asynchronous instruction jobs. The resources are available again after a job has been processed successfully or with errors.

Example: For the RDREC instruction, a CPU can process up to 20 jobs in parallel.

If the maximum number of simultaneously running jobs for an instruction is exceeded, the instruction returns error code 80C3 (lack of resources) in the STATUS block parameter. The CPU stops execution of the job until a resource becomes free again.

Note

Lower-level asynchronous instructions

Some asynchronous instructions use one or more lower-level asynchronous instructions for their processing. This dependence is shown in the tables below.

Please note that with multiple lower-level instructions, only one lower-level resource is typically allocated at a time.

Extended instructions: maximum number of simultaneously running jobs

The following table shows the maximum number of simultaneously running jobs for asynchronous extended instructions.

Table 10- 4 Extended instructions

Extended instructions	CPU 1504D TF	CPU 1507D TF
Distributed I/O		
RDREC	20	
RD_REC	10	
WRREC	20	
WR_REC	10	
D_ACT_DP	8	
ReconfigIOSystem	Uses RDREC, WRREC, D_ACT_DP	
DPSYC_FR	2	
DPNRM_DG	8	
DP_TOPOL	1	
ASI_CTRL	Uses RDREC, WRREC	
PROFIenergy		
PE_START_END	Uses RDREC, WRREC	
PE_CMD	Uses RDREC, WRREC	
PE_DS3_Write_ET200S	Uses RDREC, WRREC	
PE_WOL	Uses RDREC, WRREC, TUSEND, TURCV, TCON, TDISCON	
Module parameter assignment		
RD_DPAR	10	
RD_DPARA	10	
RD_DPARM	10	
WR_DPARM	10	
Diagnostics		
Get_IM_Data	10	
GetStationInfo	10	
Recipes and data logging		
RecipeExport	10	
RecipeImport	10	
DataLogCreate	10	
DataLogOpen	10	
DataLogWrite	10	
DataLogClear	10	
DataLogClose	10	
DataLogDelete	10	
DataLogNewFile	10	
Data block functions		
CREATE_DB	10	
READ_DBL	10	
WRIT_DBL	10	
DELETE_DB	10	

Extended instructions	CPU 1504D TF	CPU 1507D TF
File handling		
FileReadC	10	
FileWriteC	10	
Reference information		
ResolveSymbols	10	
GetSymbolForReference	10	

LAcycCom libraries enable collision-free coordination of communication resources in the CPU for acyclic communication. Additional information on the LAcycCom library is available on the Internet (https://support.industry.siemens.com/cs/ww/en/view/109479553).

Basic instructions: maximum number of simultaneously running jobs

The following table shows the maximum number of simultaneously running jobs for asynchronous basic instructions.

Table 10- 5 Basic instructions

Basic instructions	CPU 1504D TF	CPU 1507D TF
Array DB		
ReadFromArrayDBL	Uses READ_DBL (see Extended instructions)	
WriteToArrayDBL	Uses READ_DBL, WRIT_DBL (see Extended instructions)	

Communication: maximum number of simultaneously running jobs

Table 10- 6 Maximum number of simultaneous jobs for asynchronous instructions and lower-level instructions used for Open User Communication

Open User Communication	CPU 1504D TF	CPU 1507D TF
TSEND TUSEND	384	
TRCV TURCV	384	
TCON	384	
TCONSettings	384	
TDISCON	384	
T_RESET	384	
T_DIAG	384	
T_CONFIG	1	
TSEND_C	Uses TSEND, TUSEND, TRCV, TCON, TDISCON	
TRCV_C	Uses TSEND, TUSEND, TRCV, TURCV, TCON, TDISCON	
TMAIL_C	Uses TSEND, TUSEND, TRCV, TURCV, TCON, TDISCON	

Table 10- 7 Lower-level instructions used for asynchronous instructions for MODBUS TCP

MODBUS TCP	CPU 1504D TF	CPU 1507D TF
MB_CLIENT	Uses TSEND, TUSEND, TRCV, TURCV, TCON, TDISCON	
MB_SERVER	Uses TSEND, TUSEND, TRCV, TURCV, TCON, TDISCON	

Table 10- 8 Maximum number of simultaneous jobs for asynchronous instructions for S7 communication. The S7 communication instructions use a common pool of resources.

S7 communication	CPU 1504D TF	CPU 1507D TF
PUT GET USEND URCV BSEND BRCV	1152	

Table 10- 9 Lower-level instructions used for asynchronous instructions for communication processors

Communications processors	CPU 1504D TF	CPU 1507D TF
PtP communication		
Port_Config	Uses RDDEC, WRREC	
Send_Config	Uses RDDEC, WRREC	
Receive_Config	Uses RDDEC, WRREC	
Send_P2P	Uses RDDEC, WRREC	
Receive_P2P	Uses RDDEC, WRREC	
Receive_Reset	Uses RDDEC, WRREC	
Signal_Get	Uses RDDEC, WRREC	
Signal_Set	Uses RDDEC, WRREC	
Get_Features	Uses RDDEC, WRREC	
Set_Features	Uses RDDEC, WRREC	
USS communication		
USS_Port_Scan	Uses RDDEC, WRREC	
MODBUS (RTU)		
Modbus_Comm_Load	Uses RDDEC, WRREC	
ET 200S serial interface		
S_USSI	Uses CREATE_DB	
SIMATIC NET CP (cannot be used with SIMATIC Drive Controller; SIMATIC NET CPs cannot be used in distributed I/O stations)		
FTP_CMD	Uses TSEND, TRCV, TCON, TDISCON	

Table 10- 10 Maximum number of simultaneous jobs – OPC UA

OPC_UA	**CPU 1504D TF**	**CPU 1507D TF**
OPC_UA_Connect	10	
OPC_UA_Disconnect	10	
OPC_UA_NamespaceGetIndexList	10	
OPC_UA_NodeGetHandleList	10	
OPC_UA_NodeReleaseHandleList	10	
OPC_UA_TranslatePathList	10	
OPC_UA_Browse	10	
OPC_UA_ReadList	10	
OPC_UA_WriteList	10	
OPC_UA_MethodGetHandleList	10	
OPC_UA_MethodReleaseHandleList	10	
OPC_UA_MethodCall	10	
OPC_UA_ServerMethodPre	10	
OPC_UA_ServerMethodPost	10	
OPC_UA_ConnectionGetStatus	10	

Technology: maximum number of simultaneously running jobs

Table 10- 11 Maximum number of simultaneous jobs for asynchronous instructions for technology. The instructions for technology use a common pool of resources.

Technology	CPU 1504D TF	CPU 1507D TF
S7-1500 Motion Control		
MC_Power MC_Reset MC_Home MC_Halt MC_MoveAbsolute MC_MoveRelative MC_MoveVelocity MC_MoveJog MC_MoveSuperimposed MC_SetSensor MC_Stop MC_WriteParameter MC_SetAxisSTW MC_MeasuringInput MC_MeasuringInputCyclic MC_AbortMeasuringInput MC_OutputCam MC_CamTrack MC_CopyCamData MC_GearIn MC_GearInPos MC_PhasingRelative MC_PhasingAbsolute MC_OffsetRelative MC_OffsetAbsolute MC_CamIn MC_SynchronizedMotionSimulation MC_GearOut MC_CamOut MC_LeadingValueAdditive MC_InterpolateCam MC_GetCamFollowingValue MC_GetCamLeadingValue MC_MotionInVelocity MC_MotionInPosition MC_TorqueLimiting MC_TorqueAdditive MC_TorqueRange MC_GroupInterrupt MC_GroupContinue	6400	

Technology	CPU 1504D TF	CPU 1507D TF
MC_GroupStop MC_MoveLinearAbsolute MC_MoveLinearRelative MC_MoveCircularAbsolute MC_MoveCircularRelative MC_MoveDirectAbsolute MC_MoveDirectRelative MC_TrackConveyorBelt MC_KinematicsMotionSimulation MC_DefineWorkspaceZone MC_DefineKinematicsZone MC_SetWorkspaceZoneActive MC_SetWorkspaceZoneInactive MC_SetKinematicsZoneActive MC_SetKinematicsZoneInactive MC_DefineTool MC_SetTool MC_SetOcsFrame MC_KinematicsTransformation MC_InverseKinematicsTransformation		

Additional information

You can find additional information on block parameter assignment in the STEP 7 online help.

Protection

11

11.1 Overview of the protection functions

Introduction

This section describes the functions for protection from unauthorized access:

- Protection of confidential configuration data
- Access protection
- Know-how protection
- Protection by locking the CPUs

Further measures for protecting the CPU

The following measures additionally increase the protection against unauthorized access to functions and data of the CPU from external sources and via the network:

- Deactivation of the Web server
- Deactivation of the OPC UA server (you can find more information on the security mechanisms for OPC UA server in the Communication (https://support.industry.siemens.com/cs/ww/en/view/59192925) Function Manual)
- Deactivation of the time synchronization via an NTP Server
- Deactivation of the PUT/GET communication
- Deactivation of SNMP

When using the web server, you protect your automation system against unauthorized access:

- By setting password-protected access rights for specific users in the user management.
- By using the preset option "Permit access only with HTTPS".
  The option allows access to the web server only with the secure hypertext transfer protocol (HTTPS).

When you use the OPC UA server, protect your automation system against unauthorized access:

- By not setting up OPC UA server access for the "Anonymous" user.
- By disabling the "Automatically accept client certificates during runtime" option.

11.2 Protection of confidential configuration data

As of STEP 7 V17, you have the option of assigning a password for protecting confidential configuration data of the respective CPU. This refers to data such as private keys that are required for the proper functioning of certificate-based protocols.

You can find detailed information on protecting confidential configuration data in the Communication function manual (https://support.industry.siemens.com/cs/ww/en/view/59192925).

11.3 Local user management

11.3.1 Useful information on the local user administration and access control

As of TIA Portal version V19 and CPU firmware version V3.1, SIMATIC Drive Controller feature improved management of users, roles and CPU function rights (User Management & Access Control, UMAC).

From the versions mentioned above onwards, you manage all project users along with their rights (for example, access rights) for all CPUs in the project in the editor for users and roles of the project in the TIA Portal:

- Navigate to the "Security Settings > Users and roles" area in the project tree to manage users with their rights, for example, to control access rights.

The TIA Portal saves the assignment of the function rights of a CPU to user-defined roles and the assignment of these roles to users for each CPU. There are no system-defined roles with predefined function rights for CPUs.

After loading the configuration, the user management becomes effective in the respective CPUs. After loading, every CPU "knows" who may access which service and execute certain functions.

This new feature is also called "local user management and access control" below.

Note

No global user support for CPU function rights

Another option for user management in the TIA Portal is the central user management UMC (User Management Component). With this component you manage global users on connected servers, e.g. also via the connection of an MS Active Directory. The authentication is then implemented via UMC. A global user management for CPU-specific function rights via UMC is currently not supported.

Users, roles and function rights - details of new features

Users and roles were already being managed in the predecessor version by TIA Portal under "Security settings > Users and roles". In addition to the existing user management for HMI devices, for example, you can also manage all CPU function rights via this editor as of TIA Portal Version V19.

The CPU function rights are valid during runtime. Therefore, these rights are located in the "Runtime rights" tab in the editor for users and roles. For each CPU in the project, there is a section with all CPU function rights to choose from - separated according to CPU services such as PG/HMI communication (engineering access, access levels), CPU web server and OPC UA.

In addition to the user management for projects, there were additional user managements for CPU web servers and OPC UA servers (static user management for CPUs up to FW version V3.0) in the properties of the CPU:

- User for the OPC UA server (authentication)
- User for the CPU web server (authentication and access control)

These additional user managements are integrated in the local user management in the project tree as of TIA Portal V19 and as of CPU FW version V3.1.

Introduction to the local user management and access control

For SIMATIC Drive Controllers up to CPU firmware version V3.0, you have managed the users separately according to services such as "Web server" and "OPC UA" under the respective CPU properties. Web server users were parameterized in the "Web server" area, OPC UA users in the "OPC UA" area.

To restrict the PG/HMI access to the CPU at different levels, you configured passwords for the corresponding access levels. With this procedure, for example, HMI accesses could be permitted without restriction, but write accesses could be made dependent on the knowledge of a password. You have agreed passwords for the different access levels in the "Protection & Security" area of the CPU properties. The access protection therefore always related to groups that have the appropriate passwords - not to individual users.

With the introduction of the local user management and access control from TIA Portal version V19 onwards, you can use the "Security settings > Users and roles" area in TIA Portal in the project tree for all users and their roles and function rights of a CPU. This also applies to the access protection for engineering/HMI access, which as of TIA Portal version V19 no longer works via access levels with password protection by default, but also via user management.

You can find more information about the new access protection in the section From the access level to the function right of users (Page 242).

As already introduced for engineering rights, for example, you use the role assignments for combining individual function rights. In a further step, you assign the roles to individual users. All the function rights which were assigned to a user via roles and which the user can exercise for the corresponding CPU are listed In the "Assigned rights" tab.

The following figure shows an example of the available and activated function rights of a CPU. At least one user must have full access to the CPU, otherwise the configuration will not be compiled. To do this, a role with full access to the CPU must first be created.

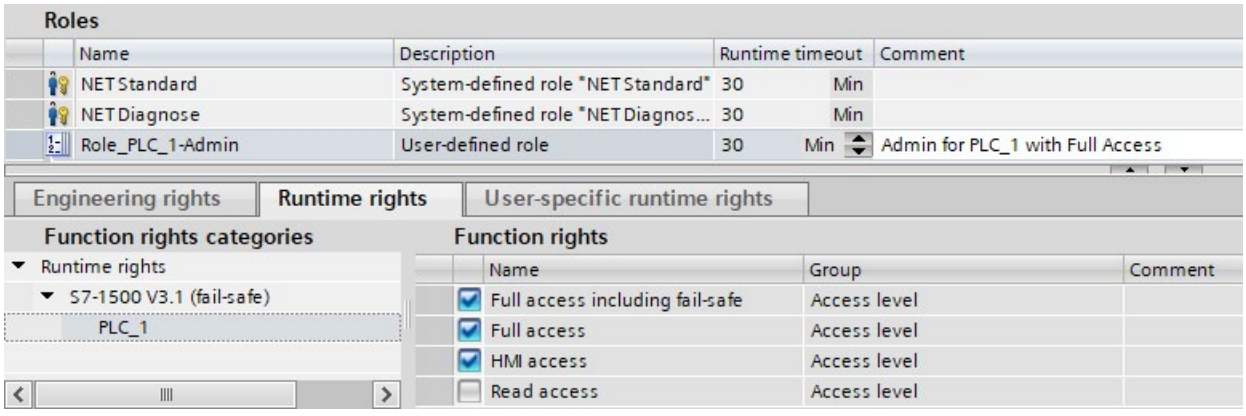


Figure 11-1 Assigning function rights of a CPU to a role

The following figure shows the assignment of the role with full access to a user ("Admin").

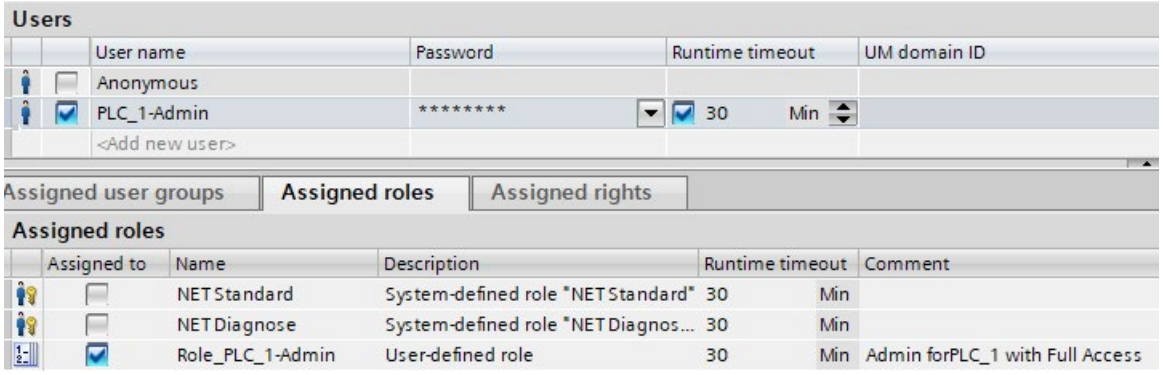


Figure 11-2 Assigning a role to a user

Requirement

CPU parameterization: To be able to use users, roles and function rights for a CPU, the "Enable access control" option in the "Protection & Security > Access control" tab must be checked.

No project protection is required for local user management.

Default characteristics

The "Activate access control" option is preset for the access control. Users, with their assigned passwords as well as their roles and function rights, can be parameterized.

Downloading to device

You can load configuration changes with regard to the local user management and access control in the STOP and RUN mode of the CPU.

Runtime timeout

You can set a runtime timeout for both the role and the user in "Security settings > Users and roles".

For a CPU, these settings are taken into account by the various services as follows:

- By means of the Web API you can, for example, create a web page or application that takes the settings for the runtime timeout into account. Standard web pages do not take the settings for the runtime timeout into account and use the default value.
- The other services (PG/HMI communication and OPC UA server) do not use the runtime timeout; the logged-in user is not logged out after the set time.

11.3.2 Advantages of the local user administration and access control

The following section discusses the advantages provided by the new local user management for SIMATIC Drive Controller and what changes for you.

Quick activation/deactivation of local user management

The options for user management are located in the "Protection & Security > Access control" tab:

- Access control deactivated: Every user has full access to all functions with the exception of the GDS Push function for the online transfer of certificates.

  ⚠ DANGER

  Disabled access control carries the risk of unauthorized access and thus the risk of personal injury and property damage.

  Only use this setting in a protected environment, for example during commissioning.

- Access control enabled: The configured users with their assigned roles and concomitant linked function rights become effective after loading.

Access protection for PG/HMI accesses, now with user authentication

While it was possible to configure passwords for access levels for SIMATIC Drive Controllers with CPU firmware versions <V3.1, with the current SIMATIC Drive Controllers, you can now configure users with the corresponding function rights. This means that the authentication options for PG/HMI access correspond to the options offered by OPC UA or web server accesses.

All in one place

Irrespective of the service for which you configure users, roles and rights for a CPU: You have to manage the data at the same location.

All users, no matter if you manage their engineering rights for the project or their local runtime rights for each CPU in the project, can be found in the editor for users and roles in the project tree.

Powerful password functions

- Support for compliance with complexity rules for password creation:
  Right from the password creation stage, you can have the TIA Portal check compliance with complexity rules, such as the password length, uppercase/lowercase letters. (Project tree, "Security settings > Settings" area).
  The complexity rules are also saved in the CPU upon loading the user management. When the password is changed online, the CPU determines and considers these rules. This prevents a user from overriding the complexity rules set by the configuration engineer and assigning a non-secure password.
- The period of validity of passwords is adjustable:
  To ensure that a user does not have access to the CPU with a compromised password for an unlimited time, you can parameterize a period of validity. Before the period of validity expires, the remaining time is then displayed on login so that each user has the possibility to change their password in time.

Loading the user management during operation

As of firmware version V3.1, you can load certain security-relevant configuration data both in the STOP mode and in the RUN mode. Therefore, loading the hardware configuration does not necessarily lead to a STOP of the CPU.

You can make the following changes in the STOP mode as well as in the RUN mode (Download to device > Hardware configuration):

- Local user management extended/changed
- TIA Portal-configured certificates added/changed
- Syslog configuration changed

If you have made additional changes to the hardware configuration (for example, adding modules, re-parameterization, etc.), the CPU automatically prompts for the STOP state before loading.

Therefore, when you load just one user with modified roles/function rights to the CPU, for example, this process does not require any STOP state of the CPU.

The preview dialog for loading contains a security area so that you can determine when loading how the CPU should deal with user data that has changed in the meantime (not when loading for the first time). This allows changes to user data (e.g. password changes during runtime) to be retained.

Loading the device as a new station - with user data

If you load an already configured CPU into a new project, for example, because you do not have the original project, the user data is loaded into the project and is available for further processing of the CPU settings.

Changing of passwords during operation

You can use the CPU web server API to write an application with which each user can change their password at runtime, provided that the original password has been entered correctly and the new password corresponds to the set password guideline.

Requirement: You have enabled access control for the CPU.

A user can change their own password at any time, even if the password has expired. If the password has expired, the user must change the password. If the password has expired, it is not possible to log in.

API methods used:

- Api.ChangePassword
- Api.GetPasswordPolicy

You can find more information about the API methods in the Web Server Function Manual (https://support.industry.siemens.com/cs/ww/en/view/59193560).

Note

Passwords changed at runtime take priority over loaded passwords

If you have changed your password during running operation and subsequently load your project, the password assigned during runtime takes precedence over the password set in the project (default setting).

If you want to overwrite the passwords changed during runtime by loading the project, you have to select the option "Load all user management data (reset to project data)". In this case, **all** passwords changed at runtime are lost!

11.3.3 From the access level to the function right of users

The following section shows how to implement access protection with the new local user management for SIMATIC Drive Controllers.

Access levels as function rights

If accesses could only be controlled via passwords for SIMATIC Drive Controller up to CPU FW version V3.0, create the appropriate users and roles with the necessary function rights for access control for SIMATIC Drive Controller as of CPU FW version V3.1. The assignment between access level and the associated function right results from the already known access levels:

- Users who are to have full access must have a role with the function right "Full access", or "Full access incl. failsafe" for F-CPUs.

  A CPU configuration can only be compiled and loaded if at least one user has the function right "Full access" or "Full access incl. failsafe".
- Users who are to have read access must have a role with the function right "Read access".
- Users who are to have HMI access must have a role with the function right "HMI access".

If a user does not have any of these specified function rights, that user also has no access to the CPU.

The hierarchical organization of the access levels also remains the same for the corresponding function rights:

- A user with full access also has the function rights "Read access" and "HMI access".
- A user with read access also has the function right "HMI access".

Note

Compatibility of the "ENDIS_PW" instruction

The "ENDIS_PW" instruction can be used only to disable or enable passwords for protection levels. The "ENDIS_PW" instruction has no effect on assigned rights for users or roles.

Continuing to use access levels

Even though the new local user management replaces the usual access protection via corresponding function rights of individual users, there is still the possibility to continue to use this familiar access protection. This is required, for example, for HMI devices which only support access levels and which do not benefit yet from possibilities of the new user management.

If you require the configuration of an access level, for example, to ensure an HMI device access even without user or password access, you have to activate the "Use legacy access control via access levels" option in the CPU properties.

Note

User for OPC UA and for the web server

Regardless of the access protection, you always have to configure the users for the web server and for the OPC UA server in the project tree in the "Security settings > Users and roles" area.

Restrictions on continued use of the access levels

When using the "Legacy access control" option, you cannot select the access level directly in the table for setting the access levels. This selection can only be set for the new local user management in one way: Via the access protection function rights of the "Anonymous" user.

The local user "Anonymous" is created in a project by the system by default. With the help of this user, you determine the behavior of the CPUs in the project for someone who logs in without a user name and password. For security reasons, the anonymous user is deactivated and needs to be activated before use.

The area where you set the access levels leads you via a link to the editor for the required settings for the "Anonymous" user.

Examples:

- If the "Anonymous" user is deactivated or if the "Anonymous" user is activated and no function rights are assigned to that user, then nobody can log in without a user name and password (corresponds to the access level "No access (complete protection").
- If the "Anonymous" user is activated and the "Full access" function right for a CPU is assigned to that user via a corresponding role, the result of this setting is "No protection". You can achieve the same effect with regard to access protection by setting "No access protection" in the "Protection & Security" area of the CPU properties.

Procedure

To activate the "Legacy access control" and set the required access level, follow these steps:

1. In the CPU properties, go to "Protection & Security > Access control".
2. Select the option "Activate access control" and, in addition, select the check box "Use legacy access control via access levels" check box.

   The access level selection cannot be used in this setting. You have to set the access level via the "Anonymous" user of the CPU.

   The "Anonymous" user is disabled in the default setting. This means that the resulting access level for users without a password is "No access (complete protection)" (default setting).
3. Go to "Security settings > Users and roles" in the project tree.
4. Activate the "Anonymous" user, if you want to set a different access level than "No access (complete protection)". You can assign a role with function rights that grants access to the CPU without password input, only to the activated "Anonymous" user.
5. You cannot assign function rights for a CPU directly to a user. You must first assign a role: Therefore switch to the "Roles" tab and add a new role. Assign a meaningful name, e.g. "PLC1-Read-Access-Role". If you assign this role to a user, this user should have read access to PLC1 during operation.

6. Assign the required function right for the access to the CPU with the name "PLC1" to the role "PLC1-Read-Access-Role" - in this case "Read access".
7. Switch to the "User" tab and assign the "PLC1-Read-Access-Role" role to the activated "Anonymous" user.

   Result: The "Anonymous" user has read access for PLC1. This means that the access level tables of the CPU "PLC1" in the project are preset to "Read access" (cannot be changed) and users who are not logged in only have read access.

   For full access, or full access including fail-safe, you have to configure a password for the full access in the table for the access protection. Users who need full access to the CPU during runtime via an action, e.g. because a project is to be loaded onto the CPU, must legitimize themselves for this action with this password.

Tip

To make the user rights transparent, use meaningful names for the respective roles. You create users and roles for the entire project; you must select the function rights of a role individually for each CPU in the project. With a descriptive name you can, for example, immediately see which CPUs have read access and which CPUs are fully protected.

11.3.4 Information about compatibility

In the following sections, you can find information on the behavior of the SIMATIC Drive Controller with the local user management, e.g. when replacing modules in STEP 7 and for further use of projects and programs without local user management.

Replacement part scenario

If you replace a SIMATIC Drive Controller with a CPU firmware version < V3.1 with a SIMATIC Drive Controller with a CPU firmware version V3.1 or higher, the program stored on the memory card runs like the original SIMATIC Drive Controller. The behavior with regard to the configured access levels, the users for the OPC UA server and the web server, corresponds to the original SIMATIC Drive Controller.

In this case, the "Change password function" via the web server API is not accepted by the CPU because the CPU has been configured for firmware version < V3.1 and has no local user management.

Replace CPU (upgrade)

If you replace a SIMATIC Drive Controller (CPU FW < V3.1) with a current SIMATIC Drive Controller (as of CPU FW V3.1) in the TIA Portal, this has the following effects on the configured user data:

- The user data from the OPC UA server and web server is transferred to the "Users and roles" editor in the project navigation.

  NOTICE

  Passwords are lost when replacing the SIMATIC Drive Controller

  Before replacing the SIMATIC Drive Controller, make sure that the passwords are available. They must be entered again in the "Users and roles" editor. Otherwise, you have to assign new passwords and inform the users.

- A corresponding role is created for each web server user in the "Users and roles" editor; the name of the role contains the CPU name, the "Web" string and the already configured web server user name. In this way, by assigning these roles in the "Users and roles" editor, you can easily restore the original rights for each CPU.
- The "OPC UA server access" role is created for each OPC UA server user.
- OPC UA guest access and the web server "Everybody" are migrated to the "Anonymous" user.
- Each OPC UA user and each web server user is listed in the "User" column in the editor for users and roles. If the names are the same (web server and OPC UA user), only one user is created.
- In the case of a protected project, you can select which action the SIMATIC Drive Controller performs:
  - Migrate user (requirement: You are logged in as a user with the right to manage users and roles and the right to edit the project/configuration)
  - Remove user
  - Cancel
- The "Legacy access control via access levels" option is set for access protection.

Replace CPU (downgrade)

If you replace a SIMATIC Drive Controller (as of FW V3.1) with a previous version (< CPU FW V3.1) in the TIA Portal, this has the following effects on the configured user data:

- The local user management is no longer available.
- Users with function rights for the web server are not transferred.
- Users of the OPC UA server remain with their user rights in the "Users and roles" editor. No users are moved to the "OPC UA" area of the CPU parameters.
- It is no longer possible for users to change passwords during runtime (via web server API).

11.4 Configuring access protection for the CPU

Introduction

The following section describes how to use the various access levels of the CPUs. The description applies to SIMATIC Drive Controllers up to CPU firmware version V3.0.

In later CPU firmware versions, use the local user management in the editor for users and roles in the project tree. The access levels are represented there by function rights of the same name which you assign to individual users via roles.

The SIMATIC Drive Controller offers you different access levels to limit access to specific functions.

By setting up access levels and passwords, you limit the functions and memory areas that are accessible without a password. The individual access levels and corresponding passwords are specified in the object properties of the CPUs.

Rules for passwords

Ensure that passwords are sufficiently secure.
Apply the following rules:

- Assign a password that is at least 8 characters long.
- Use different cases and characters: uppercase/lowercase, numbers and special characters.

Access levels for the CPUs

Table 11- 1 Access levels and access restrictions

Access levels	Access restrictions
Full access including failsafe (no protection)	Users of the TIA Portal and HMI applications will have access to all standard and failsafe functions. A password is not required.
Full access (no protection)	Users of the TIA Portal will have access to standard functions. HMI applications can access all functions (failsafe and standard). **Required password:** For additional access to failsafe functions, the TIA Portal user must enter the password for "Full access including failsafe".
Read access	In this access level, only read access to the hardware configuration and the blocks is possible without a password. HMI access and access to diagnostics data is also possible. Neither blocks nor the hardware configuration can be downloaded to the CPUs without the password. The following actions are **not** possible without the password either: Writing test functions and firmware updates (online).

Access levels	Access restrictions
HMI access	The same access restrictions apply to HMI access as to read access. The following actions are **not** possible without the password either: Change of operating state (RUN/STOP) and display of online/offline comparison status.
No access (complete protection)	When the CPUs have complete protection, no read or write access to the hardware configuration or blocks is possible (without access authorization in the form of a password). HMI access is not possible either. Authentication with the correct password provides full access to the CPUs again.

Additional information

You can find a list of which functions are possible in the various protection levels in the STEP 7 online help under "Setting options for protection".

Properties of the access levels

Each access level allows unrestricted access to certain functions without a password, for example identification using the "Accessible devices" function.

The default of the CPUs is "No access (complete protection)". In the default access level, the user is not allowed to read or modify the hardware configuration or the blocks. To get access to the CPUs, assign parameters alternatively in the properties of the CPU:

- A password for the "No access (complete protection)" level of protection
- Another level of protection, e.g. "Full access (no protection)"

Communication between the CPUs via the communication functions in the blocks is not restricted by the access level of the CPUs.

Entering the correct password enables access to all the functions that are allowed in the given level.

Note

Configuring an access level does not replace know-how protection

Configuring access levels offers a high degree of protection against unauthorized changes to the CPU through network access. Access levels restrict the rights to download the hardware and software configuration to the CPUs. However, blocks on the SIMATIC Memory Card are not write-protected or read-protected. Use know-how protection to protect the code of blocks on the SIMATIC Memory Card.

Behavior of functions in different access levels

The STEP 7 online help includes a table listing the online functions available in the various access levels.

Configuring access levels

Proceed as follows to configure the access levels for the CPUs up to CPU FW version V3.0:

1. Open the properties of the CPUs in the Inspector window.
2. Open "Protection & Security" in the area navigation.

   A table with the possible access levels appears in the Inspector window.

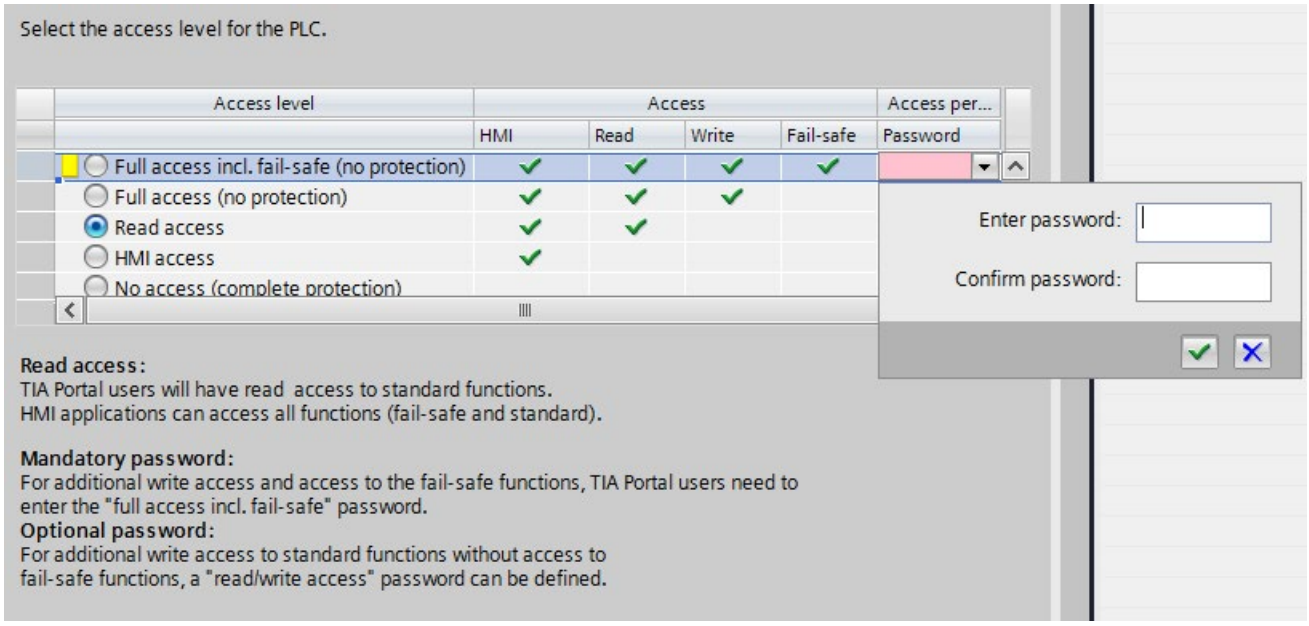


Figure 11-3 Possible access levels of a CPU up to CPU FW version V3.0

3. Activate the required protection level in the first column of the table. The green check marks in the columns to the right of the access level show which operations are still possible without entering the password. In the example (Figure: Possible access levels), read access and HMI access are still possible without a password.
4. In the "Enter password" column, specify a password for the access level "Full access including failsafe" in the first row. In the "Confirm password" column, enter the selected password again to avoid incorrect entries.
5. Assign additional passwords as required for other access levels.
6. Download the hardware configuration for the access level to take effect.

The CPUs log the following actions with an entry in the diagnostics buffer:

- Input of the correct or incorrect password
- Changes to access level configuration

Behavior of a password-protected CPU during operation

The protection of the CPUs up to CPU FW version 3.0 takes effect for an online connection after you have loaded the settings into the CPUs. If you set a higher access level and download it to the CPU, all other online connections will be interrupted. You will then need to establish a new online connection.

Before an online function is executed, the necessary permission is checked and, if necessary, the user is prompted to enter a password. The password only provides access to protected functions for the local PG/PC on which the password is entered.

Access authorization to the protected data applies for the duration of the online connection or for as long as you have STEP 7 open. The menu command "Online > Clear access rights" cancels the access authorization.

Access levels for F-CPUs

You can find more information on the access level "Full access incl. fail-safe (no protection)" for the fail-safe CPUs up to CPU FW version V3.0 in the description of the F-system SIMATIC Safety Programming and Operating Manual SIMATIC Safety – Configuring and Programming (https://support.industry.siemens.com/cs/ww/en/view/54110126).

Restricting access to SINAMICS Integrated

Note

You can find a description of how to limit access to specific functions on SINAMICS Integrated in the section Secure operation of SINAMICS Integrated (Page 52).

11.5 Using the user program to set additional access protection

Access protection with the user program

You can also restrict access to a password-protected CPU using the ENDIS_PW instruction in STEP 7.

You can find more information on this instruction in the STEP 7 online help under "ENDIS_PW: Limit and enable password legitimation".

11.6 Know-how protection

Application

You can use know-how protection to protect one or more OB, FB or FC blocks as well as global data blocks in your program from unauthorized access. Enter a password to restrict access to a block. The password offers high-level protection against unauthorized reading and manipulation of the block. Know-how protection does not involve the CPU (offline access in STEP 7).

Note

You can learn how to prevent unauthorized persons from reading your company's strictly confidential configuration and parameter assignment know-how in SINAMICS Integrated in the section Secure operation of SINAMICS Integrated (Page 52).

Password provider

As an alternative to manual password input, you can assign a password provider to STEP 7. When using a password provider, you select a password from a list of available passwords. When a protected block is opened, STEP 7 connects to the password provider and retrieves the corresponding password.

You need to install and activate a password provider before you can connect it. A settings file in which you define the use of a password provider is also required.

A password provider offers the following advantages:

- The password provider defines and manages the passwords. When know-how protected blocks are opened, you work with symbolic names for passwords. For example, a password is marked with the symbolic name "Machine_1" n the password provider. The actual password behind "Machine1" is disclosed to you.
  A password provider therefore offers optimum block protection as the users do not know the password themselves.
- STEP 7 automatically opens know-how protected blocks without the direct entry of a password. This saves you time.

You can find more information on connecting a password provider in the STEP 7 online help.

Readable data

If a block is know-how protected, only the following data is readable without the correct password:

- Block title, comments and block properties
- Block parameters (INPUT, OUTPUT, IN, OUT, RETURN)
- Call structure of the program
- Global tags without information on the point of use
- Static tags

Further actions

Further actions that can be carried out with a know-how protected block:

- Copying and deleting
- Calling in a program
- Online/offline comparison
- Loading

Global data blocks and array data blocks

You protect global data blocks (global DBs) from unauthorized access with know-how protection. If you do not have the valid password, you can read the global data block but not change it.

Know-how protection is not available for array data blocks (array DBs).

Setting up block know-how protection

Proceed as follows to set up block know-how protection:

1. Open the properties of the block in question.
2. Select the "Protection" option under "General".

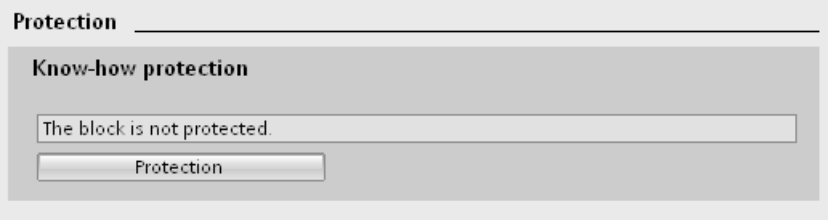


Figure 11-4 Setting up block know-how protection

3. Click the "Protection" button to display the "Define password" dialog.



Figure 11-5 Select password

4. Enter the new password in the "New password" box. Enter the same password in the "Confirm password" box.

5. Click "OK" to confirm your entry.
6. Close the "Know-how protection" dialog by clicking "OK".

Result: The blocks selected are know-how-protected. Know-how protected blocks are marked with a padlock in the project tree. The password entered applies to all blocks selected.

Note

Password provider

Alternatively, you can set up know-how protection for blocks with a password provider.

Opening know-how protected blocks

Proceed as follows to open a know-how protected block:

1. Double-click on the block to open the "Access protection" dialog.
2. Enter the password for the know-how protected block.
3. Click "OK" to confirm your entry.

Result: The know-how-protected block opens.

After opening the block you can edit the program code and the block interface of the block until you close the block or STEP 7. You need to enter the password again the next time you open the block. If you close the "Access protection" dialog with "Cancel", the block will open but the block code will not be displayed. You will not be able to edit the block.

If you copy the block or add it to a library, for example, this does not cancel the know-how protection of the block. The copies will also be know-how-protected.

Changing block know-how protection

Proceed as follows to change block know-how protection:

1. Select the block for which you want to change know-how protection. The protected block must not be open in the program editor.
2. In the "Edit" menu, select the "Know-how protection" command to open the "Change protection" dialog.
3. To change the password for know-how protection, enter the current password under "Old password".
4. Now enter a new password under "New password" and confirm the password under "Confirm password".
5. Click "OK" to confirm your entry.

Result: The password for know-how protection of the selected block has been changed.

Removing block know-how protection

Proceed as follows to remove block know-how protection:

1. Select the block from which you want to remove know-how protection. The protected block must not be open in the program editor.
2. In the "Edit" menu, select the "Know-how protection" command to open the "Change protection" dialog.



Figure 11-6 Removing know-how protection

3. To remove block protection, enter the current password under "Old password". Leave the fields for the new password blank.
4. Click "Remove" to confirm your entry.

Result: Know-how protection for the selected block has been canceled.

11.7 Copy protection

Application

The copy protection allows you to protect your program against unauthorized duplication. With copy protection, you link a block to the serial number of the SIMATIC Memory Card or the SIMATIC Drive Controller. The link to the serial number means that you can only use the block in conjunction with the corresponding SIMATIC Memory Card or the corresponding SIMATIC Drive Controller.

Note

You can find out how to protect the settings of your drive device in SINAMICS Integrated from unauthorized copying in the section Secure operation of SINAMICS Integrated (Page 52).

Copy and know-how protection

Recommendation: To prevent an unauthorized reset of the copy protection, provide a copy-protected block with additional know-how protection. First set up the copy protection for the block and after this the know-how protection. You can find additional information on setting up know-how protection in Know-how protection (Page 251).

Setting up copy protection

To set up copy protection, follow these steps:

1. Open the properties of the respective block.
2. Select the "Protection" option under "General".
3. In the "Copy protection" area, select either the "Bind to serial number of the CPU" entry or the "Bind to serial number of the memory card" entry from the drop-down list.

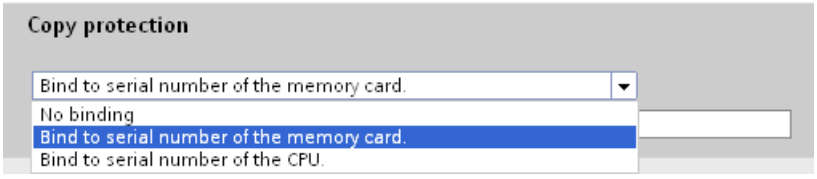


Figure 11-7 Setting up copy protection

4. Activate the option "Serial number is inserted when downloading to a device or a memory card" if STEP 7 is to automatically insert the serial number during the loading process (dynamic binding). Assign a password using the "Define password" button to link the use of a block additionally to the input of a password.
   If you want to manually bind the serial number of the SIMATIC Drive Controller or the SIMATIC Memory Card to a block (static binding), activate the "Enter serial number" option.
5. You can now set up know-how protection for the block in the "Know-how protection" area.

Note

If you download a copy-protected block to a device that does not match the specified serial number, the entire download operation is not possible. This means that you cannot download blocks without copy protection either.

Removing copy protection

To remove copy protection, follow these steps:

1. Remove any know-how protection.
2. Open the properties of the respective block.
3. Select the "Protection" option under "General".
4. In the "Copy protection" area, select the "No binding" entry from the drop-down list.

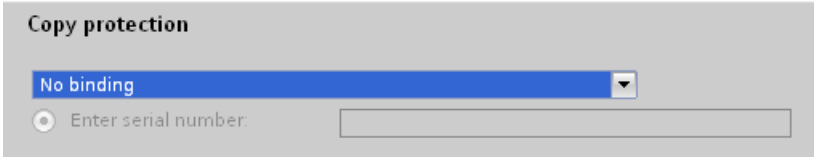


Figure 11-8 Removing copy protection

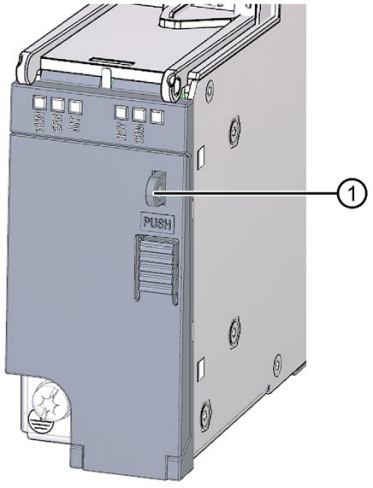
11.8 Protection by locking the CPU

Locking options

Provide additional protection for your CPUs from unauthorized access (for example to the SIMATIC Memory Card) by using a secure cover.

You have the following options, for example:

- Attach a seal
- Secure the cover with a lock (shackle diameter: 3 mm)



① Eye for seal or padlock

Note

Protection with a seal or padlock only prevents "easy" access to the SIMATIC memory card and operator controls. It does not provide protection from targeted tampering; this must be ensured with other measures (for example through the control cabinet).

Flexible automation concepts 12

12.1 Standard machine projects

Introduction

Standard machine projects are STEP 7 projects that use innovative functions. You can easily configure and commission flexible automation solutions for standard machines or for machines with a modular structure.

In the hardware configuration of a standard machine, the SIMATIC Drive Controller is an IO controller to which any number of IO devices are connected. The SIMATIC Drive Controller therefore represents a PROFINET IO system master. This master is configured with a maximum configuration that can be used as a basis from which to derive various different standard machines using options. Alongside a range of software functionalities, each option therefore also has a range of IO system configuration variants.

Greater flexibility at all levels

Standard machine projects have central features:

- From exactly one project (IO system master) with configured maximum configuration, you can load different versions of a standard machine (IO system options). The standard machine project covers all variants (options) of the IO system.
- An IO system option can be integrated into an existing network locally using simple tools.

Flexibility is provided in more ways than one:

- With a suitable configuration, you can adapt the IP address parameters of the IO controller locally using simple tools. This allows you to integrate a standard machine in different plants with little effort or to connect multiple machine modules of the same type in a network.
  IO systems with this property are known as **multiple use IO systems**.
- With suitable configuration and programming, you can operate different setups of IO system options locally. The IO system options differ in terms of the selection of IO devices used or in terms of the arrangement of the IO devices.
  The user program controls the specific configuration of the IO system. The function is therefore called **Configuration control for IO systems**.
- Independently of the functions described above, you can use different station options of distributed I/O devices in one project through suitable configuration and programming. The devices can be different in terms of selection and arrangement of the modules.
  The user program controls the specific configuration of the station. The function is therefore called **Configuration control**.

Modular machines with SINAMICS drives

The modular machine concept is based on a maximum target topology created in the commissioning tool "offline". A maximum configuration is the maximum configuration of a specific machine type. All machine components used in that machine type are preconfigured in the target topology. You remove parts of the maximum configuration by deactivating/removing drive objects (p0105 = 2).

Activating and deactivating SINAMICS components

The SINAMICS S120 drive components, including the control instances, are described in a parameter object model. You can enable/disable drives including their closed loop control or individual components using the following parameters:

- Enable/disable drive objects (including on Terminal Modules):
  - Adjustable parameter p0105 (Enable/disable drive object)
  - Display parameter r0106 (Drive object enabled/disabled)
- Enable/disable power units:
  - Adjustable parameter p0125 (Enable/disable power unit component)
  - Display parameter r0126 (Power unit components enabled/disabled)
- Enable/disable encoders (on Motor Modules):
  - Adjustable parameter p0145 (Enable/disable encoder interface)
  - Display parameter r0146 (Encoder interface enabled/disabled)
- Enable/disable Voltage Sensing Module (on Line Modules)
  - Adjustable parameter p0145 (Enable/disable Voltage Sensing Module)
  - Display parameter r0146 (Voltage Sensing Module enabled/disabled)

Note

Please check the description and the constraints for the individual parameters in the SINAMICS S120/S150 list manual (https://support.industry.siemens.com/cs/ww/en/view/109822659).

Example of partial topology with SINAMICS components

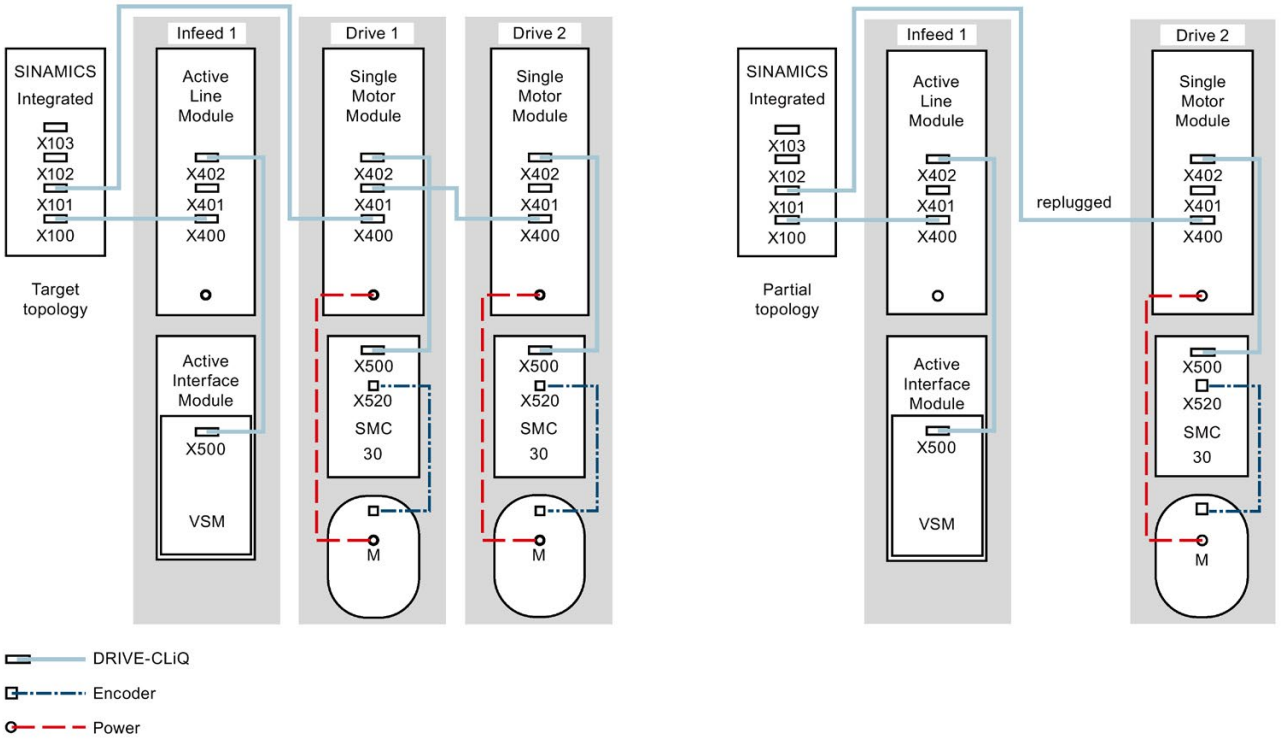


Figure 12-1 Example: Partial topology with SINAMICS components

A machine has been configured for one Active Line Module and two Motor Modules. The configuration has been saved on the SIMATIC Memory Card (target topology).

- While the machine is off, "Drive 1" is removed and the DRIVE-CLiQ cable is unplugged from the SIMATIC Drive Controller and connected directly to "Drive 2" (partial topology, actual topology).
- During power up, SINAMICS Integrated detects a difference between the target and actual topology.
- The user program executes the following actions:
  - Set drive object (DO) "Drive 1" to "deactivate and not available". For this action, the user program must set the p0105 = 2 parameter in this DO.
  - Save all parameters to non-volatile memory on the SIMATIC Memory Card. For this action, the user program must set parameter p0977 = 1.

This saves the actual topology as the target topology. An error will not be triggered in the next power up.

Note

Errors in Safety Integrated status display

If a drive that was grouped for a Safety Integrated line-up is disabled with p0105, the parameter r9774 will not be correctly output. The signals of a disabled drive are not updated.

Overview of key parameters for SINAMICS components

Table 12- 1 Key parameters for activating/deactivating SINAMICS components

Parameter	Meaning
p0105	p0105 Activate/deactivate drive object
r0106	Drive object active/inactive
p0125[0...n]	Activate/deactivate power unit component
r0126[0...n]	Power unit component active/inactive
p0145[0...n]	Activate/deactivate encoder interface
r0146[0...n]	Encoder interface active/inactive
p9495	BICO response when drive objects are deactivated
p9496	BICO response when drive objects are activated
r9498[0 ... 29]	BICO BI/CI parameter when drive objects are deactivated
r9499[0 ... 29]	BICO BO/CO parameter when drive objects are deactivated

LSINATopo library

In addition to enabling and disabling SINAMICS components, the LSINATopo library offers the following functions for SINAMICS S120, among others:

- Replacing large motor/small motor
- Replacing double-axis module with two single-axis modules (and vice versa)
- Enable/disable motor brake
- Replacing Active Line Module
- Replacing when Safety is activated

With these functions, you can temporarily or permanently change the configuration (target topology) of a SINAMICS drive saved on the storage medium.

For example, you can replace motors in a replacement part scenario without using the Engineering System.

You can use components in the machine that deviate from the configured components. This is necessary for handling variance and extensions in modular machines.

Additional information

You can find additional information on configuration control in Configuration control (option handling) (Page 261).

You can find additional information on multiple use IO systems and on configuration control for IO systems in the PROFINET function manual (https://support.industry.siemens.com/cs/ww/en/view/49948856).

You can find additional information on activating/deactivating SINAMICS components with parameters in the SINAMICS S120/S150 list manual (https://support.industry.siemens.com/cs/ww/en/view/109822659).

You can find additional information on modular machine concepts with Safety Integrated in the SINAMICS S120 Safety Integrated function manual (https://support.industry.siemens.com/cs/ww/en/view/109781722).

You can find additional information about the LSINATopo library on the Internet (https://support.industry.siemens.com/cs/ww/en/view/109770003).

12.2 Configuration control (option handling)

Introduction

Configuration control (option handling) is used to operate various standard machine configuration levels in one project without changing the configuration and the user program.

Operating principle of configuration control

You can use configuration control to operate different standard machine configurations with a single configuration of the ET 200SP or ET 200MP distributed I/O system.

- A station master (maximum configuration) is configured in a project. The station master comprises all modules needed for all possible sections of a modular machine.
- Provision is made in the user program of the project for various station options for the different configuration levels of the standard machine and for selection of a station option. A station option uses, for example, only some of the configured modules of the station master and these modules are inserted in the slots in a different order.
- During commissioning, manufacturers of standard machines select a station option for a configuration level of the standard machine. A change to the project is not required and a modified configuration therefore does not need to be loaded.
- You program a control data record. The control data record notifies the CPU/interface module as to:
  - which modules are missing in a station option as compared to the station master

    or
  - which modules are in a different slot
- The configuration control has no effect on the parameter assignment of the modules.

You can flexibly vary the distributed configuration with configuration control. As a precondition for this, it must be possible to derive the station option from the station master.

The following figure shows three configuration levels of a standard machine with the corresponding station options of the ET 200SP distributed I/O system.

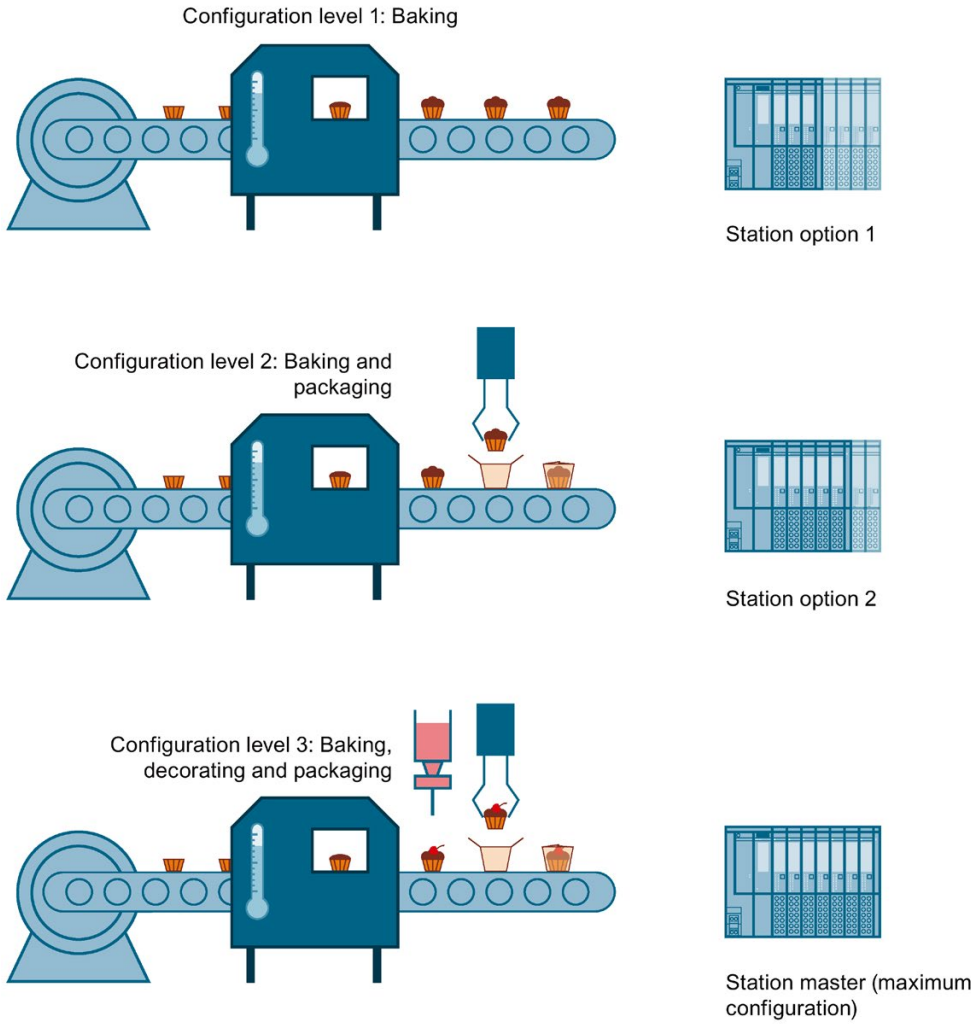


Figure 12-2 Various configuration levels of a standard machine with the corresponding station options of the ET 200SP distributed I/O system

Advantages

- Simple project execution and commissioning by using a STEP 7 project for all station options.
- Easy handling during maintenance, versioning and upgrades.
- Hardware savings: You only install the I/O modules needed for the current station option of the machine.
- Potential savings when building, commissioning and creating documentation for standard machines

Additional information

You can find information on configuration, programming and the response during operation with configuration control:

- in the S7-1500, ET 200MP Distributed I/O System system manual (https://support.industry.siemens.com/cs/ww/en/view/59191792) for configuration control in in ET 200MP.
- in the ET 200SP Distributed I/O System system manual (https://support.industry.siemens.com/cs/ww/en/view/58649293) for configuration control in ET 200SP.

12.3 TIA Portal Openness

TIA Portal Openness describes open interfaces for engineering with the TIA Portal.

You automate engineering with TIA Portal Openness by controlling the TIA Portal externally using a program that you created yourself. You can use Openness, for example, to implement modular machine concepts on the engineering level.

With TIA Portal Openness, you can implement actions including the following:

- Create project data
- Change projects and project data
- Delete project data
- Read in project data
- Make projects and project data available to other applications

Openness with SIMATIC Drive Controller

The SIMATIC Drive Controller supports Openness - including the specific SIMATIC Drive Controller properties, such as X142 technology I/Os and PROFIdrive Integrated. The Openness functionality available for SINAMICS Integrated is based on the currently available range of functions for SINAMICS S120.

Additional information

You can find more information on Openness with SIMATIC Drive Controller in the section Drive Controller specific properties of the TIA Portal Openness API interface (Page 108).

You can find more information on the topic of Openness in the TIA Portal in the system manual SIMATIC TIA Portal Openness: API for the automation of engineering workflows (https://support.industry.siemens.com/cs/de/de/view/109815199/en).

Commissioning

13

13.1 Overview

Introduction

This section includes information on the following topics:

- Check before powering on for the first time
- Removing/inserting the SIMATIC memory card
- First power-on of the SIMATIC Drive Controller
- Downloading a project to the device
- Operating states of the SIMATIC Drive Controller
- Operating states of the SINAMICS Integrated
- Runtime licensing
- CPU memory reset: automatic and manual
- Backing up and restoring the CPU configuration
- Backup/restore of SINAMICS NVRAM data
- Time-of-day synchronization
- Identification and maintenance data
- Shared commissioning of projects

Commissioning requirements

You must ensure the safety of your plant. You therefore need to perform a complete functional test and the necessary safety checks before the final commissioning of a plant.

Also allow for any possible foreseeable errors in the tests. This avoids endangering persons or equipment during operation.

WARNING

Unexpected movement of machines due to inactive safety functions

Safety functions that are inactive or have not been adjusted accordingly can cause unexpected machine movements that can lead to serious injury or death.

- Note the information in the relevant product documentation before commissioning.
- Carry out a safety inspection for safety-related functions throughout 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 suitable parameter assignment.
- Run a function test. Only put your plant into live operation once you have ensured that the safety-related functions are running correctly.

Note

Important safety instructions for Safety Integrated functions

If you want to use Safety Integrated functions, follow the safety instructions in the Safety Integrated manuals.

Commissioning a drive

For detailed information on drive configuration, parameter assignment and commissioning, see the SINAMICS S120 with Startdrive commissioning manual (https://support.industry.siemens.com/cs/ww/en/view/109781583).

You can find an example of commissioning a simple SINAMICS S120 drive in Getting Started with Startdrive (https://support.industry.siemens.com/cs/ww/en/view/109781584).

Software tools for commissioning

The following free software tools support you in commissioning:

- SIEMENS PRONETA (https://support.industry.siemens.com/cs/ww/en/view/67460624) when commissioning PROFINET systems
- SIMATIC Automation Tool (https://support.industry.siemens.com/cs/de/en/view/98161300) when commissioning the SIMATIC Drive Controller.

13.2 Check before powering on for the first time

Check before powering on for the first time

Before the first power-on, check that the SIMATIC Drive Controller and the SINAMICS components are correctly installed and wired.

Installation and wiring

- Have the required minimum clearances for heat dissipation been provided?
- Are all front connectors wired according to the circuit diagram and inserted in the correct connection?

Grounding and chassis concept

- Is the protective conductor terminal on the SIMATIC Drive Controller connected to the protective conductor?
- Have all cable shields been applied?
- Are the required equipotential bonding cables connected with low impedance to the affected plant units?

Further information

You can find information on assembly/installation and commissioning of SINAMICS S120 components in the SINAMICS S120 manuals and in the EMC Installation Guide. (https://support.industry.siemens.com/cs/ww/en/view/60612658)

13.3 Commissioning procedure

13.3.1 Removing/plugging in a SIMATIC memory card

Requirements

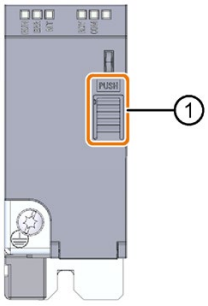
The SIMATIC Drive Controller only supports pre-formatted SIMATIC memory cards. If applicable, delete all previously stored data before using the SIMATIC memory card.

In order to work with the SIMATIC memory card, first ensure that the SIMATIC memory card is not write-protected. For this purpose, slide the slider on the SIMATIC memory card out of the lock position.

Inserting the SIMATIC memory card

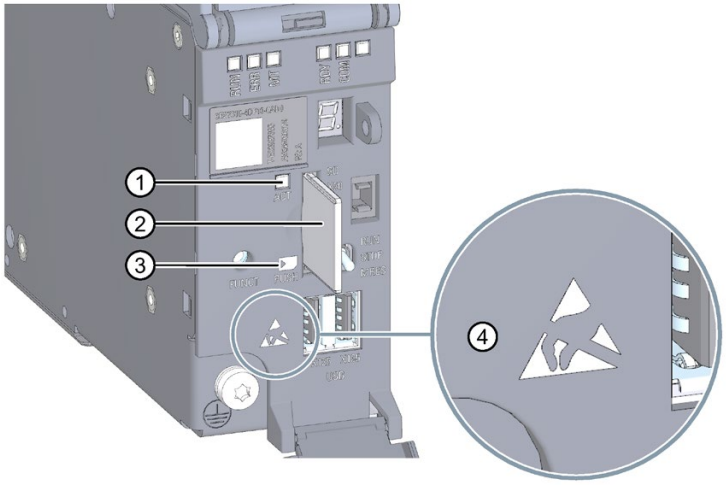
To insert a SIMATIC memory card, follow these steps:

1. You use the "PUSH" ① button to open the bottom cover on the SIMATIC Drive Controller.



① "PUSH" button

2. Ensure that either the SIMATIC Drive Controller is switched off or that the CPU is in STOP.
3. Insert the SIMATIC memory card, as depicted on the SIMATIC Drive Controller, into the slot for the SIMATIC memory card.



① ACT LED
② SIMATIC memory card
③ Symbol shows correct position of the SIMATIC memory card
④ ESD symbol: Identifies electrostatic-sensitive devices

4. Carefully push the SIMATIC memory card into the slot until the SIMATIC memory card clicks into place.

NOTICE
Possible damage of electronic components (ESD) Electrostatic discharges can damage electronic components in the device. Only open the cover when you have grounded yourself with one of the following measures: • Ground yourself at the control cabinet or the ground terminal. • Wear an ESD wrist strap. • Wear ESD shoes or ESD grounding strips in ESD areas with a conducting floor.

Removing the SIMATIC memory card

To remove a SIMATIC memory card, follow these steps:

1. You use the "PUSH" button to open the bottom cover.
2. Switch the CPU into STOP mode.
3. Carefully push the SIMATIC memory card into the slot. After audible unlatching of the SIMATIC memory card, remove it.

Only remove the SIMATIC memory card in POWER OFF or STOP mode of the CPU. Ensure that no writing functions (online functions with the programming device, e.g. loading/deleting a block, test functions) are active in STOP mode or were active before POWER OFF. Do not remove the SIMATIC memory card while the ACT LED is signaling write/read access.

NOTICE
Possible data loss If you remove the SIMATIC memory card during a write process, the following problems can occur: • The data content of a file is incomplete. • The file is no longer readable, or no longer exists. • The entire content of the card is corrupted.

Also note the following FAQ on the Internet (https://support.industry.siemens.com/cs/ww/en/view/59457183) in connection with the removal of the SIMATIC memory card.

Reactions after removing/inserting the SIMATIC memory card

Inserting and removing the SIMATIC memory card in STOP mode triggers a re-evaluation of the SIMATIC memory card. The CPU hereby compares the content of the configuration on the SIMATIC memory card with the backed-up retentive data. If the backed-up retentive data matches the data of the configuration on the SIMATIC memory card, the retentive data is retained. If the data differs, the CPU automatically performs a memory reset (which means the retentive data is deleted) and then switches to STOP.

The CPU evaluates the SIMATIC memory card and indicates this by flashing the RUN/STOP LED.

13.3.2 First power-on

Requirements

- The SIMATIC Drive Controller and the SINAMICS components have been installed and wired.
- The SIMATIC Memory Card is in the SIMATIC Drive Controller.

Procedure

Proceed as follows to commission the SIMATIC Drive Controller:

Switch on the 24 V power supply to the SIMATIC Drive Controller.

Startup characteristics of the CPU

Startup begins once the power supply has been switched on:

RUN/STOP	ERR	MAINT	Description
Alternately flashes yellow/green	Flashes red	Flashes yellow	The CPU executes a flash test. All LEDs flash at 2 Hz
Flashes yellow at 2 Hz	-	-	The CPU runs system initialization and evaluates the SIMATIC Memory Card
On and yellow	-	-	After system initialization has been completed, the CPU switches to STOP

Startup behavior of SINAMICS Integrated

SINAMICS Integrated power up begins once the power supply has been switched on. The SINAMICS Integrated state after successful power up depends on the configuration state of the SINAMICS Integrated and whether SINAMICS components are running a firmware update.

If booting up fails (for example because of a firmware update with errors), this is indicated by the RDY LED (2 Hz) flashing red.

You can find detailed information on the various LED states in the SIMATIC Drive Controller manual (https://support.industry.siemens.com/cs/ww/en/view/109766666).

13.3.3 Downloading a project to the device

Requirements

- The plant has been installed and wired.
- The SIMATIC Drive Controller is on and is in STOP.
- The TIA Portal with integrated Startdrive has been installed and has started up on the PG/PC.
- You have created a project in the TIA Portal, added a SIMATIC Drive Controller with SINAMICS Integrated to the project and configured it.

Loading the CPU project

1. To load the project, select the CPU (PLC) in the project tree and click on the "Download to device" icon in the toolbar.

   If necessary, the project data is compiled.

   - If you had previously established an online connection, the "Load preview" dialog opens. This dialog displays alarms and recommends actions needed for the loading operation.
   - If you have not already established an online connection, the "Extended download to device" dialog opens, and you must first select the interfaces via which you want to establish the online connection to the device.

2. Check the alarms in the "Load preview" dialog, and select the actions in the "Action" column if necessary. As soon as downloading becomes possible, the "Load" button is enabled.
3. Click "Load". The load operation is performed.

   If there is a need for synchronization, the system automatically displays the "Synchronization" dialog. This dialog displays alarms and suggests actions that are needed for synchronization. You have the option of performing these actions or forcing the download without synchronization by clicking "Force download to device". If you have performed the suggested actions, you are asked whether you want to continue with the download. The "Load results" dialog then opens. In this dialog, you can check whether or not the load operation was successful and take any further actions that may be necessary.

4. Click "Finish".

Loading the drive configuration

Requirements

For online functions such as "Download to device", "Upload from device" and "Go online" to be possible in SINAMICS Integrated, the following requirements must be met:

- The firmware version configured for SINAMICS Integrated corresponds to the firmware version of the device hardware.
- You have downloaded the hardware configuration to the CPU (see "Loading the CPU project").
- You must have configured a subnet for the interface to which you are connecting your programming device.

Procedure

1. To load the drive configuration, select the SINAMICS Integrated in the project tree.
2. In the toolbar, click on the "Download to device" icon.

You can find further information on downloading the drive configuration in the SINAMICS S120 Startdrive commissioning manual (https://support.industry.siemens.com/cs/ww/en/view/109781583).

13.4 Operating states of the CPU

13.4.1 Overview of operating modes: Startup, STOP, RUN

Introduction

Operating states describe the state of the CPU. The following operating states are possible with the mode selector:

- STARTUP
- RUN
- STOP

In these operating states, the CPU can communicate, for example, over the PROFINET IO interface.

The status LEDs on the front of the SIMATIC Drive Controller indicate the current operating state.

13.4.2 STARTUP operating state

Response

Before the CPU starts to execute the cyclic user program, a startup routine is executed.

By programming startup OBs, you can specify initialization tags for your cyclic program in the startup routine. You can program one or more startup OBs, or none at all.

Points to note

- The CPU resets the process image input.
- All outputs are disabled or react according to the parameter settings for the relevant module: They provide a configured substitute value or retain the last value output and switch the controlled process to a safe operating state.
- Before processing the start-up routine, the CPU transfers the I/O inputs to the process image input.
- After processing the start-up routine, the CPU releases the peripheral outputs.

  Note

  To read the current state of inputs during STARTUP, you can access inputs via the process image or via direct I/O access.
  To initialize outputs during STARTUP, you can write values via the process image or via direct I/O access. The values are output at the outputs during the transition to RUN.

- The CPU always starts up in a warm restart.
  - The non-retentive bit memories, timers and counters are initialized.
  - The non-retentive tags in data blocks are initialized.
- Cycle time monitoring is not yet running during startup.
- The CPU processes the startup OBs in the order of the startup OB numbers. The CPU processes all programmed startup OBs regardless of the selected startup type (see "Setting the startup behavior" figure below).
- If a relevant event occurs, the CPU can start the following OBs in startup:
  - OB 82: Diagnostics interrupt
  - OB 83: Removal/insertion of modules
  - OB 86: Rack error
  - OB 121: Programming error (only for global error handling)
  - OB 122: I/O access error (for global error handling only)
    You can find a description of how to use global and local error handling in the STEP 7 online help.

  The CPU cannot start any other OBs until after the transition to RUN.

Response when preset configuration does not match actual configuration

The configuration downloaded to the CPU represents the preset configuration. The actual configuration is the actual configuration of the automation system. If the preset configuration and actual configuration differ, the hardware compatibility setting defines the behavior of the CPU. For additional information on hardware compatibility, see the section Operating mode transitions (Page 276).

Cancellation of startup

If errors occur during startup, the CPU cancels startup and returns to STOP.

The CPU does not perform startup or interrupts startup under the following conditions:

- You have not inserted a SIMATIC Memory Card or have inserted an invalid one.
- You have not downloaded a hardware configuration to the CPU.

Configuring startup behavior

You configure the behavior of the CPU in the Startup group in the CPU properties.

Setting startup behavior

Proceed as follows to set the startup behavior:

1. Select the CPU in the device view of the STEP 7 hardware network editor.
2. Select the "Startup" area in the properties under "General".

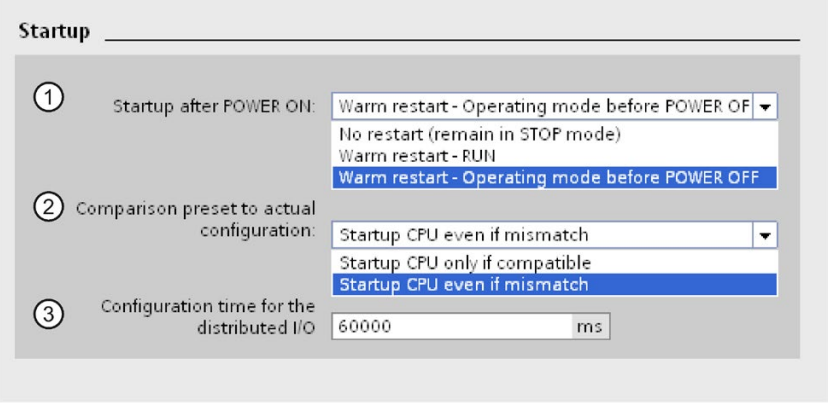


Figure 13-1 Setting startup behavior

① Sets the startup type after POWER ON

② Defines the startup behavior for the event that a (distributed I/O) module in a slot does not correspond to the configured module. This parameter applies to the CPU and to all the modules for which no other setting has been selected.

- Startup CPU only if compatible: With this setting, a module in a configured slot must be compatible with the configured module. Compatible means that the module has the relevant number of inputs and outputs and the electrical and functional properties correspond.
- Startup CPU even if mismatch: With this setting, the CPU starts up irrespective of the type of module plugged.

③ Specifies a maximum period (default: 60 000 ms) in which the distributed I/O must be ready for operation.
If the distributed I/O is ready for operation within the configuration time, the CPU switches to RUN.

If the distributed I/O is not ready for operation within the configuration time, the startup behavior of the CPU depends on the hardware compatibility setting.

13.4.3 STOP operating state

Response

The CPU does not execute the user program in STOP.

All outputs are disabled or react according to the parameter settings for the relevant module: They provide a configured substitute value or retain the last value output and thus keep the controlled process in a safe operating state.

Points to note

The STOP operating state results in a frame failure at the drive with a corresponding response at the drive end (for example, OFF3 fast stop, depends on parameter assignment). You can find additional information in the SINAMICS S120 Communication function manual (https://support.industry.siemens.com/cs/ww/de/view/109781721/en).

13.4.4 RUN operating state

Response

Cyclic, time-driven, and interrupt-driven program execution are performed in RUN. Addresses in the "Automatic update" process image are automatically updated in each program cycle. You can also find more information in Process images and process image partitions (Page 157).

Execution of the user program

Once the CPU has written the outputs and read the inputs, it executes the cyclic program from the first instruction to the last instruction. Events with a higher priority, such as hardware interrupts, diagnostic interrupts, Motion Control functions and communication, can interrupt the cyclic program flow and prolong the cycle time.

If you have configured a minimum cycle time, the CPU will not end the cycle until this minimum cycle time has expired, even if the user program is completed sooner.

The operating system monitors the execution time of the cyclic program for a configurable upper limit known as the maximum cycle time. You can restart this time monitoring at any point in your program by calling the RE_TRIGR instruction.

If the cyclic program exceeds the maximum cycle time, the operating system will attempt to start the time error OB (OB 80). If the OB does not exist, the CPU ignores the maximum cycle time overshoot. If the cycle monitoring time is exceeded for a second time, for example while the time error OB is being processed, the CPU switches to STOP.

Additional information

You can find additional information on cycle and response times in the Cycle and Response Times (https://support.industry.siemens.com/cs/ww/en/view/59193558) function manual.

13.4.5 Operating state transitions

Operating states and operating state transitions

The figure below shows the operating state and operating state transitions:

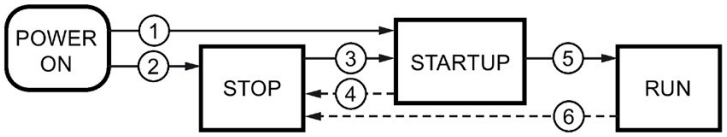


Figure 13-2 Operating states and operating state transitions

The table below shows the effects of operating state transitions:

Table 13- 1 Operating state transitions

No.	Operating state transitions		Effects
①	POWER ON → STARTUP	After switching on, the CPU switches to "STARTUP" if: • The hardware configuration and program blocks are consistent. • The preceding "POWER OFF" was triggered by an interruption in the power supply. • Startup type "Warm restart - RUN" is set. or • Startup type "Warm restart mode before POWER OFF" is set and the CPU was in RUN mode before POWER OFF.	The CPU clears the non-retentive memory, and resets the content of non-retentive DBs to the start values of the load memory. Retentive memory and retentive DB content are retained. The 500 most recent entries are retained in the diagnostics buffer.
②	POWER ON → STOP	After switching on, the CPU switches to "STOP" if: • The hardware configuration and program blocks are inconsistent. or • Startup type "No restart" is set. or • Startup type "Warm restart mode before POWER OFF" is set and the CPU was in STOP mode before POWER OFF.	The CPU clears the non-retentive memory, and resets the content of non-retentive DBs to the start values of the load memory. Retentive memory and retentive DB content are retained. The 500 most recent entries are retained in the diagnostics buffer.

No.	Operating state transitions		Effects
③	STOP → STARTUP	The CPU switches to "STARTUP" mode if: • The hardware configuration and program blocks are consistent. • You set the CPU to "RUN" via the programming device and the mode switch in is the RUN position. or • You move the mode switch from STOP to RUN.	The CPU clears the non-retentive memory, and resets the content of non-retentive DBs to the start values of the load memory. Retentive memory and retentive DB content are retained. The 500 most recent entries are retained in the diagnostics buffer.
④	STARTUP → STOP	The CPU returns to "STOP" in the following cases of "STARTUP": • The CPU detects an error during startup. • You set the CPU to "STOP" via the programming device or mode switch. • The CPU executes a STOP command in the Startup OB.	These operating mode transitions have no effect on data.
⑤	STARTUP → RUN	The CPU switches to "RUN" in the following cases of "STARTUP": • The CPU has initialized the PLC tags. • The CPU has executed the startup blocks successfully.	
⑥	RUN → STOP	The CPU returns to "STOP" in the following cases of "RUN": • The CPU detects an error which prevents further work. • The CPU executes a STOP command in the user program. • You set the CPU to "STOP" via the programming device or mode switch.	

Additional information

You can find information on the behavior of the axes in the different operating states in the S7-1500T Motion Control function manuals (https://support.industry.siemens.com/cs/ww/en/view/109751049).

13.5 SINAMICS Integrated operating states

SINAMICS Integrated operating states

SINAMICS Integrated has various different operating states. SINAMICS Integrated indicates the operating states with status LEDs. You can find further information in the SIMATIC Drive Controller (https://support.industry.siemens.com/cs/ww/en/view/109766666) manual.

13.6 Runtime licensing

A number of runtime options requiring licensing are available at the CPU and drive end for the SIMATIC Drive Controller.

Licenses for the CPU

CPU applications that require a runtime license include:

- OPC UA
- ProDiag
- Energy Suite

Proceed as follows to license the CPU:

1. Double-click the device configuration of the CPU in the project tree. The device configuration is opened in the device view.
2. Select the subordinate tab "General" in the "Properties" Inspector window.
3. Click the arrow next to the "Runtime licenses" section. The Runtime functions available for licensing and their license requirements are displayed.
4. Confirm the purchase of the required licenses.

Note

Licenses must be purchased to use the functions in question. For details, see the licensing terms for the given product.

If the CPU is sub-licensed, compilation of the CPU ends with license errors.

Licenses for the SINAMICS Integrated and S120 Control Units

Certain functionalities with the SINAMICS S120 drive system require licensing. The licensing procedure for SINAMICS Integrated differs from the licensing procedure for SINAMICS S120 Control Units.

SINAMICS Integrated (in a process similar to that for runtime licenses for the CPU) is licensed by Engineering by confirming the purchase of the licenses. SINAMICS S120 Control Units, on the other hand, are licensed over the memory card. The memory card is generally ordered pre-licensed for this purpose.

In the order, specify the type and number of licenses you wish in additional information (Z options). Alternatively, you can also license the memory card with single licenses.

Note

Note the product cancellation/discontinuation of SINAMICS licenses in the delivery form "CoL in paper form" and only use the delivery form "CoL in electronic form". You can find additional details on the Internet (https://support.industry.siemens.com/cs/ch/en/view/109812783).

Licenses for functions/Technology Extensions (TEC)	Licensing	Article number of the single license to be purchased for the SINAMICS Integrated or for SINAMICS S120 Control Units, CoL in electronic form	Z option for pre-licensing CF cards with SINAMICS S120 Control Units
Safety Integrated Extended Functions	Per axis	6SL3074-0AA10-0AH0	Fxx (xx = number of licenses)
Safety Integrated Advanced Functions	Per axis	6SL3074-0AA20-0AH0	Axx (xx = number of licenses)
Detent torque compensation	Per axis	6SL3074-0AA15-0AH0	Z option: -
Advanced Position Control (APC) including Active Vibration Suppression	Per axis	6SL3074-0AA05-0AH0	Z option: -
Dynamic network support	Per SINAMICS /CU Integrated/CU	Booksize: 6SL3074-0AA07-1AH0 Chassis: 6SL3074-0AA07-0AH0	S01
Line droop control	Per SINAMICS /CU Integrated/CU	Up to 2000 kW: 6SL3074-0AA08-0AH0 Up to 1600 kW: 6SL3074-0AA08-1AH0 Up to 1250 kW: 6SL3074-0AA08-2AH0 Up to 950 kW: 6SL3074-0AA08-3AH0 Up to 650 kW: 6SL3074-0AA08-4AH0 Up to 350 kW: 6SL3074-0AA08-5AH0 Up to 200 kW: 6SL3074-0AA08-6AH0 Up to 100 kW: 6SL3074-0AA08-7AH0 Up to 50 kW: 6SL3074-0AA08-8AH0	S02
Advanced Synchronous Reluctance Control	Per axis	6SL3074-0AA06-0AH0	Z option: -
Controller Parameter Adaption	Per axis	6SL3074-0AA17-0AH0	Z option: -
Technology Extension VIBX (Vibration Extinction)	Per SINAMICS /CU Integrated/CU	6SL3077-0AA00-5AH0	U03
Technology Extension SERVCOUP (Servo Coupling)	Per SINAMICS /CU Integrated/CU	6SL3077-0AA00-8AH0	Z option: -
Technology Extension DCDCCONV (DC-DC-Converter)	Per SINAMICS Integrated/CU	6SL3077-0AA02-0AH0	Z option: -
Technology Extension POLYGON (Polygonal Line)	Per SINAMICS Integrated/CU	6SL3077-0AA00-7AH0	Z option: -
Technology Extension SETPGEN (Setpoint Generator)	Per SINAMICS Integrated/CU	6SL3077-0AA00-3AH0	Z option: -
Technology Extension RAILCTRL (Rail Control) [1)]	Per SINAMICS Integrated/CU	6SL3077-0AA01-8AH0	U02

Licenses for functions/Technology Extensions (TEC)	Licensing	Article number of the single license to be purchased for the SINAMICS Integrated or for SINAMICS S120 Control Units, CoL in electronic form	Z option for pre-licensing CF cards with SINAMICS S120 Control Units
DCB Extension Library	Per SINAMICS /CU Integrated/CU	6SL3077-0AA00-0AH0	U01
SINAMICS Integrated only supports the licensed functions and Technology Extensions (TEC) listed. For Technology Extensions that were approved after the copy deadline of this documentation, you will find the approval information in the respective Product Information for the SINAMICS Technology Extension. Additional licensed functions and Technology Extensions (TEC) are available for SINAMICS S120 Control Units.			

1) Support for the RAILCTRL (Rail Control) Technology Extension for SINAMICS Integrated is under development.
For more information, refer to the publications for SINAMICS Technology Extension RAILCTRL (Rail Control)

Proceed as follows to license SINAMICS Integrated :

1. In the SINAMICS Integrated project tree, double-click on "Parameter assignment" under "Automatic speed control".
2. The runtime functions available for licensing and license requirements are displayed in the function view.
3. Confirm the purchase of the required licenses.

Note

The SINAMICS Technology Extension licenses are only displayed when the corresponding Technology Extension was installed in Startdrive.

Note

Licenses must be purchased to use the function in question. For details, see the licensing terms for the given product.

If the SINAMICS Integrated is sub-licensed, this is indicated in the project tree and in the Startdrive working area.

The number of licenses purchased is saved in the project. There is no sub-licensing response at the drive end.

Note

SINAMICS S120 CU320-2 connected to the SIMATIC Drive Controller are licensed with the CF card of CU320-2. With sub-licensing, there is a sub-licensing response on the CU320-2.

13.7 CPU memory reset

Basics of a memory reset

A memory reset on the CPU is possible only in the STOP mode.

During memory reset, the CPU is changed to a so-called "initial status".

This means that:

- An existing online connection between your programming device/PC and the CPU is terminated.
- The content of the work memory and the retentive and non-retentive data (applies only to manual memory reset by the user) are deleted.
- The diagnostics buffer, time of day, and IP address are retained.
- Subsequently the CPU is initialized with the loaded project data (hardware configuration, code and data blocks, force jobs). The CPU copies this data from the load memory to the work memory.

  Result:

  - If you set an IP address in the hardware configuration ("Set IP address in the project" option) and a SIMATIC Memory Card with the project is in the CPU, this IP address is valid after the memory reset.
  - Data blocks no longer have current values but rather their configured start values.
  - Force jobs remain active.

How can I tell if the CPU is performing a memory reset?

The RUN/STOP LED flashes yellow at 2 Hz. After completion the CPU goes into STOP mode, and the RUN/STOP LED is switched on (unchanging yellow).

Result after memory reset

The following table provides an overview of the contents of the memory objects after memory reset.

Table 13- 2 Memory objects after memory reset

Memory object	Contents
Actual values of the data blocks, instance data blocks, technology objects (except for retentive tags of the TOs)	Initialized
Bit memories, timers and counters	Initialized
Retentive tags of technology objects (e.g. adjustment values of absolute encoders)	Retained
Diagnostics buffer entries	Retained
IP addresses	Retained
Device name	Retained
Counter readings of the runtime meters	Retained

Memory object	Contents
Time of day	Retained
Operating mode of the CPU: RUN/STOP	The CPUs retain the STOP state.

Note

Password for protection of confidential configuration data

The password for protection of confidential configuration data is retained after a memory reset of the CPU. The password is only deleted when the "Delete password for protection of confidential PLC configuration data" option is set in STEP 7.

You can find additional information on the password for protection of confidential configuration data in the Communication function manual (https://support.industry.siemens.com/cs/ww/en/view/59192925).

13.7.1 Automatic memory reset

Possible cause of automatic memory reset

The CPU executes an automatic memory reset if an error occurs that prevents normal further processing.

Causes for such errors can be:

- User program is too large, and can't be completely loaded into work memory.
- The project data on the SIMATIC memory card are damaged, for example because a file was deleted.
- If you remove or insert the SIMATIC memory card and the backed-up retentive data differs in structure from that of the configuration on the SIMATIC memory card.

13.7.2 Manual memory reset

Reason for manual memory reset

CPU memory reset is required to reset the CPU to its "original state".

CPU memory reset

CPU memory reset is possible:

- Using the mode selector
- Using STEP 7

Procedure using the mode selector

Note

Memory reset ↔ Reset to factory settings

The procedure described below also corresponds to the procedure for resetting to factory settings:

- Selector operation with inserted SIMATIC memory card: CPU executes a memory reset
- Selector operation without inserted SIMATIC memory card: CPU executes reset to factory settings

To perform a memory reset of the CPU using the mode selector, follow these steps:

1. Set the mode selector to the STOP position.

   Result: The RUN/STOP LED lights up yellow.

2. Set the mode selector to the MRES position. Hold the selector in this position until the RUN/STOP LED lights up for the 2nd time and remains continuously lit (this takes three seconds). After this, release the selector.

3. Within the next three seconds, switch the mode selector back to the MRES position, and then back to STOP again.

Result: The CPU executes memory reset.

You can find information on resetting the CPU to factory settings in CPU reset to factory settings (Page 329).

Procedure using STEP 7

To perform a memory reset of the CPU via STEP 7, follow these steps:

1. Open the "Online Tools" task card of the CPU.
2. Click the "MRES" button in the "CPU control panel" pane.
3. Click "OK" in response to the confirmation prompt.

Result: The CPU is set to STOP mode and performs memory reset.

13.8 Configuring SIMATIC Drive Controller backup and restore

Backing up the software and hardware configuration

If you have already downloaded a configuration to the SIMATIC Drive Controller, it is advisable to back it up.

Before you test a new configuration, create a backup of the current device version. You can then restore the previous configuration at a later time.

You can create as many backups as you want and store a variety of configurations for the SIMATIC Drive Controller.

Scope of the backup

The backup includes all data that is needed to restore a particular configuration version of the SIMATIC Drive Controller.

The following data is backed up, for example:

- The content of the SIMATIC memory card including SINAMICS Integrated
- Retentive memory areas of the CPU, for example, of data blocks, counters, and bit memory
- Other retentive memory content, for example, IP address parameters

The backup is performed with the current values of the CPU. Entries in the diagnostic buffer are not included in the backup.

The current time of day of the CPU is not backed up.

SINAMICS Integrated configured

Note

If a SINAMICS Integrated is configured, the configuration of the SINAMICS Integrated is also backed by/restored from the SIMATIC memory card. NVRAM data must first have been backed up on the SIMATIC memory card.

You can find more information in Backing up, restoring and deleting SINAMICS Integrated NVRAM data (Page 288).

13.8.1 Backing up and restoring the CPU configuration

Backup from online device

You may want to make changes to your plant over time (for example, add new devices, replace existing devices or adapt the user program). Before you download a changed configuration to the CPU, first use the option "Backup from online device" to create a complete backup of the current device state. If you have assigned a password to protect confidential PLC configuration data, then this password is not secured as well. You can find more information about the password in the section Protection of confidential configuration data (Page 237).

Upload from device (software)

With the option "Upload from device (software)", you load the software project data from the CPU to an existing CPU in the project.

Upload device as new station

If you are operating a new PG/PC in a plant, the STEP 7 project that was used to create the plant configuration might not be available. In this case, you can use the option "Upload device as new station" to load the device data to a project in your PG/PC.

Snapshot of the monitor values

You can use the option "Snapshot of the monitor values" to back up the current values of the data blocks so that you can restore the current values if necessary after any changes.

Overview of backup types

The table below shows the backup of CPU data in line with the selected type of backup and its specific characteristics:

Table 13- 3 Types of backup

	Backup from online device	Upload from device (software)	Upload device as new station	Snapshot of the monitor values
Current values of all DBs (global and instance data blocks)[1]	✓	✓	✓	✓
Blocks of the type OB, FC, FB and DB	✓	✓	✓	--
PLC tags (tag names and constant names)	✓	✓	✓	--
Technology objects	✓	✓	✓	--
Hardware configuration	✓	--	✓	--
Actual values (bit memories, timers and counters)[1]	✓	--	--	--
Content of the SIMATIC Memory Card	✓	--	✓[2]	--
Archives, recipes	✓	--	--	--
Entries in the diagnostics buffer	--	--	--	--
Current time	--	--	--	--
Properties of the backup type				
Backup possible for failsafe CPUs	✓	✓	✓	✓
Backup can be edited	--	✓	✓	✓
Backup possible in operating mode	STOP	RUN, STOP	RUN, STOP	RUN, STOP
SINAMICS Integrated configuration backup	✓[3]	--	--	--

1 Only the values of the tags that are set as retentive are saved.

2 Content of DataLogs, Recipes and UserFiles folders

3 SINAMICS NVRAM data must first have been backed up on the SIMATIC Memory Card.

Example: Backup from online device

The following example shows how to carry out a complete backup of the current device state of the CPU in STEP 7. The CPU is in RUN mode. Before the backup, the CPU goes into STOP mode.

To start the backup, proceed as follows:

1. Right-click to select the CPU in the project tree.
2. Select the "Backup from online device" command from the shortcut menu.
   The "Upload preview" dialog window sets out the key information on the backup process to be run. For a backup you have to switch the CPU to the STOP mode.
3. In the "Action" column, select the "Stop module" command from the drop-down menu.
4. Click "Upload from device". The CPU changes to STOP mode. The backup of the CPU data starts. The backup is saved in the project tree in the folder of the CPU under "Online backups".

Example: Restoring a backup of an online device

If you have saved the CPU data beforehand, you can transfer the backup back to the device. The saved backup is then restored to the CPU.

The CPU is in RUN mode. Before the restoration, the CPU goes into STOP mode.

To start the backup restore, proceed as follows:

1. Open the CPU's folder in the project tree. The lower-level objects are displayed.
2. Open the "Online backups" folder.
3. Select the backup you want to restore.
4. In the "Online" menu, select the "Download to device" command.
5. The "Load preview" dialog window sets out the key information on the restore process to be run. For a restoration you have to switch the CPU to the STOP mode.
6. In the "Action" column, select the "Overwrite" command from the drop-down menu.
7. Click "Download". The CPU changes to STOP mode. The backup is transferred to the CPU and restored. The "Load results" dialog then opens. In this dialog, you can check whether or not the loading operation was successful and take any further action that may be necessary (no action, start modules).
8. Click "Finish".

Additional information

You can find more information on the different backup types in the STEP 7 online help.

For more details on backing up NVRAM data of SINAMICS Integrated, see the section Backing up, restoring and deleting SINAMICS Integrated NVRAM data (Page 288).

Emergency address (emergency IP)

The emergency address (emergency IP address) of a CPU is designed for diagnostic and download functions, for example, if the CPU can no longer be reached via the IP protocol because the wrong project has been loaded. You can find information on the emergency address in the Communication (https://support.industry.siemens.com/cs/ww/en/view/59192925) function manual.

Storing multilingual project texts

When you configure a CPU, different categories of texts are generated, for example

- Object names (names of blocks, modules, tags, etc.)
- Comments (for blocks, networks, watch tables, etc.)
- Messages and diagnostic texts

Texts are provided by the system (for example diagnostic buffer texts) or are created during configuration (for example messages).

In a project, texts exist in one single language or in several languages after a translation process. You can maintain project texts in all language available to you in the project tree (Languages & Resources > Project Texts). The texts created during configuration can be loaded to the CPU.

The following texts containing the project data are loaded to the CPU in the chosen languages and are also used by the Web server:

- Diagnostic buffer texts (not editable)
- Module state texts (not editable)
- Message texts with associated text lists
- Tag comments and step comments for S7 GRAPH and PLC Code Viewer
- Comments in watch tables

The following texts containing the project languages are also loaded to the CPU in the chosen languages, but are not used by the Web server:

- Comments in tag tables (for tags and constants)
- Comments in global data blocks
- Comments of elements in block interfaces of FBs, FCs, DBs and UDTs
- Network titles in blocks written in LAD, FBD or STL
- Block comments
- Network comments
- Comments of LAD and FBD elements

The SIMATIC Drive Controller CPU supports the storage of multilingual project texts in up to three different project languages. If the project texts belonging to a specific project language nevertheless exceed the memory space reserved for them, the project cannot be loaded to the CPU. The operation is canceled with a message indicating that not enough free storage space is available. In such a case, take measures to reduce the required storage space, for example by shortening comments.

You can find information on parameter assignment of multilingual project texts in STEP 7 in the STEP 7 online help.

Size of files and size of the SIMATIC Memory Card

Note

SIMATIC Memory Card

Ensure that there is enough available storage space on your SIMATIC Memory Card for downloading projects.

Please remember when selecting the memory card capacity that the project data of both the CPU and SINAMICS Integrated is stored on the memory card.

In order to be able to download and back up projects, the project size and the size of files on the SIMATIC Memory Card may not exceed 2 GB.

Do not manipulate any contents in the OMSSTORE directory on the SIMATIC Memory Card.

You can find information on reading out the storage space capacity utilization of the CPU and the SIMATIC Memory Card in the Structure and Use of the CPU Memory (https://support.industry.siemens.com/cs/ww/en/view/59193101) function manual.

13.8.2 Backing up, restoring and deleting SINAMICS Integrated NVRAM data

Backing up the non-volatile memory

The SINAMICS Integrated has a non-volatile memory, NVRAM (Non-Volatile Random Access Memory), for operating data. Data stored in this memory includes the data from the fault buffer, diagnostics buffer and message buffer.

In certain circumstances, for example, a defect or device replacement, this data needs to be backed up. After changing the hardware, you transfer the backup data back to the NVRAM.

p7775 (Control Unit parameter) is used to execute the following operations:

- p7775 = 1 backs up NVRAM data to the memory card.
- P7775 = 2 copies the NVRAM data from the memory card to the NVRAM.
- p7775 = 3 deletes the data in the NVRAM.

A POWER ON is executed automatically once the data has been successfully deleted. If the operation was successful, p7775 = 0 is automatically set. If the operation was not successful, p7775 displays an error value. You can find further details on error values in the SINAMICS S120/S150 list manual (https://support.industry.siemens.com/cs/ww/en/view/109822659).

Backing up NVRAM data

P7775 = 1 stores the NVRAM data of the SINAMICS Integrated in the folder "SINAMICS.S7S\USER\SINAMICS\NVRAM\PMEMORY.ACX" on the memory card.

The storage operation backs up all data from the NVRAM.

Note

Backing up NVRAM data

NVRAM data backup to the memory card is also possible during pulse enable. If the drive is moved during NVRAM data transfer, the data backup may not be consistent with the NVRAM data.

Restoring NVRAM data

There are two situations that require NVRAM data to be restored.

- Replacement of the SIMATIC Drive Controller.
- Targeted NVRAM data restore due to suspected data errors.

Replacement of the SIMATIC Drive Controller:

The SINAMICS Integrated detects a replacement based on the serial number of the SIMATIC Drive Controller. Following POWER ON, the NVRAM of the SINAMICS Integrated is cleared and the NVRAM data is then loaded from the SIMATIC Memory Card.

NVRAM restore:

A targeted restore process of the saved NVRAM data is triggered by setting p7775 = 2. The original file is first deleted in NVRAM. If the file "PMEMORY.ACX" is available and has a valid checksum, it is loaded to the NVRAM.

The following data is not restored:

- Operating hours counter
- Temperature
- Safety logbook
- Crash diagnostics data

Deleting NVRAM data

p7775 = 3 deletes the NVRAM data.

The following data is not deleted in the process:

- Operating hours counter
- Temperature
- Safety logbook
- Crash diagnostics data

13.9 Time synchronization

13.9.1 Time-of-day synchronization of the CPU

NTP procedure

All CPUs are equipped with an internal clock. The clock always shows the time-of-day with a resolution of 1 millisecond and the date including the day of the week. The time adjustment for daylight saving time is also taken into account.

You can update the time of the CPUs using the NTP procedure with an NTP server. NTP (Network Time Protocol) is a standard for synchronizing clocks.

In NTP mode, the device sends time queries at regular intervals (in client mode) to the NTP server in the subnet (LAN). Based on the replies from the server, the most reliable and most accurate time is calculated and the time of day on the CPU is synchronized. The advantage of this mode is that it allows the time to be synchronized across subnets. You can configure the IP addresses of up to a maximum of four NTP servers. You address the sources for the time-of-day synchronization via IP addresses, for example, an HMI device.

The update interval defines the interval between the time queries (in seconds). The value of the interval ranges between 10 seconds and one day. The NTP procedure generally uses UTC (Universal Time Coordinated). UTC corresponds to GMT (Greenwich Mean Time).

NTP server for the SIMATIC Drive Controller

You can assign up to 4 NTP servers to a SIMATIC Drive Controller .

You have the following options to reset the IP addresses of the NTP servers:

- Configuring IP addresses of the NTP servers in STEP 7
- Setting the IP addresses of the NTP servers with the "T_CONFIG" instruction
- Obtaining IP addresses of the NTP servers via DHCP.
  As of firmware version V2.9, the CPU can also obtain the IP addresses of the NTP servers via DHCP. You can find more information on the procedure and the DHCP communication protocol in the Communication function manual (https://support.industry.siemens.com/cs/ww/en/view/59192925).

Configuring IP addresses of the NTP servers in STEP 7

To configure the IP addresses of the NTP servers in STEP 7, follow these steps:

1. Select the CPU in STEP 7.
2. In the properties of the CPU, navigate to "Time of day" > "Time synchronization"> "NTP mode".
3. For "Time synchronization:", select "Set NTP server in the project" from the drop-down list.
4. Enter the IP addresses of up to four NTP servers for "Server 1" to "Server 4".
5. Set the time interval of time queries for "Update interval". Set the update interval to between 10 s and 86400 s.

Setting the IP addresses of the NTP servers with the "T_CONFIG" instruction

Requirement:

- You selected the option "Set NTP server directly on the device (e.g. PLC program, display)" in the "Time synchronization" drop-down list in STEP 7.

Proceed as follows to set the IP addresses of the NTP servers with the T_CONFIG instruction:

1. Save the IP addresses for the NTP servers in a tag of the data type IF_CONF_NTP.
2. Interconnect the tag of the data type IF_CONF_NTP at the block parameter CONF_DATA of the T_CONFIG instruction.
3. Call the T_CONFIG instruction in the user program.

Result: The addresses of the NTP servers from the T_CONFIG instruction are transferred to the CPU.

You can change the addresses of the NTP servers with T_CONFIG more than once if necessary.

Additional information

For additional information on time-of-day synchronization - time synchronization, refer to the following FAQ on the Internet (https://support.industry.siemens.com/cs/de/en/view/86535497).

13.9.2 Time-of-day synchronization of SINAMICS drives

In the factory setting, SINAMICS drives (SINAMICS Integrated, SINAMICS S120) use an operating hours counter. The SINAMICS drive saves interrupts or warnings that occur on the basis of the operating hours. This method does not allow comparable time stamps between multiple drives and the CPU.

If you want comparable time stamps between multiple devices, you need to switch from operating hours counting to UTC format and implement synchronization with the time-of-day master (CPU).

UTC = Universal Time Coordinated; corresponds to GMT (Greenwich Mean Time)

You can then compare the events of all bus nodes that are synchronized with the CPU time.

SINAMICS drives offer the following time-of-day synchronization options:

Synchronization type	Accuracy	Notes
Simple synchronization	Approx. 100 ms	Only possible with suitable user program
Synchronization with ping compensation in non-isochronous communication	Approx. 10 ms	
Synchronization with ping compensation in isochronous communication	Approx. 1 ms	Time-of-day synchronization is available as a system functionality for the SIMATIC Drive Controller .
Synchronization with Network Time Protocol (NTP) over a PROFINET connection	Approx. 10 ms	Only for converters on PROFINET IO (e.g. SINAMICS S120 CU320-2 PN or SINAMICS S120) Cannot be used for SINAMICS Integrated

With the SIMATIC Drive Controller, time-of-day synchronization of the SINAMICS drives can be implemented automatically by the system or through a user program.

Time-of-day synchronization by the system

Time-of-day synchronization between CPU and SINAMICS drives is activated in the TIA Portal. By default, time-of-day synchronization is deactivated.

Proceed as follows to activate time-of-day synchronization:

1. Select "General" > "Time-of-day synchronization"
2. Select the option "By the system"

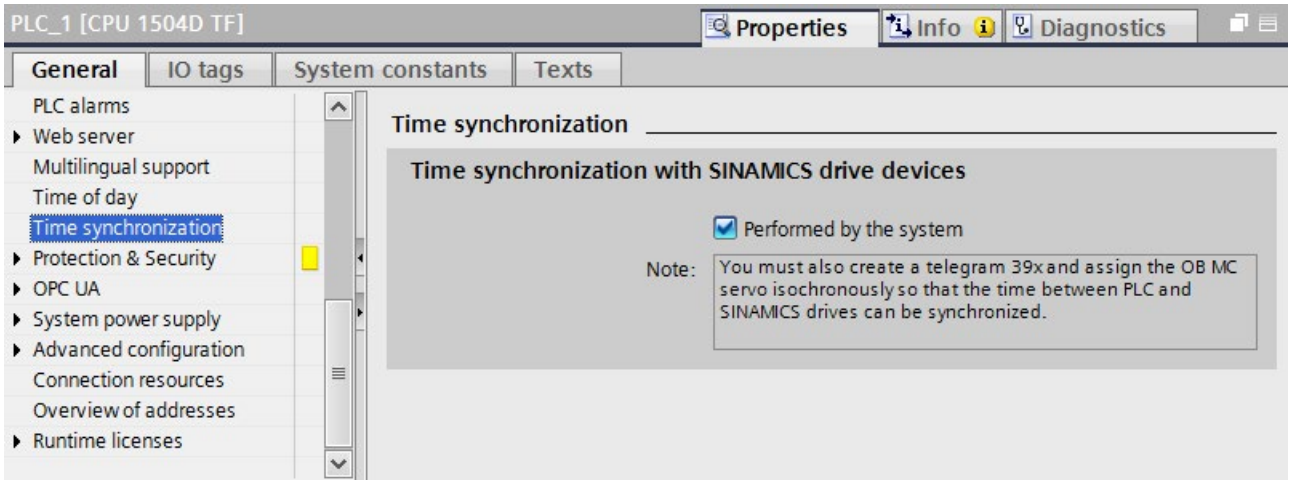


Figure 13-3 Time-of-day synchronization

Please note the following in relation to time-of-day synchronization:

- An OB MC Servo must be available and be synchronized with the relevant subnet.
- Frame 39x must be assigned to OB MC Servo and its process image.
- Selecting the "By the system" option switches the drive from operating hours counting to time-of-day synchronization with the controller.
- The time-of-day synchronization takes place with isochronous ping compensation.
- The first time-of-day synchronization takes place after the SIMATIC Drive Controller has entered the RUN state.
- Interrupts and alarms before the first synchronization are saved with the valid time stamp in SINAMICS at those times; all subsequent interrupts and alarms are saved with the synchronized time. The first time-of-day synchronization after synchronization is activated is entered in the diagnostic buffer of the drive with the status of the operating hours counter and the time of day (UTC time, synchronized with SIMATIC Drive Controller).
- If you want to implement time-of-day synchronization through a user program, the option "By the system" must be deselected.

Compensation for runtime deviations

To compensate for runtime deviations between SIMATIC and SINAMICS clocks, the time is automatically re-synchronized at regular intervals.

Please note the following response to setting the SINAMICS clock time:

SIMATIC clock time	Response of SINAMICS
Great than time/date on SINAMICS	Time and date are tracked on SINAMICS
Less than time/date on SINAMICS	The clock on SINAMICS is stopped until the "Time/date to be set" is reached (for details, see "Resetting the time").

This response ensures that the order of SINAMICS diagnostic buffer entries is retained following runtime difference compensation.

The SINAMICS clock operates with a resolution of 1 ms. A synchronization accuracy of 1 ms is achieved for all bus clock cycles divisible by 1 ms (for example 1 ms, 2 ms, 3 ms).

For all bus clock cycles that cannot be divided by 1 ms (for example 1.25 ms), a slightly lower synchronization accuracy is achieved in line with the system.

Precise synchronization is only ensured if OB MC Servo is operated in isochronous mode.

Resetting the time

Parameter p3109 is used to define a threshold that has the following effect in the event of negative time jumps:

Negative time jump	Effect on time
Less than threshold value	Time is paused (for details, see "Compensation for runtime deviations")
Greater than threshold value	Clock time is reset

Default setting for the threshold: p3109 = 100 ms

This means that the clock time is reset in the event of negative time jumps of more than 100 ms.

The default value is set so that normal runtime deviations (quartz drift) are below the threshold. If the CPU clock is set back by more than 100 ms, this is interpreted as an "intentional clock time reset" and the clock time of the drives is also set back immediately. The warning A01099 is also output.

If the real-time clock is reset by more than 60 seconds, an entry is also written to the diagnostic buffer in the drive:

Time correction (adjustment) by <correction value> seconds

Following another synchronization operation (negative time jump greater than the threshold), the parameter cu.p3107 has the following values:

- p3107[0 ... 1] the UTC time after synchronization
- p3107[2 ... 3] the UTC time before synchronization

[0] and [2] are milliseconds; [1] and [3] are days.

Note

The diagnostic buffer entries are not converted to the new time after the clock time changeover.

Time-of-day synchronization with the user program

Time-of-day synchronization can be implemented through a user program.

Example:

SIMATIC S7-1200/S7-1500 and SIMOTION: LAcycCom library for acyclic communication (https://support.industry.siemens.com/cs/ww/en/view/109479553),

FB LAcycCom_RTCSinamicsAcyclic

Note

If you want to implement time-of-day synchronization for SINAMICS S120 through a user program or the NTP time-of-day synchronization, you need to deselect the option "By the system" for "Time-of-day synchronization".

NTP time-of-day synchronization can be used for SINAMICS S210 drives independent of this.

Additional information

For additional information, see SINAMICS S120 Communication function manual (https://support.industry.siemens.com/cs/ww/en/view/109781721), "Time-of-day synchronization between controller and converter".

13.10 Identification and maintenance data

13.10.1 Reading out and entering I&M data

I&M data

Identification and maintenance data (I&M data) is data saved on the module as read-only (I data) or read/write (M data) information.

- **Identification data (I&M0):** Manufacturer information about the module that can only be read and is in part also printed on the enclosure of the module, such as article number and serial number.
- **Maintenance data (I&M1, 2, 3):** Plant-dependent information, e.g. installation location. The maintenance data for the SIMATIC Drive Controller is created during configuration and downloaded to the automation system/distributed I/O system.

The SIMATIC Drive Controller supports identification data (I&M0 to I&M3).

The I&M identification data supports you in the following activities:

- Checking the plant configuration
- Locating hardware changes in a plant
- Correcting errors in a plant

Modules can be clearly identified online using the I&M identification data.

You can read out the identification data with STEP 7 (see online help for STEP 7).

Options for reading out I&M data

- Via the user program
- Via STEP 7 or HMI devices
- Via the CPU web server

Procedure for reading I&M data via the user program

You have the following options for reading the I&M data of the modules in the user program:

- Using the RDREC instruction

  The data record structure for the CPU as well as for distributed modules accessible via PROFINET IO/PROFIBUS DP is described in Record structure for I&M data (Page 298).
- Using the Get_IM_Data instruction

Further information

The description of the instructions can be found in the STEP 7 online help.

Procedure for reading I&M data via STEP 7

Requirement: There must be an online connection to the CPU/interface module.

To read I&M data using STEP 7, follow these steps:

1. In the project tree, select the CPU/interface module and go to "Online & diagnostics".
2. In the "Diagnostics" folder, select the "General" area.

Procedure for entering maintenance data via STEP 7

STEP 7 assigns a default module name. You can enter the following information:

- Plant designation (I&M 1)
- Location identifier (I&M 1)
- Installation date (I&M 2)
- Additional information (I&M 3)

To enter maintenance data via STEP 7, follow these steps:

1. In the device view of STEP 7, select the CPU/interface module or a module.
2. In the properties under "General", select the "Identification & Maintenance" area and enter the data.

During the loading of the hardware configuration, the maintenance data (I&M 1, 2, 3) are also loaded.

Procedure for reading I&M data via the Web server

The procedure is described in detail in the Web server Function Manual (https://support.industry.siemens.com/cs/ww/en/view/59193560).

13.10.2 Record structure for I&M data

Reading I&M records via user program (centrally and distributed via PROFINET IO)

Use **Read data record** ("RDREC" instruction) to access specific identification data. Under the associated record index you obtain the corresponding part of the identification data.

The records are structured as follows:

Table 13- 4 Basic structure of data records with I&M identification data

Contents	Length (bytes)	Coding (hex)
Header information		
BlockType	2	I&M0: 0020H I&M1: 0021H I&M2: 0022H I&M3: 0023H
BlockLength	2	I&M0: 0038H I&M1: 0038H I&M2: 0012H I&M3: 0038H
BlockVersionHigh	1	01
BlockVersionLow	1	00
Identification data		
Identification data (see table below)	I&M0/Index AFF0H: 54 I&M1/Index AFF1H: 54 I&M2/Index AFF2H: 16 I&M3/Index AFF3H: 54	- - - -

Table 13- 5 Record structure for I&M identification data

Identification data	Access	Example	Explanation
Identification data 0: (record index AFF0H)			
VendorIDHigh	Read (1 byte)	0000H	Vendor name (002AH = SIEMENS AG)
VendorIDLow	Read (1 byte)	002AH	
Order_ID	Read (20 bytes)	6ES7615-4DF10-0AB0	Article number of the module (for example, CPU 1504D TF)
IM_SERIAL_NUMBER	Read (16 bytes)	-	Serial number (device-specific)
IM_HARDWARE_REVISION	Read (2 bytes)	1	corresponds to hardware version (e.g. 1)
IM_SOFTWARE_REVISION	Read	Firmware version	Provides information about the firmware version of the module (e.g. V1.0.0)
• SWRevisionPrefix	(1 byte)	V	
• IM_SWRevision_Functional_Enhancement	(1 byte)	0000H - 00FFH	
• IM_SWRevision_Bug_Fix	(1 byte)	0000H - 00FFH	
• IM_SWRevision_Internal_Change	(1 byte)	0000H - 00FFH	

Identification data	Access	Example	Explanation
IM_REVISION_COUNTER	Read (2 bytes)	0000H	Provides information about parameter changes on the module (not used)
IM_PROFILE_ID	Read (2 bytes)	0000 H	Generic Device
IM_PROFILE_SPECIFIC_TYPE	Read (2 bytes)	0001H	CPU
		0003H	I/O modules
IM_VERSION	Read	0101H	Provides information on the ID data version (0101H = Version 1.1)
• IM_Version_Major	(1 byte)		
• IM_Version_Minor	(1 byte)		
IM_SUPPORTED	Read (2 bytes)	000EH	provides information about the available identification and maintenance data (I&M1 to I&M3)
Maintenance data 1: (Record index AFF1H)			
IM_TAG_FUNCTION	Read/write (32 bytes)	-	Enter an identifier for the module here, that is unique plant-wide.
IM_TAG_LOCATION	Read/write (22 bytes)	-	Enter the installation location of the module here.
Maintenance data 2: (Record index AFF2H)			
IM_DATE	Read/write (16 bytes)	YYYY-MM-DD HH:MM	Enter the installation date of the module here.
Maintenance data 3: (Record index AFF3H)			
IM_DESCRIPTOR	Read/write (54 bytes)	-	Enter a comment about the module here.

Reading I&M records with record 255 (distributed configuration via PROFIBUS)

You can directly access specific identification data by selecting **Read data record** ("RDREC" instruction).

The modules support standardized access to identification data using DR 255 (index 65000 to 65003). For additional information on the DR 255 data structure, refer to the specifications of the Profile Guidelines Part 1: Identification & Maintenance Functions - Order no.: 3.502, Version 1.2, October 2009. You can find further information on the Internet (https://www.profibus.com/) website of the PROFIBUS user organization.

13.10.3 Example: Read out firmware version of the CPU with Get_IM_Data

Automation task

You want to check whether the modules in your automation system have the current firmware. You can find the firmware version of the modules in the I&M0 data. The I&M0 data is the basic information for a device. The I&M0 data contains information such as:

- Manufacturer ID
- Article number and serial number
- Hardware and firmware version

To read out the I&M0 data, use the "Get_IM_Data" instruction. You read the I&M0 data of all modules in the user program of the CPU with "Get_IM_Data" instructions and store the I&M data in a data block.

Conditions and parameters

To read out the I&M data of the CPU, use the following block parameters of the "Get_IM_Data" instruction:

- LADDR: Enter the hardware identifier of the module at the block parameter "LADDR".
- IM_TYPE: Enter the I&M data number (for example "0" for I&M0 data) at the "IM_TYPE" block parameter.
- DATA: Area for storing the read I&M data (for example. in a global data block). Store I&M0 data in an area of the data type "IM0_Data".

This example shows how to read out the I&M0 data of a CPU 1504D TF (6ES7615-4DF10-0AB0) . To read out the I&M0 data of a different module, simply use the hardware identifier of the module at the LADDR parameter.

Solution

Proceed as follows to read out the I&M0 data of the CPU:

1. Create a global data block to store the I&M0 data.
2. Create a structure of the data type "IM0_Data" in the global data block. You can assign any name for the structure (in this case "imData").

SLI_gDB_Get_IM_Data

	Name	Data type	Start value
1	Static		
2	imData	IM0_Data	
3	done	Bool	false
4	busy	Bool	false
5	error	Bool	false
6	status	Word	16#0

Figure 13-4 Example: Data block for I&M data

3. Create the "Get_IM_Data" instruction in the user program, for example, in OB 1.

4. Interconnect the "Get_IM_Data" instruction as follows:

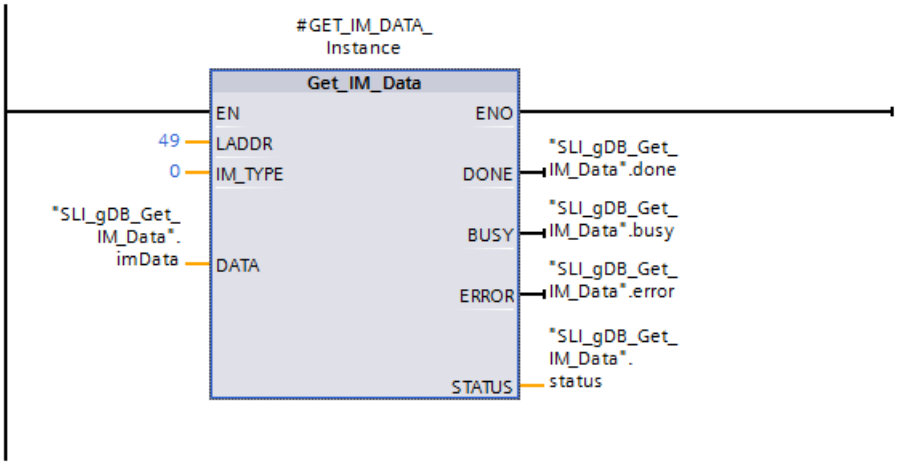


Figure 13-5 Example: Reading out I&M0 data

5. Call the "Get_IM_Data" instruction in the user program.

Result

The "Get_IM_Data" instruction has stored the I&M0 data in the data block.

You can view the I&M0 data online in STEP 7, for example, in the data block with the "Monitor all" button. The CPU in the example is a CPU 1507D TF (6ES7615-7DF10-0AB0) with the firmware version V2.8.

SLI_gDB_Get_IM_Data

	Name	Datentyp	Startwert	Beobachtungswert
1	Static			
2	imData	IM0_Data		
3	Manufacturer_ID	UInt	0	42
4	Order_ID	String[20]	''	'6ES7 615-7DF10-0AB0 '
5	Serial_Number	String[16]	''	'S C-HNPV77072016'
6	Hardware_Revision	UInt	0	10061
7	Software_Revision	IM0_Version		
8	Type	Char	' '	'V'
9	Functional	USInt	0	28
10	Bugfix	USInt	0	19
11	Internal	USInt	0	2
12	Revision_Counter	UInt	0	0
13	Profile_ID	UInt	0	0
14	Profile_Specific_Ty...	UInt	0	0
15	IM_Version	Word	16#0	16#0101
16	IM_Supported	Word	16#0	16#000E
17	<Hinzufügen>			

Figure 13-6 Example: I&M0 data of an S7-1500 CPU

13.11 Shared commissioning of projects

Team Engineering

In Team Engineering, several users from various engineering systems work on a project at the same time and access one SIMATIC Drive Controller CPU.

The users can edit separate parts of a master project independently of one another at the same time. When the configuration is loaded to the CPU, the CPU shows changes by the other editors in a synchronization dialog and – if possible – synchronizes the changes automatically.

Certain online functions can also be executed in parallel from several engineering systems on a shared CPU, for example:

- Monitoring blocks on the CPU
- Modifying blocks on the CPU
- Trace functions

You can find detailed information on the topic of Team Engineering in the STEP 7 online help.

SIMATIC memory card

14

14.1 SIMATIC memory card – Overview

Introduction

The SIMATIC Drive Controller uses the SIMATIC Memory Card of the S7-1500 automation system. The CPU data and the data of the SINAMICS Integrated is stored on the memory card.

The SIMATIC Memory Card is pre-formatted and is compatible with the Windows file system. The memory card is available in different memory sizes and can be used for the following purposes:

- Portable data storage medium
- Assigning a password to protect confidential PLC configuration data of a CPU
- CPU program card including SINAMICS Integrated configuration
- Firmware update card for CPU and SINAMICS Integrated
- Service data card for CPU and SINAMICS Integrated

You can find an overview of the memory card sizes available to order in Accessories/spare parts (Page 361).

Backing up the CPU configuration

When you transfer the user program to the CPU via an online connection, the user program is written to the SIMATIC Memory Card. The SIMATIC Memory Card must be in the card slot of the CPU for this to work.

You can also write the SIMATIC Memory Card in the PG/PC. A commercially available SD card reader is needed to read or write the SIMATIC Memory Card with the PG/PC. This allows you to copy files directly to the SIMATIC Memory Card with Windows Explorer, for example.

Note

The SIMATIC Memory Card is essential for operation of the CPU.

WARNING

Risk of death from software manipulation when using removable storage media

The storage of files on removable storage media poses an elevated risk of virus, malware or other infection of commissioning PCs.

Incorrect parameter settings can cause malfunctions on machines that can result in injuries or death.

Take appropriate measures to protect files stored on removable media from malware, e.g. through use of a virus scanner.

Backing up the drive configuration

The SINAMICS Integrated parameter assignment settings are only saved in the volatile memory. If you do not back up the settings on the SIMATIC Memory Card, they will be lost when the SIMATIC Drive Controller is switched off.

Requirements

To save the configuration of the SINAMICS Integrated to the SIMATIC Memory Card, you need an online connection to the SINAMICS Integrated. To establish the online connection, you must first load the hardware configuration to the SIMATIC Drive Controller. You can find additional information on this in Downloading a project to the device (Page 270).

Saving online data

To save the current project data to the retentive memory of the SIMATIC Memory Card, go to the function view for the active drive and click on the icon (Save data for entire device to retentive memory).

Saving offline data

Proceed as follows to save offline data to the SIMATIC Memory Card as well as in the TIA Portal project:

1. Establish an online connection to SINAMICS Integrated .
2. Download the project data to the SINAMICS Integrated.

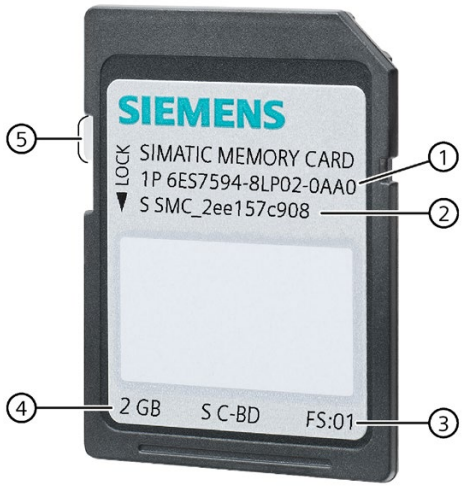
   To do so, click on the icon (Download to device) in the toolbar.
3. Click on the icon in the function view for the active drive (Save data for entire device to retentive memory).

   The parameters are saved to the SIMATIC Memory Card retentive memory.

Note

The function "Save data for entire device to retentive memory" is also known as "RAM to ROM".

Labeling of the SIMATIC Memory Card



① Article number
② Serial number
③ Production version
④ Memory size
⑤ Slider for setting write protection:
- Slider up: not write-protected
- Slider down: write-protected

Figure 14-1 Labeling of the SIMATIC Memory Card

Folders and files on the SIMATIC Memory Card

The SIMATIC Memory Card can contain the following folders and files:

Table 14- 1 Folder structure

Folder	Description
FWUPDATE.S7S	Firmware update files for CPU and SINAMICS Integrated
SIMATIC.S7S	Project data of the CPU; user program, i.e. all blocks (OBs, FCs, FBs, DBs) and system blocks
SINAMICS.S7S	If SINAMICS Integrated is configured, project data of the SINAMICS Integrated The folder structure under the SINAMICS.S7S folder is based on the structure of a SINAMICS S120 memory card.
SIMATIC.HMI	HMI-related data
DataLogs [1)]	DataLog files
Recipes [1)]	Recipe files
UserFiles [1)]	You need to manually create the folder "UserFiles" for user data on the memory card. Only files in this folder (*.pdf, *.txt, *.csv, etc.) are also loaded to the TIA Portal project with the "Upload device as new station" function.
Backups	Files for backup and restore
DUMP.S7S	Service data files

Folder	Description
SET_PWD.S7S	Files for "SET PASSWORD" job For more information, see Communication Function Manual (https://support.industry.siemens.com/cs/ww/en/view/59192925), section Assign password via SIMATIC Memory Card.
MCRC	Motion Control Runtime Component: Motion control package for KinPlus
OSSINFO	If there is a folder "OSSINFO" in the main directory of the memory card, the open source software information will be copied to the memory card after the CPU is powered-on.

1) The content of these folders is also loaded to the TIA Portal project with "Upload device as new station".

Table 14- 2 File structure

File type	Description
S7_JOB.S7S	Job file
SIMATIC.HMI\Backup*.psb	Panel backup files
SIMATICHMI_Backups_DMS.bin	Protected file (required for use of panel backup files in STEP 7)
__LOG__	Protected system file (required for use of card)
crdinfo.bin	Protected system file (required for use of card)
*.pdf, *.txt, *.csv, etc.	Additional file with different formats that you can also store in folders on the SIMATIC Memory Card If you store the files in the "UserFiles" folder, the files are stored in the STEP 7 project with "Upload device as new station" and can be used, for example, for restoring files in the event of a defective SIMATIC Memory Card.
SET_PWD.S7S/PWD.TXT	Files for protecting confidential PLC configuration data For more information, see Communication Function Manual (https://support.industry.siemens.com/cs/ww/en/view/59192925), section Assign password via SIMATIC Memory Card.
Device_Info_OSS.zip	The archive file contains Open Source Software information read from the CPU.

Note

Supported file/folder names and hierarchy levels on the SIMATIC Memory Card

The following rules apply to file names, folder names and hierarchy levels on the SIMATIC Memory Card:

- Do not use any umlauts (ö, ä, ü, Ö, Ä, Ü) in file and/or folder names.
- Use a maximum of 60 characters for file and/or folder names.
- Use a maximum of 6 hierarchy levels for the folder structure of the SIMATIC Memory Card (for example: /mountpoint/1/2/3/4/5/6/file.txt).
  The operating system of the CPU supports folders of no more than 8 levels, where one level is reserved for the root node and one for the actual file.

Using the serial number for copy protection

You can set up copy protection for CPUs that binds execution of the block to a specific SIMATIC Memory Card. Configuration is carried out in STEP 7 in the properties of the block "Bind to serial number of the SIMATIC Memory Card".

You can then only execute the block if it is on the SIMATIC Memory Card with the specified serial number (see Copy protection (Page 254)).

Note

SINAMICS Integrated

You can find information on how to protect settings on SINAMICS Integrated from unauthorized reproduction in the SINAMICS S120 Drive Functions (https://support.industry.siemens.com/cs/ww/den/view/109781535) function manual.

Removing a SIMATIC Memory Card from the CPU

Note

Do not remove the SIMATIC Memory Card while a write operation is in progress.

If you remove the memory card from the CPU during a write operation, the content of the memory card may become invalid. The memory areas can then lose their retentivity. You may need to clear the memory card on the programming device and load the program again.

Proceed as follows to remove the SIMATIC Memory Card:

- Switch off the supply voltage.

  Note

  If there is no write access over the programming device in progress, you can also remove the memory card when the supply voltage is on and the system is in STOP. In this case, first disconnect all communication connections as a precaution.

Inserting the SIMATIC Memory Card in the CPU in STOP state triggers a re-evaluation of the SIMATIC Memory Card. The CPU compares the content of the configuration on the SIMATIC Memory Card with the backed-up retentive data. If the backed-up retentive data matches the data of the configuration on the SIMATIC Memory Card, the retentive data is retained. If the data differs, the CPU automatically performs a memory reset. A memory reset deletes the retentive data on the CPU. After the memory reset, the CPU switches to STOP.

Please also note the following FAQ on the Internet (https://support.industry.siemens.com/cs/ww/en/view/59457183) relating to the removal of the SIMATIC Memory Card.

Note

Using the SIMATIC Memory Card as a firmware update card

If you use the SIMATIC Memory Card as a firmware update card, removing and inserting the card will not result in the loss of retentive data. You can find more information in SIMATIC Drive Controller firmware update (Page 319).

Removing a SIMATIC Memory Card from Windows computers

If you are using the card in a commercially available card reader under Windows, use the "Eject" function before you remove the card from the card reader. If you remove the card without using the "Eject" function, you may lose data.

Deleting content from the SIMATIC Memory Card

You have the following options for deleting the content of the SIMATIC Memory Card:

- Delete files using Windows Explorer
- Format with STEP 7

Note

If you format the card with Windows tools, you will render the SIMATIC Memory Card unusable as a storage medium for a CPU.

Deletion of files and folders is permitted, with the exception of the "__LOG__" and "crdinfo.bin" system files. The CPU needs these system files. If you delete the files, you will no longer be able to use the SIMATIC Memory Card with the CPU.

If you have deleted the "__LOG__" and "crdinfo.bin" system files, format the SIMATIC Memory Card as described in the following section.

Formatting a SIMATIC Memory Card

Note

Formatting the SIMATIC Memory Card

Do **not** format the memory card with Windows tools. Formatting with Windows renders the memory card initially unusable by a CPU.

You can find information on how to repair an inconsistent or incorrectly formatted card in the following FAQ on the Internet (https://support.industry.siemens.com/cs/ww/en/view/69063974).

To free up memory space on your SIMATIC Memory Card, you have the option of formatting the SIMATIC Memory Card. During formatting, the entire contents of the memory card including the project data of the SINAMICS Integrated are deleted.

The SIMATIC Memory Card may only be formatted in the CPU. Proceed as follows with the SIMATIC Memory Card inserted:

Formatting with STEP 7:

- Establish an online connection.
- Open the online and diagnostics view of the CPU (either from the project context or via "Accessible devices").
- In the dialog window, select "Functions > Format memory card" and then select the "Format" button.

Results:

- The SIMATIC Memory Card is formatted.
- The CPU is temporarily unavailable.
- The project data on the CPU is deleted with the exception of the IP address.

Replacing the SIMATIC Memory Card without loss of retentive data

You can change the SIMATIC Memory Card or use a larger SIMATIC Memory Card without losing the retentive data. When you switch off the CPU, the retentive data is backed up in the retentive memory of the CPU. While the CPU is off, you can remove the memory card and copy its content to a larger memory card. After the CPU is switched on, the data backed up in the CPU when the CPU was switched off is restored.

14.2 Setting the card type

Introduction

You can use the SIMATIC Memory Card as a program card or as a firmware update card.

Note

Password to protect confidential PLC configuration data

If you want to transfer the password to protect confidential PLC configuration data to a CPU without using TIA Portal, you can also use a SIMATIC Memory Card for this function.

For more information about assigning the password via SIMATIC Memory Card, refer to the Communication Function Manual (https://support.industry.siemens.com/cs/ww/en/view/59192925), in the section Assign password via SIMATIC Memory Card.

Procedure using STEP 7

1. To set the card type, insert the SIMATIC Memory Card in the card reader of the programming device.
2. Select the "SIMATIC Card Reader" folder in the project tree.
3. In the properties of the selected SIMATIC Memory Card, specify the card type:

- Program card

  You use a program card as an external load memory for the SIMATIC Drive Controller. The program card contains the complete user program for the CPU and the configuration of the SINAMICS Integrated. The SIMATIC Drive Controller transfers the user program and drive configuration from the load memory to the work memory. The user program and automatic speed control run in the work memory.

  The following folders are created on the SIMATIC Memory Card:

  – SIMATIC.S7S

  – SINAMICS.S7S (if a SINAMICS Integrated is configured)

- Firmware update card

  You can save the firmware of a CPU and SINAMICS Integrated on a SIMATIC Memory Card. This enables you to perform a firmware update with the help of a specially prepared SIMATIC Memory Card.

  The following folder is created on the SIMATIC Memory Card: FWUPDATE.S7S

  You can find information on how to update the SIMATIC Drive Controller in SIMATIC Drive Controller firmware update (Page 319) You can find information on how to update the firmware of the DRIVE-CLiQ component in DRIVE-CLiQ component firmware update (Page 327).

Procedure using the FUNCT button

You can use the FUNCT button to set whether the SIMATIC Memory Card works as a program card or as a firmware update card:

- Function 2: Switching the SIMATIC Memory Card from program card to firmware update card and performing a firmware update
- Function 3: Switching the SIMATIC Memory Card from firmware update card to program card

Function 2: Switching the SIMATIC Memory Card to firmware update card and perform update

Requirements:

- The memory card is of type program card (PROGRAM); the write protection of the card is not set.
- The CPU is in STOP mode.
- Valid firmware update files are available in the FWUPDATE.S7S folder.

Procedure:

1. To get to the function selection mode, press the FUNCT button for at least 3 seconds with a sharp object and then release it. As an aid, the 7-segment display flashes "0" at one-second intervals during this time.

   After you release the button, you are in function selection mode. The 7-segment display shows function "1": Save service data on SIMATIC Memory Card
2. Select the function "2" with a brief press of a button.
3. To confirm the selection, press the FUNCT button within 10 seconds for at least 3 seconds and then release it.

   The 7-segment display now displays a "U" (Update) for 10 seconds. The memory card is set to FWUPDATE. The CPU will then re-evaluate the SIMATIC Memory Card, and the firmware update starts.

If the requirements for the function selection are not fulfilled (for example, write protection of the card set, no card inserted, CPU not in operational state STOP), then the 7-segment display shows the status "F" (Fault) for 10 seconds and the function is not performed. Next, the menu is closed and the 7-segment display shows "0".

If the card is already of the type FWUPDATE, the function is not executed. The menu is closed and the 7-segment display displays "0".

Function 3: Switching the SIMATIC Memory Card to program card

Requirements:

- The memory card is of type firmware update card (FWUPDATE); the write protection of the card is not set.
- No firmware update in progress; otherwise, the function cannot be selected.

Procedure:

1. To get to the function selection mode, press the FUNCT button for at least 3 seconds with a sharp object and then release it. As an aid, the 7-segment display flashes "0" at one-second intervals during this time.

   After you release the button, you are in function selection mode. The 7-segment display shows function "1": Save service data on SIMATIC Memory Card
2. Select the function "3" by briefly pressing the button twice.
3. To confirm the selection, press the FUNCT button within 10 seconds for at least 3 seconds and then release it.

   The 7-segment display now displays a "P" (Program) for 10 seconds. The memory card is set to PROGRAM and the CPU re-evaluates the SIMATIC Memory Card.

   After the startup, you can change the operating mode of the CPU via the mode selector switch or via the TIA Portal. The firmware update files are retained.

If the requirements for the function selection are not fulfilled (for example, write protection of the card set, no card inserted) then the 7-segment display shows the status "F" (Fault) for 10 seconds and the function is not performed. Next, the menu is closed and the 7-segment display shows "0".

If the card is already of the PROGRAM type, the function is not executed. The menu is closed and the 7-segment display displays "0".

Note

The function 3 is available to you as of the CPU firmware version V2.9.

When downgrading to firmware version V2.8, function 3 is only available until the firmware version V2.8 has been activated by a restart. This means that, immediately after a downgrade, you can still perform Function 3 to reset the SIMATIC Memory Card back to program card.

Exit function selection mode

In function selection mode, briefly pressing a button for < 3 seconds selects the next function (function "1", "2", "3" or "4"). The last function is "E". If you press the button for at least 3 seconds, the function selection module is exited. The function selection mode is also exited if no key is pressed for 10 seconds.

Procedure using the job file

Whether the SIMATIC Memory Card is operating as a program card or firmware update card, can also be set using the job file S7_JOB.S7S on the SIMATIC Memory Card.

Entry in the job file:

- PROGRAM: the SIMATIC Memory Card is used as a program card
- FWUPDATE: the SIMATIC Memory Card is used as a firmware update card

Proceed as follows:

1. Open the job file S7_JOB.S7S with an editor.
2. Use the editor to overwrite the PROGRAM entry with FWUPDATE (or vice versa).

   Do not use any spaces, line breaks or quotation marks.
3. Save the file under the existing file name.

Service data card

You can save service data on a SIMATIC Memory Card. The service data contains the CPU diagnostic buffer and the diagnostic buffer of SINAMICS Integrated. The service data contains much more information on the internal state of the CPU and SINAMICS Integrated.

The following folder is created on the SIMATIC Memory Card: DUMP.S7S

You can find more information on service data in the section Reading/saving service data (Page 343).

Program card including firmware update files

If you want to deliver your project with firmware validated by you, for example, you can store the program data and firmware update files together on the memory card. Your customers then have the option of changing CPU and SINAMICS Integrated to exactly that firmware version.

Note

Please note that, depending on the tool used (for example STEP 7, Web server), the firmware update files may also be deleted if you reset to "Program card". Therefore, use the FUNCT button (function 3) or change the job file S7_JOB.S7S to PROGRAM with an editor.

Additional information

You can find additional information on the FUNCT button in the SIMATIC Drive Controller manual (https://support.industry.siemens.com/cs/ww/en/view/109766666).

You can find additional information in the STEP 7 online help.

14.3 Data transfer with SIMATIC memory cards

Transferring objects from the project to the SIMATIC Memory Card

While the SIMATIC Memory Card is in the programming device or external card reader, you can transfer the following objects from the project tree (STEP 7) to the SIMATIC Memory Card:

- Individual blocks (multiple selection possible)

  In this case, the transfer is consistent, i.e. the function takes account of dependencies between blocks through block calls.

- CPU folder

  In this case, all runtime-related objects such as blocks and the hardware configuration are transferred to the SIMATIC Memory Card, just as with downloading.

- Service data

  In this case, the service data saved beforehand is saved to the SIMATIC Memory Card. You can find more information on service data in the section Reading/saving service data (Page 343).

You have the following options for performing the transfer:

- Transfer the objects using drag-and-drop.
- Use the "Card Reader/USB memory > Write to memory card" command in the "Project" menu.

Storing CPU trace recordings on the SIMATIC Memory Card

The "Save measurements on device (memory card)" function allows you to save CPU trace recordings on the SIMATIC Memory Card.

1. Select "Traces" -> "Trace" in the project tree.
2. In the working area, select "Configuration" -> "Recording conditions" -> "Measurements in device (memory card)".

Response when number reached

The "Deactivate recording" parameter value repeats the measurements until the configured "Number of measurements" is reached.

The "Overwrite oldest recording" parameter value replaces the oldest measurement with the latest measurement when the configured "Number of measurements" is reached. Please note, however, that continuously writing data to the SIMATIC Memory Card shortens its service life.

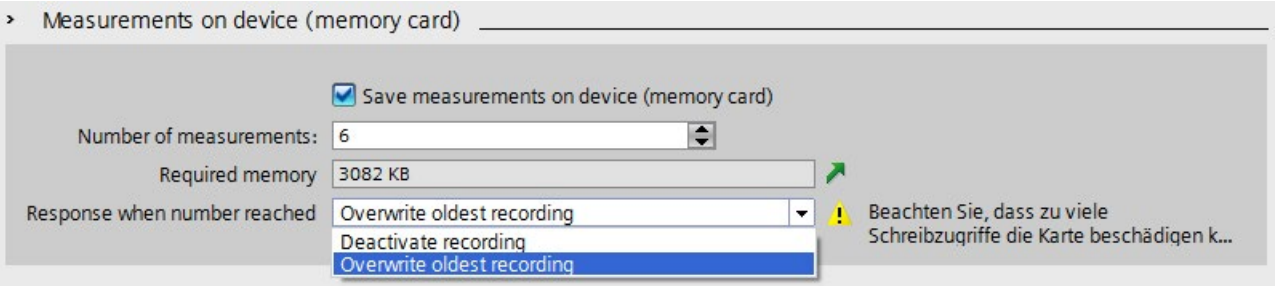


Figure 14-2 Dialog with settings for saving measurements to the memory card in STEP 7

Number of measurements

The CPU supports a maximum of 999 measurements. The CPU writes the Trace recordings to the load memory of the memory card. Meanwhile, the CPU pauses the checking of trigger conditions for the Trace job. Once the CPU has finished saving the Trace recordings, the CPU continues checking the trigger conditions.

NOTICE
Memory required on the SIMATIC Memory Card If the Trace function "Measurements on device (memory card)" requires more memory than is available on the SIMATIC Memory Card, this can have undesirable effects. Ensure there is always sufficient free memory space to use the "Measurements on device (memory card)" function. In addition to the "Measurements on device (memory card)" Trace function, other functions, such as storing data logs, use memory space on the SIMATIC Memory Card. Make sure that enough memory space is available for all functions that occupy memory.

You can find additional information on Trace measurements and Trace recordings:

- In the Using the Trace and Logic Analyzer Function (https://support.industry.siemens.com/cs/ww/en/view/64897128) function manual
- In the Web Server (https://support.industry.siemens.com/cs/ww/en/view/59193560) function manual
- In the STEP 7 online help

Firmware update using SIMATIC Memory Card

You can find information on how to perform a firmware update in SIMATIC Drive Controller firmware update (Page 319).

14.4 Service life of the SIMATIC memory card

Effects on the service life

The following factors can affect the service life of SIMATIC Memory Cards:

- Size of card and number of guaranteed write operations
- Actual number of write operations

  The number of physical write operations to the memory blocks of the card is a result of the number of write operations from the application.

Note

With the SIMATIC Drive Controller, this includes not only CPU access but also memory card access (write and delete access) by the SINAMICS Integrated.

You can find methods for calculating the service life of a SIMATIC Memory Card in the Function Manual Structure and use of the CPU memory (https://support.industry.siemens.com/cs/ww/en/view/59193101) and in an FAQ (https://support.industry.siemens.com/cs/ww/en/view/109482591) on the Internet.

GetSMCinfo instruction

If the SIMATIC Memory Card is inserted, you can read out the following information in STEP 7 (TIA Portal) with the GetSMCinfo instruction:

- Memory size in KB (1 KB = 1024 bytes)
- Occupied memory in KB (1 KB = 1024 bytes)
- Maintenance information: Percentage of service life used up so far
- Configured percentage of service life after which the CPU creates a diagnostics buffer entry and the maintenance LED is activated

You can find additional information on the "GetSMCinfo" instruction in the STEP 7 online help.

Additional information

You can find additional information on the service life of the SIMATIC Memory Card, on storage capacity utilization, and on the memory areas used in the Structure and Use of the CPU Memory (https://support.industry.siemens.com/cs/ww/en/view/59193101) function manual.

Maintenance 15

15.1 Replacing system components

15.1.1 Replacing a defective SIMATIC Drive Controller

Requirements

The power supply must be switched off before the SIMATIC Drive Controller is removed.

NOTICE
Material damage possible Install or uninstalling the SIMATIC Drive Controller with the power connected can lead to undefined states in your plant. Your automation system may be damaged as a result. Only install/uninstall the SIMATIC Drive Controller if the power supply is disconnected.

Removing the SIMATIC Drive Controller

Proceed as follows to remove the SIMATIC Drive Controller:

1. Switch off the power supply.
2. Open the bottom cover by pressing the "PUSH" button and remove the SIMATIC Memory Card from the slot.
3. Open the top cover.
4. Loosen the terminal block for the 24 V power supply.
5. Release the DRIVE-CLiQ connectors to the SINAMICS S120 modules.
6. Release the connectors of the PROFINET interfaces or PROFIBUS interface.
7. Unplug the connectors to the digital inputs and digital outputs at interfaces X122, X132 and X142
8. Separate the connection to the protective conductor.
9. Loosen the fixing screws that are holding the SIMATIC Drive Controller to the cabinet wall.

Installing and connecting a new SIMATIC Drive Controller

Proceed as follows to install the new SIMATIC Drive Controller:

1. Install the new SIMATIC Drive Controller.
2. Connect the protective conductor to the SIMATIC Drive Controller.

3. Reconnect all connectors you have previously removed.
4. You use the "PUSH" button to open the bottom cover.
5. Insert the SIMATIC Memory Card in the slot.
6. Switch the power supply back on.

Following a module replacement, the CPU operates with the configured start values. SINAMICS Integrated detects a module replacement on the basis of the new SIMATIC Drive Controller serial number. Following POWER ON, the NVRAM of the SINAMICS Integrated is cleared and the NVRAM data is then loaded from the memory card.

Note

Make sure that the new SIMATIC Drive Controller has the same or a higher main firmware version for CPU and SINAMICS Integrated .

If the main SINAMICS firmware version is higher, you will need to upgrade your project to the relevant SINAMICS version to ensure that you can still go online with your project on SINAMICS Integrated. Alternatively, you can downgrade the SINAMICS firmware main version of a new SIMATIC Drive Controller back to the configured version.

Note

Setting up copy protection

For code blocks, you can set up copy protection (Page 254) that binds execution of the blocks to a specific CPU or a specific memory card on the basis of the serial number. In such cases, a substitute controller cannot be used without additional measures being taken.

15.1.2 Replacing a defective SIMATIC memory card

Initial situation

Possible error scenario if the SIMATIC Memory Card of a CPU is defective:

- System diagnostics reports a system error.
- The CPU has switched to STOP.
- The RUN/STOP LED is yellow and the ERROR LED is flashing red.

Requirement

- Replacement is only possible if you have a suitable replacement card. The replacement card can be a copy of the defective card or a new project card created using engineering.
- The new SIMATIC Memory Card must have sufficient memory for the project.

Note

For code blocks, you can set up copy protection (Page 254) that binds execution of the blocks to a specific CPU or a specific memory card on the basis of the serial number. In such cases, a replacement card cannot be used without additional measures being taken.

Procedure

Proceed as follows to replace a defective SIMATIC Memory Card:

1. Remove the defective memory card.
2. Insert the replacement card with the correct configuration.

15.1.3 Replacing a DRIVE-CLiQ component

Replacing a DRIVE-CLiQ component

Defective components in the SINAMICS S120 drive system can be replaced with components with identical or with different article numbers depending on the equivalence level set.

You can find further information in the SINAMICS S120 function manual (https://support.industry.siemens.com/cs/ww/en/view/109781535) under "Component replacement".

Firmware update

DRIVE-CLiQ components are automatically upgraded or downgraded to the component firmware version on the memory card during power up. A module replacement can therefore lead to a firmware update (see DRIVE-CLiQ component firmware update (Page 327)).

15.2 SIMATIC Drive Controller firmware update

Introduction

You update the firmware of the SIMATIC Drive Controller using firmware files. The retentive data is retained after the firmware update on the CPU and SINAMICS Integrated.

Requirement

- You have downloaded the file(s) for the firmware update from the Siemens Industry Online Support (https://support.industry.siemens.com/cs/ww/en/view/109773914).
- Before installing the firmware update, make sure that the SIMATIC Drive Controller and any connected drives are not in use.

Additional requirement for failsafe modules

WARNING

Check the firmware version for F-approval

When using a new firmware version, always check that the version is approved for use in the module in question.

The attachments of the certificate (https://support.industry.siemens.com/cs/ww/en/ps/14675/cert) for SIMATIC Safety specify which firmware version is approved.

Options for the firmware update

There are the following options for performing a firmware update:

- Online in STEP 7 via Online & Diagnostics
- Online in STEP 7 via accessible devices (PROFINET)
- Via the SIMATIC Memory Card
- Via the SIMATIC Memory Card: with the FUNCT button (function 2) on the SIMATIC Drive Controller
- Via the integrated Web server
- Online via the SIMATIC Automation Tool

The following table provides an overview of the various options for a firmware update.

Table 15- 1 Overview of firmware update options

Firmware update	Drive Controller CPU	Drive Controller SINAMICS Integrated	Interface module	Distributed I/O module
STEP 7, Online & Diagnose	✓	--	✓	✓
STEP 7, accessible devices	✓	--	✓	--
SIMATIC Memory Card	✓	✓	--	--
Web server of the CPU	✓	✓	✓	✓
SIMATIC Automation Tool	✓	--	✓	✓

Installation of the firmware update

⚠ WARNING

Impermissible plant states possible

Installation of the firmware update causes the CPU to switch to STOP or a distributed interface module to "station failure". The STOP operating state results in a frame failure at the drive with a corresponding response at the drive end (for example, OFF3 fast stop, depends on the parameter assignment). STOP or station failure can have an adverse effect on the operation of an online process or a machine.

Unexpected operation of a process or a machine can lead to fatal or severe injuries and/or to material damages.

Before you install the firmware update, make sure that the SIMATIC Drive Controller is not controlling any active process.

Note

Management of the license conditions and copyright notices of firmware updates

Open-source software is used in the firmware of the SIMATIC Drive Controllers. For legal reasons, Siemens AG is obliged to publish the original text of the license conditions and copyright notices. You can find it on the Internet in the FW downloads (https://support.industry.siemens.com/cs/de/en/view/109773914) and in the scope of supply of the SIMATIC Drive Controller for the firmware version that has been supplied (see the note on the type plate at the side).

The license conditions and copyright notices in the scope of delivery can change as a result of firmware updates. In order to avoid license violations by the reseller and the buyer, if there are firmware updates, you must pass on the license conditions and copyright notices of the firmware update to the buyer (for example, by saving them to the SIMATIC Memory Card).

Procedure: online in STEP 7 via Online & diagnostics

Requirement: There is an online connection between the CPU/module and PG/PC.

Proceed as follows to perform an online firmware update via STEP 7:

1. Select the CPU of the SIMATIC Drive Controller in the project tree.
2. Select the "Online & diagnostics" menu command from the shortcut menu.
3. Select the "Firmware update" group in the "Functions" folder.
4. Click the "Browse" button to select the firmware update files in the "Firmware update" area.
5. Select the matching firmware file. The table in the firmware update area lists all modules for which an update is possible with the selected firmware file.
6. Click the "Run update" button. If the module can interpret the selected file, the file is downloaded to the module. If you must change the CPU mode, STEP 7 prompts you to do so with dialogs.

Updating the firmware

The "Run firmware after update" check box is always selected.

After a successful loading process the CPU includes imports the firmware and subsequently operates with the new firmware.

Note

When a firmware update is interrupted, you need to switch the SIMATIC Drive Controller off/on or remove and insert the relevant module in a distributed I/O station before starting the firmware update again. An update can only be performed for the CPU and not for the SINAMICS Integrated over STEP 7.

Procedure: online in STEP 7 via accessible devices

To perform a firmware update online via accessible devices, follow these steps:

1. From the "Online" menu, select the "Accessible devices" menu item.
2. In the Accessible devices dialog, search for the accessible devices for the selected PROFINET interface.
3. To go to a device in the project tree, select the desired device from the list of accessible devices and click the "Show" button.
4. In the project tree, select the "Online & diagnostics" option for the relevant device and perform the firmware update under the category Functions/Firmware Update (CPU, Local modules).

Note

An update can only be performed for the CPU and not for the SINAMICS Integrated over accessible devices.

Procedure via the SIMATIC Memory Card

With a SIMATIC Memory Card, you can perform an update for CPU and SINAMICS Integrated on the SIMATIC Drive Controller. Separate update files are available for CPU and SINAMICS Integrated.

Example for CPU 1504D TF

CPU: 6ES7 615-4DF10-0AB0 V03.00.00.upd

SINAMICS Integrated: 6ES7 615-xDS1x-0xxx V52.03.10.upd

Note

The update files for SINAMICS Integrated are available in 2 different file formats. In this context, see the section "Compatibility information"

Proceed as follows perform a firmware update via the SIMATIC Memory Card:

1. Insert a SIMATIC Memory Card in the SD card reader of your PG/PC.
2. To store the update file on the SIMATIC Memory Card, select the SIMATIC Memory Card in the "Card Reader/USB memory" folder in the project tree.
3. Select the "Card Reader/USB memory > Create firmware update memory card" command in the "Project" menu.
4. Use a file selection dialog to navigate to the firmware update file. You can select one or multiple files.
   You can then also decide whether to delete the content of the SIMATIC Memory Card or add the firmware update files to the SIMATIC Memory Card.
5. Insert the SIMATIC Memory Card with the firmware update files into the CPU.

   After the SIMATIC Memory Card is inserted, the boot process starts. It takes several seconds. Next, the firmware update begins and the RUN LED flashes yellow.
6. The firmware update is successfully completed when the RUN LED of the CPU lights up yellow and the MAINT LED flashes yellow. Remove the SIMATIC Memory Card.
   If you use the SIMATIC Memory Card subsequently as a program card, then manually delete the firmware update files, including JobFile "S7_JOB.S7S".

   Alternatively, you can convert the SIMATIC Memory Card to a program card in STEP 7. To do so, specify the required card type in properties in the project tree for the selected SIMATIC Memory Card.

Note

Memory size of the SIMATIC Memory Card

For a firmware update of the SIMATIC Drive Controller, you need a memory card with at least 256 MB.

Other alternatives

You can also copy the update files to the FWUPDATE.S7S folder in Windows Explorer. Alternatively, you can also unzip the ZIP file with the firmware to the SIMATIC Memory Card. For the firmware update files from the Siemens Industry Online Support on the Internet, the necessary folder structure including the job file S7_JOB.S7S (Contents: FWUPDATE) is created at the same time.

You can also use the FUNCT button to perform a firmware update (function 2: Use the SIMATIC Memory Card as firmware update card and perform a firmware update). The procedure is described in the section Setting the card type (Page 310).

Program card including firmware update files

If you want to deliver your project with firmware validated by you, for example, you can store the program data and firmware update files together on the memory card. Your customers then have the option of changing CPU and SINAMICS Integrated to exactly that firmware version.

Note

Please note that, depending on the tool used (for example STEP 7, Web server), the firmware update files may also be deleted if you reset to "Program card". Therefore, use the FUNCT button (function 3) or change the job file S7_JOB.S7S to PROGRAM with an editor.

You can find additional information on using the SIMATIC Memory Card as a program card or firmware update card in Setting the card type (Page 310).

Compatibility information

Please note the following information on combinations of CPU and SINAMICS Integrated firmware:

- An update at hotfix level is always possible.
- Restrictions apply to updates at the level of the main version for the "CPU firmware" and "SINAMICS Integrated firmware" combination.
- Update files for the SINAMICS Integrated are available in different file formats:
  - Old file formats for CPU firmware V2.x with 1-/4-digit version: for example, 6ES7615-xDS1x-0ABx_v52.upd or 6ES7 615-xDS1x-0xxx V05.02.03.10.upd
  - New file format for CPU firmware ≥ V3.0.x with 3-digit version: for example, 6ES7 615-xDS1x-0xxx V52.03.10.upd

  The new file formats supports SINAMICS Integrated firmware updates also via the web server. In this case, "52" denotes the main version V5.2.

  If only the SIMATIC S7-1500 firmware is to be upgraded to FW ≥ V3.0.x and the SINAMICS Integrated firmware remains unchanged on the SIMATIC Drive Controller, no update of the SINAMICS Integrated firmware is required.

Please note the compatibility information in the relevant publications (https://support.industry.siemens.com/cs/ww/en/view/109773914).

Note

If you insert the SIMATIC Memory Card in a SIMATIC Drive Controller with a higher SINAMICS Integrated main firmware version, you need to upgrade your project to the relevant SINAMICS version.

You can only go online with your project if the configured SINAMICS version corresponds to the SINAMICS firmware version on the SIMATIC Drive Controller.

NOTICE

SIMATIC Drive Controllers with a hardware function version ≥ FS 09 have a CPU firmware version ≥ V2.9. You must **not** downgrade these SIMATIC Drive Controllers to CPU firmware version V2.8.

The CPU firmware version V2.8 may no longer be executable on SIMATIC Drive Controllers with hardware function version ≥ FS 09. In this case, the downgrading can no longer be reversed and the device must be sent in.

SINAMICS Integrated firmware missing or incompatible

If there is no SINAMICS Integrated firmware or the firmware is incompatible with the CPU, this is signaled by a red flashing RDY LED (2 Hz) and a red ERROR LED. A corresponding error message is also entered in the diagnostic buffer.

If the SIMATIC Memory Card has a SINAMICS Integrated firmware version that is incompatible with the CPU firmware, the SINAMICS Integrated firmware update is rejected. The ERROR LED flashes red and the MAINT LED flashes yellow. A corresponding error message is also entered in the diagnostic buffer.

An update of the CPU firmware, however, is always possible.

Update sequence

If the SINAMICS Integrated firmware also needs a new CPU firmware, then the CPU firmware must always be updated first and then activated by a CPU restart. (CPU restart through power off/on or by removing/inserting the SIMATIC Memory Card).

Examples:

- The service pack of SINAMICS firmware V5.2 SP3 (V5.2.3) requires at least CPU firmware V2.9
- SINAMICS Integrated update files (upd files) with a 3-digit version need at least CPU firmware V3.0

Update with SIMATIC Memory Card

If both update files for CPU and SINAMICS Integrated firmware are located on the SIMATIC Memory Card in the directory FWUPDATE.S7S, a distinction must be made between the following two cases:

Case 1: The SINAMICS Integrated firmware does not need any new CPU firmware
The CPU and SINAMICS Integrated firmware is updated in one process.

Case 2: The SINAMICS Integrated firmware also needs a new CPU firmware
In this case, a two-step procedure is required. When you carry out the firmware update, only the CPU firmware is updated first. The SINAMICS Integrated update is rejected with errors (ERROR LED flashes red).
In order for the SINAMICS Integrated firmware to also be updated successfully in a second step, you have to force a CPU restart through power off/on or by removing/inserting the SIMATIC Memory Card.
The CPU firmware is activated due to the restart and another update for the SINAMICS

Integrated firmware takes place automatically.

Please note the compatibility information in the relevant publications (https://support.industry.siemens.com/cs/ww/en/view/109773914)

Procedure: via the integrated Web server

You can perform an update of CPU and SINAMICS Integrated from the SIMATIC Web server.

Requirements:

- SIMATIC Drive Controller including SINAMICS Integrated is configured
- Web server with user rights is configured and activated
- Configuration has been loaded into the CPU

In addition, for SINAMICS Integrated firmware updates, at least CPU firmware V3.0 is required (configured CPU version can be < V3.0). It is not necessary to download the SINAMICS Integrated configuration.

Procedure:

To perform a firmware update, go to the corresponding node on the "Module status" web page and perform the update in the "firmware" tab.
The SINAMICS Integrated can be found under the PROFIdrive system.

Alternatively, there is a direct link to SINAMICS Integrated in the "Identification" tab under "Drive Controller Info" on the "Diagnostics" web page.

You can find more details in the Web server (https://support.industry.siemens.com/cs/ww/en/view/59193560) Function Manual.

Procedure: online via the SIMATIC Automation Tool

The procedure is described in the SIMATIC Automation Tool (https://support.industry.siemens.com/cs/ww/en/view/98161300) user manual (included in the SIMATIC Automation Tool).

Note

An update can only be performed for the CPU and not for the SINAMICS Integrated using the SIMATIC Automation Tool.

Behavior after the firmware update

After the firmware update, check the firmware version of the CPU / SINAMICS Integrated.

You can find the firmware version for the CPU or SINAMICS Integrated under "Online & diagnostics". In the working area, the firmware version is under "Diagnostics" > "General".

Additional information

You can find the latest firmware versions for the SIMATIC Drive Controller on the Internet (https://support.industry.siemens.com/cs/ww/en/view/109773914).

15.3 DRIVE-CLiQ component firmware update

DRIVE-CLiQ components

The SINAMICS Integrated (for SINAMICS S120 control units, the memory card) also contains the firmware for the DRIVE-CLiQ components. With factory setting p7826 = 1, this is automatically transferred from SINAMICS Integrated (for SINAMICS S120 control units from the memory card) to the DRIVE-CLiQ components upon initial commissioning.

The firmware is saved to non-volatile memory in the DRIVE-CLiQ components in the event of an upgrade.

Following a project download or automatic configuration, a firmware update is automatically performed on all connected DRIVE-CLiQ components. This upgrades all DRIVE-CLiQ components to the correct firmware versions.

Update process

The update process can take a few minutes. It is indicated by the RDY LED on the relevant component flashing green/red and the RDY LED for SINAMICS Integrated (or on the control unit) flashing yellow at 0.5 Hz.

A progress indicator is implemented in parameter p7827.

The update is complete when the RDY LED of the SINAMICS Integrated (control unit) stops flashing at 0.5 Hz. Once the upgrade has ended, the RDY LED for the component in question remains continuously lit, provided the upgrade is complete and the new firmware has been activated.

For components whose RDY LED is flashing green/red at 2 Hz, you need to perform a POWER OFF/POWER ON to activate the new firmware.

For components without LED (for example motors with DRIVE-CLiQ interface), check for relevant warnings on the drive.

Note

During activation of the new firmware, it is possible for a component to interrupt cyclic communication. In this case, communication faults occur and must be acknowledged.

You can check the firmware versions of the individual components with parameters. The versions of the DRIVE-CLiQ components and those of SINAMICS Integrated (or of the control unit) may differ.

Note

DRIVE-CLiQ components with higher firmware versions are backward compatible and can also operate with DRIVE-CLiQ components with lower firmware versions.

Automatic firmware update

You can use parameter p7826 to influence the response for automatic firmware updates of DRIVE-CLiQ components.

With the automatic firmware update, the firmware version of the DRIVE-CLiQ components is checked against the firmware version of SINAMICS Integrated (or the control unit) and if necessary updated upon each power up. This means power up can take a few minutes longer.

The following settings are possible:

- p7826 = 0: Upgrade and downgrade deactivated
- p7826 = 1: Upgrade and downgrade (factory setting)
- p7826 = 2: upgrade only

A parameter change does not become effective until the next drive system power up.

Where Safety Basic, Extended and/or Advanced Functions are enabled, the system checks whether the parameter for automatic firmware updates p7826 = 1 is set. Otherwise, the following message is output: F01664 (SI CU: No automatic firmware update).

15.4 System update SIMATIC Drive Controller

The system software of the SIMATIC Drive Controller is necessary for basic operation of the controller and contains components like BIOS, drivers and configuration data.

Thus, the system update is different from a firmware update, with which, for example, the functionality of the SIMATIC Drive Controller can be expanded. It is only necessary to update the system software if Siemens Service & Support or your Siemens contact person has recommended it.

The version of a system update that has been performed can be determined at the following places:

- in the TIA Portal in the CPU diagnostics using the option "Online & Diagnostics" and the secondary option "Diagnostics > General" under "Drive Controller information"
- in the CPU Web server on the web page "Diagnostics" in the "Identification" tab under "Drive Controller Info"
- in the exported diagnostic buffer of the CPU

If "---" is displayed as the version, there is no system update installed.

15.5 CPU reset to factory settings

Introduction

"Reset to factory settings" restores the CPU to its delivery state. The function deletes all information that was stored internally on the CPU.

Recommendation:

Switch the CPU to its as-delivered condition if:

- You remove a CPU and use it elsewhere with a different program
- You store the CPU

When resetting to factory settings, remember that the IP address parameters are also deleted.

Options for resetting a CPU to factory settings

To reset the CPU to its delivery state, follow these steps:

- Using the mode selector
- Using STEP 7
- Using the SIMATIC Automation Tool

Procedure using the mode selector

Make sure that the CPU is in STOP: The RUN/STOP LED lights up yellow.

Note

Reset to factory settings ↔ Memory reset

The procedure described below corresponds to the procedure for a memory reset:

- Selector operation with inserted SIMATIC Memory Card: CPU executes a memory reset
- Selector operation without inserted SIMATIC Memory Card: CPU executes reset to factory settings

Restore the factory settings of the CPU as follows:

1. Set the mode selector to the STOP position.

   Result: The RUN/STOP LED lights up yellow.

2. Remove the SIMATIC Memory Card from the CPU. Wait until the RUN/STOP LED stops flashing.
3. Set the mode selector to the MRES position. Hold the mode selector in this position until the RUN/STOP LED lights up for the second time and remains lit (this takes three seconds). After this, release the selector.
4. Within the next three seconds, switch the mode selector back to the MRES position, and then back to STOP again.

Result: The CPU executes a "Reset to factory settings", during which time the RUN/STOP LED flashes yellow. When the RUN/STOP LED lights up yellow, then the CPU has been reset to factory settings, and is in the STOP mode. The "Reset to factory settings" event is entered into the diagnostics buffer.

Note

The IP address of the CPU is also deleted when the CPU is reset to the factory settings through the mode selector.

Procedure using STEP 7

To reset a CPU to factory settings via STEP 7, follow these steps:

Make sure that there is an online connection to the CPU.

1. Open the Online and Diagnostics view of the CPU.
2. In the "Functions" folder, select the "Reset to factory settings" group.
3. If you want to keep the IP address, select the "Keep IP address" option button. If you want to delete the IP address, select the "Delete IP address" option button.

   Note

   "Delete IP address" deletes all IP addresses, regardless of how you established the online connection.

   If there is a SIMATIC Memory Card inserted, selecting the "Delete IP address" option has the following effect:

   - The IP addresses are deleted and the CPU is reset to factory settings.
   - The configuration (including IP address) on the SIMATIC Memory Card is then loaded to the CPU. If there is no saved configuration (because the SIMATIC Memory Card has been cleared or formatted, for example), no new IP address is assigned.
4. Click the "Reset" button.
5. Click "OK" in response to the confirmation prompts.

Result: The CPU executes a "Reset to factory settings", during which time the RUN/STOP LED flashes yellow. A yellow RUN/STOP LED indicates that the CPU has been reset to factory settings and is in the STOP operating state. The "Reset to factory settings" event is entered into the diagnostics buffer.

Procedure using the SIMATIC Automation Tool

The procedure is described in the SIMATIC Automation Tool (https://support.industry.siemens.com/cs/ww/en/view/98161300) user manual (included in the SIMATIC Automation Tool).

Result after resetting to factory settings

The following table provides an overview of the contents of the memory objects after the reset to factory settings.

Table 15- 2 Result after resetting to factory settings

Memory object	Contents
Actual values of the data blocks, instance data blocks	Initialized
Bit memories, timers and counters	Initialized
Retentive tags of technology objects (e.g. adjustment values of absolute encoders)	Initialized
Entries in the diagnostics buffer	Initialized
IP address	Depends on the procedure: • Using mode switch: is deleted • Using STEP 7: Depending on the setting of the "Keep IP address"/"Delete IP address" option buttons
Device name	Is set to "CPU"
Counter readings of the runtime meters	Initialized
Time of day	Is set to "00:00:00, 01.01.2012"

System updates and firmware updates are retained when the CPU is reset to factory settings.

If there was a SIMATIC Memory Card inserted in the CPU prior to the reset to factory settings, the CPU downloads the configuration on the SIMATIC Memory Card (hardware and software). A configured IP address is then valid again.

Note

Password for protection of confidential configuration data

The password for protection of confidential configuration data is retained after the CPU is reset to factory settings. The password is only deleted when the "Delete password for protection of confidential PLC configuration data" option is set in STEP 7.

You can find additional information on the password for protection of confidential configuration data in the Communication function manual (https://support.industry.siemens.com/cs/ww/en/view/59192925).

Additional information

Additional information on "Reset to factory settings" can be found in the Function Manual Structure and use of the CPU memory (https://support.industry.siemens.com/cs/ww/en/view/59193101) in the section on memory areas and retentivity, and in the online help for STEP 7.

15.6 SINAMICS Integrated reset to factory settings

Restoring factory settings

In online mode, you can restore the factory settings for SINAMICS Integrated.

1. Establish an online connection to SINAMICS Integrated.
2. Open the online and diagnostics view of SINAMICS Integrated
3. In the dialog box, select "Backup/Restore > Reset to factory settings" and then the "Start" button.
4. Click "OK" in response to the confirmation prompt.

The factory settings are restored. System updates and firmware updates are retained when the SINAMICS Integrated is reset to factory settings.

Note

Alternatively, you can reset the SINAMICS Integrated to factory settings in the function view of the drive control. To do so, click the icon 

15.7 Fault reactions with failsafe components

Safe state (safety concept)

The basic principle behind the safety concept is the existence of a safe state for all process variables.

Note

For fail-safe input and output modules, this safe state is the value "0".

Fault reactions and startup of the F-system

The safety function requires the output of substitute values (safe state) instead of process values for a failsafe module (**passivation of the failsafe module**) in the following cases:

- When the F-system is started up
- If errors are detected during safety-related communication between the F-CPU and the F-module via the PROFIsafe safety protocol (communication error)
- If F-I/O faults or channel faults are detected (for example wire break, discrepancy error)

Detected faults are written to the diagnostic buffer of the F-CPU and communicated to the safety program in the F-CPU.

F-modules cannot save errors as retentive data. When the system is powered down and then restarted, any faults persisting are detected again during startup. However, you have the option of saving faults in your safety program.

WARNING

Channel faults do not trigger any diagnostic reactions or error handling for channels that have been set to "deactivated" in STEP 7. This applies even if such a channel is affected indirectly by a channel group fault (channel parameter "activated/deactivated").

Remedying faults in the F-system

To remedy faults in your F-system, follow the procedure described in IEC 61508-1:2010 section 7.15.2.4 and IEC 61508-2:2010 section 7.6.2.1 e.

The following steps must be performed:

1. Diagnostic and repair of the fault
2. Revalidation of the safety function
3. Recording in the service report

Fail-safe value output for F-modules

In the case of F-modules with inputs, if there is passivation, the F-system provides substitute values (0) for the safety program instead of the process data pending at the failsafe inputs.

In the case of F-modules with outputs, if there is passivation, the F-system transfers substitute values (0) to the failsafe outputs instead of the output values provided by the safety program. The output channels are de-energized. This also applies when the F-CPU goes into STOP mode. The parameter assignment of fail-safe values is not possible.

Substitute values are used either for the relevant channel only or for all channels of the relevant failsafe module depending on:

- The F-system used
- The type of error that occurred (F-I/O, channel or communication error)
- The F-module parameter assignment

Reintegration of a fail-safe module

The system changes from fail-safe to process values (reintegration of an F-module) either automatically or only after user acknowledgment in the safety program. If channel errors occur, it may be necessary to remove and reinsert the F-module. A detailed listing of faults requiring removal and insertion of the F-module can be found in the section Diagnostic messages of the respective F-module.

After reintegration, the following occurs:

- In the case of an F-module with inputs, the process data pending at the failsafe inputs is made available to the safety program again
- In the case of an F-module with outputs, the output values provided in the safety program are transferred to the failsafe outputs again

Additional information on passivation and reintegration

For additional information on passivation and reintegration of F-I/O, refer to the SIMATIC Safety, Configuring and Programming (https://support.industry.siemens.com/cs/ww/en/view/54110126) manual.

Reaction of the F-module with inputs to communication errors

F-modules with inputs respond differently to communication errors compared to other errors.

If a communication error is detected, the current process values remain set at the inputs of the F-module. The channels are not passivated. The current process values are passivated in the F-CPU.

15.8 Temperature monitoring

The SIMATIC Drive Controller has integrated temperature monitoring. Temperature monitoring ensures that the SIMATIC Drive Controller is only operated within the permissible temperature range. This prevents device defects and undefined device behavior.

Function

Temperature sensors monitor the inside temperature. There are temperature thresholds with the following reactions in the event of overtemperature:

Inside temperature	Maintenance event	Reaction
High limit violation Threshold 1	CPU overtemperature (Warning, incoming)	MAINT LED lights up in yellow. An entry is made in the diagnostic buffer. The diagnostics interrupt OB (OB82, incoming event) is called. For details, see Evaluation of interrupts.
Low limit violation Threshold 1	CPU overtemperature (Warning, outgoing)	The MAINT LED goes out. An entry is made in the diagnostic buffer. The diagnostics interrupt OB (OB82, outcoming event) is called. For details, see Evaluation of interrupts section
High limit violation Threshold 2	CPU overtemperature (Error)	MAINT LED lights up in yellow. ERROR LED flashes red. A diagnostic buffer entry (no OB82 call) is made. The SIMATIC Drive Controller switches to STOP and a start-up lock is set (POWER OFF/ON is required).

Evaluation of interrupts

You evaluate the interrupt and corresponding information with the "RALRM" instruction.

Call the "RALRM" instruction in the diagnostics interrupt OB (OB82).

Table 15- 3 Structure of the additional interrupt information in an overtemperature warning

Byte	Data type	Meaning	
0 to 1	WORD	Format identifier for the configuration of the following data as additional interrupt information. The overtemperature information is provided with the format identifier W#16#8002 (advanced channel diagnostics).	
2 to 3	WORD	Channel number of the component that triggered the interrupt: W#16#0C72: PLC hardware	
4	BYTE	Bit 0:	Not relevant
		Bits 1 to 2:	Maintenance type: 2: Maintenance requested
		Bits 3 to 4:	Error type: 1: Incoming error 2: Outgoing error

Byte	Data type	Meaning	
		Bits 5 to 7:	3: Input/output signal
5	BYTE	Data format: B#16#05: Word	
6 to 7	WORD	Error type: W#16#3530: Overtemperature warning	
8 to 9	WORD	Additional error value: W#16#1010: Diagnostics interrupt/OB82 call	
10 to 13	DWORD	Additional error information: Not relevant	

Programming example

You can find a programming example in the following FAQ on the Internet (https://support.industry.siemens.com/cs/ww/en/view/109782270).

15.9 Maintenance and repair

The SIMATIC Drive Controller is maintenance-free.

Note

Repairs to the SIMATIC Drive Controller may only be carried out by the manufacturer.

Test and service functions

16

16.1 Test functions

Introduction

You have the option of testing the operation of your user program on the CPU. You monitor signal states and values of tags, and preassign values to tags so that you can simulate specific situations for program execution.

Note

Using test functions

Using test functions affects the program execution time and thus the cycle and response times of the controller to a slight extent (a few milliseconds).

Requirements

- There is an online connection to the relevant CPU.
- An executable user program is available in the CPU.

Test options

- Testing with program status
- Testing with breakpoints
- Testing with a watch table
- Testing with a force table
- Testing with a PLC tag table
- Testing with a data block editor
- Testing with the LED flash test
- Testing with a trace function

Testing with program status

The program status allows you to monitor the execution of the program. You can display the values of operands and the results of logic operations (RLO). This allows you to detect and fix logical errors in your program.

Note

Restrictions with the "Program status" function

Monitoring loops can significantly increase the cycle time. The increase in cycle time depends on the following factors:

- The number of tags to be monitored
- The actual numbers of loops run through

WARNING

Testing with program status

A test with the "Program status" function can cause serious damage to property or injury to persons if there are functional disturbances or program errors.

Make sure that you take appropriate measures to exclude the risk of dangerous states occurring before running a test with the "Program status" function.

Testing with breakpoints

With this test option, you set breakpoints in your program, establish an online connection, and enable the breakpoints on the CPU. You then execute a program from one breakpoint to another.

Requirements:

- Setting breakpoints is possible in the programming language SCL or STL.

Testing with breakpoints provides you with the following advantages:

- Localization of logic errors step by step
- Simple and quick analysis of complex programs prior to actual commissioning
- Recording of current values within individual executed loops
- Use of breakpoints for program validation also possible in SCL/STL networks within LAD/FBD blocks

Note

Restriction during testing with breakpoints

- When you test with breakpoints, there is a risk of overwriting the cycle time of the CPU.
- If you are using technology objects and test them with breakpoints, the CPU switches to STOP.

Note

F-System SIMATIC Safety

Setting breakpoints in the standard user program results in errors in the

security program:

- Sequence of F cycle time monitoring
- Error in communication with the fail-safe I/O
- Error during safety-oriented CPU-CPU communication
- internal CPU error

If you still wish to use breakpoints for testing, you must deactivate

the safety mode beforehand. This will result in the following errors:

- Error in communication with the fail-safe I/O
- Error during safety-oriented CPU-CPU communication

Testing with watch tables

The following functions are available in the watch table:

- Monitoring of tags

  With watch tables, you monitor the current values of individual tags in a user program or a CPU on the PG/PC and Web server. Please note the following requirement for displaying the tag values on the Web server: You must specify a symbolic name for the tag in the "Name" column of the watch table.

  You monitor the following operand areas:

  - Inputs and outputs (process image) and bit memory
  - Contents of data blocks
  - Peripheral inputs and peripheral outputs
  - Timers and counters

- Modifying tags

  You use this function to assign fixed values to individual tags in a user program or a CPU on the PG/PC. Modifying is also possible with Test with program status.

  The following operand areas are modifiable:

  - Inputs and outputs (process image) and bit memory
  - Contents of data blocks
  - Peripheral inputs and peripheral outputs (for example, %I0.0:P, %Q0.0:P)
  - Timers and counters

- "Enable peripheral outputs" and "Modify now"

  These two functions enable you to assign fixed values to individual peripheral outputs of a CPU in the STOP mode. You can also use them to check your wiring.

Testing with a force table

The following functions are available in the force table:

- Monitoring of tags

  Force tables are used to monitor the actual values of the individual tags of a CPU user program or a CPU

  - On the PG/PC

  - On the Web server

  You monitor the table with or without a trigger condition.

  You monitor the following tags:

  – Bit memory

  – Contents of data blocks

  – Peripheral inputs

- Modifying tags

  You use this function to assign fixed values to individual tags in a user program or a CPU on the PG/PC and Web server. Modifying is also possible with Test with program status.

  The following tags are modifiable:

  – Bit memory

  – Contents of data blocks

  – Peripheral inputs (e.g. %I0.0:P)

- Forcing of peripheral inputs and peripheral outputs

  You can force individual peripheral inputs or peripheral outputs.

  – Peripheral inputs: Forcing of peripheral inputs (for example %I0.0:P) is a "bypassing" of sensors / inputs by the specification of fixed values to the program. The program receives the force value instead of the actual input value (via process image or via direct access).

  – Peripheral outputs: Forcing of peripheral outputs (for example %Q0.0:P) is a "bypassing" of the complete program by the specification of fixed values to the actuators.

The advantage of the force table is that you can simulate different test environments and overwrite tags in the CPU with a fixed value. This enables you to intervene in the ongoing process for regulating purposes.

Difference between modifying and forcing

The fundamental difference between the modifying and forcing functions consists in the storage behavior:

- Modifying: Modifying of tags is an online function and is not stored in the CPU. You can end modifying of tags in the watch table or force table or by terminating the online connection.
- Forcing: A force job is written to the SIMATIC memory card and is retained after a POWER OFF. You can only end the forcing of peripheral inputs and peripheral outputs in the force table.

Testing with a PLC tag table

You can monitor the current data values of tags in the CPU directly in the PLC tag table. To do so, open the PLC tag table and start the monitoring.

You can also copy PLC tags to a watch or force table and monitor, modify or force them there.

Testing with a data block editor

The data block editor offers different options for monitoring and modifying tags. These functions directly access the actual values of the tags in the online program. Actual values are the current values of tags in the CPU work memory at any moment during program execution. The following functions for monitoring and modifying are available in the database editor.

- Monitor tags online
- Modify individual actual values
- Create a snapshot of the actual values
- Overwrite actual values with a snapshot

Note

Setting data values during commissioning

During plant commissioning, you often need to adjust data values to adapt the program to local conditions. The declaration table for data blocks offers some functions for this purpose.

Testing with the LED flash test

In many online dialogs, you can perform an LED flash test. This feature is useful if you are not sure which device in the hardware configuration corresponds to the device currently selected in the software.

If you click on the "Flash LED" button in STEP 7 under Online & diagnostics (online access), an LED flashes on the device currently selected. The RUN/STOP, ERROR, and MAINT LEDs flash on the CPU. The LEDs flash until you cancel the flash test.

Testing with CPU Trace

The trace function is used to record the CPU tags, depending on the settable trigger conditions. Examples of tags are the system and user tags of a CPU. Plant states can also be recorded if the drive parameters have been interconnected with CPU tags using relevant frames.

The CPU saves the recordings. If necessary, you can display and evaluate the recordings with STEP 7 or over the Web server. The Trace function can be called from the CPU's folder in the project tree, under "Traces".

Please also see the following FAQ on the Internet (https://support.industry.siemens.com/cs/ww/en/view/102781176) relevant for Trace functions.

Testing with Drive Trace

You use Drive Trace to records the states of a drive and evaluate them using Startdrive. As the states are recorded in the drive itself (minimum clock 125 µs), Drive Trace is particularly useful for monitoring highly dynamic processes.

For further information, see the Trace function section in the SINAMICS S120 Startdrive (https://support.industry.siemens.com/cs/ww/de/view/109781583/en) commissioning manual

Simulation

With STEP 7 and S7-PLCSIM or S7-PLCSIM Advanced you can run and test the hardware and software of the project in a simulated environment.

Start the simulation with S7-PLCSIM using the menu command "Online" > "Simulation" > "Start".

You can find more information on simulation with S7-PLCSIM Advanced in the S7 PLCSIM Advanced (https://support.industry.siemens.com/cs/de/en/view/109813110) function manual.

Additional information

Additional information on the test functions can be found in the STEP 7 online help.

Additional information about testing with trace functions is available in the Function Manual Using the trace and logic analyzer function (https://support.industry.siemens.com/cs/ww/en/view/64897128).

16.2 Reading/saving service data

Service data

The service data contain the CPU diagnostic buffer and the diagnostic buffer of SINAMICS Integrated. It also contains much more information on the internal state of the CPU and SINAMICS Integrated. If a problem occurs with the SIMATIC Drive Controller that cannot be solved with other methods, send the service data to SIEMENS Service & Support. The service data allows Service & Support to quickly analyze the problems that have occurred.

Note

You cannot execute a download to the device while reading the service data of the SIMATIC Drive Controller.

Methods of reading service data

You can read service data with:

- The FUNCT button on the SIMATIC Drive Controller (function 1, storing the service data on the SIMATIC Memory Card)
- the web server
- STEP 7
- the SIMATIC Memory Card

Only use the SIMATIC Memory Card to read service data if you are no longer able to communicate with the CPU via Ethernet. In all other cases, it is preferable to read service data via the Web server or STEP 7.

- Since the service data must be directly loaded to the PC, you need not ensure that there is still sufficient memory space on the SIMATIC Memory Card.
- You can send the service data straight from the PC.

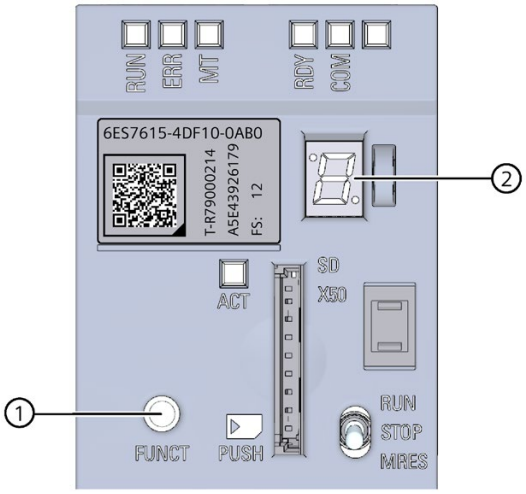
Procedure using the FUNCT button

You can save the service data to the SIMATIC Memory Card on the SIMATIC Drive Controller with the FUNCT button.

In principle, there are 2 options for reading the service data:

- Reading out service data in the STOP or RUN state of the SIMATIC Drive Controller
- Reading out service data during SIMATIC Drive Controller startup

Reading service data in STOP or RUN allows you to back up the data quickly and easily on a memory card. If backup is no longer possible (due to a persistent error, for example), you can also back up the service data during startup immediately after switch-on. In this case, only the service data of the CPU are saved and not the service data of the SINAMICS Integrated.



① FUNCT button
② 7-segment display

Figure 16-1 SIMATIC Drive Controller FUNCT button

Requirements:

- The memory card is inserted and the write protection of the card is not set.
- There is sufficient free memory available on the card.

Saving the service data in STOP or RUN state of the SIMATIC Drive Controller

1. To get to the function selection mode, press the FUNCT button for at least 3 seconds with a sharp object and then release it. As an aid, the 7-segment display flashes "0" at one-second intervals during this time.

   After you release the button, you are in function selection mode. The 7-segment display shows function "1" (Save service data).

2. To confirm the selection, press the FUNCT button within 10 seconds for at least 3 seconds and then release it. The service data is saved.

   While the function is being executed:

   - The 7-segment display shows "d" (DUMP)
   - The ACT-LED flickers
   - The RUN/STOP LED flashes yellow
   - The ERROR and MAINT LEDs are off

   After the function has been executed, the 7-segment display shows "0".

Result: The CPU writes the service data to the folder DUMP.S7S on the SIMATIC Memory Card.

If the requirements for the function selection are not fulfilled (for example, write protection set, no card inserted) then the 7-segment display shows the status "F" (Fault) for 10 seconds and the function is not performed. Next, the menu is closed and the 7-segment display shows "0".

If an error occurs during saving:

- The RUN/STOP LED flashes yellow (for STOP) or green (for RUN) depending on the previous operating state
- The ERROR LED flashes red

In this case, the text file in the DUMP.S7S folder contains information about the error that has occurred.

Note

In the function selection mode, a brief button press for less than 3 seconds selects the next function (function "1", "2" or "3"). The last function is "E". If you press the button for at least 3 seconds, the function selection module is exited. The function selection mode is also exited if no key is pressed for 10 seconds.

Saving the service data during SIMATIC Drive Controller startup

During startup, only the service data of the CPU are saved and not the service data of the SINAMICS Integrated.

1. Switch the supply voltage off at the SIMATIC Drive Controller.
2. Press and hold down the FUNCT button.

3. Switch the supply voltage on at the SIMATIC Drive Controller.
4. To start the saving process, release the FUNCT button as soon as the 7-segment display flashes at least once (approx. 1 to 2 seconds after POWER ON).

   The save process only begins after about 45 seconds and is indicated by a yellow flashing RUN/STOP LED. The ERROR and MAINT LEDs are off. As the save process progresses, the 7-segment display shows "d" (DUMP) and the ACT LED flickers. After completion of the saving process, the 7-segment display shows "0".

Result: The CPU writes the service data to the folder DUMP.S7S on the SIMATIC Memory Card.

If an error occurs during saving:

- The RUN/STOP LED flashes yellow (for STOP) or green (for RUN) depending on the previous operating state
- The ERROR LED flashes red

In the event of an error, the text file in the DUMP.S7S folder contains information about the error that has occurred.

Note

Procedure using the SIMATIC Memory Card

Instead of using the FUNCT button, you can also initiate saving the service data using the job file S7_JOB.S7S and the DUMP string.

To do so, use an editor to overwrite the PROGRAM entry with the DUMP string.

To ensure that the file size is exactly 4 bytes, do not use any spaces/line breaks/quotation marks.

If you read out the service data (with the entry String DUMP), the SIMATIC Drive Controller does not start.

You must change the entry back to PROGRAM once the function has been executed.

Procedure using the Web server

Requirement: Access to the Web server has been activated for the interface used.

Proceed as follows to read service data using the Web server:

1. Open a Web browser that is suitable for communication with the SIMATIC Drive Controller. You can find additional information in the Web server (https://support.industry.siemens.com/cs/ww/en/view/59193560) function manual.
2. Enter the following address in the address bar of the web browser: https://<CPU IP address>/save_service_data, e.g. https://172.23.15.3/save_service_data

3. The service data page will appear on your screen, with a button for saving the service data.



Figure 16-2 Saving service data via the Web server

4. Save the service data locally on your PC/programming device, by clicking "Save ServiceData".

Result: The data is saved in a .dmp file with the following naming convention: "<Article number> <Serial number> <Time stamp>.dmp". You can change the file name.

Note

If you have defined your user page as the Web server homepage, you cannot directly access the service data by entering the IP address of the SIMATIC Drive Controller. For more information on reading out service data via a user-defined page, refer to the Web server (https://support.industry.siemens.com/cs/ww/en/view/59193560) function manual.

Procedure using STEP 7

A description of how to save service data is available under the keyword "Save service data" in STEP 7 online help.

16.3 Reading Open Source Software information

Requirements for reading Open Source Software information

To read the Open Source Software information from a SIMATIC Drive Controller, you require the following components:

- SD card reader
- Empty standard SD card (FAT32-formatted) or SIMATIC Memory Card; minimum size: 1 GB
- SIMATIC Drive Controller with hardware function version ≥ FS 11.

Procedure

To read Open Source Software information, proceed as follows:

1. Insert the memory card into the SD card reader of your PG/PC.
2. Create a folder "OSSINFO" (uppercase) in the main directory of the memory card.
3. Remove the memory card from the SD card reader.

4. Switch off the SIMATIC Drive Controller and insert the memory card into the SIMATIC Drive Controller.
5. Switch on the SIMATIC Drive Controller.

   The data is copied to the memory card (7-segment display shows "c." during the copy operation).
6. When the 7-segment display shows "0.", remove the memory card.
7. Insert the memory card into the SD card reader.
8. Read out the file "Device_Info_OSS.zip" and unzip this file.

If the 7-segment display shows "F.", an error has occurred (e.g. memory card is full).

Special note for resellers to avoid license violations

Note

The license conditions and copyright notices stored on the SIMATIC Drive Controller are subject to change as a result of firmware updates.

In order to avoid license violations by the reseller and the buyer, if there are firmware updates, you must pass on the license conditions and copyright notices of the firmware update to the buyer (for example, by saving them to the SIMATIC Memory Card).

The license conditions and copyright notices stored on the SIMATIC Drive Controller are NOT updated by a firmware update.

Technical data

17

17.1 Introduction

System data

This section sets out general technical data for a system comprising the SIMATIC Drive Controller and components of the S120 drive system (Booksize). You can find detailed technical data for individual system components in the relevant manuals.

Technical data of the SIMATIC Drive Controller

You can find the technical data for the SIMATIC Drive Controller in the SIMATIC Drive Controller manual.

17.2 Standards and Approvals

Currently valid markings and authorizations

Note

Information on the system components

The markings and approvals currently valid are printed on the system components.

EU Declaration of Conformity



Our products fulfill the requirements and safety objectives of the following EC Directives and comply with the harmonized European standards (EN):

The EU Declaration of Conformity is available on the Siemens Industry Online Support (https://support.industry.siemens.com/cs/ww/en/ps/25715/cert) website.

UK Declaration of Conformity



The SIMATIC Drive Controller complies with the designated British Standards (BS) published in the official consolidated list of the British Government.
The UK Declaration of Conformity is also available on the Siemens Industry Online Support (https://support.industry.siemens.com/cs/ww/en/ps/25715/cert) website.

cULus approval



Underwriters Laboratories Inc. in accordance with

- UL 508 (Industrial Control Equipment)

RCM (C-Tick) Declaration of conformity for Australia/New Zealand



The device fulfills the requirements of standard AS/NZS CISPR 16.

Korea Certification



KC registration number: R-R-S7M-SimaticDC

Please note that this device corresponds to limit value class A in terms of the emission of radio frequency interference. This device can be used in all areas, except residential areas.

이 기기는 업무용(A급) 전자파 적합기기로서 판매자 또는 사용자는 이 점을 주의하시기 바라며 가정 외의 지역에서 사용하는 것을 목적으로 합니다.

The EMC limits for Korea correspond to the limits of the EMC product standard for variable-speed electrical drives EN 61800-3 of the category C2 or the limit class A, group 1 to EN 55011. The limits to category C2 or limit class A, group 1, are maintained with adequate additional measures. Additional measures, such as the use of an additional radio interference suppression filter (EMC filter), may be necessary.

Measures for an appropriate EMC-compliant setup of the plant are also described in detail in this manual and in the Configuration Manual EMC installation guidelines (https://support.industry.siemens.com/cs/ww/en/view/60612658).

Please note that it is ultimately the label on the device that determines the compliance with standards.

Marking for the Eurasian Customs Union



EAC (Eurasian Conformity)

Customs Union of Russia, Belarus and Kazakhstan

Declaration of conformity with the technical requirements of the Customs Union (TR CU).

China RoHS

The SIMATIC Drive Controllers comply with the China RoHS directive. Additional information can be found on the Internet (https://support.industry.siemens.com/cs/ww/en/view/109775373).

Environmental Product Declaration (EPD)

Siemens is committed to the development and production of environmentally compatible and sustainably produced equipment.

With the help of an Environmental Product Declaration (EPD), you can obtain information on the "ecological footprint" of your Siemens product.

The EPD is based on the ISO 14021 "Environmental labels and declarations – Self declared environmental claims – Type II" international standard.

EPDs are based on independently verified data from life cycle assessments, life cycle inventory analyses, or information modules which comply with the ISO 14040 series of standards. The EPD contains comprehensive data relating to ingredients and substances (REACH, RoHS), fire load, energy consumption, packaging, and disposal information for your Siemens product.

Additional information

The certificates for the markings and approvals can be found on the Internet under Service&Support (https://support.industry.siemens.com/cs/ww/en/ps/25715/cert).

You can find the current Environmental Product Declarations (EPDs) for Siemens products at Siemens Industry Online Support (https://www.siemens.com/automation/service&support) by searching under the keyword "Environmental Product Declaration".

17.3 Electromagnetic compatibility

EMC

Electromagnetic compatibility (EMC) is the ability of an electrical installation to function satisfactorily in its electromagnetic environment without interfering with that environment.

The SIMATIC Drive Controller meets the electromagnetic compatibility requirements for drive systems (PDS – Power Drive Systems) as defined in IEC 61800-3 category C2; 2. Environment.

Environments

EN 61800-3 defines different requirements depending on the location of the drive system, referred to as the First and Second Environment.

First Environment locations are defined as residential buildings or locations in which the drive system is directly connected to the public low-voltage power supply network without intermediate transformers.

The **Second Environment** is understood as all non-residential locations. The main Second Environment locations are industrial zones supplied by the medium voltage network via their own transformers.

Category

The SIMATIC Drive Controller meets the electromagnetic compatibility requirements for drive systems (PDS – Power Drive Systems) as defined in IEC 61800-3 category C2; 2. Environment.

Table 17- 1 Category pursuant to EN 61800-3

Category	Description
C2	Fixed drive systems for rated voltages <1000 V for use in the Second Environment. Use in the First Environment is possible if the drive system is installed by a professional. The system must be configured in accordance with the EC Declaration of Conformity on EMC and the "EMC Design Guidelines" configuration manual.

To observe the limits according to EN 61800-3 category C2 for the SINAMICS S120 drive system, additional measures, such as the use of line filters, may be necessary. For details, see the SINAMICS S120 manuals.

Range of applications of drive systems

The SIMATIC Drive Controller and the SINAMICS S120 drive system are designed for use in the Second Environment. They are intended for professional use in the industry, in specific professions or industries and are not sold to the general public.

To meet the EMC requirements, the drive system must be installed EMC-compliant by trained personnel taking into account the installation instructions in the SINAMICS S120 manuals.

Note

Trained personnel

Trained personnel have the necessary experience for the setup and/or commissioning of drive systems (Power drive system - PDS) including their EMC aspects.

Further information

Additional information is available in the SINAMICS S120 manuals and in the EMC Installation Guideline. (https://support.industry.siemens.com/cs/ww/en/view/60612658)

17.4 Shipping and storage conditions

Introduction

The SIMATIC Drive Controller exceeds requirements in terms of shipping and storage conditions pursuant to EN 61800-2.

The following applies under these conditions:

- Long-term storage in transport and product packaging:
  At weather-protected locations that have continuous contact with outside air through openings.
- Transport in transport packaging:
  - In unventilated containers in conditions without protection from the weather.
  - In the "cold" as in open-air climate.
  - Air transport in the air-conditioned cargo hold.

Transport and storage conditions for devices

Table 17- 2 Ambient conditions during storage and transport

Type of condition	Permissible range/class		
	Transport	**Storage**	
Classification	EN 60721-3-2	EN 60721-3-1	
Environmental class	2K4	1K4	
Ambient temperature	From -40° C to +70° C	From -25° C to +55° C	
Biological ambient conditions	2B1 [1]	1B1 [1]	
Chemically active environmental conditions	2C2 [2]	1C2 [2]	
Maximum permissible temperature change	Direct interaction in air/air: -40/+30 °C at 95% relative humidity	30 K/h	
Relative humidity	5 to 95%		
Precipitation, rain	6 mm/min [1]	Not permitted	
Water other than rain	1 m/s and wet loading surfaces [3]	Not permitted [4]	1 m/s and wet loading surfaces [3]
Condensation, splash water, icing, salt spray	Permitted	Not permitted [4]	Permitted [3]

[1] Mold growth, slime, rodents, termites and other vermin are not permissible.

[2] In marine and weather-resistant transport packaging (container).

[3] For storage in transport packaging.

[4] For storage in product packaging.

Note

Remove the packaging material before installing the components.

17.5 Mechanical and climatic ambient conditions

Ambient conditions for operation

The SIMATIC Drive Controller is designed for stationary use at weather-protected locations. The documented ambient conditions apply for conditions in the immediate vicinity of the devices and for the cooling air inlet. Compliance with the following standards: EN 60204-1, EN 61800-2, EN 61131-2 and IEC 62477-1.

Table 17- 3 Ambient conditions for operation

Ambient conditions	Areas of application	Comments
Climatic ambient conditions		
Environmental class	Better than class 3K3	In accordance with EN 60721-3-3
Temperature limits at 100% load	0 °C to 55 °C	From an altitude of 2000 m, the max. ambient temperature is reduced by 7 °C for each additional 1000 m (derating).
Relative humidity (without condensation)	5 to 95% (60% in the presence of corrosive gases and/or dust)	
Condensation; icing; drip, spray and splash water	Not permitted	
Max. installation altitude	4000 m above sea level	For SINAMICS S120 drive components, see SINAMICS documentation
Barometric pressure	620 to 1060 hPa	
Biological, chemical and mechanical influences; pollutants		
Biological ambient conditions		Class 3B1 in accordance with EN 60721-3-3: Mold, mold growth, slime, rodents, termites and other vermin are not permissible.
Mechanically active environmental conditions		Class 3S1 in accordance with EN 60721-3-3: Conductive dust is not permissible.
Classification of the mechanical environment		Class 3M1 in accordance with EN 60721-3-3
Vibratory load		Frequency range: 10 to 150 Hz Displacement at 10 to 58 Hz: 0.075 mm Acceleration at 58 to 150 Hz: 1 g
Shock load with shock-sensitive parts		Acceleration: 5 g Duration of shock: 30 ms Load: 3 x in each direction
Pollution degree		2 (inside use only)
Type of enclosure		Open type
Overvoltage category		OVC 2

Note

The user must consider emitted interference for the complete plant. Particular attention should be paid to cabling. Please contact your sales partner for assistance.

Note

In a residential environment, this product can cause high-frequency interference that can make radio interference suppression measures necessary.

Have the installation and commissioning with appropriate radio interference suppression measures preformed by qualified personnel.

Maximum installation altitude

From an altitude of 2000 m, the max. ambient temperature is reduced by 7 °C for each additional 1000 m (derating).

- The derating factor compensates for the decreasing cooling effect of air at higher elevations due to lower density.
- Linear interpolation between elevations is permissible.
- Install the SIMATIC Drive Controller only in a vertical mounting position and maintain a ventilation clearance of 80 mm above and below the SIMATIC Drive Controller.
- Make sure that the power supplies you use are also rated for altitudes > 2000 m.
- Observe the maximum installation altitude of the SINAMICS S120 drive components. Refer to the SINAMICS documentation for details.

Protection of the device against environmental factors

Protect the device against the following environmental factors:

- Direct sunlight and heat sources
- Mechanical vibrations
- Dust
- Humidity
- Strong magnetic fields

Reduction of vibrations

If the SIMATIC Drive Controller is exposed to severe shock or vibration, take appropriate measures to reduce the acceleration or amplitude.

We recommend installing the SIMATIC Drive Controller on damping materials (for example rubber-bonded-to-metal mounting.)

Use in dry rooms

SIMATIC Drive Controllers are designed and tested for relative humidity in the range of 5 to 95%.

Note

Use in low humidity (< 5%)

If you use the SIMATIC Drive Controller in a humidity < 5%, the risk of damage due to electric fields or electrostatic discharge increases.

In very dry environments, appropriate precautions (ETUC measures) are particularly important to prevent equipment damage. Be sure to observe the ETUC instructions in the section General Safety Instructions (Page 17) as well as the installation instructions in the section Protective conductor and equipotential bonding, functional grounding (Page 131).

17.6 Information on insulation tests, protection class, degree of protection and rated voltage

Insulation

The insulation is designed in accordance with the requirements of EN 61131-2: 2007.

Note

Galvanic isolation with 707 V DC (Type Test) is tested for modules with 24 V DC supply voltage (SELV/PELV).

Pollution degree

The SIMATIC Drive Controller is designed for pollution degree 2 in accordance with EN 61800-5.

This means that the components must be protected from conductive contamination, for example, by installing them in a control cabinet with degree of protection IP54 pursuant to IEC 60529 or Type 12 pursuant to NEMA 250. If the occurrence of conductive contamination can be ruled out, a correspondingly lower degree of protection for the control cabinet is permitted.

Protection class

Protection class of the SIMATIC Drive Controllers	Note
Protection class III	Protection class III equipment may only be connected to SELV or PELV current sources.

Degree of protection

The SIMATIC Drive Controller has the degree of protection IP20 in accordance with IEC 60529, open type pursuant to UL/CSA:

- Protection against contact with standard test finger
- Protection against foreign objects with diameters in excess of 12.5 mm
- No protection against water

Rated voltage for operation

The rated voltages and corresponding tolerances for the power supply to the system components are listed in the following table.

Table 17- 4 Rated voltage of system components

Component/connection	Tolerance range
Electronics power supply for SIMATIC Drive Controllers or SINAMICS S120 components	24 V DC -15/+20% (20.4 to 28.8 V)[1] Protective extra low voltage PELV or SELV
Line connection (power units)	3 AC 380 to 480 V ±10 % (-15 % < 1 min)
Line frequency	47 to 63 Hz

1) The supply voltage must not fall below the minimum of 20.4 V (24 V -15%) at the final device in the line-up as malfunctions can otherwise occur. A sufficiently high input voltage must therefore be selected. To prevent the maximum 24 V supply voltage (= 28.8 V) being exceeded, the voltage can be supplied at various different points in the line-up.

Information for users changing from SIMOTION D4x5-2

A

SIMATIC S7-1500 and the SIMOTION Motion Control system are two automation systems whose architecture and therefore programming are fundamentally different. Be aware of these differences when switching between the two automation systems.

Comparison

The comparison below is based largely on the hardware differences between a SIMATIC Drive Controller and a SIMOTION D4x5-2 control unit.

Table A- 1 Differences between SIMOTION D4x5-2 control unit and SIMATIC Drive Controller

Feature	SIMOTION D4x5-2 DP/PN	SIMATIC Drive Controller
General		
Size (width x height x depth)	Booksize 50 x 380 x 230 mm	Booksize compact 50 x 300 x 226 mm
Automation system	SIMOTION	SIMATIC S7-1500
Available Performance classes	Four performance classes (D425-2 / D435-2 / D445-2 / D455-2)	Two performance classes currently available (CPU 1504D and CPU 1507D)
Failsafe CPU	No (additional SIMATIC S7 F-CPU required)	Yes (TF-CPU)
Integrated in the drive Safety functions	Yes, on the basis of SINAMICS S120	Yes, on the basis of SINAMICS S120
Engineering • Controller • Drive	STEP 7 V5.x or TIA Portal with • SCOUT or SCOUT TIA • STARTER integrated in SCOUT	TIA Portal with • STEP 7 Professional • Startdrive
Device modeling	Controller and integrated automatic speed control (SINAMICS Integrated) are modeled as ONE device	Controller and integrated automatic speed control (SINAMICS Integrated) are modeled as TWO devices in a TIA Portal group.
Runtime licenses (control)	With licensed memory card licenses: axis licenses, technology packages, etc.	With engineering (STEP 7 Professional) licenses: OPC UA, etc. (no axis licenses required with SIMATIC)
Interfaces		
Option slot	Yes (for TB30 or CBE30-2)	No
PROFINET interface 1	PN IO with IRT: X150 (3 ports, 100 Mbps)	PN IO with IRT: X150 (3 ports, 100 Mbps)
PROFINET interface 2	PN basic communication: X127 (1 port, 1000 Mbps)	PN IO with RT: X160 (1 port, 100 Mbps)
PROFINET interface 3	PN basic communication: X130 (1 port, 1000 Mbps)	PN basic communication: X130 (1 port, 1000 Mbps)
PROFINET interface 4	Optional, CBE30-2 (PN IO with IRT, 4 ports)	-
PROFIBUS interfaces	2 (master/slave)	1 (master) Note: PROFIBUS cannot be operated in isochronous mode at the same time as other bus systems on MC Servo.

Feature	SIMOTION D4x5-2 DP/PN	SIMATIC Drive Controller
Interface to SINAMICS Integrated	PROFIBUS Integrated	PROFIdrive Integrated
DRIVE-CLiQ	4 ports (D425-2); 6 ports (D435-2, D445-2, D455-2)	4 ports
Onboard I/Os (assigned to the drive)	12 DI, 8 DI/DQ	12 DI, 8 DI/DQ Terminal type and terminal assignment as SIMOTION D4x5-2
Onboard I/Os (assigned to the controller)	8 DI/DQ, channel-by-channel as: DI, DQ, measuring input, output cam	8 DI/DQ, channel-by-channel as: DI, DQ, Timer DI (for measuring inputs), Timer DQ (for output cams), Oversampling DI, Oversampling DQ, PWM, Event/period measurement DQ can be operated as high-speed output Terminal type and terminal assignment as SIMOTION D4x5-2
Other interfaces	2 x USB (for device updates)	2 x USB (non-functional, no connection permitted)
SINAMICS Integrated		
SINAMICS Integrated	On basis of CU320-2 (no EPos, no SINAMICS Web server)	On basis of CU320-2 (no free function blocks, no SINAMICS Web server, no output frequencies > 550 Hz)
CX32-2	Yes	No, expansion with CU320-2 PN
Memory card	CF card For firmware and project	SD card (SIMATIC Memory Card) Can be used as program card or firmware update card
Firmware	Firmware is located on the memory card A common firmware file for controller and SINAMICS Integrated	Firmware is located on the Drive Controller Separate firmware update files for controller and SINAMICS Integrated
Runtime licensing	With licensed memory card	With engineering (Startdrive)
Miscellaneous		
Controls	2 rotary switches (mode selector; service selector switch) Diagnostics button; reset button	Toggle switch (mode selector) Function button (for example, for diagnostics)
Display elements	10 LEDs for controller and SINAMICS Integrated PN interfaces with LINK/Activity LED 7-segment display	3 LEDs for controller / 3 LEDs for SINAMICS Integrated PN interfaces with LINK/Activity LED LED for memory card access 7-segment display
Fan	Yes (dual fan for redundancy)	No
Battery	Yes (required for buffering date/time > 4 days)	No (buffering date/time > 6 weeks)
Protection with seal	No	Yes, cover can be secured
Installation	On the cabinet wall with/without spacer (D445-2 / D455-2: without spacer only with external heat dissipation with cooling fins)	On the cabinet wall with/without spacer (as for CU320-2)

Feature	SIMOTION D4x5-2 DP/PN	SIMATIC Drive Controller
Possible installation positions	Vertical and on its back	Vertical
SIPLUS variant for use in tough operating conditions, for example, in atmospheres with harmful gases	Yes (SIMOTION D435-2 DP/PN and D455-2 DP/PN)	No

Accessories/spare parts

B

Accessories

You can order the following accessories for the SIMATIC Drive Controller:

Table B- 1 Accessories

Article	Article number	Comments
SIMATIC Memory Card		When using SINAMICS Integrated, a memory card capacity of at least 12 MB is recommended (at least 24 MB for extensive DCC use, e.g. with a DCB Extension Library). A memory card of at least 256 MB is required for firmware updates.
4 MB	6ES7954-8LC04-0AA0	
12 MB	6ES7954-8LE04-0AA0	
24 MB	6ES7954-8LF04-0AA0	
256 MB	6ES7954-8LL04-0AA0	
2 GB	6ES7954-8LP04-0AA0	
32 GB	6ES7954-8LT04-0AA0	

Note

S7-1500T Motion Control KinPlus with SIMATIC Drive Controllers

The required function extensions are not contained in the firmware of the SIMATIC Drive Controller. To be able to use "S7-1500T motion control KinPlus", a special S7-1500T motion control KinPlus memory card is required instead of the standard SIMATIC Memory Card. For more information on this, see the Function Manual SIMATIC S7-1500T Kinematics functions (https://support.industry.siemens.com/cs/ww/en/view/109812058)

Table B- 2 SIMATIC Memory Cards S7-1500 Motion Control KinPlus

Article number	Capacity
6ES7 954-8LP80-0AA0	2 GB
6ES7 954-8LT80-0AA0	32 GB

Accessories for PROFIBUS	Article number	Comments
PROFIBUS bus connector RS485		
With angled cable outlet (35°) in screw-type connection technology, max. transmission rate 12 Mbps:		
• without PG/PC interface	6ES7972-0BA42-0XA0	-
• with PG/PC interface	6ES7972-0BB42-0XA0	-
PROFIBUS FastConnect bus connector RS485		
With angled cable outlet (35°) in insulation displacement technology, max. transmission rate 12 Mbps:		
• without PG/PC interface	6ES7972-0BA61-0XA0	-
• with PG/PC interface	6ES7972-0BB61-0XA0	-
FastConnect cables for PROFIBUS		
Sold by the meter; max. consignment 1000 m; minimum order quantity 20 m:		
• FC Standard Cable GP	6XV1830-0EH10	-
• FC Robust Cable	6XV1830-0JH10	-
• FC Flexible Cable	6XV1831-2K	-
• FC Trailing Cable, sheath color: Petrol	6XV1830-3EH10	-
• FC Trailing Cable, sheath color: Violet	6XV1831-2L	-
• FC Food Cable	6XV1830-0GH10	-
• FC Ground Cable	6XV1830-3FH10	-
• FC FRNC Cable GP	6XV1830-0LH10	-
PROFIBUS FastConnect Stripping Tool Default stripping tool for the fast stripping of PROFIBUS FastConnect bus cables	6GK1905-6AA00	-

Accessories for PROFINET (X150/X160 interface)	Article number	Comments
RJ45 connector FastConnect for Industrial Ethernet/PROFINET		
145° cable outlet (10/100 Mbps):		
• 1 pack= 1 item	6GK1901-1BB30-0AA0	-
• 1 pack= 10 items	6GK1901-1BB30-0AB0	-
• 1 pack= 50 items	6GK1901-1BB30-0AE0	-
FastConnect cables for Industrial Ethernet/PROFINET [1)]		
• IE FC Standard Cable GP 2x2	6XV1840-2AH10	-
• IE FC Flexible Cable GP 2x2	6XV1870-2B	-
• IE FC Trailing Cable GP 2x2	6XV1870-2D	-
• IE FC Trailing Cable 2x2	6XV1840-3AH10	-
• IE FC Marine Cable 2x2	6XV1840-4AH10	-
Stripping tool for Industrial Ethernet/PROFINET FastConnect cables		
• IE FC Stripping Tool	6GK1901-1GA00	-

[1)] Sold by the meter; max. delivery unit depends on cable type; minimum order quantity 20 m.

Accessories for Industrial Ethernet (interface X130)	Article number	Comments
RJ45 FastConnect connector for Industrial Ethernet/PROFINET		
180° cable outlet (10/100/1000 Mbps):		
• 1 pack= 1 item	6GK1901-1BB11-2AA0	-
• 1 pack= 10 items	6GK1901-1BB11-2AB0	-
• 1 pack= 50 items	6GK1901-1BB11-2AE0	-
FastConnect cables for Industrial Ethernet/PROFINET [1]		
• IE FC Standard Cable GP 4x2	6XV1878-2A	-
• IE FC Flexible Cable GP 4x2	6XV1878-2B	-
Stripping tool for Industrial Ethernet/PROFINET FastConnect cables		
• IE FC Stripping Tool	6GK1901-1GA00	-
Dust cover blanking plug for protecting unused DRIVE-CLiQ, Ethernet and PROFINET ports		
• Blanking plug (50 units)	6SL3066-4CA00-0AA0	-

[1] Sold by the meter; max. consignment 1000 m; minimum order quantity 20 m.

Note

The PROFINET interface X130 supports transmission rates of 10, 100 and 1000 Mbps.

For the maximum transmission rate of 1000 Mbps, use:

- 8-wire cables (4x2)
- 1000 Mbit 180° FastConnect connectors

You can use the 145° FastConnect connectors for PROFINET interface X130 only with a max. of 100 Mbps.

Spare parts

You can order the following spare parts for the SIMATIC Drive Controller:

Table B- 3 Spare parts

Article	Article number	Comments
Bottom cover	6ES7615-0AC10-0AA0	-
Top cover	6ES7615-0AC10-1AA0	-

Article	Article number	Comments
Spacer	6SL3064-1BB00-0AA0	-
Terminal kit • 3 x I/O connector for X122/X132/X142 • 1 x 24 V connector for X124 • 5 x DRIVE-CLiQ blanking cover	6SL3064-2CB00-0AA0	-

Glossary

Accessible devices

Accessible devices are all devices connected to an interface of the programming device / PC that are turned on.

Automatic speed control, for example S120

Automatic speed control covers all elements and components for current and speed control of an electric drive.

Automation system

Programmable logic controller for the open-loop and closed-loop control of process chains in the process engineering industry and in manufacturing technology. The automation system consists of different components and integrated system functions according to the automation task.

Basic positioner (EPos)

SINAMICS converter function for calculating profiles for the position controller.

Baud rate

Baud rate is the symbol or modulation rate in data transmission. For example, if a symbol comprises 4 bits, 9600 bps are transmitted at a modulation rate of 2400 baud. For symbols with only two possible states (binary symbols), the baud rate is the same as the bit rate.

Bit memory

Bit memory is a component of the system memory of the CPU for saving intermediate results. It can be accessed in bit, byte, word or double word mode.

Booksize device

Booksize design of the components of a drive unit, suitable for installation side-by-side. Usually intended for the operation of multiple motors.

Bus

Joint transmission path to which all devices in a fieldbus system are connected; has two defined ends.

Bus cable connector

Physical connection between the bus node and the bus cable.

Code block

In SIMATIC S7, a code block is a block that contains a section of the STEP 7 user program. (in contrast to a data block, which contains only data)

Configuration

Systematic arrangement of the individual modules (configuration).

Connection plug

Physical connection between device and cable.

Consistent data

Data whose content belongs together and must not be separated is known as consistent data.

Control Unit

Converter component with automatic speed control function (e.g. CU320-2). With SIMOTION D, SINUMERIK NCUs and the SIMATIC Drive Controller, the Control Unit and controller are combined in one device as SINAMICS Integrated.

Controller extension

This component scales the number of drive controls in SIMOTION D4x5-2.

Counter

Counters are components of the system memory of the CPU. You can modify the content of the "counter cells" using STEP 7 instructions (e.g. count up/down).

CPU

The CPU contains the operating system and executes the user program. The user program is located on the SIMATIC Memory Card and is processed in the work memory of the CPU. The PROFINET interfaces on the CPU allow simultaneous communication with PROFINET devices, PROFINET controllers, HMI devices, programming devices, other controllers and other systems. The S7-1500 CPUs support operation as an IO controller and I-device. Similarly to the PROFINET interface, the PROFIBUS interface available on some of the S7-1500 CPUs allows communication with other devices. When the interface is used as PROFIBUS DP interface, the CPU on the PROFIBUS DP also assumes the role of a DP master.

Cross-PLC synchronous operation

This functionality allows you to create a master value source and a synchronous axis on different controllers.

Cycle control point

The cycle control point marks the end of a cycle and the start of the next cycle. The cycle time statistics and monitoring of the configured maximum cycle time start at the cycle control point.

Once the cycle control point has been reached, the CPU writes the process image output to the output modules, reads the state of the inputs in the input modules and then executes the first cyclic OB.

Cycle time

The cycle time represents the time a CPU requires to execute the user program once.

Cyclic interrupt

You can find relevant information in the entry "Interrupt, cyclic".

Data block

Data blocks (DBs) are data areas in the user program that contain user data. There are global data blocks, which can be accessed from all code blocks, and instance data blocks, which are assigned to a specific FB call.

Device

A device can send, receive or amplify data via the bus, e.g. IO device via PROFINET IO.

Device names

Before an IO device can be addressed by an IO controller, it must have a device name. This approach was chosen for PROFINET because names are easier to administer than complex IP addresses.

In its delivery state, an IO device has no device name. An IO device can only be addressed by an IO controller – for example for transferring configuration data (including the IP address) during startup, or for user data exchange during cyclic operation – after it has been assigned a device name with the PG/PC.

Diagnostic buffer

The diagnostic buffer is a battery-backed memory area in the CPU where diagnostic events are stored in their order of occurrence.

Diagnostics

Monitoring functions for the detection, localization, classification, display, and further evaluation of errors, faults, and alarms. They run automatically while the system is in operation. This increases the availability of systems by reducing commissioning times and downtimes.

Diagnostics interrupt

You can find relevant information in the entry "Interrupt, diagnostics".

Distributed I/O system

System with I/O modules that are configured on a distributed basis, at a large distance from the CPU controlling them.

DP

Distributed I/O

DP master

The DP master is a central component in the PROFIBUS DP data bus that exchanges data with its assigned distributed stations (slaves) in a defined, continually repeating message cycle.

DP slave

An I/O device acting as a passive node in PROFIBUS DP that reads in input information and sends output information to the I/O.

Drive Control Block (DCB)

Multi-instance block that is selected from a predefined block library in the DCC editor and is used to set the control functionality.

Drive Control Chart (DCC)

Allows the user to implement additional continuous, drive control and math functions using a set of function blocks ("Drive Control Blocks", DCB) in a function block library. These function blocks can be graphically interconnected using a configuration tool ("Drive Control Chart Editor", DCC editor).

Drive object

A drive object is a separate, discrete software functionality with its own parameters and in some cases also its own faults and warnings.

DRIVE-CLiQ

Abbreviation for Drive Component Link with IQ. This is a SINAMICS drive technology communication system for connecting the various drive components such as Control Unit, Line Modules, Motor Modules, motors and speed/positioning encoders. In terms of hardware, DRIVE-CLiQ is based on the Industrial Ethernet standard with twisted-pair lines. In addition to the transmit and receive signals, the 24 V voltage supply is also provided via the DRIVE-CLiQ cable.

Equipotential bonding

Electrical connection (potential equalization conductor) that brings the bodies of electrical equipment and other conductive bodies to the same or almost the same potential, in order to prevent disruptive or dangerous voltages between these bodies.

Failsafe module

Collective name for failsafe inputs and outputs available in SIMATIC S7 for integration into F-systems.

Firmware update

Upgrade of firmware for the CPU and modules (interface modules, I/O modules etc.), for example after function extensions, to the newest firmware version (update).

Forcing

Preassigning to variables in a user program fixed values that cannot subsequently be modified or overwritten by the program.

Free function blocks (FBLOCKS)

Software blocks in a SINAMICS converter that are not active in the factory settings and can be activated and interconnected as required for additional control and math instructions. Free function blocks allow you to implement additional control and math instructions (for example logic functions, math functions, time functions, and storage functions).

Function

A function (FC) is a code block with no static data. A function allows you to pass parameters in the user program. Functions are thus suited for programming frequently recurring complex functions, such as calculations.

Function block

A function block (FB) is a code block with static data. An FB allows you to pass parameters in the user program. Function blocks are thus suited for programming frequently recurring complex functions, such as closed-loop controls or operating mode selection.

Functional ground

The functional ground is a low-impedance current path between electric circuits and ground. It is not intended as a protective measure but rather, for example, for improvement of interference immunity.

Ground

Conductive ground whose electrical potential can be set to zero at any point.

All interconnected, inactive parts of a piece of equipment that cannot accept any dangerous contact voltage, even in the event of a fault.

Ground

Conductive ground whose electrical potential can be set to zero at any point.

All interconnected, inactive parts of a piece of equipment that cannot accept any dangerous contact voltage, even in the event of a fault.

Grounding

Grounding means connecting an electrically conductive part to a grounding electrode by means of a grounding system.

GSD file

The Generic Station Description file contains all properties of a PROFINET or PROFIBUS device that are necessary for its configuration.

Handling system

A device that manages the flow of material from or to a workstation, in other words that is used for handling.

Hardware interrupt

You can find relevant information in the entry "Interrupt, process".

I/O modules

All modules that can be operated with a CPU or an interface module.

Identification data

Information that is saved in modules, and that supports the user in reviewing the system configuration and locating hardware changes.

Instance data block

Each call of a function block in the STEP 7 user program is assigned a data block, which is automatically generated. Values of the input, output and in/out parameters, as well as local block data, are stored in the instance data block.

Interrupt

The operating system of the CPU distinguishes between various priority classes that control the execution of the user program. These priority classes include, for example, hardware interrupts. When an interrupt occurs, the operating system automatically calls an assigned organization block. The user can program the desired reaction in the organization block, for example in an FB.

Interrupt, cyclic

The CPU generates a cyclic interrupt periodically within a parameterizable time grid and then processes the corresponding organization block.

Interrupt, hardware

A hardware interrupt is triggered by interrupt-triggering modules due to a certain event in the process. The hardware interrupt is signaled to the CPU. The CPU then processes the assigned organization block according to the priority of this interrupt.

Interrupt, time-delay

The time-delay interrupt is one of the program execution priority classes of SIMATIC S7. It is generated after expiration of a timer started in the user program. The CPU then processes the corresponding organization block.

Interrupt, time-of-day

The time-of-day interrupt is one of the program execution priority classes of SIMATIC S7.. It is generated based on a defined date (or daily) and time (e.g. 9:50 or every hour, every minute). The CPU then processes the corresponding organization block.

Interrupt, update

When it receives an update interrupt, the operating system calls the update interrupt OB. This may happen if you changed a parameter on a slot of a device.

IP address

The IP address is made up of four decimal numbers with a range of values from 0 through 255. The decimal numbers are separated by a dot (for example 192.162.0.0).

The IP address consists of the following:

- Address of the network
- Address of the device (PROFINET interface of the IO controller/IO device)

IRT, isochronous real time

A synchronized transmission method for the cyclic exchange of I/O data between PROFINET IO devices.

A fixed bandwidth within the send clock is reserved for the I/O data, ensuring that the I/O data is exchanged at equal intervals.

Isochronous mode

Signal acquisition, transmission and processing linked to a specified cycle.

Line Module

Self-commutated infeed/regenerative feedback unit for generating a controlled DC-link voltage, which decouples connected Motor Modules from the line voltage and thus prevents line voltage fluctuations within the permitted line tolerances from affecting the motor voltage.

Load current supply

Supply of the module's input and output electric circuits.

MAC address

Every PROFINET device is assigned a worldwide unique device identification before it leaves the factory. This 6-byte long device identification is the MAC address. Each interface and also each port has its own MAC address.

The MAC address is divided into:

- 3-byte manufacturer identification
- 3-byte device identification (consecutive number)

The MAC address is generally shown on the front of the device.
Example: 08-00-06-6B-80-C0

Motion control

Siemens AG product family for drives that control motion. Covers all functions and components for coordination in terms of position and time for machine components in processing machinery.

Motor Module

Converter component (inverter) that provides power for one or two connected motors.

NTP

The Network Time Protocol (NTP) is a standard for synchronizing clocks in automation systems via Industrial Ethernet. NTP uses the UDP connectionless network protocol.

Onboard I/O

The digital onboard I/O of the SIMATIC Drive Controller is designed for connecting sensors and actuators. Connection is over the interfaces X122, X132 and X142.

The digital inputs and digital inputs/outputs at X122 and X132 interfaces are assigned to SINAMICS Integrated. Through configuration (frames 39x), you can, however, also use the digital inputs and digital inputs/outputs (X122/X132) for the CPU. The digital input/outputs at interface X142 are assigned to the CPU of the SIMATIC Drive Controller and that assignment is fixed.

Operating mode

The operating mode is a defined manner in which a device or system is able to execute its function (for example continuous duty, short-time duty or periodic duty).

Operating states

Operating states describe the behavior of a single CPU at a specific time.

Organization block

Organization blocks (OBs) form the interface between the operating system of the CPU and the user program. The organization blocks determine the order in which the user program is executed.

Parameter

- Tag of a STEP 7 code block:
- Tag for setting the behavior of a module (one or more per module). In as-delivered state, every module has an appropriate basic setting, which you can change by configuring in STEP 7. There are static and dynamic parameters

Parameters, dynamic

In contrast to static parameters, you can change dynamic parameters of modules during operation by calling an SFC in the user program, e.g. limit values of an analog input module.

Parameters, static

In contrast to dynamic parameters, you cannot change static parameters of modules with the user program but only by configuring in STEP 7, e.g. input delay of a digital input module.

PELV

Protective **E**xtra **L**ow **V**oltage = grounded extra low voltage with safe isolation

PLCopen

With these standardized instructions, you can use OPC UA client functions executed in an S7-1500 CPU in your user program.

Process image (I/O)

The CPU transfers the values from the input and output modules to this memory area. At the start of the cyclic program the signal states of the input modules are transmitted to the process image of the inputs. At the end of the cyclic program the process image of the outputs is transmitted as signal state to the output modules.

Product version (PV) = Function version (FV)

The product version or function version provides information on the hardware version of the module.

PROFIBUS

PROcess FIeld BUS, process and fieldbus standard that is specified in IEC 61158 Type 3. It specifies functional, electrical and mechanical characteristics for a bit-serial field bus system.

PROFIBUS supports the protocols DP (= Distributed I/O), FMS (= Fieldbus Message Specification), PA (= Process Automation), or TF (= Technological Functions).

PROFIdrive Integrated

PROFIBUS profile specified by the PNO (PROFIBUS user organization) for speed-controlled and position-controlled drives.

PROFINET

PROcess FIeld NETwork, open Industrial Ethernet standard which further develops PROFIBUS and Industrial Ethernet. A cross-manufacturer communication, automation, and engineering model defined by PROFIBUS International e.V. as an automation standard.

PROFINET IO

Communication concept for the realization of modular, distributed applications within the scope of PROFINET.

PROFINET IO controller

Device used to address connected I/O devices (for example distributed I/O systems). This means that: The IO controller exchanges input and output signals with assigned IO devices. Often, the IO controller is the CPU on which the automation program runs.

PROFINET IO device

Distributed field device that can be assigned to one or more IO controllers (for example distributed I/O system, valve terminals, frequency converters, switches).

Reference potential

Potential from which the voltages of the circuits involved are observed and/or measured.

Restart

During a warm restart, all non-retentive bit memory is deleted and non-retentive DB contents are reset to the initial values from load memory. Retentive bit memory and retentive DB contents are retained. Program execution begins at the call of the first startup OB.

Retentivity

A memory area whose content is retained after power failure and after a STOP to RUN transition is retentive. The non-retentive area of the bit memory, timers and counters is reset after power failure and after a STOP to RUN transition.

RT, real-time

A transmission method for the cyclic exchange of I/O data between PROFINET devices. The transmission method guarantees that the I/O data is transferred at deterministic intervals.

Runtime error

Error that occurs during execution of the user program in the automation system (thus not in the process).

SELV

Safety **E**xtra **L**ow **V**oltage = Safety extra-low voltage

Sensor Module

Component for implementing encoder interfaces on DRIVE-CLiQ.

SIMATIC Drive Controller

The SIMATIC Drive Controller is a drive-based controller in the SIMATIC S7-1500 range.

SIMATIC Memory Card

External memory card for memory expansion in SIMATIC PLC.

SIMATIC Safe Kinematics

Safe zones and velocity monitoring of kinematics motions.

SIMATIC Safety Integrated

Coordinated product line, for example safety-related low-voltage switchgears and sensors, failsafe PLC, CNC controllers and variable-speed drives, which can be used in automation and drive technology to achieve the required plant security.

SINAMICS Integrated

SINAMICS Integrated is the integrated automatic speed control for controller platforms on which CPU and SINAMICS automatic speed control are combined in one hardware product – for example on the SIMATIC Drive Controller.

SINAMICS S210 servo drive system

A new servo drive system with five performance classes from 50 to 750 watts. The converter already has an integrated safety function.

SINAMICS Startdrive

TIA Portal option package for intuitive integration of SINAMICS drives in automation.

SINAMICS Technology Extension (TEC)

Software component that is installed as an additional technology function and extends the functionality of the SINAMICS drive system.

Slave station

A slave may only exchange data with a master after being requested to by the master.

SNMP

SNMP (Simple Network Management Protocol) is the standardized protocol for performing diagnostics on and assigning parameters to the Ethernet network infrastructure.

In the office setting and in automation engineering, devices from a wide range of vendors on the Ethernet support SNMP.

SNMP-based applications can be operated on the same network in parallel to applications with PROFINET.

The scope of supported functions varies depending on the device type. For example a switch has more functions than a CP 1616.

Switch

PROFIBUS is a linear network. The communication nodes are linked by means of a passive cable - the bus.

By contrast, Industrial Ethernet consists of point-to-point connections: Each communication node is directly connected to exactly one communication node.

If a communication node is linked to several communication nodes, this communication node is connected to the port of an active network component - the switch. Additional communication nodes (including switches) can now be connected to the other ports of the switch. The connection between a communication node and the switch remains a point-to-point connection.

A switch thus has the task of regenerating and distributing received signals. The switch "learns" the Ethernet address(es) of a connected PROFINET device or additional switches and only forwards those signals that are intended for the connected PROFINET device or switch.

A switch has a specific number of connections (ports). You connect at most one PROFINET device or additional switch to each port.

Technology I/Os

Designation for inputs and outputs with hardware-level signal processing, for example for rapid counting, measuring or time-controlled output of signals. Technology I/Os are provided by the ET 200SP/MP technology modules, for example. CPUs with integrated inputs and outputs are also available.

Technology object

A technology object supports you in the configuration and commissioning of a technological function.

The properties of real objects are represented by technology objects in the controller. Real objects include controlled systems and drives.

The technology object contains all data of the real object required for its open-loop or closed-loop control, and it signals back status information.

Terminal Module

Component for implementing inputs and outputs on DRIVE-CLiQ.

TIA Portal

Totally Integrated Automation Portal

High-performance engineering framework for the most important components of an automation project, such as controller, HMI, drives and distributed I/O. Engineering with TIA Portal offers:

- Configuration and programming
- Shared data management
- Uniform operating concept

The TIA Portal simplifies integrated engineering in all configuration phases of a plant.

Time-delay interrupt

You can find relevant information in the entry "Interrupt, delay".

Time-of-day interrupt

You can find relevant information in the entry "Interrupt, time".

Timer

Timers are components of the system memory of the CPU. The operating system automatically updates the content of the "timer cells" asynchronously to the user program. STEP 7 instructions define the precise function of the timer cell (for example on-delay) and trigger its execution.

U/f control

Speed control with output voltage setting on the basis of a V/f characteristic.

Update interrupt

You can find relevant information in the entry "Interrupt, update".

User program

SIMATIC differentiates between the operating system of the CPU and user programs. The user program contains all instructions and declarations as well as data for the signal processing that enable a plant or process to be controlled. The user program is assigned to a programmable module (e.g. CPU) and can be structured in smaller units.

Value status

The value status is additional binary information of a digital input or output signal. The value status is entered simultaneously with the process signal in the process image input and provides information about the validity of the signal.

Vector control

Speed control with sublevel closed-loop control of flow and torque.

Warm restart

You can find relevant information in the entry "Restart".

Index

2

24 V DC supply, 119

A

Access protection with the user program, 250
Accessible devices
  Firmware update, 322
Accessories, 361
Addressing, 154
  Basics, 154
Approvals, 349
  CE, 349
  cULus, 350
  Korea, 350
Asynchronous instructions, 225

C

Cable shield
  Shield bus, 135
  Shield connection, 135
CE approval, 349
China RoHS, 350
Commissioning, 264, 298
  First power-on, 269
  First power-on, requirements, 269
  Identification data, 296, 298
  Identification data - record structure, 298
  Removing/inserting SIMATIC memory card, 266
Comparison, 358
Components
  open, 113
Configuration control, 257, 261
Configuration control for IO systems, 257
Configuring, 137, 137
Connecting
  PROFIBUS DP, 127
  PROFINET, 127
Control interface, 191
CPU
  Backup/restore content, 285
  Memory reset, 281
  Programming, 222
  Reading out service data, 343
  Reset to factory settings, 329
C-Tick, 350
cULus approval, 350

D

Data block editor, 341
Degree of protection IP20, 357
Device replacement, 143
Digital inputs/outputs, 127
Display, 305
DRIVE-CLiQ
  Firmware update, 327
  Rules for wiring, 130

E

EAC, 350
Electromagnetic compatibility (EMC), 351
EMC (Electromagnetic compatibility), 351
  Disturbances, 352
EMC guidelines, 120
EMERGENCY STOP concept, 118
EMERGENCY STOP devices, 118

F

Factory settings, 329
FAQ
  Emergency address, 287
  Formatting a SIMATIC Memory Card, 309
  Removing a SIMATIC Memory Card, 308
  Repairing the SIMATIC Memory Card, 309
FAQs
  Firmware update, 327
  Removing a SIMATIC memory card, 268
F-CPU, 218
Feedback interface, 192
Firmware update, 319
  Card, 310
Force table, 340
F-system, 332
FUNCT, 311, 344
FUNCT button, 311, 344

H

Hardware
Components, 109
Configuration, 110
Hardware requirements, 103

I

Identification data, 296
Record structure, 298
IEC 60204, 118
Installation, 115
Instructions
GetSMCinfo, 316
Insulation, 356
Interfaces, 94

K

Know-how protection, 251
Korea certification, 350

L

LED flash test, 341
Licenses, 91
Licensing, 278
Lightning protection, 119
Line voltage, 119
LSINATopo library, 260

M

Maintenance, 336
Firmware update, 319
Reading out service data, 343
Reset to factory settings, 329
Test functions, 337
Maximum cycle time, (Cycle monitoring time), (Cycle monitoring time)
Memory reset
Automatic, 282
Basics, 281
Manual, 283
Modular machine, 258
Multiple use IO systems, 257

O

OBs, 222
Event source, 224
Priorities, 222
Priorities and runtime behavior, 225
Queue, 222
Triggers, 222
Openness, 263
Operating conditions, 101
Operating states
Operating state transitions, 276
RUN, 275
Setting startup behavior, 274
STARTUP, 272
STOP, 274
Option handling, (See Configuration control)

P

Parameter assignment, 137
DI operating mode, 162
Digital inputs/outputs, 160
DQ operating mode, 164
Event/period duration measurement operating mode, 182
Oversampling DI operating mode, 177
Oversampling DQ, 179
PWM operating mode, 188
Timer DI operating mode, 165
Timer DQ operating mode, 170
Password provider, 251
Performance classes, 58
Performance features, 59
PFD values, 219
PFH values, 219
PID control, 87
Plant components, 65
PLC tag table, 341
Pollution degree, 356
Potential equalization, 133
Power supply
Safety rules, 118
Process image
Inputs and outputs, 157
Process image partition
Updating in the user program, 159
PROFIsafe V2, 219
Program card, 310
Project
Adding a SIMATIC Drive Controller, 139
Creating, 139

Display, 140
Grouping, 141
Project tree, 146
PRONETA, 98
Protection, 247, 252, 255, 256
Access levels, 247
Behavior of a password-protected CPU, 250
Copy protection, 255
Know-how protection, 252
Mechanical locking, 256
Protection class, 356
Protection concept, 239
Protection from external electrical effects, 119
Protection functions, 77
Protective conductor connection, 131

R

rated voltage, 357
RCM, 350
Reading out service data, 343
Repair, 336
Requirements
Hardware, 138
Software, 138
Retentive data, 309

S

Safety mode, 218
Scaling, 67
Security, 77
Shipping conditions, 353
SIMATIC Automation Tool, 99
SIMATIC Memory Card, 314
Basics, 303
Possible applications, 314
Repairing, 309
SIMATIC Safe Kinematics, 74
SIMATIC Safety Integrated, 73
SIMOTION D4x5-2, 358
SINAMICS
Digital inputs/outputs, 195
SINAMICS Integrated
Functions, 91
NVRAM, 288
Operating states, 277
reset to factory settings, 332
Time-of-day synchronization, 292
SINETPLAN, 98
Software requirements, 104
Spare parts, 363
Specific application, 118
Standard machine project, 257
Standard mode, 218
Standards, 349
Storage conditions, 353

T

Team Engineering, 302
Technical specifications
Electromagnetic compatibility (EMC), 351
Shipping and storage conditions, 353
Standards and Approvals, 349
Technology functions, 86
Technology objects, 85
Temperature monitoring, 335
Test functions, 337
Test voltage, 356
TIA Portal, 97
Openness, 263
TIA Portal
TIA Selection Tool, 98
Time-of-day synchronization, 290
Trace, 342
Trace recordings, 314

W

Web server, 82, 221, 346