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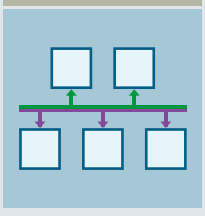
Communication



Function Manual

SINAMICS

S120

Communication

Edition 06/2020

www.siemens.com/drives

SIEMENS

SINAMICS

S120 Communication

Function Manual

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Valid as of:
Firmware Version 5.2 SP3

06/2020
6SL3097-5BD00-0BP2

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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Introduction 1

1.1 The SINAMICS converter family

With the SINAMICS converter family, you can solve any individual drive task in the low-voltage, medium-voltage and DC voltage range. From converters to motors and controllers, all Siemens drive components are perfectly matched to each other and can be easily integrated into your existing automation system. With SINAMICS you are prepared for digitization. You benefit from highly efficient engineering with a variety of tools for the entire product development and production process. And you also save space in the control cabinet – thanks to the integrated safety technology.

You can find additional information about SINAMICS at the following address (http://www.siemens.com/sinamics).

1.2 General information about SINAMICS documentation

SINAMICS documentation

The SINAMICS documentation is organized in the following categories:

- General documentation/catalogs
- User documentation
- Manufacturer/service documentation

Standard scope

The scope of the functionality described in this document can differ from that of the drive system that is actually supplied.

- Other functions not described in this documentation might be able to be executed in the drive system. However, no claim can be made regarding the availability of these functions when the equipment is first supplied or in the event of service.
- The documentation can also contain descriptions of functions that are not available in a particular product version of the drive system. Please refer to the ordering documentation only for the functionality of the supplied drive system.
- Extensions or changes made by the machine manufacturer must be documented by the machine manufacturer.

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

Target group

This documentation is intended for machine manufacturers, commissioning engineers, and service personnel who use the SINAMICS drive system.

Benefits

This manual provides all of the information, procedures and operator actions required for the particular usage phase.

Siemens MySupport/Documentation

You can find information on how to create your own individual documentation based on Siemens content and adapt it for your own machine documentation at the following address (https://support.industry.siemens.com/My/ww/en/documentation).

Additional information

You can find information on the topics below at the following address (https://support.industry.siemens.com/cs/de/en/view/108993276):

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

Questions relating to the technical documentation

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

FAQs

You can find Frequently Asked Questions about SINAMICS under Product Support (https://support.industry.siemens.com/cs/de/en/ps/faq).

Siemens Support while on the move

With the "Siemens Industry Online Support" app, you can access more than 300,000 documents for Siemens Industry products – any time and from anywhere. The app supports you in the following areas, for example:

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

Furthermore, you have access to the Technical Forum and other articles that our experts have drawn up:

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

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

Data matrix code on the rating plate

The data matrix code on the rating plate contains the specific device data. This code can be read-in with any smartphone and technical information for the appropriate device can be displayed via the "Industry Online Support" mobile app.

Websites of third-party companies

This document includes hyperlinks to websites of third-party companies. Siemens is not responsible for and shall not be liable for these websites or their content, as Siemens has not checked the information contained in the websites and is not responsible for the content or information they provide. The use of such websites is at the user's own risk.

1.3 Usage phases and their documents/tools

Usage phase	Document/tool
Orientation	SINAMICS S Sales Documentation
Planning/configuration	• SIZER Engineering Tool • Configuration Manuals, Motors
Deciding/ordering	SINAMICS S120 catalogs • SINAMICS S120 and SIMOTICS (Catalog D 21.4) • SINAMICS Converters for Single-Axis Drives and SIMOTICS Motors (Catalog D 31) • SINAMICS Converters for Single-Axis Drives – Built-In Units (D 31.1) • SINAMICS Converters for Single-Axis Drives – Distributed Converters (D 31.2) • SINAMICS S210 Servo Drive System (D 32) • SINUMERIK 840 Equipment for Machine Tools (Catalog NC 62)

Usage phase	Document/tool
Installation/assembly	• SINAMICS S120 Equipment Manual for Control Units and Supplementary System Components • SINAMICS S120 Equipment Manual for Booksize Power Units • SINAMICS S120 Equipment Manual for Chassis Power Units • SINAMICS S120 Equipment Manual for Chassis Power Units, Liquid-cooled • SINAMICS S120 Equipment Manual water-cooled chassis power units for common cooling circuits • SINAMICS S120 Equipment Manual for Chassis Power Units, Air-cooled • SINAMICS S120 Equipment Manual for AC Drives • SINAMICS S120 Equipment Manual Combi • SINAMICS S120M Equipment Manual Distributed Drive Technology • SINAMICS HLA System Manual Hydraulic Drives
Commissioning	• Startdrive Commissioning Tool • SINAMICS S120 Getting Started with Startdrive • SINAMICS S120 Commissioning Manual with Startdrive • SINAMICS S120 Function Manual Drive Functions • SINAMICS S120 Safety Integrated Function Manual • SINAMICS S120 Function Manual Communication • SINAMICS S120/S150 List Manual • SINAMICS HLA System Manual Hydraulic Drives
Usage/operation	• SINAMICS S120 Commissioning Manual with Startdrive • SINAMICS S120/S150 List Manual • SINAMICS HLA System Manual Hydraulic Drives
Maintenance/servicing	• SINAMICS S120 Commissioning Manual with Startdrive • SINAMICS S120/S150 List Manual
References	• SINAMICS S120/S150 List Manual

1.4 Where can the various topics be found?

Software		Manual
Alarms	Described in order of ascending numbers	SINAMICS S120/S150 List Manual
Parameters	Described in order of ascending numbers	SINAMICS S120/S150 List Manual
Function block diagrams	Sorted according to topic	SINAMICS S120/S150 List Manual
	Described in order of ascending numbers	
Drive functions		SINAMICS S120 Function Manual Drive Functions
Communication topics		SINAMICS S120 Function Manual Communication[2]
Safety Integrated	Basic and Extended Functions	SINAMICS S120 Safety Integrated Function Manual
	Basic Functions	SINAMICS S120 Function Manual Drive Functions
Commissioning	Of a simple SINAMICS S120 drive with STARTER	Getting Started[1]
Commissioning	With STARTER	SINAMICS S120 Commissioning Manual[1]
Commissioning	Of a simple SINAMICS S120 drive with Startdrive	Getting Started with Startdrive[2]
Commissioning	With Startdrive	SINAMICS S120 Commissioning Manual with Startdrive[2]
Web server		SINAMICS S120 Function Manual Drive Functions

Hardware			Manual
Control Units and expansion components	• Control Units • Option Boards • Terminal Modules	• DRIVE-CLiQ HUB Modules • VSM10 • Encoder system connection	SINAMICS S120 Equipment Manual for Control Units and Supplementary System Components
Booksize power units	• Line connection • Line Modules • Motor Modules	• DC link components • Braking resistors • Control cabinet design	SINAMICS S120 Equipment Manual for Booksize Power Units
Chassis power units			SINAMICS S120 Equipment Manual for Chassis Power Units, air, liquid or water cooled
AC drive components			SINAMICS S120 Equipment Manual for AC Drives
S120 Combi components			SINAMICS S120 Equipment Manual Combi
Diagnostics via LEDs	STARTER		SINAMICS S120 Commissioning Manual[1]
	Startdrive		SINAMICS S120 Commissioning Manual with Startdrive[2]
Meaning of the LEDs			Equipment Manuals
High Frequency Drive components			SINAMICS S120 System Manual High Frequency Drives

[1] Up to firmware version 5.1 SP1

[2] From firmware version 5.2

1.5 Training and support

Training

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

Technical Support

To ask a technical question or create a support request, click on "Support Request" at the following address (https://support.industry.siemens.com/cs/ww/en/sc) and select "Create Request".

1.6 Using OpenSSL

Many SINAMICS products include OpenSSL. The following applies to these products:

- This product contains software (https://www.openssl.org/) that has been developed by the OpenSSL project for use in the OpenSSL toolkit.
- This product contains cryptographic software (mailto:eay@cryptsoft.com) created by Eric Young.
- This product contains software (mailto:eay@cryptsoft.com) developed by Eric Young.

1.7 General Data Protection Regulation

Compliance with the General Data Protection Regulation

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

For this product, this means:
The product does not process neither store any person-related data, only technical function data (e.g. time stamps). If the user links these data with other data (e.g. shift plans) or if he stores person-related data on the same data medium (e.g. hard disk), thus personalizing these data, he has to ensure compliance with the applicable data protection stipulations.

Fundamental safety instructions 2

2.1 General safety instructions

⚠ WARNING

Danger to life if the safety instructions and residual risks are not observed

If the safety instructions and residual risks in the associated hardware documentation are not observed, accidents involving severe injuries or death can occur.

- Observe the safety instructions given in the hardware documentation.
- Consider the residual risks for the risk evaluation.

⚠ WARNING

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

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

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

2.2 Warranty and liability for application examples

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

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

2.3 Security information

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

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

Customers are responsible for preventing unauthorized access to their plants, systems, machines and networks. Such systems, machines and components should only be connected

to an enterprise network or the internet if and to the extent such a connection is necessary and only when appropriate security measures (e.g. firewalls and/or network segmentation) are in place.

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

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

To stay informed about product updates, subscribe to the Siemens Industrial Security RSS Feed under
https://www.siemens.com/industrialsecurity (https://new.siemens.com/global/en/products/services/cert.html#Subscriptions).

Further information is provided on the Internet:

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

⚠ WARNING

Unsafe operating states resulting from software manipulation

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

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

General information

3

3.1 Field of application

SINAMICS is the family of drives from Siemens designed for machine and plant engineering applications. SINAMICS offers solutions for all drive tasks:

- Simple pump and fan applications in the process industry
- Complex single drives in centrifuges, presses, extruders, elevators, as well as conveyor and transport systems
- Drive line-ups in textile, plastic film, and paper machines as well as in rolling mill plants
- High-precision servo drives in the manufacture of wind turbines
- Highly dynamic servo drives for machine tools, as well as packaging and printing machines

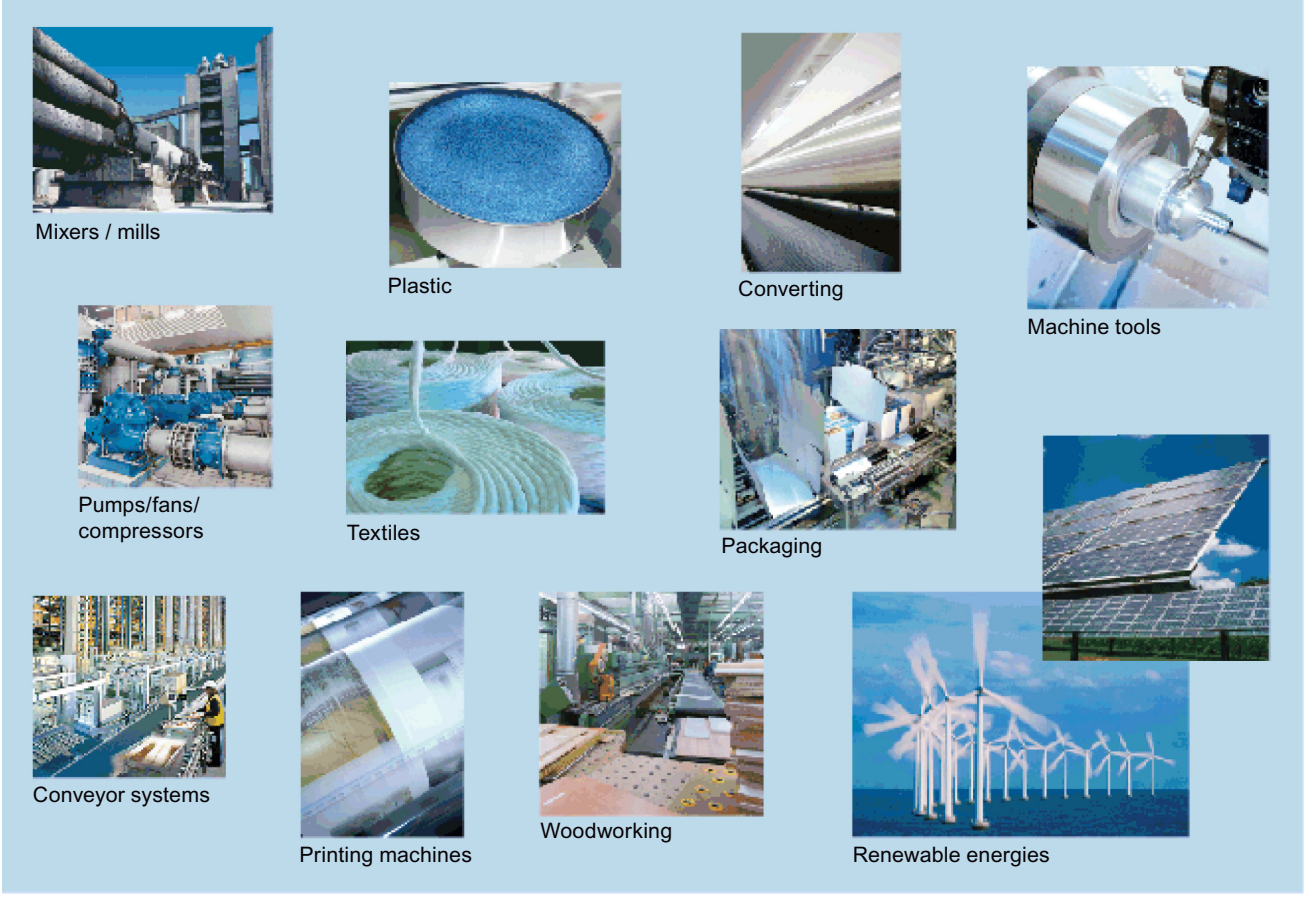


Figure 3-1 SINAMICS applications

Depending on the application, the SINAMICS range offers the ideal variant for any drive task.

- SINAMICS S handles complex drive tasks with synchronous motors and induction motors and fulfills stringent requirements regarding:
  - the dynamic performance and accuracy
  - the integration of extensive technological functions in the drive control system
- SINAMICS G is designed for standard applications with induction motors. These applications have less stringent requirements regarding the dynamic performance of the motor speed.
- SINAMICS V is designed to address applications where basic drive functions are available quickly and at a favorable cost - and which are easy to handle.

3.2 Platform Concept and Totally Integrated Automation

All SINAMICS versions are based on a platform concept. Joint hardware and software components, as well as standardized tools for design, configuration, and commissioning tasks ensure high-level integration across all components. SINAMICS handles a wide variety of drive tasks with no system gaps. The different SINAMICS versions can be easily combined with each other.

Totally Integrated Automation (TIA) with SINAMICS S120

Apart from SIMATIC, SIMOTION and SINUMERIK, SINAMICS is one of the core components of TIA. It is thus possible to parameterize, program and commission all components in the automation system via the Startdrive commissioning tool using a standardized engineering platform and without any system transitions (seamless engineering). The system-wide data management functions ensure consistent data and simplify archiving of the entire plant project.

From V14, the Startdrive commissioning tool is an integral element of the TIA platform.

SINAMICS S120 supports communication via PROFINET and PROFIBUS DP.

Communication via PROFINET

This Ethernet-based bus enables control data to be exchanged at high speed via PROFINET IO with IRT or RT and makes SINAMICS S120 a suitable choice for integration in high-performance multi-axis applications. At the same time, PROFINET also uses standard IT mechanisms (TCP/IP) to transport information, e.g. operating and diagnostic data, to higher-level systems. This makes it easy to integrate into an IT corporate network.

Communication via PROFIBUS DP

This bus provides a high-performance, system-wide and integrated communication network which links all automation components of the automation solution:

- HMI (operator control and monitoring)
- Control
- Drives and I/O

Figure 3-2 SINAMICS as part of the Siemens modular automation system

3.3 System overview

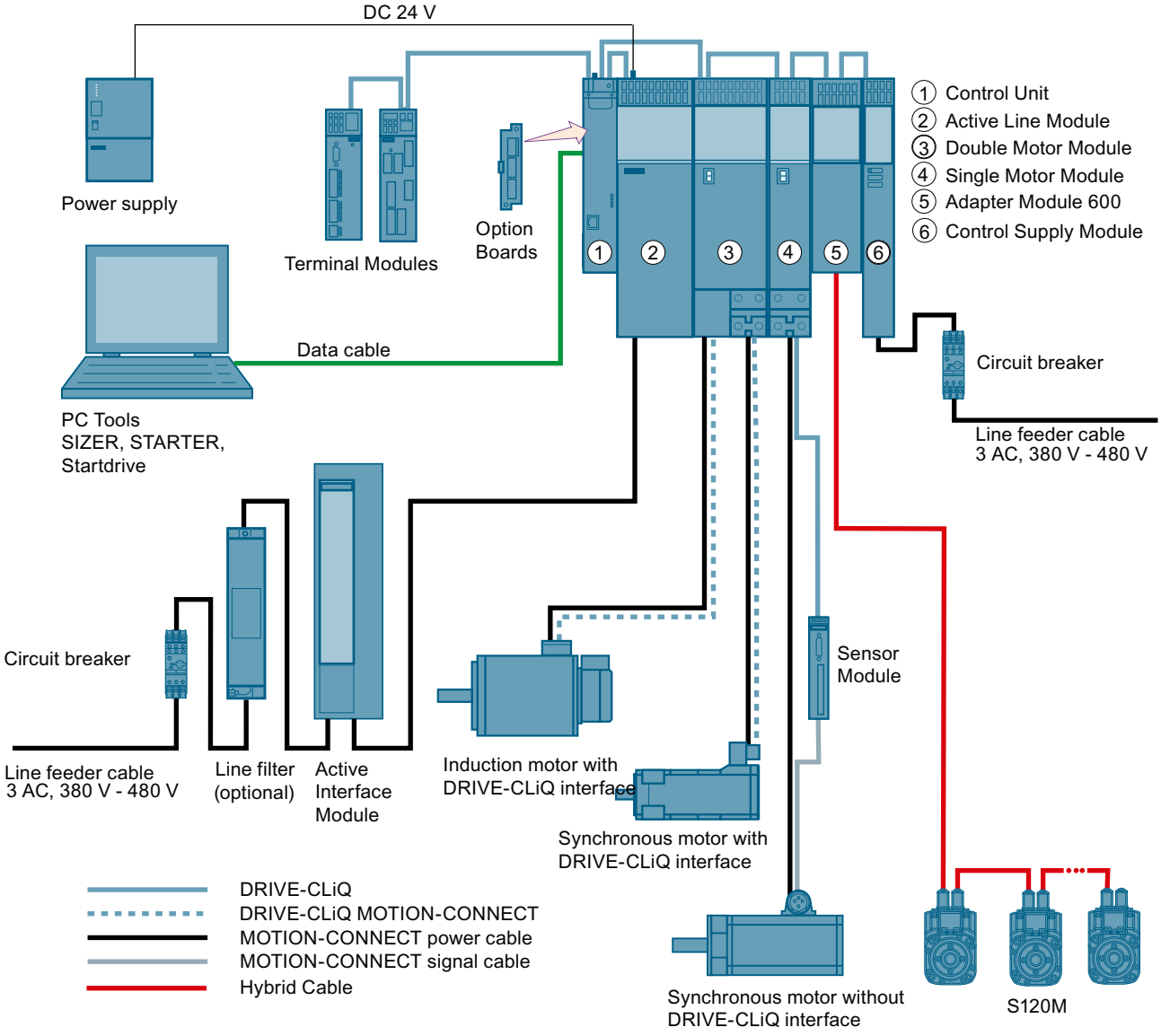


Figure 3-3 System overview, SINAMICS S120 with distributed servo drive technology S120M

Modular system for sophisticated drive tasks

SINAMICS S120 solves complex drive tasks for a wide range of industrial applications and is, therefore, designed as a modular system. You can choose from many different harmonized components and functions to create a solution that best meets your requirements. SIZER, a high-performance engineering tool, makes it easier to select and determine the optimum drive configuration.

SINAMICS S120 is supplemented by a wide range of motors. SINAMICS S120 optimally supports:

- SINAMICS S120M
- Synchronous and induction motors
- Linear and torque motors

System architecture with a central Control Unit

On the SINAMICS S120, the drive intelligence is combined with closed-loop control functions into Control Units. These units are capable of controlling drives in the vector, servo and U/f control modes. They also perform the speed and torque control functions plus other intelligent drive functions for all axes on the drive. Cross-axis couplings can be established within a component and easily configured in the Startdrive commissioning tool using a mouse.

Functions for higher efficiency

- Basic functions: Speed control, torque control, positioning functions
- Intelligent starting functions for independent restart after power supply interruption
- BICO technology with interconnection of drive-related I/Os for easy adaptation of the drive system to its operating environment
- Integrated safety functions for rational implementation of safety concepts
- Regulated infeed/regenerative feedback functions for preventing undesirable reactions on the supply, allowing recovery of braking energy and ensuring greater stability against line fluctuations.

DRIVE-CLiQ – the digital interface between SINAMICS components

Most of the SINAMICS S120 components, including the motors and encoders, are connected to each other via the common DRIVE-CLiQ serial interface. The standardized cables and connectors reduce the variety of different parts and cut storage costs. Encoder evaluations for converting standard encoder signals to DRIVE-CLiQ are available for third-party motors or retrofit applications.

Electronic rating plates in all components

An important digital linkage element of the SINAMICS S120 drive system are the electronic type plates integrated in every component. They allow all drive components to be detected automatically via a DRIVE-CLiQ link. As a result, data does not have to be entered manually during commissioning or component replacement – helping to ensure that drives are commissioned more reliably.

The rating plate contains all the relevant technical data about that particular component. For motors, these are the parameters of the electrical equivalent circuit diagram and key values of the integrated motor encoder, for example.

In addition to the technical data, the type plate includes logistical data (manufacturer ID, article number and ID). Since this data can be called up electronically on site or remotely, all the

components used in a machine can always be individually identified, which helps simplify servicing.

3.4 Information about CANopen

Information about communication via CANopen is provided in the following Manual:

- SINAMICS S120 Commissioning Manual CANopen Interface

3.5 X127 LAN (Ethernet)

Note

Use

Ethernet interface X127 is intended for commissioning and diagnostics, which means that it must always be accessible (e.g. for service).

Further, the following restrictions apply to X127:

- Only local access is possible
- No networking - or only local networking in a closed and locked electrical cabinet permissible

If it is necessary to remotely access the electrical cabinet, then additional security measures must be applied so that misuse through sabotage, unqualified data manipulation and intercepting confidential data is completely ruled out (also see "Security information (Page 15)").

3.6 SINAMICS network settings

SINAMICS converters support the communication protocols listed in the following table. The address parameters, the relevant communication layer, as well as the communication role and the communication direction are decisive for each protocol. You require this information to match the security measures for the protection of the automation system to the used protocols (e.g. firewall). The security measures are restricted to Ethernet and PROFINET networks.

The following table shows the various layers and protocols that are used.

PROFINET protocols

PROFINET protocols	Port number	(2) Link layer (4) Transport layer	Function	Description
DCP Discovery and Configuration Protocol	Not relevant	(2) Ethernet II and IEEE 802.1Q and Ethertype 0x8892 (PROFINET)	Accessible nodes, PROFINET Discovery and configuration	DCP is used by PROFINET to determine PROFINET devices and to make basic settings. DCP uses the special multicast MAC address: xx-xx-xx-01-0E-CF, xx-xx-xx = Organizationally Unique Identifier
LLDP Link Layer Discovery Protocol	Not relevant	(2) Ethernet II and IEEE 802.1Q and Ethertype 0x88CC (PROFINET)	PROFINET Link Layer Discovery protocol	LLDP is used by PROFINET to determine and manage neighborhood relationships between PROFINET devices. LLDP uses the special multicast MAC address: 01-80-C2-00-00-0E
MRP Media Redundancy Protocol	Not relevant	(2) Ethernet II and IEEE 802.1Q and Ethertype 0x88E3 (PROFINET)	PROFINET medium redundancy	MRP enables the control of redundant routes through a ring topology. MRP uses the special multicast MAC address: xx-xx-xx-01-15-4E, xx-xx-xx = Organizationally Unique Identifier
PTCP Precision Transparent Clock Protocol	Not relevant	(2) Ethernet II and IEEE 802.1Q and Ethertype 0x8892 (PROFINET)	PROFINET send clock and time synchronisation, based on IEEE 1588	PTC enables a time delay measurement between RJ45 ports and therefore the send cycle synchronization and time synchronization. PTCP uses the special multicast MAC address: xx-xx-xx-01-0E-CF, xx-xx-xx = Organizationally Unique Identifier

PROFINET protocols	Port number	(2) Link layer (4) Transport layer	Function	Description
PROFINET IO data	Not relevant	(2) Ethernet II and IEEE 802.1Q and Ethertype 0x8892 (PROFINET)	PROFINET Cyclic IO data transfer	The PROFINET IO telegrams are used to cyclically transfer IO data between the PROFINET IO controller and IO devices via Ethernet.
PROFINET Context Manager	34964	(4) UDP	PROFINET connection less RPC	The PROFINET context manager provides an endpoint mapper in order to establish an application relationship (PROFINET AR).
Network Time Protocol (NTP)	Dynamic	(4) UDP	NTP client; time synchronization	NTP is only supported for onboard PROFINET (X150). An NTP client port (dynamic UDP port > 50000) is only open at this interface.

Connection-oriented communication protocols

Connection-oriented communication protocols	Port number	(2) Link layer (4) Transport layer	Function	Description
FTP File Transfer Protocol	21	(4) TCP	Server/ incoming	FTP can be used for the first commissioning. FTP can be activated/deactivated using parameter p8908.
DHCP Dynamic Host Configuration Protocol	68	(4) UDP	Dynamic Host Configuration Protocol	Is used to query an IP address. Is closed when delivered, and is opened when selecting the DHCP mode.
http Hypertext Transfer Protocol	80	(4) TCP	Hypertext transfer protocol	http is used for the communication with the CU-internal web server. Is open in the delivery state and can be deactivated.
ISO on TCP (according to RFC 1006)	102	(4) TCP	ISO-on-TCP protocol	ISO on TCP (according to RFC 1006) is used for the message-oriented data exchange to a remote CPU, WinAC, or devices of other suppliers. Communication with ES, HMI, etc. Is open in the delivery state and is always required.

Connection-oriented communication protocols	Port number	(2) Link layer (4) Transport layer	Function	Description
SNMP Simple Network Management Protocol	161	(4) UDP	Simple network management protocol	SNMP enables the reading out and setting of network management data (SNMP managed Objects) by the SNMP manager. Is open in the delivery state and is always required.
https Secure Hypertext Transfer Protocol	443	(4) TCP	Secure Hypertext transfer protocol	https is used for the communication with the CU-internal web server via Transport Layer Security(TLS). Is open in the delivery state and can be deactivated.
Internal protocol	5188	(4) TCP	Server/ incoming	Communication with commissioning tools for downloading project data.
Reserved	49152...65535	(4) TCP (4) UDP	-	Dynamic port area that is used for the active connection endpoint if the application does not specify the local port.

EtherNet/IP protocols

EtherNet/IP protocols	Port number	(2) Link layer (4) Transport layer	Function	Description
Explicit messaging	44818	(4) TCP (4) UDP	-	Is used for parameter access, etc. Is closed when delivered, and is opened when selecting EtherNet/IP.
Implicit messaging	2222	(4) UDP	-	Is used for exchanging I/O data. Is closed when delivered, and is opened when selecting EtherNet/IP.

Modbus TCP protocols (server)

Modbus TCP protocols (server)	Port number	(2) Link layer (4) Transport layer	Function	Description
Request & Response	502	(4) TCP	-	Is used for exchanging data packages. Is closed when delivered, and is opened when selecting Modbus TCP.

3.7 Time synchronization between the control and converter

In the factory setting, SINAMICS S120 drives use an operating hours counter. Based on the operating hours, SINAMICS S120 saves alarms and warnings that occur. Using this method, it is not possible to have a comparable timestamp between various converters.

In order to obtain a comparable timestamp between several converters, you must change over the operating hours counting to time in the UTC format and synchronize with the time master (control system).

This means that the events of all bus nodes, which are synchronized with the control system time, can be referenced with one another.

Benefits: Improved diagnostic options by having a comparable time stamp of the bus nodes involved.

Converters provide the following options to synchronize the time:

Synchronization type	Accuracy
Basic synchronization	approx. 100ms
Synchronization using ping compensation for non-isochronous communication	approx. 10 ms
Synchronization using ping compensation for isochronous communication	approx. 1 ms
Synchronization with the Network Time Protocol via a PROFINET connection	approx. 10 ms

Principle of operation of time synchronization

Basic synchronization

The control system transfers the time to the converter at time intervals that you specify in the control system. Transfer is realized acyclically in the UTC format. The converter accepts this time as soon as transfer has been completed without correcting the transfer duration. The converter logs alarms and warnings based on this time.

Time synchronization with ping compensation

At intervals that you specify in the control system, the control system sends a ping (a positive signal edge) cyclically to the converter. Simultaneously, in acyclic operation, the device sends the time in the UTC format in what is known as "snap".

As soon as the ping has been received in the drive, a timer starts which measures the time until the snap has been completely transferred. The drive accepts the time that the snap transfers. It then corrects it by the time that has expired between receiving the ping and the complete transfer of the snap.

If the snap has not been transferred within 5 s after receiving the ping, then this synchronization cycle is not used.

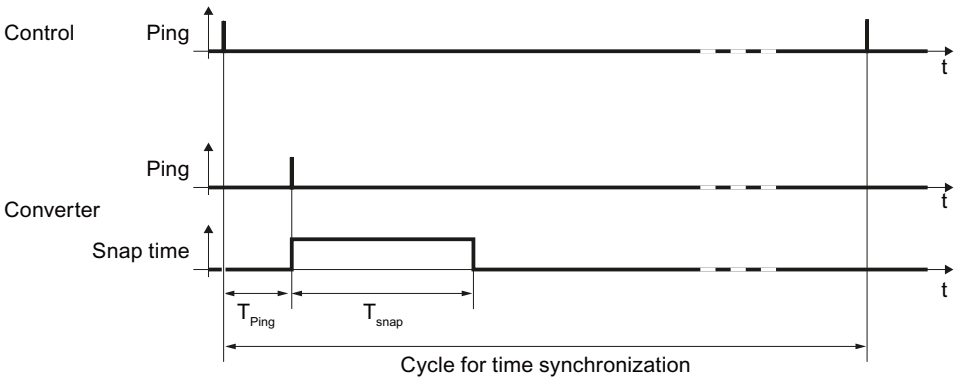


Figure 3-4 Ping snap

Differences for isochronous and non-isochronous communication:

Communication	Description
Isochronous	The ping compensation value is determined in the converter.
not isochronous	You can influence the accuracy of the ping compensation using the PZD sampling time (p2048).

Time synchronization via Network Time Protocol (NTP)

Through NTP, all computers worldwide can synchronize their time. An inverter configured as an NTP client synchronizes the time via a PROFINET connection to an NTP server (a time source).

As NTP server, the following constellations are possible:

- Local NTP server that receives the time via GPS or DCF77 (e.g. SICLOCK).
- Control as NTP server if the plant network is divided into a control level and a field level.

3.7.1 Setting SINAMICS time synchronization

Setting time synchronization

1. Using p3100, changeover the time format from operating hours into the UTC format (see "Changing the time format").
2. Set the synchronization technique:
   - Basic synchronization (p3103 = 2)
   - Time synchronization with ping compensation (p3103 = 0)
3. Using p3104, set the ping source:
   - If you are working with one of the telegrams 390, 391 or 392, then the source of the ping (p3104) is internally connected with bit 1 of the CU control word (DO1:CU_STW.1). In this case, parameter p3104 is blocked.
   - If you are using a free telegram (999), interconnect the ping source (p3104) via BICO in the control word.
   - If you are working with CANopen, interconnect a free bit in the CANopen control word with p3104 via a BICO connection.

Result:

After time synchronization, the current time is obtained from the time transferred by the time master plus the necessary delay time associated with the transfer (ping-snap time).

The actual UTC time is displayed in the drive system using r3102.

At certain intervals, synchronization (according to the same technique) is repeated (depending on the setting in the time master).

If a previously defined tolerance window is exceeded, then alarm A01099 is output. Define the tolerance window for time synchronization using p3109. If alarm A01099 occurs, then generally the synchronization interval is too long.

In this case, reduce the synchronization interval in your control system.

Changing the time format

The time format is entered via parameter p3100. This parameter cannot be changed online To change the value, proceed as follows:

1. Connect Startdrive ONLINE with the converter.
2. Carry out an upload using the "Load from device" function.
3. In Startdrive, exit the ONLINE mode.
4. Offline, make the setting p3100 = 1.
5. Reactivate the ONLINE mode.
6. Carry out a parameter download ("Load to device").
7. Save the settings in a non-volatile fashion on the memory card of the drive.
   You have now changed over the converter time format to the UTC format.

Application example

You can find an application example for SINAMICS time synchronization in the SIEMENS "Industry Online Support":

Example: Specific SINAMICS time synchronization (https://support.industry.siemens.com/cs/de/en/view/88231134)

3.7.2 Set NTP time synchronization

Setting time synchronization with NTP

1. Using p3100, changeover the time format from operating hours into the UTC format (see "Changing the time format").
2. Set the synchronization technique NTP (p3103 = 4).
3. Set the IP address of the NTP server used (p3105[0...3]).
   – Special case: To use a PROFINET controller as NTP server, set p3105[0...3] = 0.
4. Set the local time zone (p3106).

Result:

After successful NTP time synchronization, the NTP time is converted to the already existing UTC time.

If a previously defined tolerance window is exceeded, then alarm A01099 is output. The tolerance window for time synchronization is defined using p3109. If alarm A01099 occurs, then generally the synchronization interval is too long.

The converter outputs alarm A01097 if it does not reach the set NTP server within 10 minutes.

Changing the time format

The time format is entered via parameter p3100. This parameter cannot be changed online To change the value, proceed as follows:

1. Connect Startdrive ONLINE with the converter.
2. Carry out an upload using the "Load from device" function.
3. In Startdrive, exit the ONLINE mode.
4. Offline, make the setting p3100 = 1.
5. Reactivate the ONLINE mode.
6. Carry out a parameter download ("Load to device").
7. Save the settings in a non-volatile fashion on the memory card of the drive.
   You have now changed over the converter time format to UTC format.

Application example

You can find the following application example in the SIEMENS "Industry Online Support":

Example: Converter as NTP client (https://support.industry.siemens.com/cs/ww/en/view/82203451)

3.7.3 Messages and parameters

Faults and alarms (see SINAMICS S120/S150 List Manual)

- A01099 UTC synchronization tolerance violated
- A01097 (N) NTP server cannot be reached

Overview of important parameters (see SINAMICS S120/S150 List Manual)

- p2048 IF1 PROFIdrive PZD sampling time
- p3100 RTC time stamp mode
- p3101[0...1] Set UTC time
- r3102[0...1] Display UTC time
- p3103 UTC synchronization technique
- p3104 BI: UTC PING synchronization
- p3105[0...3] NTP server IP address
- p3106 NTP time zone
- r3107[0...3] UTC synchronization time out of tolerance
- r3108[0...1] UTC synchronization deviation
- p3109 UTC synchronization tolerance
- p3116 BI: Suppress automatic acknowledgment

Communication according to PROFIdrive

4

PROFIdrive is the PROFIBUS and PROFINET profile for drive technology with a wide range of applications in production and process automation systems.

PROFIdrive is independent of the bus system used (PROFIBUS, PROFINET).

Note

PROFIdrive for drive technology is standardized and described in the following document:

- PROFIdrive – Profile Drive Technology,
  PROFIBUS User Organization e. V.
  Haid-und-Neu-Straße 7, D-76131 Karlsruhe,
  Internet: (http://www.profibus.com)
- IEC 61800-7

PROFIdrive device classes

Table 4-1 PROFIdrive device classes

PROFIdrive	PROFIBUS DP	PROFINET IO	Example
Peripheral device (P device)	DP slave	IO Device	Drive unit, Control Unit CU320-2
Motion controller (higher-level controller or host of the automation system)	Class 1 DP master	IO Controller	Higher-level control, SIMATIC S7 and SIMOTION
Supervisor (engineering station)	Class 2 DP master	IO Supervisor	Programming devices, human machine interfaces

Note

Consistent naming conventions

For reasons of consistency, the terms "device", "controller", and "supervisor" are used below. The terms "slave" and "master" are only applied in the PROFIBUS chapter and are used there still.

Controller, Supervisor and drive unit

Table 4-2 Properties of the Controller, Supervisor and drive units

Properties	Controller	Supervisor	Drive unit
As bus node	Active		Passive
Send messages	Permitted without external request		Only possible on request by the Controller
Receive messages	Possible without any restrictions		Only receive and acknowledge permitted

Communication types

4 communication types are defined in the PROFIdrive profile:

- Cyclic data exchange via a cyclic data channel
  Motion control systems require cyclically updated data in operation for open-loop and closed-loop control tasks. This data must be sent to the drive units in the form of setpoints or transmitted from the drive units in the form of actual values, via the communications system. Transmission of this data is usually time-critical.
- Acyclic data exchange via an acyclic data channel
  The PROFIdrive profile also provides an acyclic parameter channel to exchange parameters between the controller – or the supervisor and drive units. Access to this data is not time-critical.
- Alarm channel
  Alarms are output on an event-driven basis, and show the occurrence and expiry of error states.
- Isochronous mode
  - Cyclic data exchange in a fixed time grid
  - The controller and device are synchronized

Interface IF1 and IF2

The CU320-2 Control Unit can communicate via two different interfaces (IF1 and IF2).

You can assign both interfaces to the following physical interfaces (p8839):

- (1) Onboard X126 PROFIBUS / X150 PROFINET
- (2) Communication Board X1400

Table 4-3 Properties of IF1 and IF2

	IF1	IF2
PROFIdrive and SIEMENS telegram	x	-
Free telegram	x	x
Isochronous mode	x	x
Drive object types	All	All

	IF1	IF2
Can be used for	PROFINET IO PROFIBUS DP SINAMICS Link PN Gate Ethernet/IP	PROFINET IO PROFIBUS DP CANopen SINAMICS Link PN Gate Ethernet/IP
Cyclic operation	x	x
PROFIsafe	x	x

Note

For additional information on the IF1 and IF2 interfaces, see Chapter "Parallel operation of communication interfaces (Page 49)" in this manual.

Connecting a PG/PC with the Startdrive commissioning tool

The following connection options are available for Startdrive for commissioning a Control Unit with a PG/PC using a commissioning tool.

- PROFINET
- Ethernet

See also

Security information (Page 15)

4.1 PROFIdrive application classes

There are different application classes for PROFIdrive according to the scope and type of the application processes. PROFIdrive features a total of 6 application classes, the 3 most important are compared here.

- Class 1 (AK1):
  The drive is controlled using a speed setpoint via PROFIBUS/PROFINET. In this case, speed control is fully handled in the drive.
  Typical application examples include simple frequency converters for controlling pumps and fans.
- Class 3 (AK3):
  In addition to the speed control, the drive also includes a positioning control, which means that it operates as an autonomous single-axis positioning drive while the higher-level technological processes are performed in the control system. Positioning requests are transferred to the drive controller via PROFINET (or PROFIBUS) and started.
- Class 4 (AK4):
  This PROFIdrive application class defines a speed setpoint interface, where the speed control is realized in the drive and the closed-loop position control in the control system, such as is required for robotics and machine tool applications with coordinated motion sequences on multiple drives.
  Motion control is primarily implemented using a central numerical controller (NC). The position control loop is closed via the bus, i.e. the communication between the controller and the drive must be isochronous.

Selection of telegrams depending on the PROFIdrive application class

The following Table provides an overview of which telegram can be used reach which PROFIdrive application class:

Table 4-4 Selection of telegrams depending on the PROFIdrive application class

Telegram (p0922 = x)	Description	Class 1	Class 3	Class 4
1	Speed setpoint, 16-bit	x	-	-
2	Speed setpoint, 32-bit	x	-	-
3	Speed setpoint, 32-bit with 1 position encoder	x	-	x
4	Speed setpoint, 32-bit with 2 position encoders	x	-	x
5	Speed setpoint, 32 bit with 1 position encoder and Dynamic Servo Control	-	-	x
6	Speed setpoint, 32 bit with 2 position encoders and Dynamic Servo Control	-	-	x
7	Basic positioner with selection of the traversing block	-	x	-
9	Basic positioner with direct setpoint input (MDI)	-	x	-
20	16-bit speed setpoint for VIK-Namur	x	-	-
81	Standard encoder	-	-	-
82	Standard encoder with speed actual value 16 bit	-	-	-
83	Standard encoder with speed actual value 32 bit	-	-	-
102	Speed setpoint, 32 bit with 1 position encoder and torque reduction	x	-	x

Telegram (p0922 = x)	Description	Class 1	Class 3	Class 4
103	Speed setpoint, 32 bit with 2 position encoders and torque reduction	x	-	x
105	Speed setpoint, 32 bit with 1 position encoder, torque reduction and Dynamic Servo Control	-	-	x
106	Speed setpoint, 32 bit with 2 position encoders, torque reduction and Dynamic Servo Control	-	-	x
110	Basic positioner with direct setpoint input (MDI), override and position actual value	-	x	-
111	Basic positioner with direct setpoint input (MDI), override, position actual value and speed actual value	-	x	-
116	32-bit speed setpoint with 2 position encoders, torque reduction, DSC and additional actual values	-	-	x
118	32-bit speed setpoint with 2 position encoders, torque reduction, DSC, additional actual values and 2 external encoders	-	-	x
125	Dynamic Servo Control with torque precontrol, 1 position encoder (encoder 1)	-	-	x
126	Dynamic Servo Control with torque precontrol, 2 position encoders (encoder 1 and encoder 2)	-	-	x
136	Dynamic Servo Control with torque precontrol, 2 position encoders (encoder 1 and encoder 2), 4 trace signals	-	-	x
138	Dynamic Servo Control with torque precontrol, 2 external position encoders (encoder 2 and encoder 3), 4 trace signals	-	-	x
139	Speed/position control with Dynamic Servo Control and torque precontrol, 1 position encoder, clamping status, additional actual values	-	-	x
146	Closed-loop speed/position control with Dynamic Servo Control and torque precontrol, 2 position encoders (encoder 1 and encoder 2), additional actual values, adaptation parameters	-	-	x
148	Closed-loop speed/position control with Dynamic Servo Control and torque precontrol, 2 external position encoders (encoder 2 and encoder 3), additional actual values, adaptation parameters	-	-	x
149	Speed/position control with Dynamic Servo Control and torque precontrol, 1 position encoder, clamping status, additional actual values, adaptation parameters	-	-	x
166	Hydraulic axis (HLA) with two encoder channels and HLA additional signals	-	-	-
220	Speed setpoint, 32 bit, metal industry	x	-	-
352	16-bit speed setpoint for PCS7	x	-	-
370	Infeed	-	-	-
371	Infeed, metal industry	-	-	-
390	Control Unit with digital inputs DI 0 … DI 15 and digital outputs DO 8 … DO 15	-	-	-
391	Control Unit with digital inputs DI 0 … DI 15, DO 8 … DO 15 and 2 probes	-	-	-
392	Control Unit with digital inputs DI 0 … DI 15, digital outputs DO 8 … DO 15 and 6 probes	-	-	-

Telegram (p0922 = x)	Description	Class 1	Class 3	Class 4
393	Control Unit with digital inputs DI 0 … DI 22, digital outputs DO 8 … DO 16, 8 probes and analog input	-	-	-
394	Control Unit with digital inputs DI 0 … DI 22 and digital outputs DO 8 … DO 16	-	-	-
395	Control Unit with digital inputs DI 0 … DI 22, digital outputs DO 8 … DO 16 and 16 probes	-	-	-
700	Supplementary PZD-0/3	-	-	-
701	Supplementary PZD-2/5	-	-	-
750	Supplementary PZD-3/1	-	-	-
999	Free interconnection and length	x	x	x

Dynamic Servo Control (DSC)

The PROFIdrive profile contains the "Dynamic Servo Control" control concept. This requires PROFIdrive application class 4 and transfers not only the speed setpoint, but also the KPC position controller gain factor and the XERR system deviation. With the aid of this data, the position controller can be calculated in the drive. The position setpoint interpolation is still performed in the controller. This can be used to significantly increase the dynamic stability/ stiffness of the position control loop in PROFIdrive application class 4.

4.2 Cyclic communication

Cyclic communication is used to exchange time-critical process data (e.g. setpoints and actual values).

4.2.1 PROFIdrive telegrams

The process data (PZD) that is to be transferred is defined through the configuration of the drive unit (Control Unit). From the perspective of the drive unit, the received process data represents the receive words and the process data to be sent the send words.

PROFIdrive telegrams

- Standard telegrams
  The standard telegrams are structured in accordance with the PROFIdrive profile. The drive-internal process data links are set up automatically in accordance with the set telegram number.
  The SINAMICS S120/S150 List Manual contains the standard telegrams in the following function diagrams:
  - 2415 PROFIdrive - Standard telegrams and process data 1
  - 2416 PROFIdrive - Standard telegrams and process data 2
- Manufacturer-specific telegrams
  The manufacturer-specific telegrams are structured in accordance with internal company specifications. The drive-internal process data links are set up automatically in accordance with the set telegram number.
  The SINAMICS S120/S150 List Manual contains the manufacturer-specific telegrams (SIEMENS telegrams) in the following function diagrams:
  - 2419 PROFIdrive - Manufacturer-specific telegrams and process data 1
  - 2420 PROFIdrive - Manufacturer-specific telegrams and process data 2
  - 2421 PROFIdrive - Manufacturer-specific telegrams and process data 3
  - 2422 PROFIdrive - Manufacturer-specific telegrams and process data 4
- Supplementary telegrams
  The SINAMICS S120/S150 List Manual contains supplementary telegrams in the following function diagrams:
  - 2423 PROFIdrive - Manufacturer-specific/free telegrams and process data
- Free telegrams (p0922 = 999)
  The SINAMICS S120/S150 List Manual contains free telegrams in the following function diagrams:
  - 2468 PROFIdrive – IF1 receive telegram, free interconnection via BICO (p0922 = 999)
  - 2470 PROFIdrive – IF1 send telegram, free interconnection via BICO (p0922 = 999)

  The receive and send data can be freely connected using BICO technology.

4.2.2 Process data

Process data

	SERVO, TM41	VECTOR	CU_S	A_INF, B_INF, S_INF	TB30, TM31, TM15DI_DO, TM120, TM150	ENCODER
Receive process data						
DWORD connector output	r2060[0 ... 18]	r2060[0 ... 30]	-	-	-	r2060[0 ... 2]
WORD connector output	r2050[0 ... 19]	r2050[0 ... 31]	r2050[0 ... 19]	r2050[0 ... 9]	r2050[0 ... 4]	r2050[0 ... 3]
Binector output	r2090.0 ... 15 r2091.0 ... 15 r2092.0 ... 15 r2093.0 ... 15			r2090.0 ... 15 r2091.0 ... 15		r2090.0 ... 15 r2091.0 ... 15 r2092.0 ... 15 r2093.0 ... 15
Free connector-binector converter	p2099[0 ... 1] / r2094.0 ... 15, r2095.0 ... 15					
Send process data						
DWORD connector input	p2061[0 ... 26]	p2061[0 ... 30]	-	-	-	p2061[0 ... 10]
WORD connector input	p2051[0 ... 27]	p2051[0 ... 31]	p2051[0 ... 24]	p2051[0 ... 9]	p2051[0 ... 4]	p2051[0 ... 11]
Free binector-connector converter	p2080[0 ... 15], p2081[0 ... 15], p2082[0 ... 15], p2083[0 ... 15], p2084[0...15] / r2089[0 ... 4]					

4.2.3 Telegram interconnections

- The telegram interconnection is made automatically and blocked.
  Telegrams 20, 111, 220, 352 are exceptions. There, in addition to the fixed interconnections, selected process data (PZD) can be interconnected as required in the send/receive telegram.
- When you change p0922 ≠ 999 to p0922 = 999, the previous telegram interconnection is retained. You can now change this telegram interconnection.
- If p0922 = 999, a telegram can be selected in p2079. A telegram interconnection is automatically made and blocked. The telegram can also be extended.
  This is an easy method for creating extended telegram interconnections on the basis of existing telegrams.

4.2.4 The telegram structure

- Parameter p0978 contains the drive objects that use a cyclic PZD exchange. All drive objects after the first zero do not participate in the cyclic exchange.
- If the value 255 is written to p0978, this drive object is visible to the PROFIdrive controller and empty (without actual process data exchange). This permits cyclic communication of a PROFIdrive controller in the following cases:
  - with unchanged configuration to drive units that have a different number of drive objects.
  - with deactivated drive objects, without having to change the project
- One PZD = one word.
- Physical word and double word values are inserted in the telegram as referenced variables.
- p200x apply as reference variables (telegram contents = 4000 hex or 4000 0000 hex in the case of double words if the input variable has the value p200x).

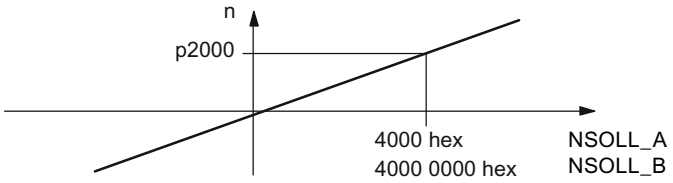


Figure 4-1 Normalization of speed

You can find the detailed structure of the telegrams in the SINAMICS S120/S150 List Manual in the associated function diagrams.

Which drive objects support which telegrams?

Drive object	Telegrams (p0922)	Function diagrams
A_INF	370, 371, 999	2421, 2423
B_INF	370, 371, 999	2421, 2423
S_INF	370, 371, 999	2421, 2423
SERVO	1, 2, 3, 4, 5, 6, 102, 103, 105, 106, 116, 118, 125, 126, 136, 138, 139, 146, 148, 149, 220, 999	2415, 2419, 2420, 2423
SERVO (EPOS)	7, 9, 110, 111, 999	2415, 2423
SERVO (position control)	139, 149, 999	2420, 2423
VECTOR	1, 2, 3, 4, 20, 220, 352, 999	2415, 2416, 2421, 2423
VECTOR (EPOS)	7, 9, 110, 111, 999	2415, 2419, 2423
ENC	81, 82, 83, 999	2416, 2423
TM15DI_DO	No predefined telegram.	-
HLA	166, 999	2415, 2420, 2423
TM31	No predefined telegram.	-
TM41	3, 999	2415, 2423
TM120	No predefined telegram.	-

Drive object	Telegrams (p0922)	Function diagrams
TM150	No predefined telegram.	-
TB30	No predefined telegram.	-
CU_S	390, 391, 392, 393, 394, 395, 999	2422, 2423

4.2.5 Number of process data per drive object

Depending on the drive object, different process data (PZD) can be sent and received:

Drive objects	Maximum number of PZD	
	Send	Receive
A_INF	10	10
B_INF	10	10
S_INF	10	10
SERVO	28	20
VECTOR	32	32
ENC	12	4
TM15DI_DO	5	5
TM31	5	5
TM41	28	20
TM120	5	5
TM150	5	5
TB30	5	5
CU	25	20

4.2.6 Interface Mode

Interface Mode is used for displaying the assignment of the control and status words in line with other drive systems and standardized interfaces.

Interface Mode cannot be set by p2038, but rather by setting the telegrams in p0922:

- When standard telegram 20 is set, the "VIK-NAMUR" Interface Mode is permanently specified (p2038 = 2). This relationship cannot be changed.
- When telegrams 102, 103, 105, 106, 116, 118, 125, 126, 136, 138, 139, 146, 148, 149 and 166 are set, the "SIMODRIVE 611 universal" Interface Mode is permanently specified (p2038 = 1). This relationship cannot be changed.
- When all other telegrams are set, the "SINAMICS" Interface Mode is permanently specified (p2038 = 0). This relationship cannot be changed.

4.2.7 Information about control words and status words

Overview of control words and setpoints

A detailed overview of the control words and setpoints is contained in the SINAMICS S120/ S150 List Manual in the following function diagrams:

- 2439 PROFIdrive - PZD receive signals, profile-specific interconnection
- 2440 PROFIdrive - PZD receive signals, manufacturer-specific interconnection

Overview of status words and actual values

A detailed overview of the status words and actual values is contained in the SINAMICS S120/ S150 List Manual in the following function diagrams:

- 2449 PROFIdrive - PZD send signals, profile-specific interconnection
- 2450 PROFIdrive - PZD send signals, manufacturer-specific interconnection

4.2.8 Examples

4.2.8.1 Examples

Based on the PROFIdrive communication of the encoder interface, the following application examples show:

- The chronological sequence of the communication
- The chronological changes to the control and status words
- The mutual dependencies of these changes

Examples:

- Example: Encoder interface (Page 43)
- Example: Find reference mark (Page 44)
- Example: Flying measurement (Page 45)

4.2.8.2 Example: Encoder interface

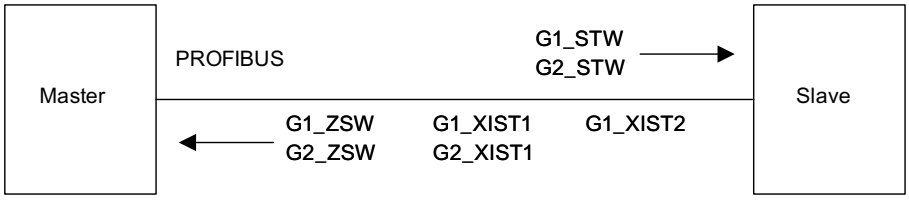
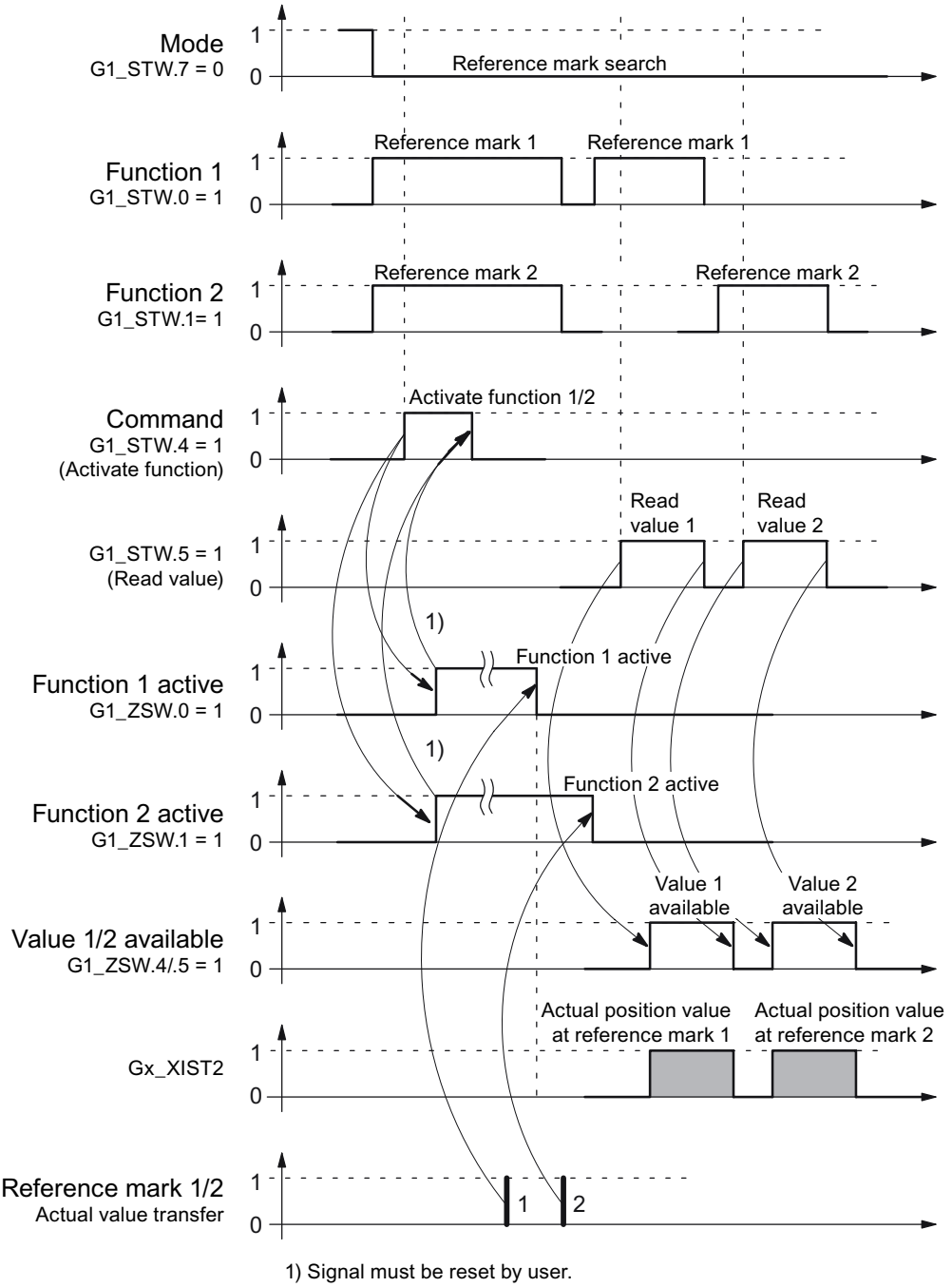


Figure 4-2 Example of encoder interface (encoder 1: Two actual values, encoder 2: One actual value)

4.2.8.3 Example: Find reference mark

Assumptions for the example:

- Distance-coded reference mark
- Two reference marks (function 1 / function 2)
- Position control with encoder 1



1) Signal must be reset by user.

Figure 4-3 Sequence chart for "Find reference mark"

4.2.8.4 Example: Flying measurement

Assumptions for the example:

- Measuring probe with rising edge (function 1)
- Position control with encoder 1

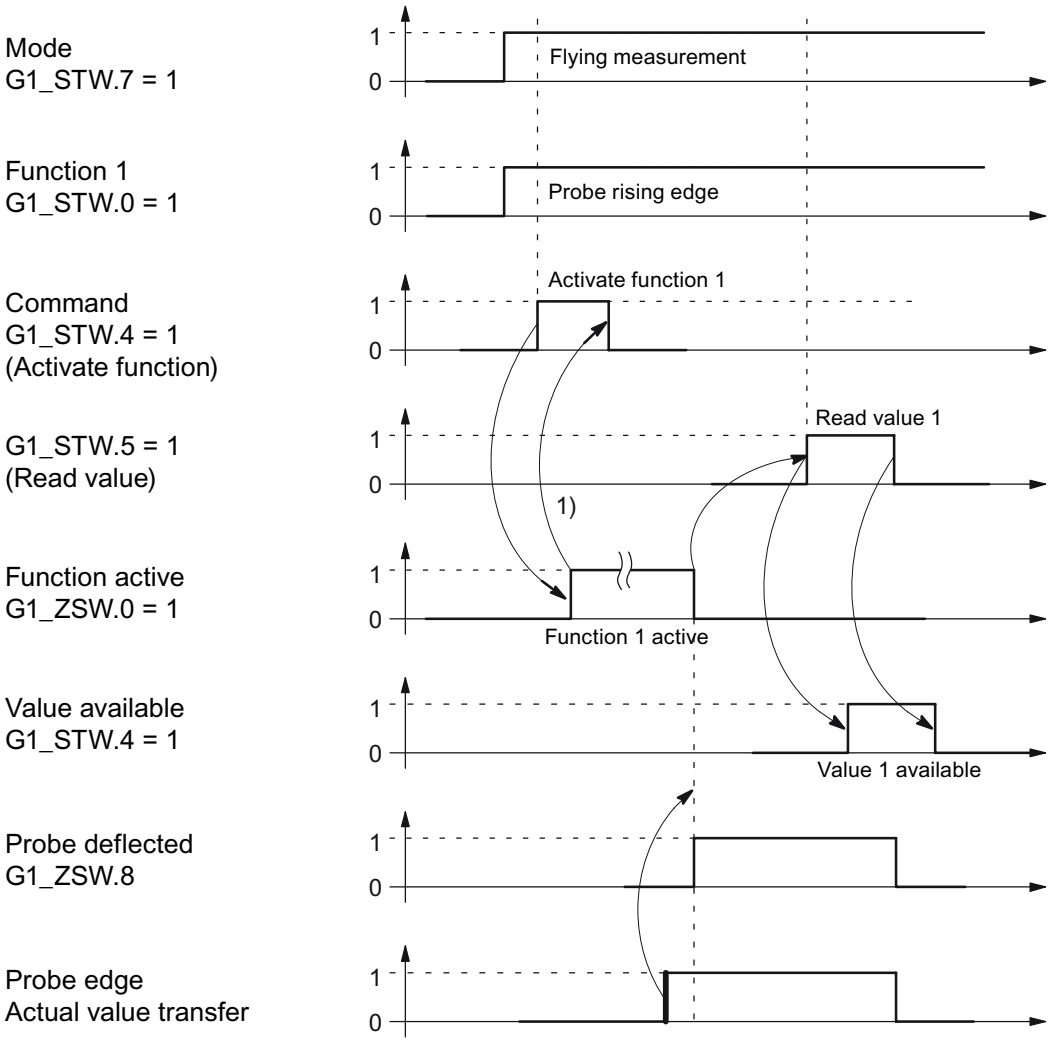


Figure 4-4 Sequence chart for "Flying measurement"

4.2.9 Motion control with PROFIdrive

An isochronous drive coupling can be established between the control and device using the "Motion control with PROFIdrive" function.

Note

The isochronous drive coupling is defined in the following documentation:
PROFIdrive Profile Drive Technology

PROFIBUS User Organization e. V.
Haid-und-Neu-Straße 7, D-76131 Karlsruhe,
Internet: (http://www.profibus.com)

Properties

- No additional parameters need to be entered in addition to the bus configuration in order to activate this function, the master and slave must only be preset for this function (PROFIBUS).
- The controller-side default setting is made via the hardware configuration, e.g. HW Config with SIMATIC S7. The device-side default setting is made using the parameterization telegram when the bus ramps up.
- Fixed sampling times are used for all data communication.
- The Global Control (GC) clock information on PROFIBUS is sent before the beginning of each cycle.
- The cycle length depends on the bus configuration. When the cycle is selected, the bus configuration tool (e.g. HW Config) supports:
  - Large number of drives per device/drive unit → longer cycle
  - Large number of devices/ drive units → longer cycle
- A sign-of-life counter is used to monitor user data transfer and clock pulse failures.

More information

- Overview of closed-loop control (Page 47)
- Structure of the data cycle (Page 48)
- Overview of important parameters (Page 48)

4.2.9.1 Overview of closed-loop control

- Position actual value sensing in the device is alternatively realized using an:
  - Indirect measuring system (motor encoder)
  - Additional direct measuring system
- The encoder interface must be configured in the process data.
- The control loop is closed via PROFIBUS.
- The position controller is located in the controller.
- The current and speed control and actual value sensing (encoder interface) are located in the device.
- The position controller cycle is transferred via the fieldbus to the devices.
- The slaves synchronize their speed and/or current controller sampling time with the position controller clock cycle of the controller.
- The speed setpoint is specified by the controller.

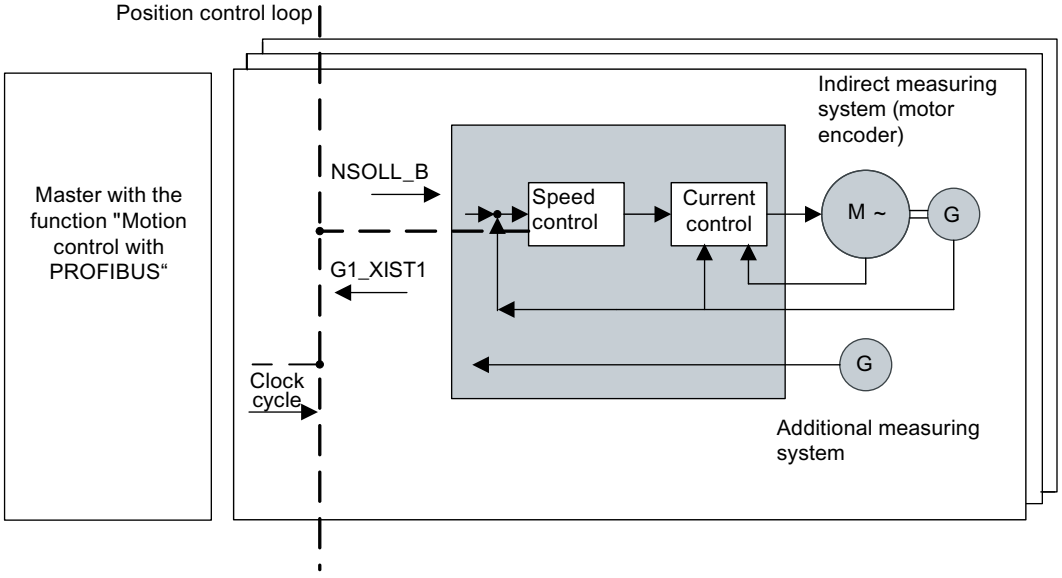


Figure 4-5 Overview of "Motion Control with PROFIBUS" (example: controller and 3 devices)

4.2.9.2 Structure of the data cycle

The data cycle comprises the following elements:

- Global control telegram (PROFIBUS only)
- Cyclic part - setpoints and actual values
- Acyclic part - parameters and diagnostic data
- Reserve (PROFIBUS only)
  - Token passing (Token Holding Time, TTH)
  - For searching for a new node in the drive line-up (GAP)
  - Waiting time until start of the next cycle

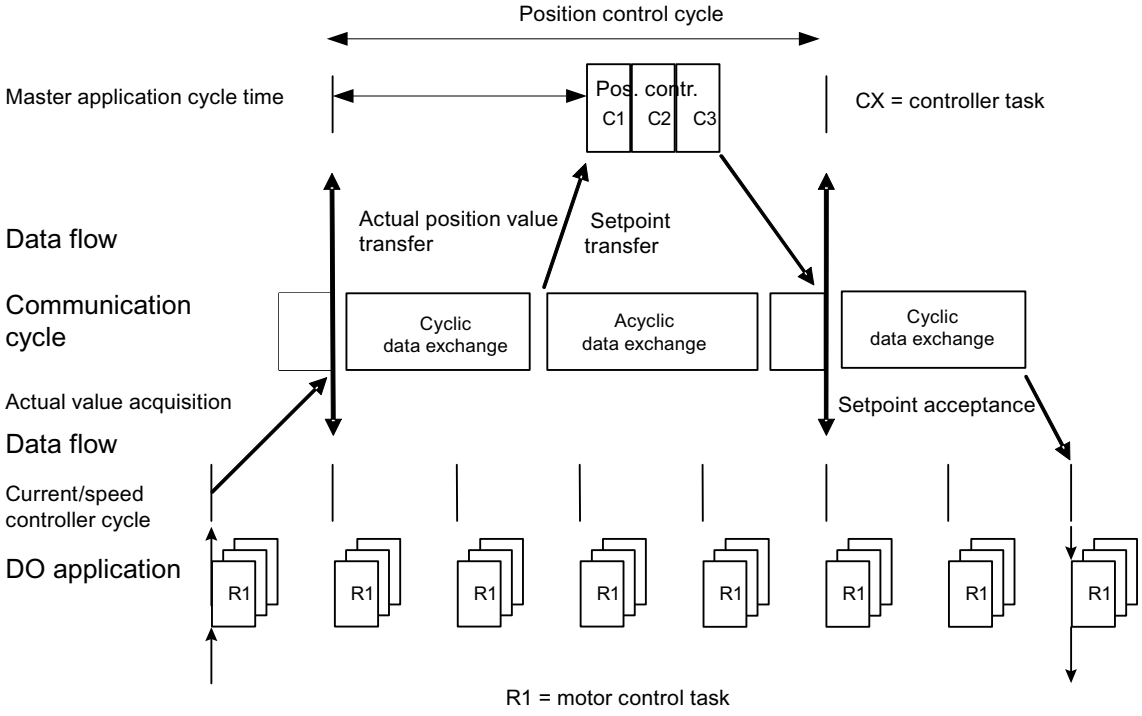


Figure 4-6 Isochronous drive coupling / motion control with PROFIdrive

4.2.9.3 Overview of important parameters

Overview of important parameters (see SINAMICS S120/S150 List Manual)

- p0922 IF1 PROFIdrive PZD telegram selection
- p0978[0...n] List of drive objects
- p8815[0...1] IF1/IF2 PZD functionality selection
- p8839[0...1] PZD interface hardware assignment

4.3 Parallel operation of communication interfaces

The two cyclic interfaces for the setpoints and actual values differ by the parameter ranges used (BICO technology etc.) and the functions that can be used. The interfaces are designated as cyclic interface 1 (IF1) and cyclic interface 2 (IF2).

Cyclic process data (setpoints / actual values) are processed using interfaces IF1 and IF2. The following interfaces are used:

- Onboard interfaces of the Control Unit for PROFIBUS DP or PROFINET.
- An optional interface (COMM BOARD) for PROFINET (CBE20) or CANopen (CBC10) for insertion in the Control Unit.

Parameter p8839 is used to set the parallel use of the Control Unit onboard interfaces and COMM - BOARD in the SINAMICS system. The functionality is assigned to interfaces IF1 and IF2 using indices.

For example, the following applications are possible:

- PROFIBUS DP for control and PROFINET to acquire actual values / measured values of the drive
- PROFIBUS DP for control and PROFINET for engineering only
- Mixed mode with two masters (the first for logic and coordination and the second for technology)
- SINAMICS Link via IF2 (CBE20); standard telegrams and PROFIsafe via IF1
- Operation of redundant communication interfaces

Assignment of communication interfaces to cyclic interfaces

With the factory setting p8839 = 99, the communication interfaces are permanently assigned one of the cyclic interfaces (IF1, IF2), depending on the communication system, e.g. PROFIBUS DP, PROFINET or CANopen.

The assignment to the cyclic interfaces can essentially be freely defined by user parameterization for the parallel operation of the communication interfaces.

More information

- Properties of the cyclic interfaces IF1 and IF2 (Page 50)
- Assigning the hardware for cyclic communication (Page 51)

4.3.1 Properties of the cyclic interfaces IF1 and IF2

Table 4-5 Properties of the cyclic interfaces IF1 and IF2

Feature	IF1	IF2
Setpoint (BICO signal source)	r2050, r2060	r8850, r8860
Actual value (BICO signal sink)	p2051, p2061	p8851, p8861

Table 4-6 Implicit assignment of hardware to the cyclic interfaces for p8839[0] = p8839[1] = 99

Plugged hardware interface	IF1	IF2
No option, only use Control Unit onboard interface (PROFIBUS, PROFINET or USS)	Control Unit onboard	--
CU320-2 DP with CBE20 (optional PROFINET interface)	COMM BOARD	Control Unit onboard PROFIBUS or Control Unit onboard USS
CU320-2 PN with CBE20 (optional PROFINET interface)	Control Unit onboard PROFINET	COMM BOARD PROFINET
CAN option CBC10	Control Unit onboard	COMM BOARD CAN

Parameter p8839[0,1] is used to set the parallel operation of the hardware interfaces and the assignment to the cyclic interfaces IF1 and IF2 for the Control Unit drive object.

The sequence of objects is in line with p0978 (list of drive objects) for both interfaces.

The factory setting of p8839[0,1] = 99 enables the implicit assignment (see table above).

An alarm is generated in case of invalid or inconsistent parameterization of the assignment.

Parallel operation of PROFIBUS and PROFINET

Either the isochronous mode or the PROFIsafe functionality can be assigned to an interface via p8815 (IF1 or IF2).

Example:

- p8815[0] = 1: IF1 supports the isochronous mode
- p8815[1] = 2: IF2 supports PROFIsafe

Additional parameter assignment options are possible if additionally the PROFINET module CBE20 is inserted in the CU320-2 DP:

- p8839[0] = 1 and p8839[1] = 2: PROFIBUS isochronous, PROFINET cyclic
- p8839[0] = 2 and p8839[1] = 1: PROFINET isochronous, PROFIBUS cyclic

Parameters for IF2

The following parameters are available in order to tune the IF2 for a PROFIBUS or PROFINET interface:

- Receive and send process data:
  r8850, p8851, r8853, r8860, p8861, r8863[1)]
- Diagnostic parameters:
  r8874, r8875, r8876[1)]
- Binector-connector converters:
  p8880, p8881, p8882, p8883, p8884, r8889[1)]
- Connector-binector converters:
  r8894, r8895, p8898, p8899[1)]

[1)] Meaning of 88xx is identical to 20xx (for IF1)

Note

Using the HW Config configuration tool, a PROFIBUS slave / PROFINET device with two interfaces cannot be shown. In parallel operation, this is the reason that SINAMICS drive appears twice in the project or in two projects, although physically it is just one device.

4.3.2 Assigning the hardware for cyclic communication

Use parameter p8839 to allocate the hardware for the cyclic communication:

p8839	PZD interface hardware assignment
Description:	Assigning the hardware for cyclic communication via PZD interface 1 and interface 2.
Values:	0: Inactive
	1: Control Unit onboard
	2: COMM BOARD
	99: Automatic

For p8839, the following rules apply:

- The setting of p8839 applies for all drive objects of a Control Unit (device parameter).
- For the setting p8839[0] = 99 and p8839[1] = 99 (automatic assignment, factory setting), the hardware used is automatically assigned to interfaces IF1 and IF2. Both indices must be selected so that the automatic assignment is activated. If both indices are not selected, then an alarm is output and the setting p8839[x] = 99 is treated just like 'inactive'.
- An alarm is issued if the same hardware (Control Unit onboard or COMM BOARD) is selected in p8839[0] and p8839[1]. The following then applies: The setting of p8839[0] is valid, and the setting of p8839[1] is treated like 'inactive'.
- If the CAN board (CBC10) is used, the entry of p8839[0] = 2 is not permissible (no assignment of the CAN board to IF1). An alarm is then issued.
- If p8839[x] is set to 2, and the COMM BOARD is missing or defective, then the corresponding interface is not supplied from the Control Unit onboard interface. Message A08550 is output instead.

4.4 Acyclic communication

4.4.1 General information about acyclic communication

With acyclic communication, as opposed to cyclic communication, data transfer takes place only when an explicit request is made (e.g. in order to read and write parameters).

The "Read data record" and "Write data record" services are available for acyclic communication.

The following options are available for reading and writing parameters:

- S7 protocol
  This protocol uses the Startdrive commissioning tool in online operation via PROFIBUS/ PROFINET.
- PROFIdrive parameter channel with the following data sets:
  - PROFIBUS: Data block 47 (0x002F)
    The DPV1 services are available for master class 1 and class 2.
  - PROFINET: Data block 47 and 0xB02F al global access, data set 0xB02E as local access

Note

A detailed description of acyclic communication is provided in the following reference:

- References: PROFIdrive profile
  You can obtain the current version from "PROFIBUS and PROFINET International (PI) (https://www.profibus.com/download/profidrive-profile-drive-technology/)".

Addressing:

- PROFIBUS DP
  The addressing is carried out via the logical address or the diagnostics address.
- PROFINET IO
  The addressing is only undertaken using a diagnostics address which is assigned to a module as of slot 1. Parameters cannot be accessed via socket 0.

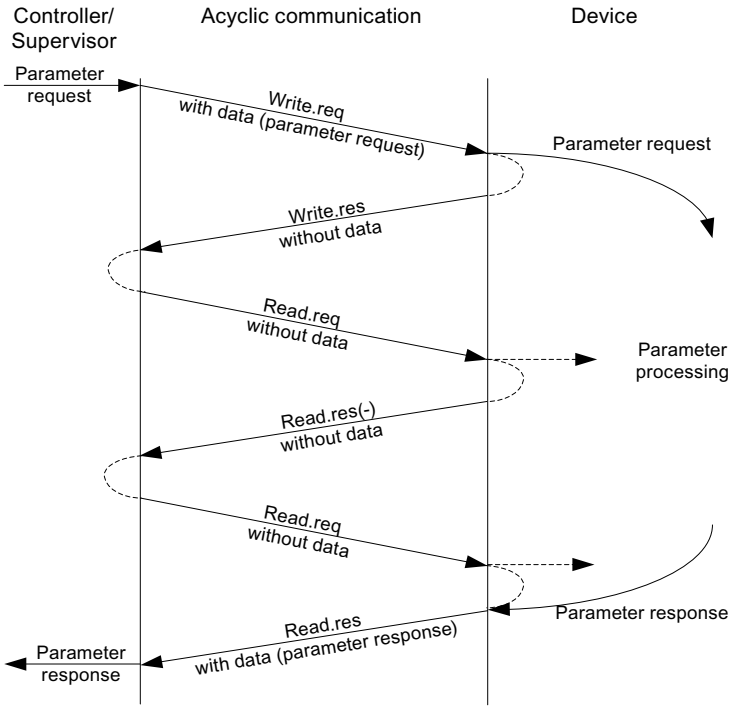


Figure 4-7 Reading and writing data

Characteristics of the parameter channel

- One 16-bit address exists for each parameter number and subindex.
- Concurrent access by several additional PROFIBUS masters (master class 2) or PROFINET IO supervisor (e.g. commissioning tool).
- Transfer of different parameters in one access (multiple parameter request).
- Transfer of complete arrays or part of an array possible.
- Only one parameter request is processed at a time for each controller/device connection (no pipelining).
- A parameter request/response must fit into a data set (e.g. PROFIBUS: Max. 240 bytes).
- The request or the response header is user data.

4.4.2 Structure of requests and responses

Structure of parameter request and parameter response

	Parameter request			**Offset**
Values for write access only	Request header	Request reference	Request ID	0
		Axis	Number of parameters	2
	1st parameter address	Attribute	Number of elements	4
		Parameter number		6
		Subindex		8
	...			
	nth parameter address	Attribute	Number of elements	
		Parameter number		
		Subindex		
	1st parameter value(s)	Format	Number of values	
		Values		
		...		
	...			
	nth parameter value(s)	Format	Number of values	
		Values		
		...		

	Parameter response			Offset
Values for read access only Error values for negative response only	Response header	Request reference mirrored	Response ID	0
		Axis mirrored	Number of parameters	2
	1st parameter value(s)	Format	Number of values	4
		Values or error values		6
		...		
	...			
	nth parameter value(s)	Format	Number of values	
		Values or error values		
		...		

Description of fields in the parameter request and response

Field	Data type	Values	Remark
Request reference	Unsigned8	0x01 ... 0xFF	
	Unique identification of the request/response pair for the controller. The controller changes the request reference with each new request. The device mirrors the request reference in its response.		
Request ID	Unsigned8	0x01 0x02	Read request Write request
	Specifies the type of request. In the case of a write request, the changes are made in a volatile memory (RAM). A save operation is needed in order to transfer the modified data to the non-volatile memory (p0971, p0977).		
Response ID	Unsigned8	0x01 0x02 0x81 0x82	Read request (+) Write request (+) Read request (-) Write request (-)
	Mirrors the request identifier and specifies whether request execution was positive or negative. Negative means: Cannot execute part or all of request. The error values are transferred instead of the values for each subresponse.		
Drive object number	Unsigned8	0x01 ... 0xFE	Number
	Specification of the drive object number for a drive unit with more than one drive object. Different drive objects with separate parameter number ranges can be accessed over the same DPV1 connection.		
Number of parameters	Unsigned8	0x01 ... 0x27	No. 1 ... 39 Limited by DPV1 telegram length
	Defines the number of adjoining areas for the parameter address and/or parameter value for multi-parameter requests. The number of parameters = 1 for single requests.		
Attribute	Unsigned8	0x10 0x20 0x30	Value Description Text (not implemented)
	Type of parameter element accessed.		

Field	Data type	Values	Remark
Number of elements	Unsigned8	0x00 0x01 ... 0x75	Special function No. 1 ... 117 Limited by DPV1 telegram length
	Number of array elements accessed.		
Parameter number	Unsigned16	0x0001 ... 0xFFFF	No. 1 ... 65535
	Addresses the parameter to be accessed.		
Subindex	Unsigned16	0x0000 ... 0xFFFE	Number 0 ... 65534
	Addresses the first array element of the parameter to be accessed.		
Format	Unsigned8	0x02 0x03 0x04 0x05 0x06 0x07 0x08 Other values	Data type integer8 Data type integer16 Data type integer32 Data type unsigned8 Data type unsigned16 Data type unsigned32 Data type floating point See the actual PROFIdrive profile
		0x40 0x41 0x42 0x43 0x44	Zero (without values as a positive subresponse to a write request) Byte Word Double word Error
	The format and number specify the adjoining space containing values in the telegram. For write access, it is preferable to specify data types according to the PROFIdrive profile. Bytes, words and double words are also possible as a substitute.		
Number of values	Unsigned8	0x00 ... 0xEA	No. 0 ... 234 Limited by DPV1 telegram length
	Specifies the number of subsequent values.		
Error values	Unsigned16	0x0000 ... 0x00FF	Significance of the error values → refer to the following table "Error values in the DPV1 parameter responses"
	The error values in the event of a negative response. If the values make up an odd number of bytes, a zero byte is attached. This ensures the integrity of the word structure of the telegram.		
Values	Unsigned16	0x0000 ... 0x00FF	
	The values of the parameter for read or write access. If the number of bytes is odd, a zero byte is appended. This ensures the integrity of the word structure of the telegram.		

Error values in parameter responses

Error value	Meaning	Remark	Additional info
0x00	Illegal parameter number.	Access to a parameter that does not exist.	–
0x01	Parameter value cannot be changed.	Modification access to a parameter value that cannot be changed.	Subindex
0x02	Lower or upper value limit exceeded.	Modification access with value outside value limits.	Subindex

Error value	Meaning	Remark	Additional info
0x03	Invalid subindex.	Access to a subindex that does not exist.	Subindex
0x04	No array.	Access with subindex to an unindexed parameter.	–
0x05	Wrong data type.	Modification access with a value that does not match the data type of the parameter.	–
0x06	Illegal set operation (only reset allowed).	Modification access with a value not equal to 0 in a case where this is not allowed.	Subindex
0x07	Description element cannot be changed.	Modification access to a description element that cannot be changed.	Subindex
0x09	No description data available.	Access to a description that does not exist (the parameter value exists).	–
0x10	Read job will not be executed.	The read request is refused because know-how protection is active.	
0x0B	No operating priority.	Modification access with no operating priority.	–
0x0F	No text array exists.	Access to a text array that does not exist (the parameter value exists).	–
0x11	Request cannot be executed due to operating status.	Access is temporarily not possible for unspecified reasons.	–
0x14	Illegal value.	Modification access with a value that is within the limits but is illegal for other permanent reasons (parameter with defined individual values).	Subindex
0x15	Response too long.	The length of the present response exceeds the maximum transfer length.	–
0x16	Illegal parameter address.	Illegal or unsupported value for attribute, number of elements, parameter number, subindex or a combination of these.	–
0x17	Illegal format.	Write request: Illegal or unsupported parameter data format.	–
0x18	Number of values inconsistent.	Write request: A mismatch exists between the number of values in the parameter data and the number of elements in the parameter address.	–
0x19	Drive object does not exist.	You have attempted to access a drive object that does not exist.	–
0x20	Parameter text cannot be changed	–	–
0x21	Service not supported.	Illegal or unknown request ID	–
0x65	Parameter presently deactivated.	You have tried to access a parameter that, although available, does not currently perform a function (e.g. n control set and access to a V/f control parameter).	–
0x6B	Write access for enabled controller.	Write access is possible while the device is in the "Controller enable" state. Pay attention to the parameter attribute "changeable" in the SINAMICS S120/S150 List Manual (C1, C2, U, T).	–
0x6C	Parameter %s [%s]: Unknown unit.	–	–
0x6D	Parameter %s [%s]: Write access only in the commissioning state, encoder (p0010 = 4).	–	–
0x6E	Parameter %s [%s]: Write access only in the commissioning state, motor (p0010 = 3).	–	–

Error value	Meaning	Remark	Additional info
0x6F	Parameter %s [%s]: Write access only in the commissioning state, power unit (p0010 = 2).	–	–
0x70	Parameter %s [%s]: Write access only in the quick commissioning mode (p0010 = 1).	–	–
0x71	Parameter %s [%s]: Write access only in the ready mode (p0010 = 0).	–	–
0x72	Parameter %s [%s]: Write access only in the commissioning state, parameter reset (p0010 = 30).	–	–
0x73	Parameter %s [%s]: Write access only in the commissioning state, Safety (p0010 = 95).	–	–
0x74	Parameter %s [%s]: Write access only in the commissioning state, tech. application/units (p0010 = 5).	–	–
0x75	Parameter %s [%s]: Write access only in the commissioning state (p0010 not equal to 0).	–	–
0x76	Parameter %s [%s]: Write access only in the commissioning state, download (p0010 = 29).	–	–
0x77	Parameter %s [%s] must not be written during download.	–	–
0x78	Parameter %s [%s]: Write access only in the commissioning state, drive configuration (device: p0009 = 3).	–	–
0x79	Parameter %s [%s]: Write access only in the commissioning state, define drive type (device: p0009 = 2).	–	–
0x7A	Parameter %s [%s]: Write access only in the commissioning state, data record base configuration (device: p0009 = 4).	–	–
0x7B	Parameter %s [%s]: Write access only in the commissioning state, device configuration (device: p0009 = 1).	–	–
0x7C	Parameter %s [%s]: Write access only in the commissioning state, device download (device: p0009 = 29).	–	–
0x7D	Parameter %s [%s]: Write access only in the commissioning state, device parameter reset (device: p0009 = 30).	–	–
0x7E	Parameter %s [%s]: Write access only in the commissioning state, device ready (device: p0009 = 0).	–	–

Error value	Meaning	Remark	Additional info
0x7F	Parameter %s [%s]: Write access only in the commissioning state, device (device: p0009 not equal to 0).	–	–
0x81	Parameter %s [%s] must not be written during download.	–	–
0x82	Transfer of master control is blocked by BI: p0806.	–	–
0x83	Parameter %s [%s]: Requested BICO interconnection not possible.	BICO output does not supply float values. The BICO input, however, requires a float value.	–
0x84	Parameter %s [%s]: Parameter change inhibited (refer to p0300, p0400, p0922)	–	–
0x85	Parameter %s [%s]: Access method not defined.	–	–
0x87	Write job will not be executed.	The write request is rejected because know-how protection is active.	–
0xC8	Below currently valid limit.	Modification request for a value that, although within "absolute" limits, is below the currently valid lower limit.	–
0xC9	Above currently valid limit.	Modification request for a value that, although within "absolute" limits, is above the currently valid upper limit (e.g. governed by the current converter rating).	–
0xCC	Write access not permitted.	Write access is not permitted because an access code is not available.	–

4.4.3 Determining the drive object numbers

Further information about the drive system (e.g. drive object numbers) can be determined as follows using parameters p0101, r0102, and p0107/r0107:

1. The value of parameter r0102 ("Number of drive objects") for drive object/axis 1 is read via a read request.
   Drive object 1 is the Control Unit (CU) which is a minimum requirement for each drive system.
2. Depending on the result of the initial read request, further read requests for drive object 1 are used to read the indices for parameter p0101 "Drive object numbers", as specified by parameter r0102.
   Example:
   If the number of drive objects is "5", the values of indices 0 to 4 of parameter p0101 are read.
   Of course, the relevant indexes can also be read at once.
3. Following this, parameter r0107/p0107 ("Drive object type") is read for each drive object/axis (indicated by the drive object number).
   Depending on the drive object, parameter 107 can be either an adjustable parameter or a display parameter.
   The value in parameter r0107/p0107 indicates the drive object type. The coding for the drive object type is specified in the parameter list.

4.4.4 Example 1: read parameters

Requirements

- The PROFIdrive controller has been commissioned and is fully operational.
- PROFIdrive communication between the controller and the device is operational.
- The controller can read and write data sets in conformance with PROFINET/PROFIBUS.

Task description

Following the occurrence of at least one fault (ZSW1.3 = "1") on drive 2 (also drive object number 2), the active fault codes must be read from the fault buffer r0945[0] ... r0945[7].

The request is to be handled using a request and response data block.

Basic procedure

1. Create a request to read the parameters.
2. Invoke the request.
3. Evaluate the response.

Create the request

Parameter request			Offset
Request header	Request reference = 25 hex	Request ID = 01 hex	0 + 1
	Axis = 02 hex	Number of parameters = 01 hex	2 + 3
Parameter address	Attribute = 10 hex	Number of elements = 08 hex	4 + 5
	Parameter no. = 945 dec		6
	Subindex = 0 dec		8

Information about the parameter request:

- Request reference:
  The value is selected at random from the valid value range. The request reference establishes the relationship between request and response.
- Request ID:
  01 hex → This identifier is required for a read request.
- Axis:
  02 hex → Drive 2, fault buffer with drive- and device-specific faults.
- Number of parameters:
  01 hex → One parameter is read.
- Attribute:
  10 hex → The parameter values are read.
- Number of elements:
  08 hex → The actual fault incident with eight faults is to be read.

- Parameter number:
  945 dec → p0945 (fault code) is read.
- Subindex:
  0 dec → Reading starts at index 0.

Initiate parameter request.

If ZSW1.3 = "1" → Initiate parameter request

Evaluate the parameter response.

Parameter response			Offset
Response header	Request reference mirrored = 25 hex	Response ID = 01 hex	0 + 1
	Axis mirrored = 02 hex	Number of parameters = 01 hex	2 + 3
Parameter value	Format = 06 hex	Number of values = 08 hex	4 + 5
	1st value = 1355 dec		6
	2nd value = 0 dec		8
	...		...
	8th value = 0 dec		20

Information about the parameter response:

- Request reference mirrored:
  This response belongs to the request with request reference 25.
- Response ID:
  01 hex → Read request positive, values stored as of 1st value.
- Axis mirrored, number of parameters:
  The values correspond to the values from the request.
- Format:
  06 hex → Parameter values are in the unsigned16 format.
- Number of values:
  08 hex → Eight parameter values are available.
- 1st value ... 8th value
  A fault is only entered in value 1 of the fault buffer for drive 2.

4.4.5 Example 2: Writing parameters (multi-parameter request)

Requirements

- The PROFIdrive controller has been commissioned and is fully operational.
- PROFIdrive communication between the controller and the device is operational.

- The controller can read and write data sets in conformance with PROFINET/PROFIBUS.
- Special requirements for this example:
  Servo control or vector control with activated "Extended setpoint channel" function module

Task description

Jog 1 and 2 are to be set up for drive 2 (also drive object number 2) via the input terminals of the Control Unit. A parameter request is to be used to write the corresponding parameters as follows:

- BI: p1055 = r0722.4 — Jog bit 0
- BI: p1056 = r0722.5 — Jog bit 1
- p1058 = 300 rpm — Jog 1 speed setpoint
- p1059 = 600 rpm — Jog 2 speed setpoint

The request is to be handled using a request and response data block.

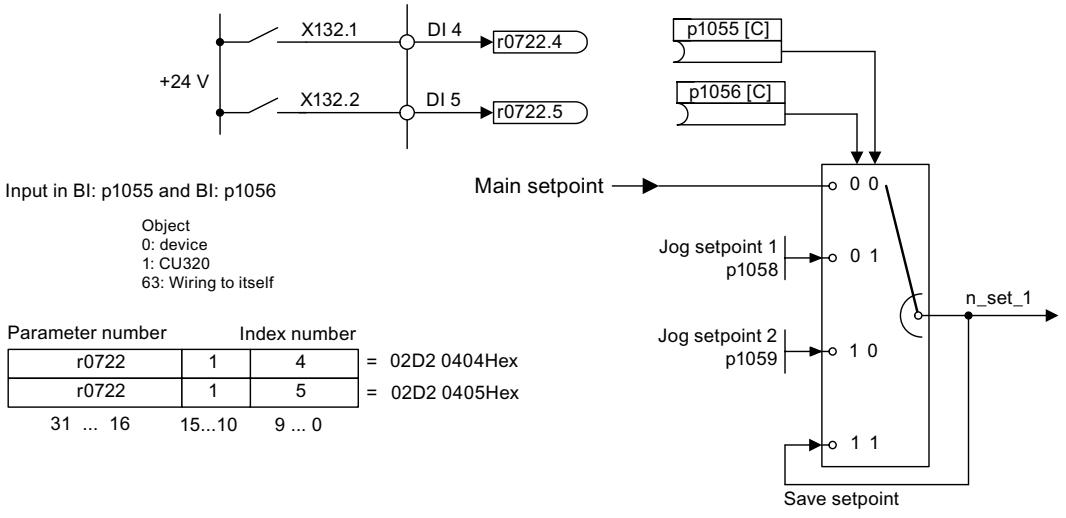


Figure 4-8 Task description for multi-parameter request (example)

Basic procedure

1. Create a request to write the parameters.
2. Invoke the request.
3. Evaluate the response.

Create the request

Parameter request			Offset
Request header	Request reference = 40 hex	Request ID = 02 hex	0 + 1
	Axis = 02 hex	Number of parameters = 04 hex	2 + 3

Parameter request			Offset
1st parameter address	Attribute = 10 hex	Number of elements = 01 hex	4 + 5
	Parameter no. = 1055 dec		6
	Subindex = 0 dec		8
2nd parameter address	Attribute = 10 hex	Number of elements = 01 hex	10 + 11
	Parameter no. = 1056 dec		12
	Subindex = 0 dec		14
3rd parameter address	Attribute = 10 hex	Number of elements = 01 hex	16 + 17
	Parameter no. = 1058 dec		18
	Subindex = 0 dec		20
4th parameter address	Attribute = 10 hex	Number of elements = 01 hex	22 + 23
	Parameter no. = 1059 dec		24
	Subindex = 0 dec		26
1st parameter value(s)	Format = 07 hex	Number of values = 01 hex	28 + 29
	Value = 02D2 hex		30
	Value = 0404 hex		32
2nd parameter value(s)	Format = 07 hex	Number of values = 01 hex	34 + 35
	Value = 02D2 hex		36
	Value = 0405 hex		38
3rd parameter value(s)	Format = 08 hex	Number of values = 01 hex	40 + 41
	Value = 4396 hex		42
	Value = 0000 hex		44
4th parameter value(s)	Format = 08 hex	Number of values = 01 hex	46 + 47
	Value = 4416 hex		48
	Value = 0000 hex		50

Information about the parameter request:

- Request reference:
  The value is selected at random from the valid value range. The request reference establishes the relationship between request and response.
- Request ID:
  02 hex → This identifier is required for a write request.
- Axis:
  02 hex → The parameters are written to drive 2.
- Number of parameters
  04 hex → The multi-parameter request comprises four individual parameter requests.

1st parameter address ... 4. Parameter address

- Attribute:
  10 hex → The parameter values are to be written.
- Number of elements
  01 hex → One array element is written.

- Parameter number
  Specifies the number of the parameter to be written (p1055, p1056, p1058, p1059).
- Subindex:
  0 dec → ID of the first array element.

1st parameter value ... 4th Parameter value

- Format:
  07 hex → Data type, unsigned32
  08 hex → Data type, floating point
- Number of values:
  01 hex → A value is written to each parameter in the specified format.
- Value:
  BICO input parameter: Enter signal source
  Adjustable parameter: Enter value

Initiate parameter request.

If ZSW1.3 = "1" → Initiate parameter request

Evaluate the parameter response.

Parameter response			Offset
Response header	Request reference mirrored = 40 hex	Response ID = 02 hex	0
	Axis mirrored = 02 hex	Number of parameters = 04 hex	2

Information about the parameter response:

- Request reference mirrored:
  This response belongs to the request with request reference 40.
- Response ID:
  02 hex → Write request positive
- Axis mirrored:
  02 hex → The value matches the value from the request.
- Number of parameters:
  04 hex → The value matches the value from the request.

4.5 Diagnostics channels

SINAMICS drives provide the standard diagnostics for PROFIBUS and PROFINET. This allows the PROFIdrive classes of the SINAMICS drive to be integrated into the system diagnostics of a higher-level control system and automatically displayed on an HMI.

The information transferred is saved for the drive objects in the following parameters:

- r0947[0...63] fault number
- r2122[0...63] alarm code
- r9747[0...63] SI message code (with safety messages)
- r3120[0..63] component fault
- r3121[0..63] component alarm
- r9745[0..63] SI component (with safety message)

The messages entered in these parameters are combined to create PROFIdrive message classes for diagnostics. Determining the source of a message is realized by transferring the component number as channel number.

The diagnostics are activated through appropriate parameterization in the configuring tools used (e.g. using HW Config or via HWCN in the TIA Portal).

The functional scope of the diagnostic channels depends on the bus system.

		PROFIdrive message classes		
		Faults	Alarms	Component assignment
PN	GSDML	X	X	X
	TIA	X	X	X
DP	GSD	X	-	-
	TIA	X	-	-

- SINAMICS transfers the messages in the sequence in which they occurred.
- If an alarm appears, SINAMICS sends an "incoming" message. The alarm remains until SINAMICS sends the corresponding "outgoing" message.
- The time stamps are generated from the higher-level controller when the messages are received
- The existing mechanisms of TIA and S7 Classic can be used.
- Alarms or faults are acknowledged using the already known acknowledgment routes.
- Transfer is possible via interface IF1 and/or IF2.

Note

Constraint

If a shared device is activated, only the A-controller can receive diagnostics.

Note

Additional information

PROFIdrive message classes of the individual SINAMICS faults and alarms are provided in the SINAMICS List Manuals.

4.5.1 PROFINET-based diagnostics

For PROFINET, to transfer PROFIdrive message classes, channel diagnostics (Channel Diagnosis) are used (see PROFINET IO specification (http://www.profibus.com)).

A message always comprises the following components in this specific sequence:

- Block Header (6 Byte)
  - Blocktype
  - Blocklength
  - BlockversionHigh
  - BlockversionLow
- API (4 Byte)
- Slot Number (2 Byte)
- Sub Slot Number (2 Byte)
- Channel Number (2 Byte)
- Channel Properties (0x8000) (2 Byte)
- User Structure Identifier (2 Byte)
- Channel Diagnosis Data (6 Byte)
  - Channel Number (2 Byte)
  - Channel Properties (2 Byte)
  - Channel Error Type (2 Byte)

More information

- Message components (Page 67)
- System response - reading out diagnostics data (Page 69)

4.5.1.1 Message components

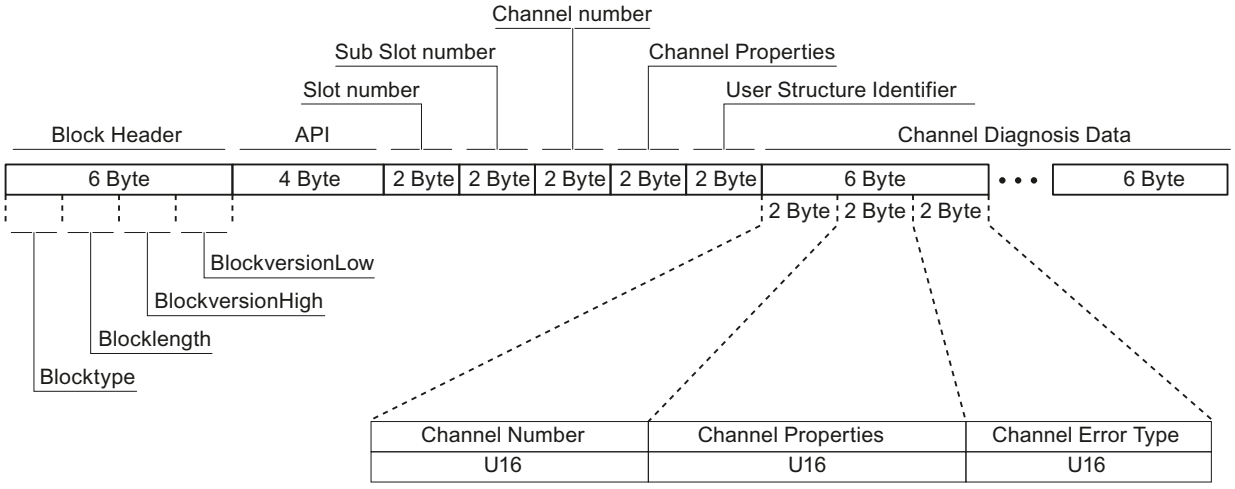


Figure 4-9 Components of a message

Explanation of these message components

Individual components of the Channel Diagnosis Data block can be included n times in a message. A precise explanation of these message components is subsequently provided:

Designation	Data type/ length	For SINAMICS	
		Value	Significance
Channel Number	U16	1 ... 399	Component number
		0x8000	No component assignment[1)]
Channel Properties	U16		

Designation		Data type/ length	For SINAMICS	
			Value	Significance
	.Type	Bits 7 ... 0	0	No data length
	.Accumulative	Bit 8	0	1 channel; no group formation
	.Maintenance	Bits 10, 9	0	Fault → diagnostics
			1	Alarm, Class 0 or A → maintenance *required* Alarm, Class B or C → maintenance *demanded*
			2	
	.Specifier	Bits 12, 11	0	Not used
			1	Message received
			2	Message issued, no additional message available in the channel
			3	Message issued, additional messages are available in the channel
	.Direction	Bits 15 ... 13	3	Input/Output
Channel Error Type		U16	0x9000	Hardware / software error
			0x9001	Network fault
			0x9002	Supply voltage fault
			0x9003	DC link overvoltage
			0x9004	Power electronics faulted
			0x9005	Overtemperature of the electronic components
			0x9006	Ground fault / inter-phase short circuit
			0x9007	Motor overload
			0x9008	Communication error to the higher-level control system
			0x9009	Safety monitoring channel has identified an error
			0x900A	Position/speed actual value incorrect or not available
			0x900B	Internal (DRIVE-CLiQ) communication error
			0x900C	Infeed faulted
			0x900E	Line filter faulted
			0x900F	External measured value / signal state outside the permissible range
			0x9010	Application / technological function faulted
			0x9011	Error in the parameterization / configuration / commissioning procedure
			0x9012	General drive fault
			0x9013	Auxiliary unit faulted

[1] For messages, which cannot be assigned to any particular component

4.5.1.2 System response - reading out diagnostics data

The converter can request diagnostics data via "Read data set" (detailed information is provided in the PROFINET-IO specification (http://www.profibus.com)).

Example:

For example, a read record with index 0x800C can be used to read out diagnostics data from specific sub slots. The following rules apply as example:

- 1 message block
  if, at this drive object (one or several) faults of the same message class are identified
- n messages
  if, at this drive object, n faults of different message classes are identified

Note

If a fault is active on the CU drive object, then this fault is propagated to all of the drive objects associated with the CU. This fault can therefore be read out at each drive object.

4.5.2 PROFIBUS-based diagnostics

For communication via PROFIBUS, in the case of fault the following diagnostics data is output:

- Standard diagnostics (Page 70)
- Identifier-related diagnostics (Page 71)
- Status messages/module status (Page 71)
- Channel-related diagnostics (Page 72)
- Data sets DS0/DS1 and diagnostics alarm (Page 73)

Message structure

The following applies if a message contains all of the specified diagnostics data:

- Standard diagnostics
  Is always located at the beginning of the message.
- Data sets DS0/DS1 and diagnostics alarm
  Is always located at the end of the message. This message part is always slot-specific. The actual state of the slot responsible for the message is always transferred in the message.

The other diagnostics data (types) can be in any sequence. This is the reason that the following diagnostics data include a header:

- Identifier-related diagnostics
- Status messages/module status
- Channel-related diagnostics

The diagnostic data type can be uniquely identified based on the header.

Note

The master must operate in the DPV1 mode.

4.5.2.1 Standard diagnostics

For communication via PROFIBUS, standard diagnostics is structured as follows.

Bit		7	6	5	4	3	2	1	0
Octet	**Name**								
1	Station status 1	Master_ Lock = 0	Prm_Fault	0	Not_ Supported	**Ext_Diag**	Cfg_Fault	Station_ Not_ Ready	Station_ Non_ Exist = 0
2	Station status 2	0	0	Sync_ Mode	Freeze_ Mode	WD_On	1	**Stat_Diag** = 0	Prm_Req
3	Station status 3	**Ext_ Diag_ Overflow**	0	0	0	0	0	0	0
4		Master_Add							
5		Ident_Number (HighByte) of the slave							
6		Ident_Number (LowByte) of the slave							

In this context, the following values are decisive for diagnostics:

- Ext_Diag
  - Group signal for diagnostics in the slave
  - = 1, if at least 1 alarm is active
- Ext_Diag_Overflow
  Display, diagnostics overflow in the slave (for more than 240 bytes)

4.5.2.2 Identifier-related diagnostics

The identifier-related diagnostics provides a bit (KB_n) for each slot 1 allocated when configuring the device. If a diagnostics message is active at a slot, then it's KB_n = true.

Bit		7	6	5	4	3	2	1	0
Octet	Name								
1	Header-Byte Station status 1	0	1	Block length (2 ... 32) incl. this byte					
2	Bit structure	KB_7	KB_6	KB_5	KB_4	KB_3	KB_2	KB_1	KB_0
3	Bit structure	...	...	...	...	KB_11	KB_10	KB_9	KB_8
...		...							
x	Bit structure	...	...	KB_n+1	KB_n	...	...	...	...

4.5.2.3 Status messages/module status

Status messages and module status briefly represent an overview of the state of the devices:

Bit		7	6	5	4	3	2	1	0
Octet	Name								
1	Header byte	0	0	Block length (2 ... 32) incl. this byte					
2	Module status	0x82							
3	Slot	0							
4	Specifier	0							
5		Slot_4		Slot_3		Slot_2		Slot_1	
6		...		Slot_7		Slot_6		Slot_5	
...		...							
x		00		Slot_n		...		...	

Note

Status value

Diagnostics for SINAMICS are only available in cyclic PROFIBUS operation, so that the state 00 = "Valid useful data" is always output for all slots.

4.5.2.4 Channel-related diagnostics

Channel-related diagnostics encompasses the following data:

Bit		7	6	5	4	3	2	1	0
Octet	Name								
x	Header-Byte	1[1]	0[1]	0 ... 63 (module number) including this byte					
x + 1		1[2]	1[2]	0 (no component assignment)					
x + 2		0[3]	0[3]	Message classes: 2 undervoltage 3 overvoltage 9 error 16 Hardware/software error 17 Line supply/filter faulted 18 DC-link overvoltage 19 Power electronics faulted 20 Electronic component overtemp. 21 Ground/phase fault detected 22 Motor overload 23 Commun. with controller faulted 24 Safety monit. Detected an error 25 Act. Position/speed value error 26 Internal communication faulted 27 Infeed faulted 28 Braking controller faulted 29 External signal state error 30 Application/function faulted 31 Parameterization/commiss. error					

[1] ≙ Channel-related diagnostics

[2] ≙ Input/output

[3] ≙ "Channel type "non specific"

System response

Only one signal is generated if channel-related diagnostics identifies several faults belonging to the same message class at the same drive object.

4.5.2.5 Data sets DS0/DS1 and diagnostics alarm

The PROFIdrive message classes are transferred using diagnostic alarm DS0/DS1. All faults are assigned channel 0. The drive objects are assigned using the slot number.

The structure is as follows:

Bit		7	6	5	4	3	2	1	0
Octet	**Name**								
1	Header-Byte	0	0	= 15 (block length)					
2		0	= 1 (diagnostics alarm)						
3		0 ... 244 (slot number ≙ drive object)							
4		0 ... 31 (sequence number)					Add_Ack	Alarm_Specifier[1]	
5	DS0 (byte 0)	0	0	0	0	1[2]	0	1[3]	1[4]
6	DS0 (byte 1)	0	0	0	1[5]	0[6]	0[6]	1[6]	1[6]
7	DS0 (Byte 2)	0	0	0	0	0	0	0	0
8	DS0 (byte 3)	0	0	0	0	0	0	0	0
9	Info (byte 1)	Mixed	= 0x45 (ChannelTypeID = SINAMICS)						
10	Info (byte 2)	= 24 (number of diagnostic bits/channel)							
11	Info (byte 3)	= 1 (1 channel signals)							
12	Channel Error Vector	0	0	0	0	0	0	0	Channel 0 1
13	Channel -related diag-nostics (channel 0)	Err 7	Err 6	Err 5	Err 4	Err 3	Err 2	Err 1	Err 0
14		Err 15	Err 14	Err 13	Err 12	Err 11	Err 10	Err 9	Err 8
15		0	0	0	0	Err 19	Err 18	Err 17	Err 16

1) Alarm_Specifier
1 ≙ error has occurred and the slot is not OK
2 ≙ error is resolved and the slot is OK
3 ≙ error is resolved and the slot is not okay

2) Channel fault present
= 1; as long as the drive object has an error condition

3) Internal fault
= 1; as long as the drive object has an error condition

4) Module fault
= 1; as long as the drive object has an error condition

5) Channel information present
= 1; ≙ DS1 exists

6) Type class of module
= 0011; ≙ Distributed

4.6 Configuring telegrams in Startdrive

If communication is established between the drive and higher-level control system via PROFINET IO, then the data (setpoints and actual values) are cyclically transferred using PROFIdrive telegrams.

To configure a cyclic data transfer, proceed as follows:

- Insert the drive and controller
- Insert a PROFINET subnet
- Assign the drive to the controller
- Check the bus settings
- Parameterize the drive
  You must create telegrams for the relevant drive objects, e.g. for drive axes, drive control or infeed
- Check and edit the telegram settings
- If you are controlling a drive with safety functions via PROFIsafe, you must insert the appropriate PROFIsafe telegram.

4.6.1 Displaying telegram configuration

The "Telegram configuration" screen form is part of the device configuration and is displayed in the inspector window.

You can call this screen form, either via the project navigation or via direct links from the communication screen forms.

Call the telegram configuration via the project navigation

1. Open the drive device in the project navigation.
2. Double-click on the entry "Device configuration."
   The device configuration opens.
3. Select the entry "Telegram configuration" in the "Properties" tab of the inspector window.
   The telegram configuration settings are displayed under the respective fieldbus interface

4.6.2 Dialog overview

The dialog box for the telegram configuration is structured as follows:

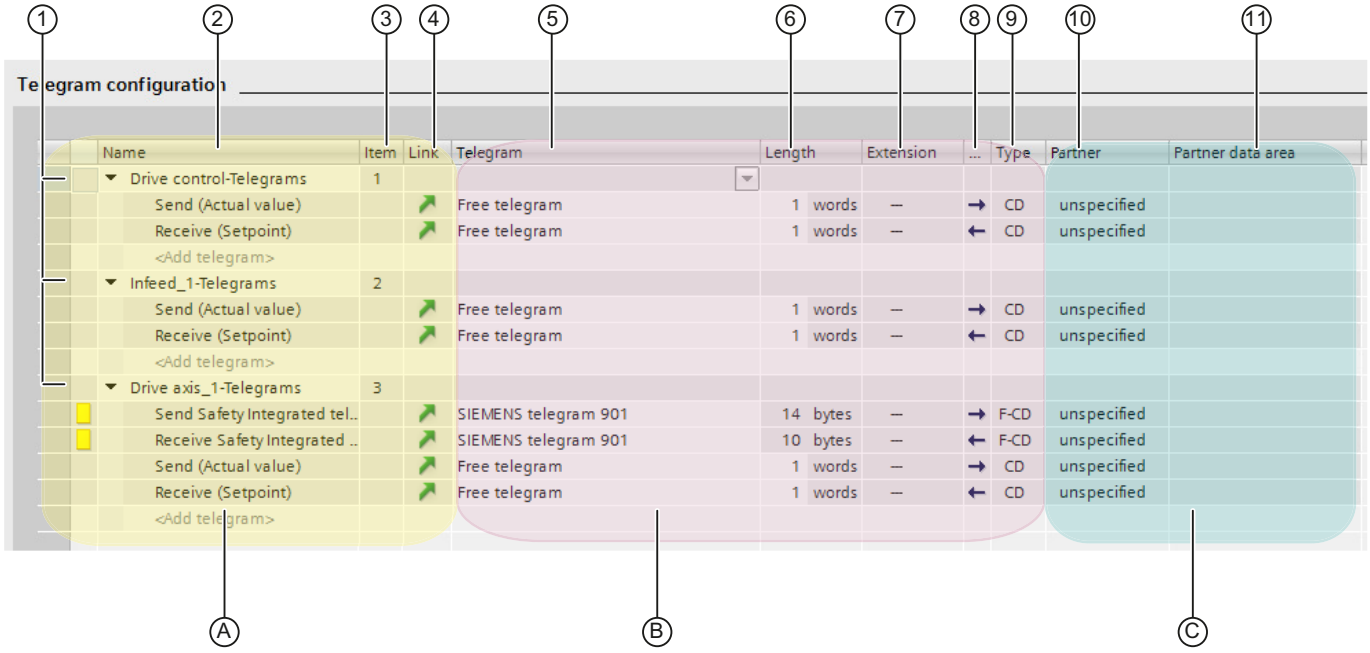


Figure 4-10 Example: Telegram configuration with several drive objects

Num-ber	Description	
A	Area for the drive objects (setpoints, actual values and safety components). A telegram is assigned to each drive object for setpoints and actual values. "Free telegram" is selected by default.	
B	Area for the interfaces	
C	Area for the communication partners of the drive (e.g. controller or another drive)	
①	Header of a drive object Using the header, you can move the drive object in the list with drag and drop (in the first column). This changes the sorting in the table and at the same time in the secondary navigation of the telegram configuration.	
②	Display of the drive object	
③	Number of the drive object This number is generated automatically according to the order in which a drive object is created in the device configuration, and can no longer be changed. Resorting in the table does not change this number.	
④	Link to the communication screen forms of the particular drive object	
⑤	Drop-down list with the available telegrams	
⑥	Telegram length	
⑦	Telegram extension	
⑧	Communication direction (send direction →/receive direction ←)	
⑨	Type of communication	CD = Controller - Device for PROFINET IO
		F_ = PROFIsafe-specific extension (safety telegram)
⑩	Name of the partner (controller)	
⑪	I/O addresses of the controller	

Communication via PROFIBUS DP 5

5.1 General information about PROFIBUS

5.1.1 General information about PROFIBUS for SINAMICS

PROFIBUS is an open international fieldbus standard for a wide range of production and process automation applications.

The following standards ensure open, multi-vendor systems:

- International standard EN 50170
- International standard IEC 61158

PROFIBUS is tuned for high-speed, time-critical data communication at field level.

Note

PROFIBUS for drive technology is standardized and described in the following document:
PROFIdrive Profile Drive Technology

PROFIBUS User Organization e. V.
Haid-und-Neu-Strasse 7, D-76131 Karlsruhe

Internet: (http://www.profibus.com)

Note

Startdrive

Please note that you still cannot use this function with Startdrive.

Note

Before synchronizing to the isochronous PROFIBUS, all of the drive object pulses must be inhibited - also for those drives that are not controlled via PROFIBUS.

PROFIBUS interface: The cyclic PZD channel is deactivated when the **CBE20** is plugged in!

NOTICE
Destruction of the CU320-2 or other CAN bus nodes by connecting a CAN cable
Connecting a CAN cable to interface X126 of the CU320-2 can destroy the CU320-2 or other CAN bus nodes. • Do not connect any CAN cable to the X126 interface.

5.1.2 Master and slave

- Master and slave properties

Properties	Master	Slave
As bus node	Active	Passive
Send messages	Permitted without external request	Only possible on request by master
Receive messages	Possible without any restrictions	Only receive and acknowledge permitted

- Master
  The following classes are differentiated:
  - Master class 1 (DPMC1):
    Central automation stations that exchange data with the slaves in cyclic and acyclic mode. Communication between the masters is also possible.
    Examples: SIMATIC S7, SIMOTION
  - Master class 2 (DPMC2):
    Devices for configuration, commissioning, operator control and monitoring during bus operation. Devices that only exchange data with the slaves in acyclic mode.
    Examples: Programming devices, human machine interfaces
- Slaves
  With respect to PROFIBUS, the SINAMICS drive unit is a slave.

5.1.3 Bus access method

PROFIBUS uses the token passing method, i.e. the active stations (masters) are arranged in a logical ring in which the authorization to send is received within a defined time frame.

Within this time frame, the master with authorization to send can communicate with the assigned slaves and/or with other masters in a master/slave procedure.

5.1.4 PROFIBUS telegram for cyclic data transmission and acyclic services

Each drive unit that supports cyclic process data exchange uses a telegram to send and receive all the process data. A separate telegram is sent in order to perform all the acyclic services (read/write parameters) under a single PROFIBUS address. The acyclic data is transferred with a lower priority after cyclic data transmission.

The overall length of the telegram increases with the number of drive objects that are involved in exchanging process data.

5.1.5 Sequence of drive objects in the telegram

Sequence of drive objects in the telegram

On the drive side, the sequence of drive objects in the telegram is displayed via a list in p0978[0...24] where it can also be changed.

Using the Startdrive commissioning tool you can display the sequence of drive objects for a commissioned drive system in the project navigator under "Drive unit" > "Communication" > "Telegram configuration".

When you create the configuration on the controller side (e.g. HW Config), the process-data-capable drive objects for the application are added to the telegram in the sequence shown (see above).

The following drive objects can exchange process data:

- Active Infeed (A_INF)
- Basic Infeed (B_INF)
- Control Unit (CU_S)
- ENC
- Smart Infeed (S_INF)
- SERVO
- VECTOR
- Terminal Board 30 (TB30)
- Terminal Module 15 (TM15)
- Terminal Module 31 (TM31)
- Terminal Module 41 (TM41)
- Terminal Module 120 (TM120)
- Terminal Module 150 (TM150)

Note

The sequence of drive objects in HW Config must be the same as that in the drive (p0978).

Drive objects after the first zero in p0978 must not be configured in the HW Config.

The structure of the telegram depends on the drive objects taken into account during configuration. Configurations are permitted that do not take into account all of the drive objects that are present in the drive system.

Example:

The following configurations are possible:

- Configuration with SERVO, SERVO, SERVO
- Configuration with A_INF, SERVO, SERVO, SERVO, TB30
- ...

5.1.6 Example: telegram structure for cyclic data transmission

Task

The drive system comprises the following drive objects:

- Control Unit (CU_S)
- Active Infeed (A_INF)
- SERVO 1 (comprises a Single Motor Module and other components)
- SERVO 2 (comprises a Double Motor Module terminal X1 and other components)
- SERVO 3 (comprises a Double Motor Module terminal X2 and other components)
- Terminal Board 30 (TB30)

The process data is to be exchanged between the drive objects and the higher-level automation system.

Telegrams to be used:

- Telegram 370 for Active Infeed
- Standard telegram 6 for SERVO
- User-defined for Terminal Board 30 for the three SERVO drives

Component and telegram structure

The predefined component structure results in the telegram structure shown in the following diagram.

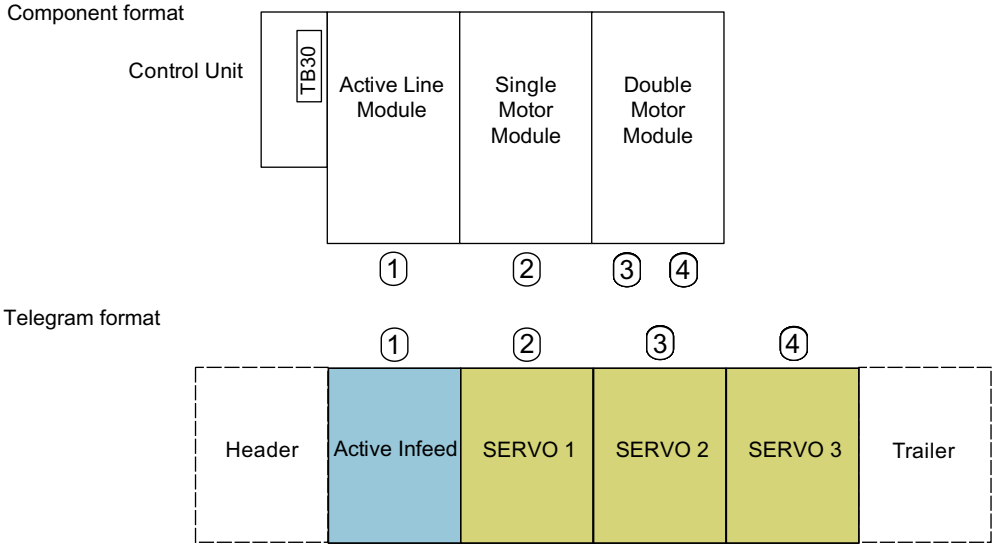


Figure 5-1 Component and telegram structure

You can check and change the sequence of the telegrams via p0978[0...24].

Configuration settings (e.g. HW Config for SIMATIC S7)

Due to the telegram structure shown, the objects in the "DP slave properties" overview must be configured as follows:

- Active Infeed (A_INF): Telegram 370
- SERVO 1: Standard telegram 6
- SERVO 2: Standard telegram 6
- SERVO 3: Standard telegram 6
- Terminal Board 30 (TB30): User-defined

DP slave properties – overview

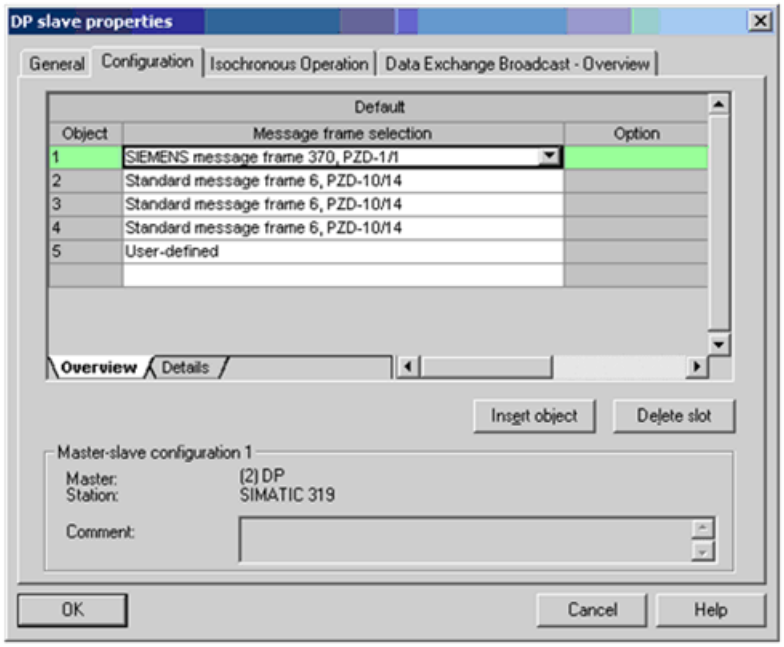


Figure 5-2 Slave properties – overview

When you click "Details", the properties of the configured telegram structure are displayed (e.g. I/O addresses, axis separator).

DP slave properties – details

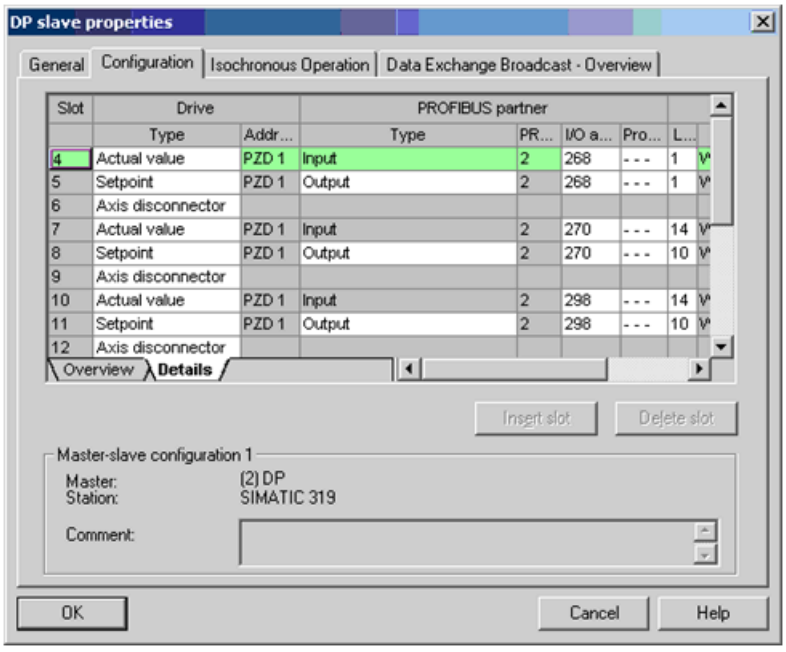


Figure 5-3 Slave properties – details

The axis separator separates the objects in the telegram as follows:

- Slots 4 and 5: Object 1 —> Active Infeed (A_INF)
- Slots 7 and 8: Object 2 —> SERVO 1
- Slots 10 and 11: Object 3 —> SERVO 2

etc.

5.2 Commissioning PROFIBUS

5.2.1 Interfaces and diagnostic LEDs

Interfaces and diagnostic LED

A PROFIBUS interface with LEDs and address switches is available as standard on the CU320-2 DP Control Unit.

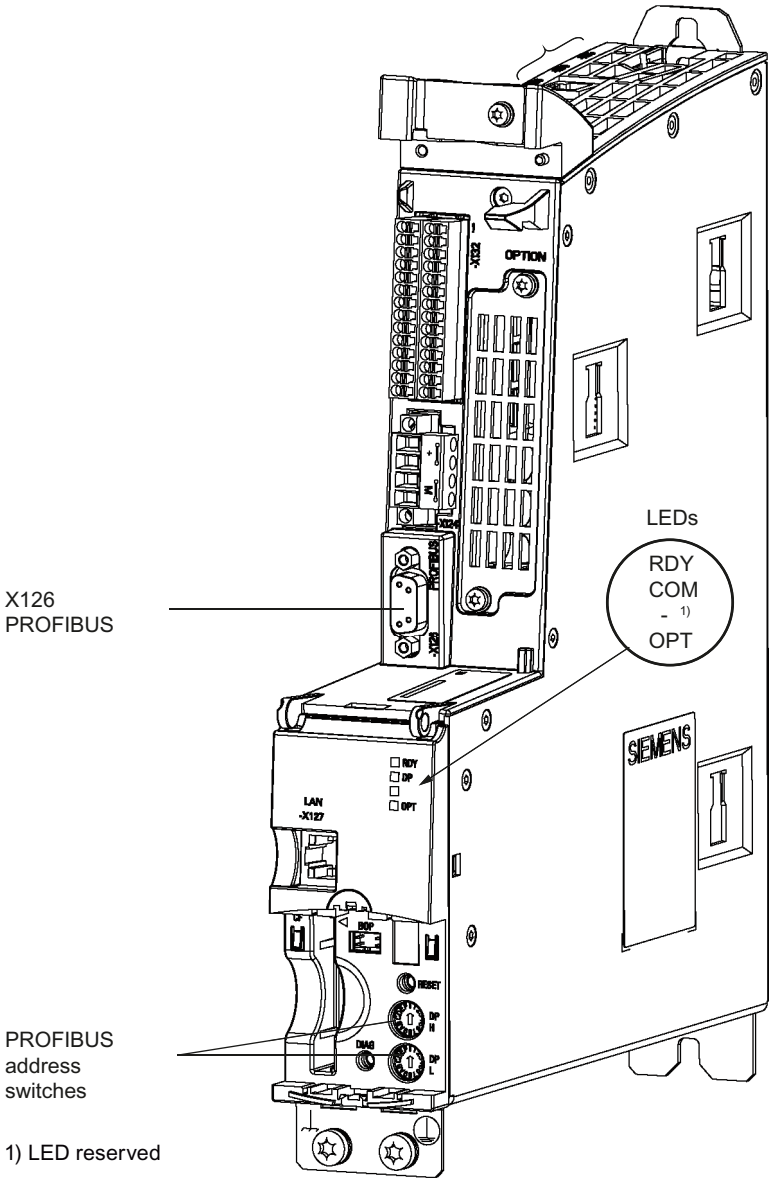


Figure 5-4 Interfaces and diagnostic LED

- PROFIBUS interface
  The PROFIBUS is described in the "SINAMICS S120 Control Units and Supplementary System Components Manual".
- PROFIBUS diagnostic LED

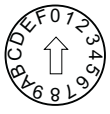
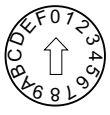
Note

A teleservice adapter can be connected to the PROFIBUS interface (X126) for remote diagnostics purposes.

5.2.2 PROFIBUS address switch

On the CU320-2 DP, the PROFIBUS address is set as a hexadecimal value via two rotary coding switches. You can set values from 0_{dec} (00_{hex}) to 127_{dec} ($7F_{hex}$). At the upper rotary coding switch (H) you set the hexadecimal value for 16^1 and at the lower rotary coding switch (L) you set the hexadecimal value for 16^0.

Table 5-1 PROFIBUS address switch

Rotary coding switches	Significance	Examples		
		21_{dec}	35_{dec}	126_{dec}
		15_{hex}	23_{hex}	$7E_{hex}$
 DP H	$16^1 = 16$	1	2	7
 DP L	$16^0 = 1$	5	3	E

5.2.3 Setting the PROFIBUS address

Observe the properties of the rotary coding switch:

- The rotary coding switches used to set the PROFIBUS address are located beneath the cover.
- The factory setting for the rotary coding switches is 0_{dec} (00_{hex}).
- Address 126 is used for commissioning. Permitted PROFIBUS addresses are 1 ... 126.
- The currently set address of the rotary coding switch is displayed in parameter r2057.
- When several Control Units are connected to a PROFIBUS line, you set the addresses differently than for the factory setting. Each PROFIBUS address in a PROFIBUS line can only be assigned once. Either set the PROFIBUS address in absolute terms using the rotary coding switches – or selectively in parameter p0918. Each change made to the bus address is not effective until POWER ON.

Note

Only values from 1 to 126 ($7E_{hex}$) are valid for PROFIBUS addressing. If values above 127 are set, then the set value is interpreted as "0". If a value "0" or "127" is set, the value in parameter p0918 defines the PROFIBUS address.

There are two ways to set the PROFIBUS address:

1. Using the STARTER commissioning tool (parameter p0918)
   - To set the bus address for a PROFIBUS node using STARTER, first set the rotary code switches to 0_{dec} (00_{hex}) and/or 127_{dec} ($7F_{hex}$).
   - Then set the address to a value from 1 to 126 using parameter p0918.
2. Using the PROFIBUS address switches on the Control Unit
   - The address is set manually to values from 1 to 126 using the rotary coding switches. In this case, parameter p0918 is only used to read the address.

5.2.4 PROFIBUS interface in operation

Generic station description file

A generic station description file clearly and completely defines the properties of a PROFIBUS slave.

The SINAMICS S GSD file contains among other things standard telegrams, free telegrams and slave-to-slave telegrams for configuring slave-to-slave communication. With the aid of these telegram parts and an axis separator, a telegram for the drive unit must be composed for each drive object.

The GSD files can be found:

- On the Internet:
  PROFINET I/O (https://support.industry.siemens.com/cs/ww/en/view/49217480) (GSDML files)
  PROFIBUS DP (https://support.industry.siemens.com/cs/ww/en/view/49216293) (GSD files)
- On the CD/DVD of the Startdrive commissioning tool
- On the memory card in the directory:
  \\SIEMENS\SINAMICS\DATA\CFG\

The integration of a GSD file in HW Config is covered in the SIMATIC documentation. Suppliers of PROFIBUS components can provide their own bus configuration tool. The operation of the respective bus configuration tool is described in the relevant documentation.

Note for commissioning for VIK-NAMUR

To be able to operate a SINAMICS drive as a VIK-NAMUR drive, standard telegram 20 must be set and the VIK-NAMUR identification number activated via p2042 =1.

Device identification

Identification for individual slaves facilitates diagnostics and provides an overview of the nodes on the PROFIBUS.

The information for each slave is stored in the following CU-specific parameter:
r0964[0...6] device identification

Bus terminating resistor and shielding

Reliable data transmission via PROFIBUS depends, amongst other things, on the setting of the bus terminating resistors and the shielding of the PROFIBUS cables.

- Bus terminating resistor
  The bus terminating resistors in the PROFIBUS plugs must be set as follows:
  - First and last nodes in the line: Switch on terminating resistor
  - Other nodes in the line: Switch off terminating resistor
- Shielding of the PROFIBUS cables
  The cable shield must be connected in the plug through a large surface area at both ends (see SINAMICS S120 Control Units and Supplementary System Components Manual).

5.2.5 Commissioning PROFIBUS

Preconditions and assumptions for commissioning

	Requirement
PROFIBUS slave	• The PROFIBUS address to be set for the device application is known. • The telegram type for each drive object is known by the application.
PROFIBUS master	• The communication properties of the SINAMICS S120 slave must be available in the master (GSD file or Drive ES slave OM).

Commissioning steps (example with SIMATIC S7)

1. Set the PROFIBUS address on the slave.
2. Set the telegram type on the slave.

3. Perform the following in HW Config:
   – Connect the drive unit to PROFIBUS and assign the address.
   – Set the telegram type.
     The same telegram type as on the slave should be set for every drive object exchanging process data via PROFIBUS.
     The master can send more process data than the slave uses. A telegram with a larger number of PZDs than assigned for the SINAMICS drive object can be configured on the master.
     The PZDs not supplied by the drive object are filled with zeros.
     The setting "without PZD" can be defined on a node or object (e.g. infeed controlled via terminals).
4. Assign the I/O addresses according to the user program.

5.2.6 Diagnostics options

The standard slave diagnostics can be read online in the HW config.

5.2.7 SIMATIC HMI addressing

You can use a SIMATIC HMI as a PROFIBUS master (master class 2) to access SINAMICS directly. With respect to SIMATIC HMI, SINAMICS behaves like a SIMATIC S7. For accessing drive parameters, the following applies:

- Parameter number = data block number
- Parameter sub-index = bit 0 ... 9 of data block offset
- Drive object number = bit 10 ... 15 of data block offset

Pro Tool and WinCC flexible

The SIMATIC HMI can be configured flexibly with "Pro Tool" or "WinCC flexible".

The following specific settings for drives must be observed when configuration is carried out with Pro Tool or WinCC flexible.

Controllers: Protocol always "SIMATIC S7 - 300/400"

Table 5-2 Additional parameters

Field	Value
Network parameter profile	DP
Network parameter baud rate	Any
Communication partner address	PROFIBUS address of the drive unit
Communication partner slot/rack	Don’t care, 0

Table 5-3 Variables: "General" tab

Field	Value
Name	Any
Controller	Any
Type	Depending on the addressed parameter value, e.g.: INT: for integer 16 DINT: for integer 32 WORD: for unsigned 16 REAL: for float
Area	DB
DB (data block number)	Parameter number 1 ... 65535
DBB, DBW, DBD (data block offset)	Drive object No. and sub-index bit 15 ... 10: Drive object No. 0 ... 63 bit 9 ... 0: Sub-index 0 ... 1023 or expressed differently DBW = 1024 * drive object No. + sub-index
Length	Not activated
Acquisition cycle	Any
Number of elements	1
Decimal places	Any

Note

- You can operate a SIMATIC HMI together with a drive unit independently of an existing controller.
  A basic "point-to-point" connection can only be established between two nodes (devices).
- The "variable" HMI function can be used for drive units. Other functions cannot be used (e.g. "messages" or "recipes").
- Individual parameter values can be accessed. Entire arrays, descriptions, or texts cannot be accessed.

5.2.8 Monitoring telegram failure

Monitoring telegram failure

When monitoring the telegram failure, SINAMICS differentiates between two cases:

- Telegram failure with a bus fault
- Telegram failure with a CPU stop

Telegram failure with a bus fault

- After a telegram failure and the additional monitoring time has elapsed (p2047), bit r2043.0 is set to "1" and alarm A01920 is output. Binector output r2043.0 can be used for a quick stop, for example.
- Once the delay time p2044 has elapsed, fault F01910 is output. Fault F01910 triggers fault response OFF2 (pulse inhibit) for the infeed and OFF3 (quick stop) for SERVO/VECTOR. If no OFF response is to be triggered, the fault response can be reparameterized accordingly.
- Fault F01910 can be acknowledged immediately. The drive can then be operated even without PROFIdrive.
- After telegram failure, bit r2043.0 is set to "1". Binector output r2043.0 can be used for a quick stop, for example.

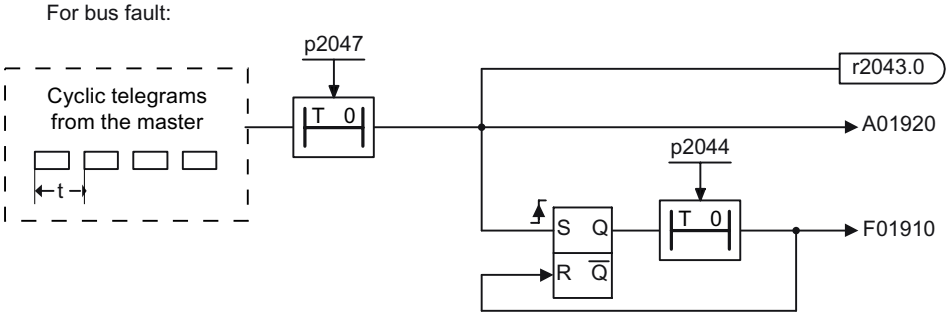


Figure 5-5 Monitoring telegram failure with a bus fault

Telegram failure with a CPU stop

- Once the delay time p2044 has elapsed, fault F01910 is output. Fault F01910 triggers fault response OFF2 (pulse inhibit) for the infeed and OFF3 (quick stop) for SERVO/VECTOR. If no OFF response is to be triggered, the fault response can be reparameterized accordingly.
- Fault F01910 can be acknowledged immediately. The drive can then be operated even without PROFIdrive.

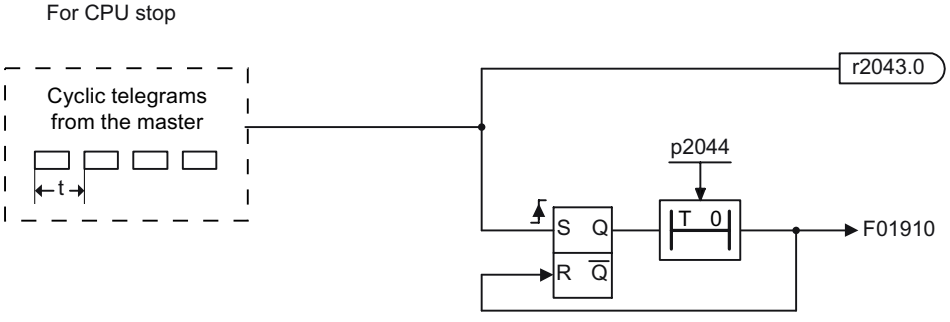


Figure 5-6 Monitoring telegram failure for a CPU stop

Example: Quick stop at telegram failure

- Assumption
  - A drive unit with an Active Line Module and a Single Motor Module.
  - VECTOR mode is activated.
  - After a ramp-down time (p1135) of two seconds, the drive is at a standstill.
- Settings

CU	p2047	= 20 ms
A_INF	p2044	= 2 s
VECTOR	p2044	= 0 s

- Sequence
  - Following a telegram failure and once the additional monitoring time (p2047) has elapsed, binector output r2043.0 of drive object CU switches to "1".
  - At the same time, alarm A01920 is output for the A_INF drive objects and alarm A01920 and fault F01910 are output for VECTOR.
  - When F01910 is output, an OFF3 is triggered for the drive.
  - After a two-second delay time (p2044), fault F01910 is output on the infeed and triggers OFF2.

5.3 Motion Control with PROFIBUS

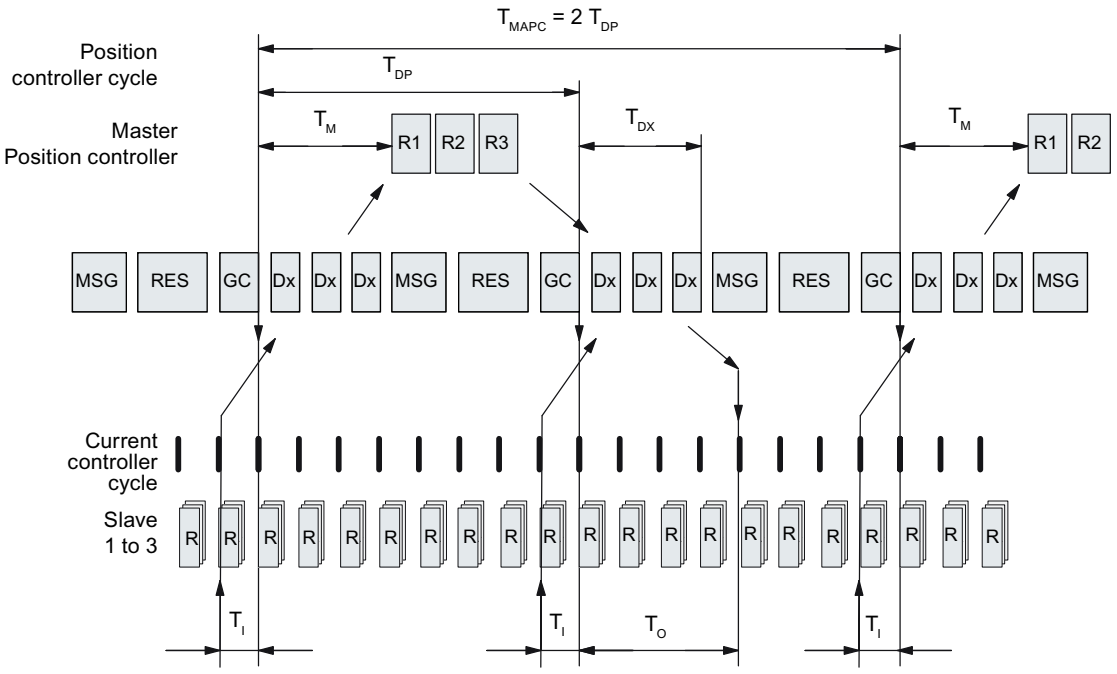


Figure 5-7 Motion control / isochronous drive coupling with PROFIBUS, optimized cycle with $T_{MAPC} = 2 \bullet T_{DP}$

5.3.1 Sequence of data transfer to closed-loop control system

1. The actual position value G1_XACT1 is read into at time T_I before the start of each cycle and transferred to the master in the next cycle.
2. The closed-loop control of the master starts at time T_M after each position controller cycle and uses the transferred actual value in the telegram.
3. In the next cycle, the master forwards the calculated setpoints to the slaves. The speed setpoint command NSET_B is issued to the closed-loop control system at time T_O after the beginning of the cycle.

5.3.2 Time settings

Designations and descriptions for motion control

Table 5-4 Time settings and meanings

Name	Limit value	Description
T_{BASE_DP}	250 µs	Time base for T_{DP}
T_{DP}	$T_{DP} \geq T_{DP\_MIN}$ $T_{DP\_MIN} \leq T_{DP} \leq T_{DP\_MAX}$	DP cycle time T_{DP} = Dx + MSG + RES + GC T_{DP} = multiple integer • T_{BASE_DP} T_{DP_MIN} = 1 ms T_{DP_MAX} = 32 ms
T_{MAPC}		Master application cycle time This is the time frame in which the master application generates new setpoints (e.g. in the position controller cycle). T_{MAPC} = integer multiple of T_{DP}
T_{BASE_IO}	125 µs	Time base for T_I, T_O
T_I	$T_{I\_MIN} \leq T_I < T_{DP}$	Time of actual value sensing This is the time at which the actual position value is captured before the start of each cycle. T_I = integer multiple of T_{BASE_IO} T_{I_MIN} corresponds to the longest current controller sampling time (p0115[0]) of a drive object (SERVO/VECTOR) in the drive unit, minimum 125 µs. Does not apply to vector U/f.
T_O	$T_{DX} + T_{O\_MIN} \leq T_O < T_{DP}$	Time of setpoint transfer This is the time at which the transferred setpoints (speed setpoint) are accepted by the closed-loop control system after the start of the cycle. T_O = integer multiple of T_{BASE_IO} T_{O_MIN} corresponds to the longest speed controller cycle (p0115[1]) of a drive object (SERVO/VECTOR) in the drive unit, minimum 125 µsec
T_{DX}	$T_{DX} < T_{DP}$	Data exchange time This is the time required within one cycle for transferring process data to all available slaves.
T_{PLL_W}	-	PLL window
T_{PLL_D}	-	PLL delay time
GC	-	Global Control Telegram (broadcast telegram)
Dx	-	Data_Exchange This service is used to implement user data exchange between master and slave 1 - n.
MSG	-	Acyclic service This service is used to implement user data exchange between master and slave 1 - n on an acyclic basis.
RES	-	Reserve: "Active pause" until the isochronous cycle has expired
R	-	Computation time, speed or position controller in the master or slave
T_M	-	Master time Start of closed-loop master control

Setting criteria for times

- Cycle (T_{DP})
  - T_{DP} must be set to the same value for all bus nodes.
  - $T_{DP} > T_{DX}$ and $T_{DP} > T_O$

  Note

  After T_{DP} has been changed on the PROFIBUS master, the drive system must be switched on (POWER ON) or parameter p0972 = 1 (reset drive unit) must be set.

- T_I and T_O
  - Setting the times in T_I and T_O as short as possible reduces the dead time in the position control loop.
  - $T_O > T_{DX} + T_{Omin}$
- Settings and tuning can be done using a tool (e.g. HW Config in SIMATIC S7).

Minimum times for reserves

Table 5-5 Minimum times for reserves

Data	Time required [µs]
Basic load	300
Per slave	20
Per byte of user data	1.5
One additional class 2 master	500

Example: SINAMICS vector drives with SIMOTION D4x5 and/or CX modules

To determine which cycles in the SINAMICS drive unit will be set after a project has been downloaded, dependable cycle values should be initially set in HW Config.

The following settings and sequences are recommended:

1. T_{DP} = 3.0 ms (T_{DP} = DP cycle time)
2. $T_I = T_o$ = 1.5 ms (T_I = time of actual value acquisition, T_o = time of setpoint transfer)
3. T_{MAPC} = 6.0 ms (T_{MAPC} = master application cycle time)

After a successful download, all current and speed controller cycles are visible. These cycles can be optimized in HW Config if necessary.

The cycles are set in HW Config under the DP slave properties of the SINAMICS drive unit (slave, master e.g. SIMOTION D4x5) under the "Clock synchronization" tab.

5.3.3 User data integrity

User data integrity is verified in both transfer directions (master <—> slave) by a sign-of-life (4-bit counter).

The sign-of-life counters are incremented from 1 to 15 and then start again at an arbitrary value between 1 and 15.

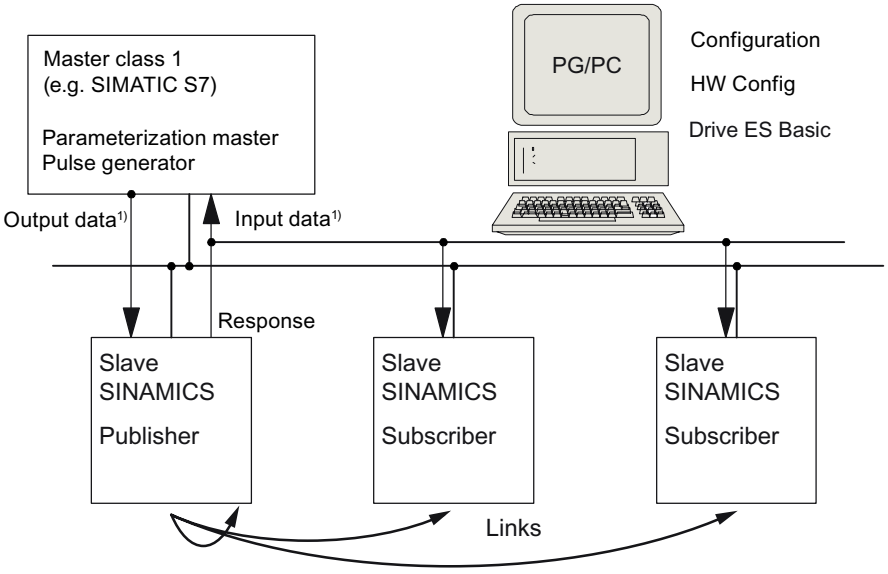
- Master sign-of-life
  - STW2.12 ... STW2.15 are used for the master sign-of-life.
  - The master sign-of-life counter is incremented on each master application cycle (T_{MAPC}).
  - The number of tolerated master sign-of-life errors in succession (of an isochronous motor) can be set via p0925
  - p0925 = 65535 deactivates sign-of-life monitoring on the slave.
  - Monitoring
    The master sign-of-life is monitored on the slave and any sign-of-life errors are evaluated accordingly.
    The maximum number of tolerated master sign-of-life errors can be set via p0925.
    If the number of tolerated sign-of-life errors in succession set in p0925 is exceeded, the response is as follows:
    – A corresponding message is output.
    – The value zero is output as the slave sign-of-life.
    – Synchronization with the master sign-of-life is started.
- Slave sign-of-life
  - ZSW2.12 ... ZSW2.15 are used for the slave sign-of-life.
  - The slave sign-of-life counter is incremented in each DP cycle (T_{DP}).

5.4 Slave-to-slave communication

For PROFIBUS DP, the master interrogates all of the slaves one after the other in a DP cycle. In this case, the master transfers its output data (setpoints) to the particular slave and receives as response the input data (actual values). Fast, distributed data transfer between drives (slaves) is possible using the "slave-to-slave communication" function without direct involvement from the master.

The following terms are used for the function described in this chapter:

- Slave-to-slave communication
- Data Exchange Broadcast (DXB.req)
- Slave-to-slave communication (is used in the following)



1) From the perspective of the Class 1 master

Figure 5-8 Slave-to-slave communication with the publisher-subscriber model

Publisher

With the "slave-to-slave communication" function, at least one slave must act as the publisher.

The publisher is addressed by the master when the output data is transferred with a modified layer 2 function code (DXB.req). The publisher then sends its input data for the master with a broadcast telegram to all bus nodes.

Subscriber

The subscribers evaluate the broadcast telegrams, sent from the publishers, and use the data which has been received as setpoints. These setpoints of the publisher are used, in addition to the setpoints received from the master, corresponding to the configured telegram structure (p0922).

Links and taps

The links configured in the subscriber (connections to publisher) contain the following information:

- From which publisher is the input data received?
- What is the content of the input data?
- Where are the additional setpoints received?

Several taps are possible within a link. Several input data or input data areas, which are not associated with one another, can be used as setpoint via a tap.

Links on the drive unit itself are possible. For example, data in a Double Motor Module can be transferred from drive A to drive B. This internal link corresponds, as far as the timing is concerned, to a link via PROFIBUS.

Requirements

The following preconditions should be observed for the "slave-to-slave communication" function:

- STARTER as of Version 4.2

  Note
  Startdrive

  Please note that you still cannot use this function with Startdrive.

- Configuration:
  - Drive ES Basic, Drive ES SIMATIC or Drive ES PCS7 Version 5.3 SP3 or higher
  - Alternatively, using a GSD file
- Firmware as of Version 4.3
- The maximum number of process data per drive can be identified from the value in r2050 – minus the resources that have already been used
- A maximum of 16 links to publishers

Note

The "slave-to-slave communication" function is not available for the CU310-2 PN.

Applications

For example, the following applications can be implemented using the "slave-to-slave communication" function:

- Axis couplings (this is practical for isochronous mode)
- Specifying binector connections from another slave

5.4.1 Setpoint assignment in the subscriber

Information about setpoints

- Number of setpoint
  When bus communication is being established, the master signals the slave the number of setpoints (process data) to be transferred using the configuring telegram (ChkCfg).
- Contents of the setpoints
  The structure and contents of the data are determined using the local process data configuration for the "SINAMICS slave".
- Operation as "standard" slave
  The drive unit (slave) only receives its setpoints as output data from the master.
- Operation as subscriber
  These setpoints of the publisher are used, in addition to the setpoints received from the master, corresponding to the configured telegram structure (p0922).
  The slave is informed of the assignment via the parameterization and configuration telegram when bus communication is being established.

5.4.2 Activating/parameterizing slave-to-slave communication

The "slave-to-slave communication" function must be activated both in the publishers as well as in the subscribers, whereby only the subscriber is to be configured. The publisher is automatically activated during bus startup.

Activation in the publisher

The master is informed abut which slaves are to be addressed as publishers with a modified layer 2 function code (DXB req) via the configuration of the subscriber links.

The publisher then sends its input data not only to the master but also as a broadcast telegram to all bus nodes.

These settings are made automatically using the bus configuration tool (e.g. HW Config).

Activation in the subscriber

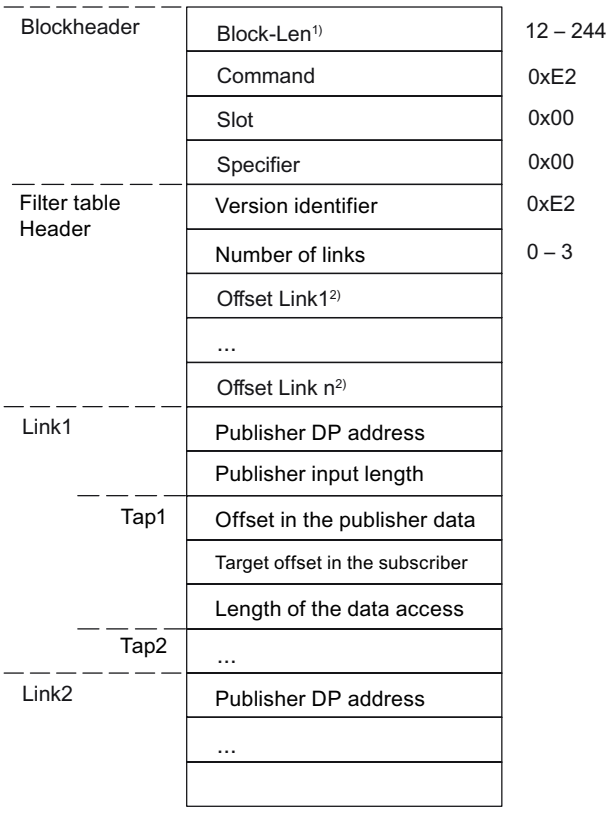
The slave, which is to be used as subscriber, requires a filter table. The slave must know which setpoints are received from the master and which are received from a publisher.

The filter table is created automatically via the bus configuration tool (e.g. HW Config).

The following diagram shows the information contained in the filter table.

Parameterizing telegram (SetPrm)

The filter table is transferred, as dedicated block from the master to the slave with the parameterizing telegram when a bus communication is established.



1) Specification in bytes
2) Calculated from Version ID

Figure 5-9 Filter block in the parameterizing telegram (SetPrm)

Configuration telegram (ChkCfg)

Using the configuration telegram, a slave knows how many setpoints are to be received from the master and how many actual values are to be sent to the master.

For slave-to-slave communication, a special space ID is required for each tap. The PROFIBUS configuration tool (e.g. HW Config) generates this ID. The ID is then transferred with the ChkCfg into the drive devices that operate as subscribers.

5.4.3 Commissioning PROFIBUS slave-to-slave communication

The commissioning of slave-to-slave communication between two SINAMICS drive devices using the additional Drive ES package is described below in an example.

Settings in HW Config

Based on the example of the project below, the settings in HW Config are described when using standard telegrams.

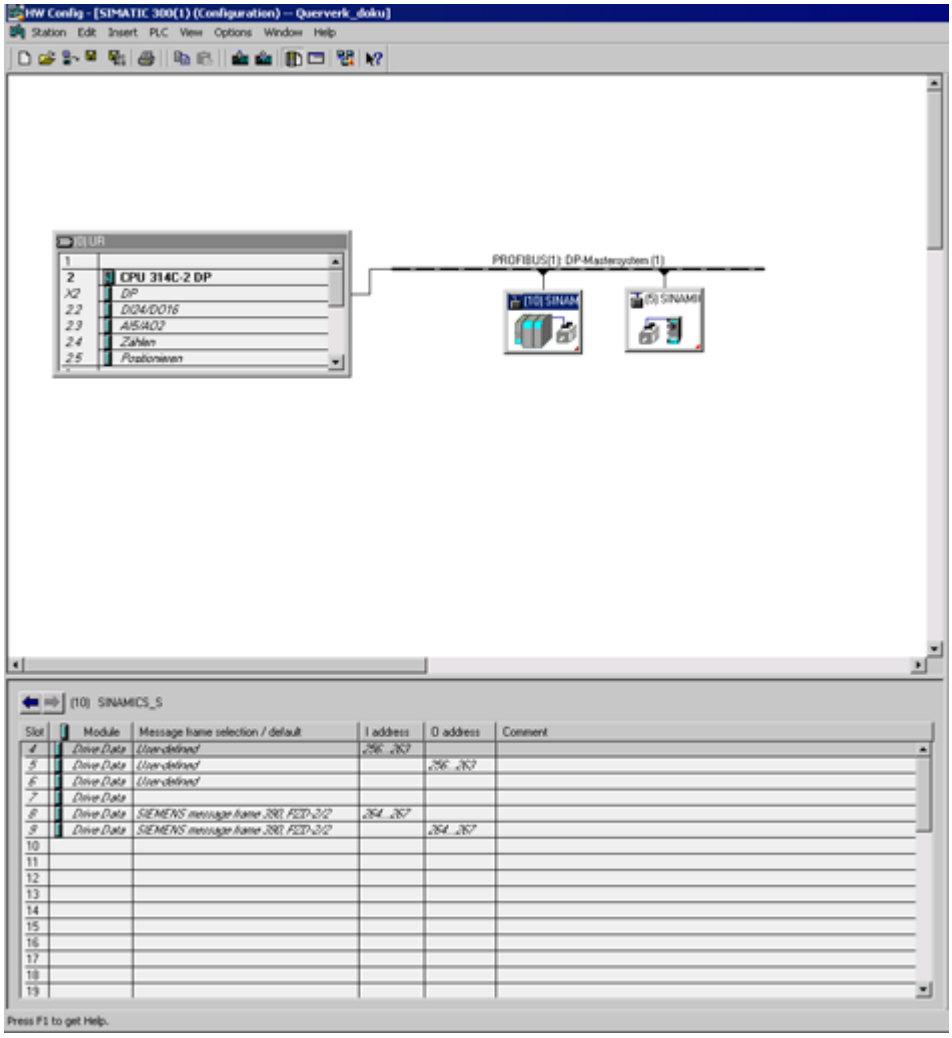


Figure 5-10 Example project of a PROFIBUS network in HW Config

Procedure

1. You have generated a project, e.g. with SIMATIC Manager and HW Config. In the project example, you defined a CPU 314 controller as master and 2 SINAMICS S120 Control Units as slaves. Of the slaves, one CU310-2 DP is the publisher and one CU320-2 DP the subscriber.
2. Select the CU320-2 DP Control Unit as slave.

3. Via its properties dialog in the overview, configure the telegram for the connected drive object.

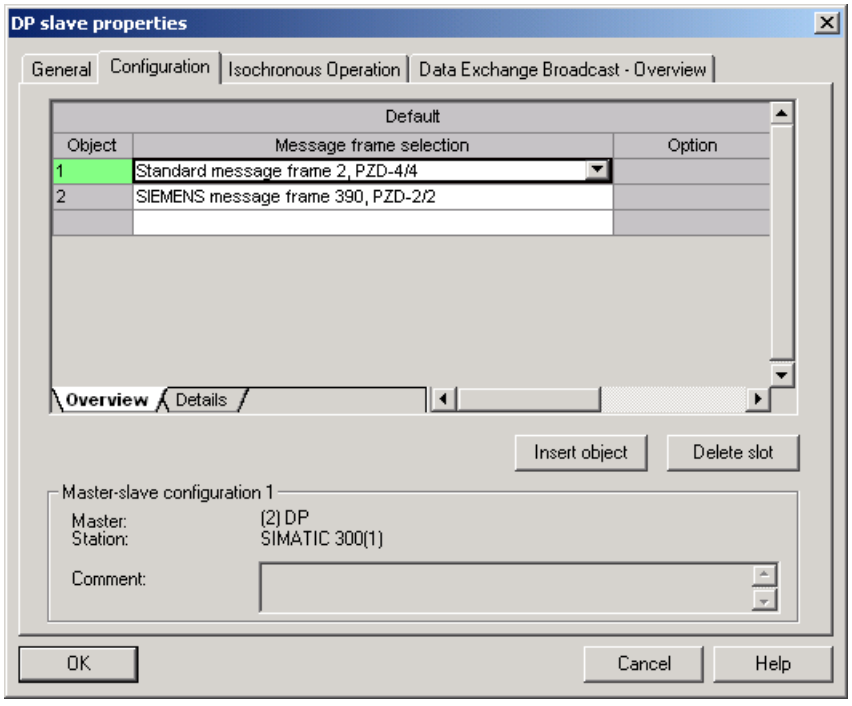


Figure 5-11 Telegram selection for drive object

4. Then switch to the detailed view.
   - Slots 4/5 contain the actual and setpoint values for the first drive object, e.g. SERVO.
   - Slots 7/8 contain the telegram components for the actual values and setpoints for the second drive object, e.g. CU310-2 DP.

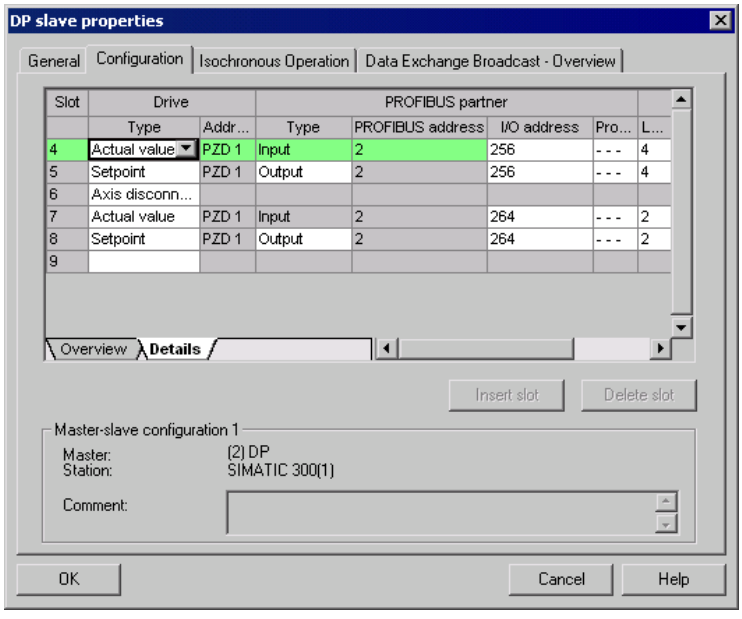


Figure 5-12 Detail view of slave configuration

5. Create an additional setpoint slot 6 for the first drive object using the "Insert slot" button behind the existing setpoint slot 5.

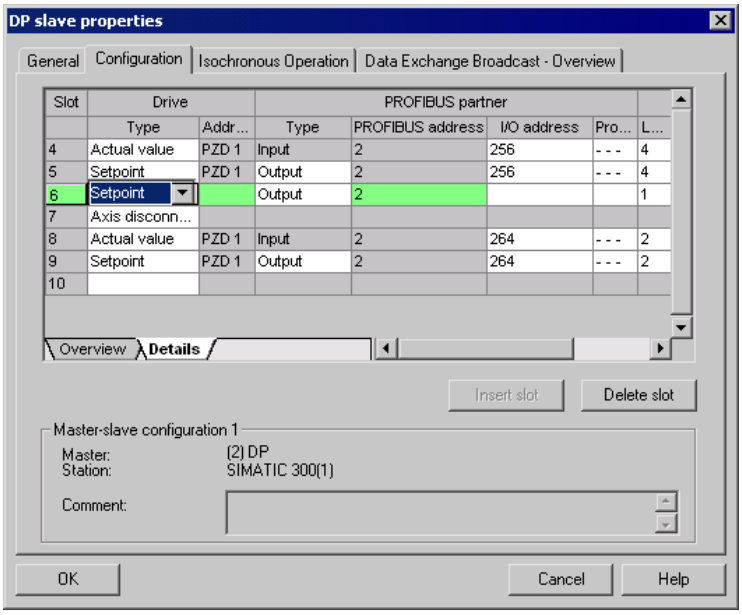


Figure 5-13 Insert new slot

6. Under the "PROFIBUS Partner" column, change the new setpoint slot 6 from an "output" type to a "slave-to-slave communication" type.
7. In the first column, select the PROFIBUS DP address of the publisher, in this example "5". All PROFIBUS DP slaves are listed here, for which actual value data can be retrieved. It also provides the possibility of sharing data via slave-to-slave communication within the same drive device.

8. The "I/O address" column displays the start address for every drive object.
   Select the start address of the data of the drive object to be read. In the example, "268" is proposed.
   If the complete data of the publisher is not to be read, set this using the "Length" column.
   Alternatively, you can shift the start address of the access, so that the required data can be read out from the center section of the telegram component of the drive object.

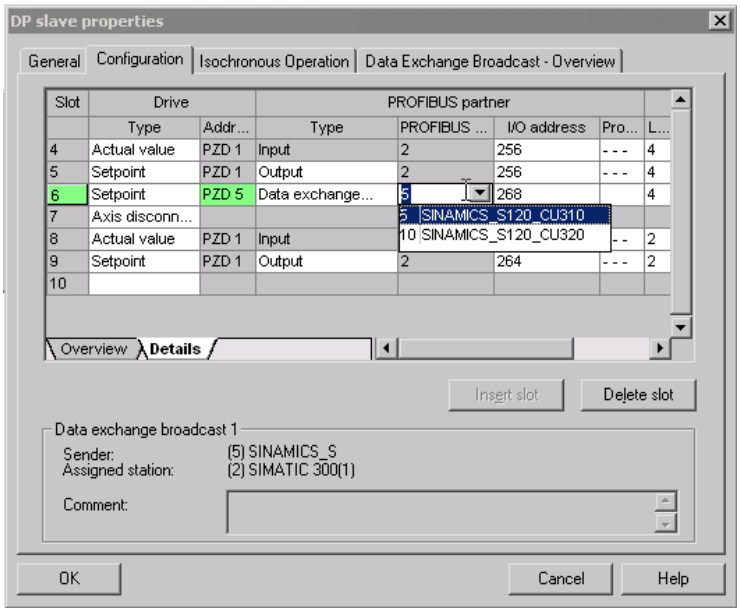


Figure 5-14 Configuring the slave-to-slave communication nodes

9. Click the "Slave-to-slave communication overview" tab.
   The configured slave-to-slave communication relationships are shown here which correspond to the current status of the configuration in HW Config.

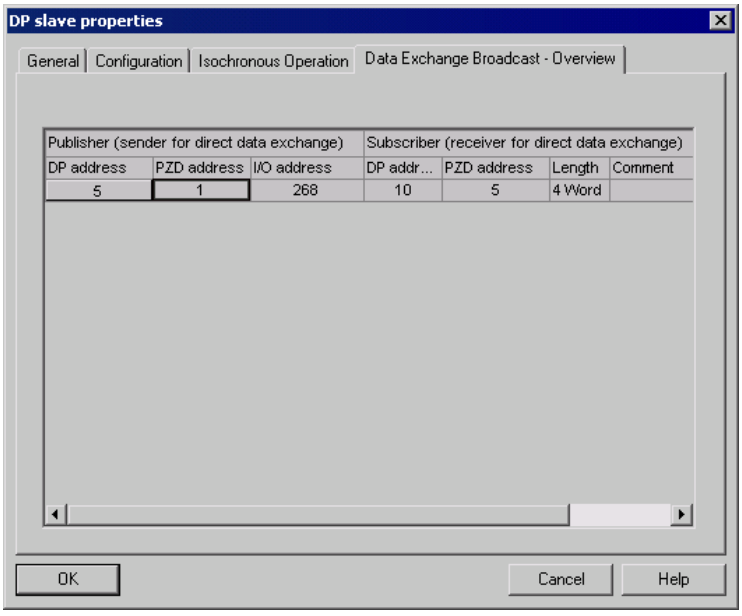


Figure 5-15 Slave-to-slave communication - overview

After the slave-to-slave communication link has been created, instead of showing "Standard telegram 2" for the drive object, "User-defined" appears in the configuration overview under telegram selection.

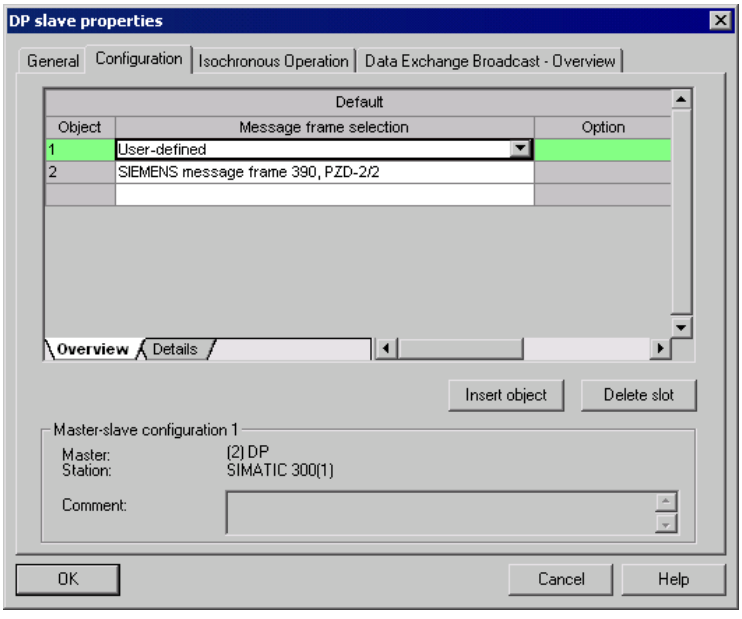


Figure 5-16 Telegram assignment for slave-to-slave communication

The details after creation of the slave-to-slave communication link for a drive object of the drive device are as follows:

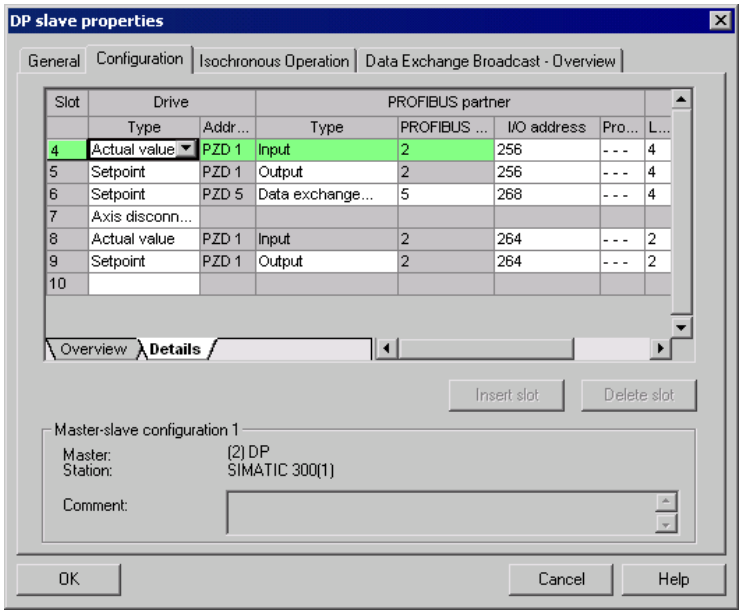


Figure 5-17 Details after the creation of the slave-to-slave communication link

10. You should therefore adjust the telegrams for each drive object of the selected drive device that is to participate actively in slave-to-slave communication.

Automatic identification in Startdrive

The settings made in HW Config for the slave-to-slave telegrams are automatically detected by Startdrive. A telegram extension is not required in Startdrive.

5.4.4 Diagnosing PROFIBUS slave-to-slave communication

Since the PROFIBUS slave-to-slave communication is implemented on the basis of a broadcast telegram, only the subscriber can detect connection or data faults, e.g. via the publisher data length (see "Configuration telegram").

The publisher can only detect and report an interruption of the cyclic connection to the DP master (A01920, F01910). The broadcast telegram to the subscriber will not provide any feedback. A fault of a subscriber must be fed back via slave-to-slave communication. In case of a "master drive" 1:n, however, the limited quantity framework (see "Links and requests") should be observed. It is not possible to have n subscribers report their status via slave-to-slave communication directly to the "master drive" (publisher).

Diagnostics can be performed using the diagnostic parameters r2075 ("Receive PROFIBUS diagnostics telegram offset PZD") and r2076 ("Send PROFIBUS diagnostics telegram offset PZD"). The parameter r2074 ("PROFIBUS diagnostics, receive bus address PZD") displays the DP address of the setpoint source of the respective PZD.

r2074 and r2075 enable the source of a slave-to-slave communication relationship to be verified in the subscriber.

Note

The subscribers do not monitor the existence of an isochronous publisher sign-of-life.

Faults and alarms with PROFIBUS slave-to-slave communication

The alarm A01945 signals that the connection to a least one publisher of the drive device is missing or has failed. Any interruption to the publisher is also reported by the fault F01946 at the affected drive object. A failure of the publisher only impacts the respective drive objects.

More detailed information on the messages can be found in the SINAMICS S120/S150 List Manual.

5.5 Messages via diagnostics channels

Overview

Messages are not just able to be displayed via the Startdrive commissioning tools. After the activation of a diagnostic function, the messages are also transferred to the higher-level controller via the standardized PROFIdrive fault classes. The messages are evaluated there or forwarded for convenient display to the corresponding user interfaces (SIMATIC HMI, TIA Portal, etc.).

In this way, problems or faults can be located immediately regardless of the tool currently being used, and then corrected immediately.

Also note the general information on the diagnostics channels in Chapter Diagnostics channels (Page 64).

Activating the diagnostic function

The diagnostics function is activated or deactivated via the parameterization of the relevant configuration tool (HW Config, TIA Portal, etc.).

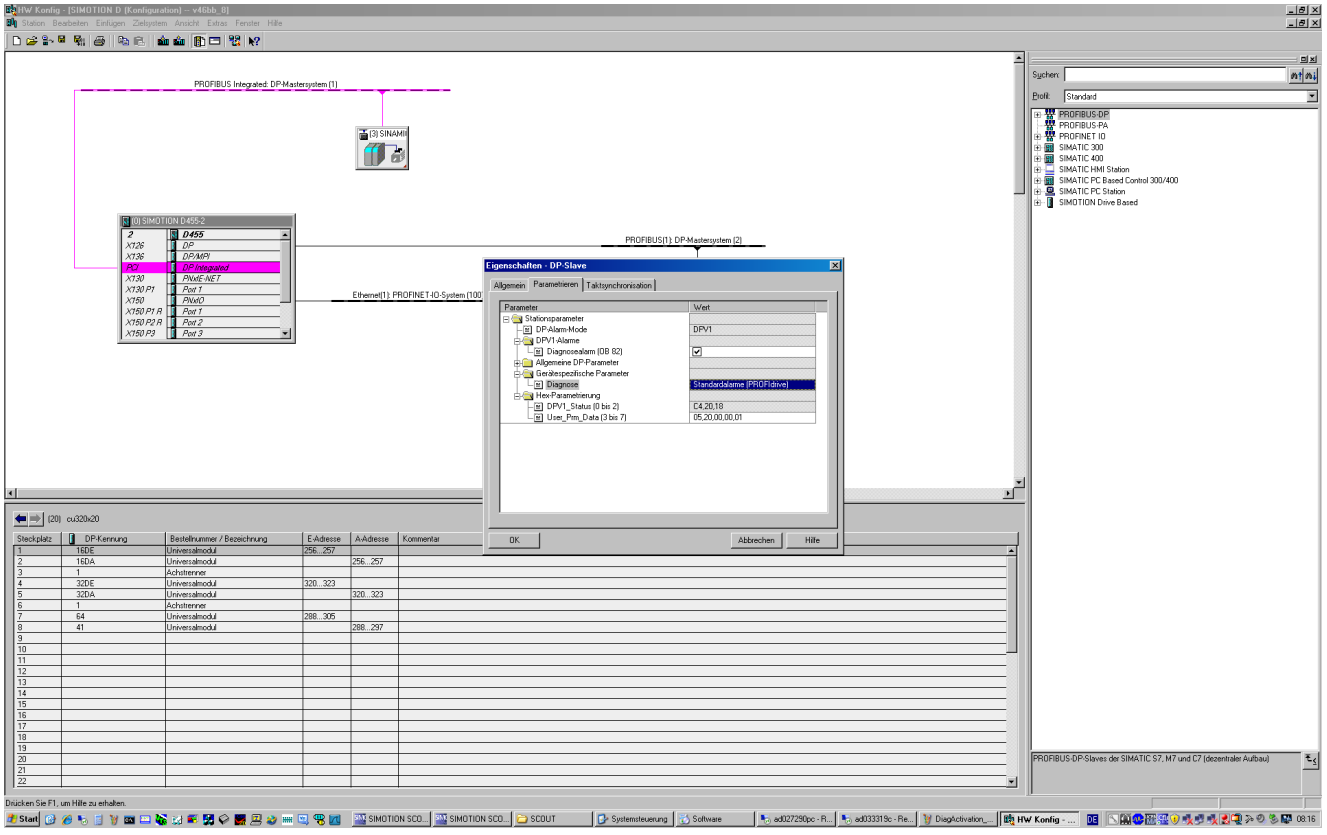


Figure 5-18 Activation of PROFIBUS

The following parameter assignments are possible:

Setting	Code for parameter assignment
Inactive	0
PROFIdrive error classes	1

When establishing the communication between SINAMICS and a master, the activated diagnostics mode of this controller is first transferred to the drive. With activated diagnostics, SINAMICS first transfers all pending messages to the master. Symmetrically, all currently active messages in the master are deleted by SINAMICS when closing the communication connection.

Messages

The message texts are described in detail in the SINAMICS S120/S150 List Manual, Section 4.1.2 "Explanations on the list of faults and alarms". A current list of the message texts can be found in the "Message classes and coding of different diagnostics interfaces" table.

Communication via PROFINET IO 6

6.1 General information about PROFINET IO

PROFINET IO is an open Industrial Ethernet standard for a wide range of production and process automation applications. PROFINET IO is based on Industrial Ethernet and observes TCP/IP and IT standards.

Deterministic signal processing in real time is important in industrial networks. PROFINET IO satisfies these requirements.

The international standard IEC 61158 ensures open, multi-vendor systems:

PROFINET IO is tuned for high-speed, time-critical data transfers at field level.

PROFINET IO

Within the context of Totally Integrated Automation (TIA), PROFINET IO is the systematic development of the following systems:

- PROFIBUS DP, the established fieldbus,
- Industrial Ethernet, the communications bus for the cell level.

Experience gained from both systems was integrated into PROFINET IO. An Ethernet-based automation standard defined by PROFIBUS International (PROFIBUS user organization), PROFINET IO is a manufacturer-independent communication and engineering model.

PROFINET IO defines every aspect of the data exchange between IO controllers (devices with so-called "master functionality" and the IO devices (devices with so-called "slave functionality") as well as carrying out parameterization and diagnostics. A PROFINET IO system is configured in virtually the same way as a PROFIBUS system.

A PROFINET IO system is assembled from the following devices:

- An IO controller controls automation tasks.
- An IO device is controlled and monitored by an IO controller. An IO device can consist of several modules and submodules.
- An IO supervisor is an engineering tool, typically based on a PC, to configure e and diagnose the individual IO devices (drive units).

IO devices: Drive units with PROFINET interface

- SINAMICS S120 with CU320-2 DP and inserted CBE20 (X1400)
- SINAMICS S120 with CU320-2 PN
- SINAMICS S120 with CU310-2 PN

Cyclic communication using PROFINET IO with IRT or using RT is possible on all drive units equipped with a PROFINET interface. This means that error-free communication using other standard protocols is guaranteed within the same network.

Note

PROFINET for drive technology is standardized and described in the following document:

PROFIBUS profile PROFIdrive - Profile Drive Technology

PROFIBUS User Organization e. V.

Haid-und-Neu-Straße 7

D-76131 Karlsruhe

You can obtain the current version from "PROFIBUS and PROFINET International (PI) (https://www.profibus.com/download/profidrive-profile-drive-technology/)".

Order no. 3.172, spec. Section 6

- IEC 61800-7

Note

For CU320-2 DP with inserted CBE20 (X1400), the cyclic PZD channel for PROFIBUS DP is deactivated. When setting parameter p8839 = 1, the PZD channel can be reactivated (see Section "Parallel operation of communication interfaces (Page 49)").

See also

Profibus address (http://www.profibus.com)

6.1.1 Real-time (RT) and isochronous real-time (IRT) communication

Real-time communication

When communication takes place via TCP/IP, the resultant transmission times may be too long and not defined to meet the production automation requirements. When communicating time-critical IO user data, PROFINET IO therefore uses its own real-time channel, rather than TCP/IP.

Real time means that a system processes external events over a defined period.

Determinism

Determinism means that a system will react in a predictable ("deterministic") manner.
With PROFINET IO with IRT, it is possible to precisely determine (predict) transmission times.

PROFINET IO with RT (Real Time)

Real-time data is treated with a higher priority than TCP(UDP)/IP data. Transmission of time-critical data takes place at guaranteed time intervals. RT communication provides the basis for data exchange with PROFINET IO.

PROFINET IO with IRT (Isochronous Real Time)

Isochronous real time: Real time property of PROFINET IO where IRT telegrams are transferred deterministically via planned communication paths in a defined sequence to achieve the best possible synchronism and performance between the IO controller and IO device (drive unit). IRT is also known as time-scheduled communication whereby knowledge about the network structure (topology) is utilized. IRT requires special network components that support planned data transfer.

SINAMICS cycle times of minimum 250 µs (onboard) / 500 µs (CBE20) and a jitter accuracy of less than 1 µs can be achieved when this transmission method is implemented.

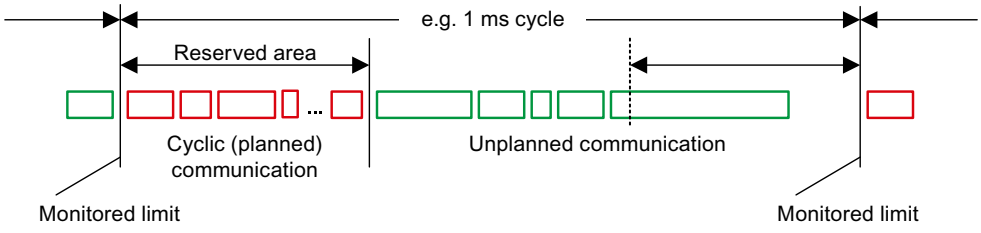


Figure 6-1 Bandwidth distribution/reservation, PROFINET IO

6.1.2 Addresses

MAC address

Every Ethernet and therefore every PROFINET interface is assigned a worldwide unique device identifier in the factory. This 6-byte long device identifier is the MAC address. The MAC address is divided up as follows:

- Three bytes for the manufacturer's ID
- Three bytes for the device identifier (consecutive number)

The MAC address is printed on a label (CBE20) or specified on the type plate (CU320-2 PN and CU310-2 PN), e.g.: 08-00-06-6B-80-C0.

The Control Units CU320-2 PN and CU310-2 PN have two integrated interfaces:

- One Ethernet interface
- One PROFINET interface with two ports

The MAC addresses of the Ethernet and PROFINET interfaces are stamped on the type plate.

IP address

The TCP/IP protocol is a prerequisite for establishing a connection and parameterization. To allow a PROFINET device to be addressed as a node on Industrial Ethernet, this device requires a unique IP address in the network. The IP address is made up of 4 decimal numbers with a range of values from 0 through 255. The decimal numbers are separated by a decimal point. The IP address comprises:

- The address of the node (also called host or network node)
- The address of the (sub) network

IP address assignment

The IP addresses of IO devices can be assigned by the IO controller and always have the same subnet mask as the IO controller. In this case, the IP address is not stored permanently. The IP address entry is lost after POWER ON/OFF. The IP address can be assigned retentively via the Startdrive function "Accessible nodes" (see SINAMICS S120 Commissioning Manual with Startdrive).

This function can also be performed with HW Config of STEP 7. The function is called "Edit Ethernet node" here.

Note

IP addresses of the onboard interfaces

It is not permissible that the IP address band of the Ethernet interface and the PROFINET interface are the same. The factory setting of the IP address of the Ethernet interface X127 is 169.254.11.22; the subnet mask is 255.255.0.0.

Note

If the network is part of an existing Ethernet company network, obtain the information (IP address) from your network administrator.

Notes regarding interface X127 LAN (Ethernet)

Note

Use

Ethernet interface X127 is intended for commissioning and diagnostics, which means that it must always be accessible (e.g. for service).

Further, the following restrictions apply to X127:

- Only local access is possible
- No networking - or only local networking in a closed and locked electrical cabinet permissible

If it is necessary to remotely access the electrical cabinet, then additional security measures must be applied so that misuse through sabotage, unqualified data manipulation and intercepting confidential data is completely ruled out (also see "Security information (Page 15)").

Device name (NameOfStation)

When it is shipped, an IO device does not have a device name. An IO device can only be addressed by an IO controller, for example, for the transfer of project engineering data (including the IP address) during startup or for user data exchange in cyclic operation, after it has been assigned a device name with the IO supervisor.

Note

The device name must be retentively saved – either with Startdrive or with the hardware configuration from STEP 7.

Note

Address information for interfaces

The address data for the corresponding interfaces can be entered in Startdrive in the expert list using the following parameters:

- X127 Ethernet interfaces:
  Parameters p8901, p8902, and p8903
- Internal PROFINET interfaces X150 P1 and P2:
  Parameters p8921, p8922 and p8923
- Interfaces of the optional CBE20 module (X1400):
  Parameters p8941, p8942 and p8943

Activating the interface configuration and saving it in non-volatile memory

To activate the interface configuration and save it in non-volatile memory, use the following parameter settings:

- X127 Ethernet interfaces: p8905 = 2
- Internal PROFINET interfaces X150 P1 and P2: p8925 = 2
- Interfaces of the optional CBE20 module (X1400): p8945 = 2

Replacing the CU320-2 DP/PN and CU310-2 PN Control Units (IO device)

If the IP address and device name are stored in non-volatile memory, this data is also forwarded with the memory card of the Control Unit. The memory card allows module exchange without an IO supervisor when a fault occurs in a PROFINET device.

If a complete Control Unit needs to be replaced due to a device or module defect, the new Control Unit automatically parameterizes and configures using the data on the memory card. Following this, cyclic exchange of user data is restarted.

6.1.3 Dynamic IP address assignment

In those cases in which the PROFINET interface is not used for the IO communication, it is possible to generate an IP address centrally using a DHCP (DHCP = Dynamic Host Configuration Protocol) server. The following requirements must be satisfied to do this:

- At least one DHCP server must be active.
- The PG/PC and the SINAMICS devices must be connected to the same physical Ethernet subnet.

Note

DHCP is not supported together with PROFINET. No cyclical connection is established for an activated DHCP. It is therefore recommended that DHCP not be used within PROFINET networks!

The DHCP address assignment can be set from the SIMATIC Manager or using SINAMICS parameters.

Setting the DHCP address assignment with SIMATIC Manager (STEP 7)

1. Call the "Target system > Edit Ethernet node" menu path in the SIMATIC Manager.
2. Click the "Search" button in the "Ethernet nodes" area.
3. Select the desired SINAMICS device.
   You can now specify in the "Edit Ethernet nodes" configuration dialog that a dynamic IP address will be generated via a DHCP server. The IP address can be identified in two ways:
   – MAC address
   – Device name (name of station)

   The "MAC address" option has the disadvantage that the MAC addresses are no longer correct after a device has been replaced.
4. Click the "Obtain the IP address from a DHCP server" option in the dialog to activate.
5. Activate either the "MAC address" or the "Device name" option in the "Identified via" area.
6. Click "Assign IP configuration".
   The IP address is then taken from the DHCP server. The SINAMICS device uses the associated setting after a POWER ON to obtain a new IP address from the DHCP server.

Setting the DHCP address assignment with SINAMICS parameters

As an alternative to the address assignment by the SIMATIC Manager, the DHCP address assignment can also be initiated using SINAMICS parameters. In this case, the Control Unit always fetches the IP address from a DHCP server after each POWER ON. You can make the settings using Startdrive "Parameter list":

1. Activate the DHCP address assignment using one of the following settings (where the values 2 and 3 mean "MAC address" and "Device name", respectively):
   - For Ethernet onboard (X127): p8904 = 2 or 3
   - For PROFINET onboard: p8924 = 2 or 3
   - For CBE20 (X1400): p8944 = 2 or 3

   The DHCP server now assigns temporarily an IP address.
2. You can now activate the interface configuration (value of 1) or activate and save retentively (value of 2). Make one of the following settings:
   - For Ethernet onboard (X127): p8905 = 1 or 2
   - For PROFINET onboard: p8925 = 1 or 2 (applies only to SINAMICS S120 devices)
   - For CBE20 (X1400): p8945 = 2
     Direct activation is not possible for the CBE20. The configuration can only be saved. The setting then becomes automatically active for the next POWER ON.

6.1.4 DCP flashing

This function is used to check the correct assignment to a module and its interfaces. This function is supported by a CU310-2 PN and a CU320-2 DP/PN with inserted CBE20. The function can also be used without CBE20 in a CU320-2 PN.

Activating DCP flashing:

1. In HW Config or the STEP 7 Manager, select the menu item "Target system > Ethernet > Edit Ethernet node".
   The "Edit Ethernet Node" dialog box opens.
2. Click the "Browse" button.
   The "Browse Network" dialog box opens and displays the connected nodes.
3. Select the CU310-2 PN or the CU320-2 DP with inserted CBE20 as node.
   The "DCP flashing" function is then activated via the "Flash" button.

The DCP flashing will be effective on the RDY LED (READY LED 2 Hz, green/orange or red/orange) on the CU310-2 PN/CU320-2 DP.

The LED will continue to flash as long as the dialog is open. When the dialog box is closed, the LED automatically goes dark. The function is available from STEP 7 V5.3 SP1 and higher via Ethernet or via Startdrive.

6.1.5 Data transfer

Properties

The PROFINET interface on a drive unit supports the simultaneous operation of:

- IRT – Isochronous Real Time Ethernet
- RT – Real Time Ethernet
- Standard Ethernet services (TCP/IP, LLDP, UDP and DCP)

PROFIdrive telegram for cyclic data transmission, acyclic services

PROFIdrive telegrams are available for implementing cyclic communication via PROFINET IO (see chapter "Communication according to PROFIdrive", Cyclic communication (Page 38)).

Telegrams to send and receive process data are available for each drive object of a drive unit with cyclic process data exchange.
In addition to cyclic data transfer, acyclic services can also be used for parameterizing and configuring the drive unit. These acyclic services can be utilized by the IO supervisor or IO controller.

6.1.5.1 Sequence of drive objects in the telegram

Sequence of drive objects in the telegram

On the drive side, the sequence of drive objects in the telegram is displayed via a list in p0978[0...24] where it can also be changed.

Using the Startdrive commissioning tool you can display the sequence of drive objects for a commissioned drive system in the project navigator under "Drive unit" > "Communication" > "Telegram configuration".

When you create the configuration on the controller side (e.g. HW Config), the process-data-capable drive objects for the application are added to the telegram in the sequence shown (see above).

The following drive objects can exchange process data:

- Active Infeed (A_INF)
- Basic Infeed (B_INF)
- Control Unit (CU_S)
- ENC
- Smart Infeed (S_INF)
- SERVO
- VECTOR
- Terminal Board 30 (TB30)
- Terminal Module 15 (TM15)
- Terminal Module 31 (TM31)
- Terminal Module 41 (TM41)
- Terminal Module 120 (TM120)
- Terminal Module 150 (TM150)

Note

The sequence of drive objects in HW Config must be the same as that in the drive (p0978).

Drive objects after the first zero in p0978 must not be configured in the HW Config.

The structure of the telegram depends on the drive objects taken into account during configuration. Configurations are permitted that do not take into account all of the drive objects that are present in the drive system.

Example:

The following configurations are possible:

- Configuration with SERVO, SERVO, SERVO
- Configuration with A_INF, SERVO, SERVO, SERVO, TB30
- ...

6.1.6 Communication channels for PROFINET

PROFINET connection channels

- A Control Unit has an integrated Ethernet interface (X127).
- The PROFINET versions CU320-2 PN and CU310-2 PN each have a PROFINET interface (X150) with two onboard ports: P1 and P2
- A CU320-2 PN or a CU310-2 PN Control Unit can simultaneously establish a total of eight acyclic connections (e.g. S7) via the integrated PROFINET interfaces.

Notes regarding interface X127 LAN (Ethernet)

Note

Use

Ethernet interface X127 is intended for commissioning and diagnostics, which means that it must always be accessible (e.g. for service).

Further, the following restrictions apply to X127:

- Only local access is possible
- No networking - or only local networking in a closed and locked electrical cabinet permissible

If it is necessary to remotely access the electrical cabinet, then additional security measures must be applied so that misuse through sabotage, unqualified data manipulation and intercepting confidential data is completely ruled out (also see "Security information (Page 15)").

Control Unit with CBE20

A Communication Board can be optionally inserted in the CU320-2 PN/DP Control Unit:

- The CBE20 Communication Board (X1400) is a PROFINET switch with 4 additional PROFINET ports.

Notes

Note

PROFINET routing

Routing is not possible between the onboard interfaces X127 and X150 – or between the onboard interfaces of the Control Unit 320-2 PN and an inserted CBE20 (X1400).

Note

PROFINET interfaces on the CU320-2 PN with CBE20

The integrated PROFINET interface of the CU320-2 PN is independent of the optionally inserted CBE20 module. The two PROFINET interfaces are not connected with each other. Routing is not possible between the two PROFINET interfaces.

Note

Ring topology

When connecting the ports, it must be ensured that for standard applications a ring topology is not created. Additional information on ring topologies can be found in Section Media redundancy (Page 144).

Note

Support for the medium-dependent interface auto-MDI(X)

- The Ethernet interface does not support auto-MDI(X). If the LAN interface of the communication partner also cannot handle auto-MDI(X), then a crossover cable must be used to establish the connection.
- The PROFINET interfaces support Auto MDI(X). It is therefore possible to use both crossed and uncrossed cables to connect the devices.
- The CBE20 Communication Board also supports auto-MDI(X). It is therefore possible to use both crossed and uncrossed cables to connect the devices.

6.1.7 References

- The integration of a SINAMICS S120 with CU310-2 PN/CU320-2 DP/CU320-2 PN in a PROFINET IO system is described in detail in the "SIMOTION SCOUT Communication" System Manual.
- For an example of how to link a Control Unit to a SIMATIC S7 via PROFINET IO, please refer to the FAQ in the Online Support "PROFINET IO communication between an S7-CPU and SINAMICS S120 (http://support.automation.siemens.com/WW/view/en/27196655)".

- A description of the CBE20 and how you can install it is provided in the SINAMICS S120 Control Units and Additional System Components Manual.
- The PROFINET interface on the CU310-2 PN unit is described in the SINAMICS S120 AC Drive Manual:

6.1.8 Overview of important parameters

Ethernet interface

- p8900[0...239] IE Name of Station
- p8901[0...3] IE IP Address
- p8902[0...3] IE Default Gateway
- p8903[0...3] IE Subnet Mask
- p8904 IE DHCP Mode
- p8905 IE Interface Configuration
- r8910[0...239] IE Name of Station actual
- r8911[0...3] IE IP Address actual
- r8912[0...3] IE Default Gateway actual
- r8913[0...3] IE Subnet Mask actual
- r8915[0...5] IE MAC Address

Integrated PROFINET interface

- p8920[0...239] PN name of station
- p8921[0...3] PN IP address
- p8922[0...3] PN default gateway
- p8923[0...3] PN Subnet Mask
- p8924 PN DHCP mode
- p8925 PN interfaces configuration
- r8930[0...239] PN Name of Station actual
- r8931[0...3] PN IP Address actual
- r8932[0...3] PN Default Gateway actual
- r8933[0...3] PN Subnet Mask actual
- r8935[0...5] PN MAC Address
- r8936[0...1] PN cyclic connection state
- r8937[0...5] PN diagnostics
- r61000[0...239] PROFINET name of station
- r61001[0...3] PROFINET IP of station

CBE20

- p8940[0...239] CBE2x Name of Station
- p8941[0...3] CBE2x IP address
- p8942[0...3] CBE2x Default Gateway
- p8943[0...3] CBE2x Subnet Mask
- p8944 CBE2x DHCP mode
- p8945 CBE2x interfaces configuration
- r8950[0...239] CBE2x Name of Station actual
- r8951[0...3] CBE2x IP address actual
- r8952[0...3] CBE2x Default Gateway actual
- r8953[0...3] CBE2x Subnet Mask actual
- r8954 CBE2x DHCP Mode actual
- r8955[0...5] CBE2x MAC address
- r8959 CBE2x DAP ID
- r61000[0...239] PROFINET name of station
- r61001[0...3] PROFINET IP of station

6.2 RT classes for PROFINET IO

PROFINET IO is a scalable realtime communication system based on Ethernet technology. The scalable approach is expressed with three realtime classes.

RT

RT communication is based on standard Ethernet. The data is transferred via prioritized Ethernet telegrams. As standard Ethernet does not support any synchronization mechanisms, isochronous operation is not possible with PROFINET IO with RT.

The real update cycle in which cyclic data is exchanged depends on the bus load, the devices used and the quantity framework of the I/O data. The update cycle is a multiple of the send cycle.

IRT

Two options are available with this RT class:

- IRT "high flexibility"
- IRT "high performance"

The real-time classes IRT "high flexibility" and IRT "high performance" can be selected as options in the synchronization settings configuration area of HW Config. In the description below, both these classes are simply referred to as "IRT".

Software preconditions for configuring IRT:

- STEP 7 5.4 SP4 (HW Config)

Note

For further information about configuring the PROFINET interface for the I/O controller and I/O device, please refer to the following document: SIMOTION SCOUT Communication System Manual.

IRT "high flexibility"

The telegrams are sent cyclically in a deterministic cycle (Isochronous Real Time). The telegrams are exchanged in a bandwidth reserved by the hardware. One IRT time interval and one standard Ethernet time interval are created for each cycle.

Note

IRT "high flexibility" cannot be used for isochronous applications.

IRT "high performance"

In addition to the bandwidth reservation, the telegram traffic can be further tuned by configuring the topology. This enhances the performance during data exchange and the deterministic behavior. The IRT time interval can thus be further tuned or minimized with respect to IRT "high flexibility".

In addition to the isochronous data transfer provided by IRT, even the application itself (position control cycle, IPO cycle) can be isochronous in the devices. This is an essential requirement for closed-loop axis control and synchronization via the bus. Isochronous data transfer with cycle times well below one millisecond and with a deviation in the cycle start (jitter) of less than a microsecond provide sufficient performance reserves for demanding motion control applications.

In contrast to standard Ethernet and PROFINET IO with RT, the telegrams for PROFINET IO with IRT are transferred according to a schedule.

Modules

The following S110/S120 modules support the IRT "high performance":

- S120 CU320 together with the CBE20
- S120 CU320-2 DP together with the CBE20
- S120 CU320-2 PN
- S120 CU310 PN
- S120 CU310-2 PN
- S110 CU305 PN

Clock generation via PROFINET IO (isochronous communication)

SINAMICS S120 with CU310-2 PN/CU320-2 DP/CU320-2 PN can only assume the role of a synchronization device within a PROFINET IO network.

For a CU310-2 PN/CU320-2 DP/CU320-2 PN with CBE20 module, the following applies:

- Transmission type IRT, IO device is synchronization slave and isochronous, send cycle is applied to bus: Control Unit synchronizes with the bus and the send cycle becomes the cycle for the Control Unit.
- RT or IRT (option drive unit "not isochronous") has been configured. SINAMICS uses the local cycle configured in SINAMICS.

The following applies to a CU320-2 DP/CU320-2 PN for which a CBE20 is configured, but does not actually exist:

- SINAMICS uses the local clock (clock configured in SINAMICS); if there is no data exchange via PROFINET, alarm A01487 is output ("Topology: Comparison option slot components missing in the actual topology").
  Access via PROFINET is not available.

Comparison between RT and IRT

Table 6-1 Comparison between RT and IRT

	RT	IRT "high flexibility"	IRT "high performance"
Transfer mode	Switching based on the MAC address; prioritization of the RT telegrams possible using Ethernet-Prio (VLAN tag).	Switching using the MAC address; bandwidth reservation by reserving an IRT "high flexibility" interval in which only IRT "high flexibility" frames are transferred but, for example, no TCP/IP frames.	Path-based switching according to a topology-based plan; no transmission of TCP/IP frames and IRT "high flexibility" frames in the IRT "high performance" interval.
Isochronous application in the IO controller	No	No	Yes
Determinism	Variance of the transmission duration by started TCP/IP telegrams.	Guaranteed transmission of the IRT "high flexibility" telegrams in the current cycle by the reserved bandwidth.	Exactly planned transfer; times for transmission and receiving are guaranteed for any topologies.
Reload the network configuration after a change	Not relevant	Only when the size of the IRT "high flexibility" interval needs to be modified (reservation of position is possible).	Always when the topology or the communications relationships change.
Maximum switching depth (number of switches in one line)	10 at 1 ms	61	64
For possible send cycles, see subitem "Send cycles and update cycles for RT classes" in table "Adjustable send cycles and update cycles"			

Set the RT class

The RT class is set by means of the properties of the controller interface of the IO controller. If RT class IRT "high performance" is set, it is not possible to operate any IRT "high flexibility" devices on the IO controller and vice versa. IO devices with RT can always be operated, regardless of the IRT class setting.

You can set the RT class in the HW Config for the associated PROFINET device.

1. In HW Config, double-click item PROFINET interface in the module.
   The "Properties" dialog box opens.
2. Select the RT class under RT class on the "Synchronization" tab.
3. Once you have selected "IRT", you can also choose between option "high flexibility" and "high performance".
4. Confirm with "OK".

Synchronization domain

The sum of all devices to be synchronized form a synchronization domain. The whole domain must be set to a single, specific RT class (real-time class) for synchronization. Different synchronization domains can communicate with one another via RT.

For IRT, all IO devices and IO controllers must be synchronized with a common synchronization master.

RT allows an IO controller to communicate with a drive unit outside a synchronization domain or "through" another synchronization domain. As of version 5.4 SP1, STEP 7 supports multiple synchronization domains on a single Ethernet subnet.

Example:

- Synchronization domain IRT: SIMOTION2 with SINAMICS
- SINAMICS drive that is assigned to the I/O system of SIMOTION1. This is arranged in the topology in such a way that its RT communication must be established through the IRT synchronization domain.

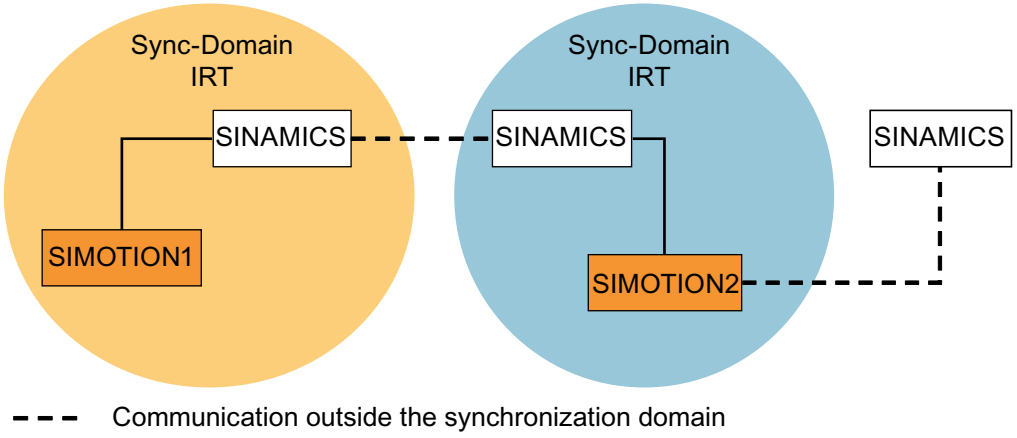


Figure 6-2 RT communication across the limits of synchronization domains

Update cycles and send cycles for RT classes

Definition of the update time / send cycle:

If we take a single IO device in the PROFINET IO system as an example, this device has been supplied with new data (outputs) by the IO controller and has transferred new data (inputs) to the IO controller within the update time. The send cycle is the shortest possible update cycle.

All cyclic data is transferred within the send cycle. The actual send cycle that can be set depends on various factors:

- Bus load
- Type of devices used
- Computing capacity available in the IO controller
- Supported send clocks in the participating PROFINET devices of a synchronization domain. A typical send cycle is 1 ms.

The table below specifies the reduction ratios which can be set between the send cycle and the update times for IRT "high performance", IRT "high flexibility", and RT.

Table 6-2 Settable send cycles and update cycles

Send cycle		Reduction ratios between update time and send cycles	
		RT IRT "high flexibility" [4]	IRT "high performance"
Range "even" [1]	250, 500, 1000 µs	1, 2, 4, 8, 16, 32, 64, 128, 256, 512	1, 2, 4, 8, 16[2]
	2000 µs	1, 2, 4, 8, 16, 32, 64, 128, 256	1, 2, 4, 8, 16[2]
	4000 µs	1, 2, 4, 8, 16, 32, 64, 128	1, 2, 4, 8, 16[2]
Range "odd" [3]	375, 625, 750, 875, 1125, 1250 µs ... 3875 µs (increment 125 µs)	Not supported[5]	1

Explanations for the above table:

1) It is only possible to set send cycles from the "even" range when IO devices with real-time class "RT" are assigned to a synchronization domain. Likewise, only the reduction ratios from the "even" range can be set for a send cycle setting from the "even" range.

2) It is generally only possible to set a reduction ratio of 1:1 between the update time and send cycle for IO devices (ET200S IM151-3 PN HS, SINAMICS S) which are operated in isochronous mode. In this case, the update cycle mode must always be set to "fixed factor" (under IO device properties, "IO cycle" tab, "Mode" pulldown menu). This means that STEP 7 will not automatically adjust the update cycle and thus the update cycle will always correspond to the send cycle.

3) The send cycles from the "odd" range can be set only if a synchronization domain does not include any IO devices with real-time class "RT". Likewise, only the reduction ratios from the "odd" range can be set for a send cycle setting from the "odd" range.

4) Isochronous operation is not compatible with IRT "high flexibility".

5) Odd send cycles can be used only if the IO systems assigned to the synchronization domain do not include any RT or IRT "high flexibility" devices.

Furthermore, the send cycles which can actually be set are determined by the intersection of the send cycles supported by all the devices in the synchronization domain.

The reduction ratio between the update cycle of an IO device and the send cycle is set in the "Properties" of the PROFINET interface for the relevant device.

Note

There is no intersection between the send cycles for the "even" and "odd" ranges!

Send cycles for SINAMICS drive units

A SINAMICS drive unit with PROFINET interface which supports IRT permits send cycle settings of between 0.25 ms and 4.0 ms in a 250 µs time frame.

Topology rules

Topology rules for RT

- A topology can be, but need not be configured for RT. If a topology has been configured, the devices must be wired in accordance with the topology.
- Otherwise, the wiring between devices is entirely optional.

Topology rules for IRT

- Mixed operation is not supported by STEP 7 V5.4 SP4, i.e. IRT "high performance" cannot be combined with IRT "high flexibility" in the same synchronization domain.
- A synchronization domain with IRT "high performance" can contain a maximum of one IRT "high performance" island. "Island" means that the devices must be interconnected to match the configured topology. A synchronization master must be positioned in the relevant island.
- IRT "high flexibility" is subject to the same topology rules as for IRT "high performance", the only exception being that a topology does not need to be configured. However, if a topology has been configured, the devices must be wired to match the topology.

Device selection in HW Config

Hardware catalog

The drive unit from the appropriate device family entry in the hardware catalog must be configured. For the real-time class IRT, these are all entries as of firmware version V2.5.

GSDML

GSDML files for devices which contain IRT as of firmware version V2.5.

6.3 PROFINET GSDML

SINAMICS S120 supports the GSDML version: "PROFINET GSDML" to embed the converter in a PROFINET network.

PROFINET GSDML allows standard telegrams to be combined with a PROFIsafe telegram – and if required, a telegram extension. Each of the modules has four subslots: The Module Access Point (MAP), the PROFIsafe telegram, a PZD telegram to transfer process data and where necessary, a telegram for PZD extensions. Example:

GSDML-V2.31-Siemens-Sinamics_S_CU3x0_20160101.xml

You can download GSDML files from the following Siemens Internet address:

PROFINET GSDML (https://support.industry.siemens.com/cs/ww/en/view/49217480)

The GSDML files on the memory card are saved in the following location: ..\SIEMENS\SINAMICS\DATA\CFG\PNGSD.ZIP

Submodules depending on the particular drive object

The following table shows the possible submodules depending on the particular drive object.

Table 6-3 Submodules depending on the particular drive object

Module	Sub-slot 1 MAP	Subslot 2 PROFIsafe	Subslot 3 PZD telegram	Subslot 4 PZD extension	Subslot 5	Max. num-ber of PZD
SERVO	MAP	Telegram 30/31/901/902/903	Telegrams: 1...220 free PZD-16/16	Supplementary telegrams 700/701/750, PZD-2/2, -2/4, -2/6, -8/8	Supplementary telegrams 700/701/750, PZD-2/2, -2/4, -2/6, -8/8	20/28
VECTOR	MAP	Telegram 30/31/901/902/903	Telegrams: 1...352 free PZD-16/16, 32/32	Supplementary telegrams 700/701/750, PZD-2/2, -2/4, -2/6, -8/8	Supplementary telegrams 700/701/750, PZD-2/2, -2/4, -2/6, -8/8	32/32
Infeed	MAP	Reserved	Telegrams: 370, 371 free PZD-4/4	PZD-2/2, -2/4, -2/6	Reserved	10/10
Encoder	MAP	Reserved	Telegrams: 81, 82, 83 free PZD-4/4	PZD-2/2, -2/4, -2/6	Reserved	4/12
TB30, TM31, TM15 DI_DO, TM120	MAP	Reserved	Telegrams: no free PZD-4/4	Reserved	Reserved	5/5
TM150	MAP	Reserved	Telegrams: no free PZD-4/4	Reserved	Reserved	7/7
TM41	MAP	Reserved	Telegrams: 3 free PZD-4/4, 16/16	Reserved	Reserved	20/28
Control Unit	MAP	Reserved	Telegrams: 390, 391, 392, 393, 394, 395 free PZD-4/4	Reserved	Reserved	5/21
TM15/TM17	Not supported.					

The telegrams in subslots 2, 3 and 4 can be freely configured, i.e. they can also remain empty.

Configuration

1. Insert a "DO SERVO/VECTOR/..." module.
2. Insert the optional submodule "PROFIsafe telegram 30".
3. Insert a submodule "PZD telegram xyz".
4. Insert the optional submodule "PZD extension".
5. Assign the I/O addresses for the module and the submodules.

You will find a detailed description for processing a GSDML file in HW Config in the SIMATIC documentation.

6.4 Motion Control with PROFINET

Motion Control / isochronous drive link with PROFINET

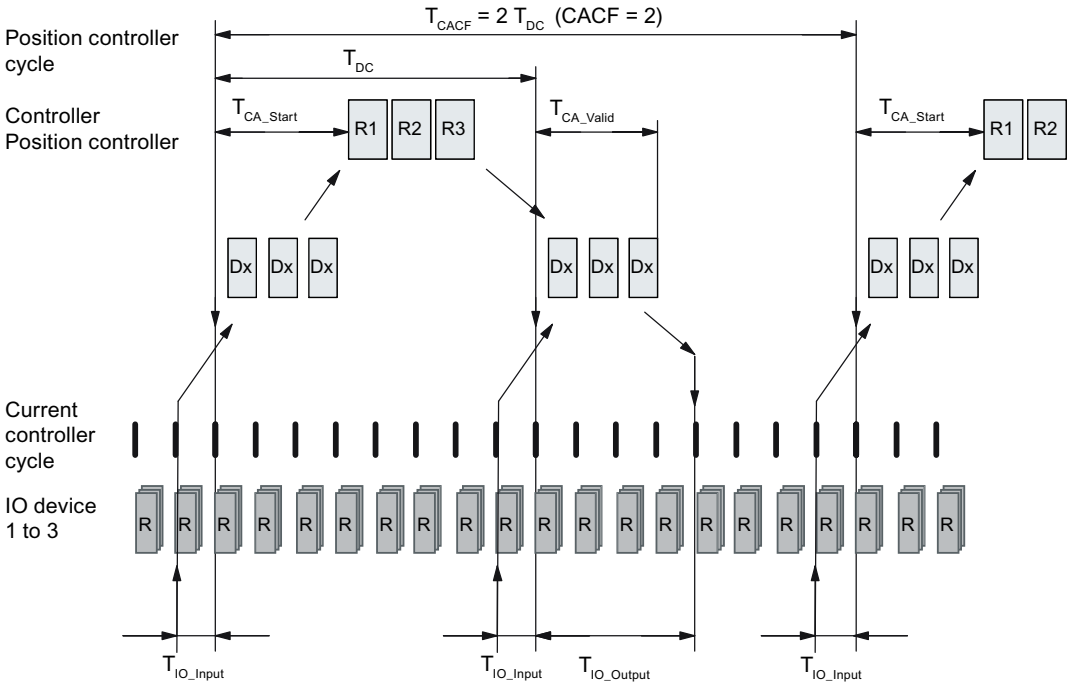


Figure 6-3 Motion Control / isochronous drive link with PROFINET, optimized cycle with CACF = 2 (Controller Application Cycle Factor)

When planning the communication system, please observe the following interrelationships between the synchronism of the communication and your specific application:

- Isochronous data transfer
  With the PROFINET IRT (Isochronous Real Time) communication profile, PROFINET provides a mechanism for isochronous data transfer. Details are provided in Chapter "RT classes for PROFINET IO (Page 118)".
- Synchronous applications
  - An isochronous application involves an application where it is necessary to have a precise correlation of the process data with respect to time (process data image that is consistent over time). Process data are transferred with a synchronized communication.
  - You must synchronize the application to the communication cycle so that the bus and the application can interact with one another. This means that you can directly correlate all process data of a communication cycle with respect to time.

6.4.1 Sequence of data transfer to closed-loop control system

1. Actual position value G1_XIST1 is read into the telegram image at time T_{IO_Input} before the start of each clock cycle - and transferred to the controllers in the next cycle.
2. Closed-loop control of the controller starts at time T_{CA_Start} after each position controller cycle and uses the current actual values read previously from the devices.
3. In the next cycle, the controller transfers the calculated setpoints to the telegram image of the device. The speed setpoint command NSET_B is issued to the closed-loop control system at time T_{IO_Output} after the beginning of the cycle.

Note

With the isochronous telegram setting, the complete SINAMICS device is in clock cycle synchronism with all data. Reasons:

- Between the controller and device, all data are only exchanged in one IRT frame.
- In SINAMICS, all data are consistently processed in synchronism.

Designations and descriptions for motion control

Table 6-4 Time settings and meanings

Name	Limit value	Description
T_{DC_BASE}	-	Time basis for cycle time T_{DC} calculation: T_{DC_BASE} = T_DC_BASE · 31.25 µs = 4 · 31.25 µs = 125 µs
T_{DC}	T_DC_MIN ≤ T_DC ≤ T_DC_MAX	Cycle time T_{DC} = T_DC · T_{DC_BASE} ,T_DC: integer factor CBE20: T_{DC_MIN} = T_DC_MIN · T_{DC_BASE} = 4 · 125 µs = 500 µs T_{DC_MAX} = T_DC_MAX · T_{DC_BASE} = 32 · 125 µs = 4 ms X150 (CU3x0-2 PN): T_{DC_MIN} = T_DC_MIN · T_{DC_BASE} = 2 · 125 µs = 250 µs T_{DC_MAX} = T_DC_MAX · T_{DC_BASE} = 32 · 125 µs = 4 ms
T_{CACF}	CACF = 1-14	IO controller application cycle time This is the time frame in which the IO controller application generates new setpoints (e.g. in the position controller cycle). Calculation example: T_{CACF} = CACF · T_DC = 2 · 500 µs = 1 ms
T_{CA_Valid}	T_{CA_Valid} < T_{DC}	Time, measured from the beginning of the cycle, at which the actual values of all IO devices for the controller application process (position control) are available.
T_{CA_Start}	T_{CA_Start} > T_{CA_Valid}	Time, measured from the beginning of the cycle, at which the controller application process (position control) starts.
T_{IO_BASE}		Timebase for T_{IO_Input}, T_{IO_Output} T_{IO_BASE} = T_IO_BASE · 1 ns = 125000 · 1 ns = 125 µs

Name	Limit value	Description
T_{IO_Input}	T_IO_InputMIN ≤ T_IO_Input < T_DC	Time of actual value acquisition This is the time at which actual values are acquired before a new cycle starts. T_{IO_Input} = T_IO_Input · T_{IO_BASE} T_IO_Input: integer factor
	$T_{IO\_InputMIN}$	Minimum value for T_{IO_Input} Calculation: $T_{IO\_InputMIN}$ = T_IO_InputMIN · T_{IO_BASE} = 375 µs
T_{IO_Output}	T_IO_Output_valid + T_IO_OutputMIN ≤ T_IO_Output < T_DC	Time of setpoint transfer This is the time, calculated from the beginning of the cycle, at which the transferred setpoints (speed setpoint) are accepted by the closed-loop control system. T_{IO_Output} = T_IO_Output · T_{IO_BASE} T_IO_Output: integer factor
	$T_{IO\_OutputMIN}$	Minimum value for T_{IO_Output} Calculation: $T_{IO\_OutputMIN}$ = T_IO_OutputMIN · T_{IO_BASE} = 250 µs
	T_IO_Output_valid	The time after which the new control output data (setpoints) is available for the drive object.
Dx		Data_Exchange This service is used to implement user data exchange between the IO controller and IO device 1 - n.
R or Rx		Computation time, current or position controller

Setting criteria for times

- Cycle (T_{DC})
  - T_{DC} must be set to the same value for all bus nodes. T_{DC} is a multiple of SendClock.
  - T_{DC} > T_{CA_Valid} and T_{DC} ≧ T_{IO_Output}
    T_{DC} is thus large enough to enable communication with all bus nodes.
- T_{IO_Input} and T_{IO_Output}
  - Setting the times in T_{IO_Input} and T_{IO_Output} to be as short as possible reduces the dead time in the position control loop.
  - T_{IO_Output} > T_{CA_Valid} + $T_{IO\_Output\_MIN}$
- Settings and tuning can be done via a tool (e.g. HW Config in SIMATIC S7).

6.4.2 User data integrity

User data integrity is verified in both transfer directions (IO controller <—> IO device) by a sign-of-life (4-bit counter).

The sign-of-life counters are incremented from 1 to 15 and then start again at 1.

- IO controller sign-of-life
  - STW2.12 ... STW2.15 are used as the IO controller sign-of-life.
  - The IO controller sign-of-life counter is incremented in each IO controller application cycle (T_{CACF}).
  - The number of sign-of-life errors tolerated can be set via p0925.
  - p0925 = 65535 deactivates sign-of-life monitoring on the IO device.
  - Monitoring
    The IO controller sign-of-life is monitored on the IO device and any sign-of-life errors are evaluated accordingly.
    The maximum number of tolerated IO controller sign-of-life errors in succession can be set via p0925.
    If the number of tolerated sign-of-life errors set in p0925 is exceeded, the response is as follows:
    1. A fault (F01912) is output.
    2. The value "0" is output as the IO device sign-of-life.
    3. A new synchronization (at least 15 received correct signs-of-life in succession) with the IO controller sign-of-life is started.
    One sign-of-life error can be reset with ten correct signs-of-life in succession.
- IO device sign-of-life
  - ZSW2.12 ... ZSW2.15 are used as the IO device sign-of-life.
  - The IO device sign-of-life counter is incremented in each DC cycle (T_{DC}).
  - Monitoring of the IO device sign-of-life can be implemented in the controller application.

6.4.3 Overview of important parameters

Overview of important parameters (see SINAMICS S120/S150 List Manual)

T_{DC}	r2064[1]	PB/PN diagnostics isochronous operation: Bus cycle time
T_{CACF}	r2064[2]	PB/PN diagnostics isochronous operation: Master cycle time
T_I	r2064[3]	PB/PN diagnostics isochronous operation: Instant that the actual value is acquired
T_O	r2064[4]	PB/PN diagnostics isochronous operation: Instant that the set-point is acquired

6.5 Communication with CBE20

The CBE20 is a flexibly usable communications module that can operate with different communication profiles. You can only load the firmware of a communication profile at any one time. The available firmware files are saved with the communication profiles in UFW files on the Control Unit memory card. Firmware can only be selected prior to commissioning.

Select the required file via parameter p8835. Carry out a POWER ON after selecting the required UFW file. During the subsequent system boot, the corresponding UFW file is loaded. The new selection then becomes active.

Table 6-5 Functionality and selection in the pointer file

Functionality (p8835)	Content	Detailed information on this is provided in Chapter:
PROFINET device	1	-
PROFINET Gate	2	"Communication via PROFINET Gate (Page 129)"
SINAMICS Link	3	"Communication via SINAMICS Link (Page 195)"
EtherNet/IP	4	"Communication via Ethernet/IP (EIP) (Page 175)"
Modbus TCP	5	"Communication via Modbus TCP (Page 159)"
Customer-specific[1)] from OEM directory	99	-

1) Path for the UFW file and folders on the memory card: /OEM/SINAMICS/CODE/CB/CBE20.UFW

Identification of the firmware version

Parameter r8858 can uniquely identify the loaded firmware version of the PROFINET interface.

Overview of important parameters (see SINAMICS S120/S150 List Manual)

- p8835 CBE20 firmware selection
- r8858[0...39] COMM BOARD read diagnostics channel
- r8859[0...7] COMM BOARD identification data

6.6 Communication via PROFINET Gate

The "PN GATE FOR SINAMICS" is a PROFINET solution for controller manufacturers or mechanical equipment manufacturers who wish to simply integrate an interface to a PROFINET network in their controllers. PROFINET communication is implemented via the standard Ethernet interface of the controller without the need for a communication module or an option module.

"PN GATE FOR SINAMICS" enables control devices with a standard Ethernet interface to be connected isochronously via PROFINET with IRT to SINAMICS S120 and motion control, robotics or CNC applications to be implemented with SINAMICS S120 drives. In addition to the SINAMICS S120, other PROFINET devices (drives, distributed I/O, etc.) can be connected.

Possible drive units:

- CU320-2 PN

The CBE20 in the CU320-2 PN of the SINAMICS S120 contains the "PN Gate" function (p8835 = 2). The PN Gate represents the controller in the sense of PROFINET. It covers a standard PROFINET network.

The CBE20 (port 4) is connected via the standard Ethernet interface of the machine control.

The controller supplies the PROFINET controller in the CBE20 with the content required for all the I/O data cyclically and in a compact form in one or more Ethernet telegrams. For this purpose, a driver (part of the PN Gate) is used on the controller for the communication with the CBE20.

The CBE20 then distributes the I/O data to each individual device in the PROFINET network with one telegram in each case - both IRT and RT telegrams.

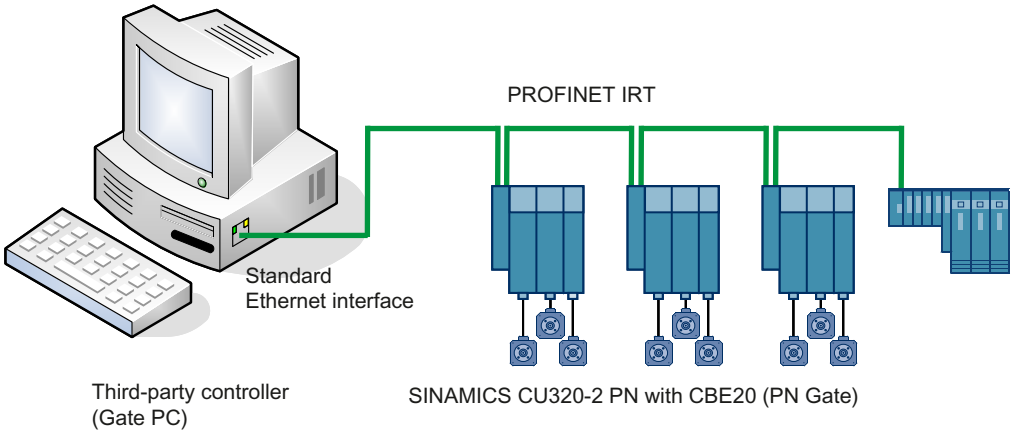


Figure 6-4 Schematic representation of SINAMICS PROFINET Gate (in short: PN Gate)

6.6.1 Functions supported by PN Gate

PN Gate function overview

Function	Description
Communication channels	• Cyclic data communication: – IRT – RT • Acyclic data communication: – PROFINET alarms – Read/write data record – TCP/IP
PROFINET basic services	• LLDP • DCP • SNMP
Accesses to process data	Access to the process image: • Subslot granular • Device granular
Consistency of the cyclic data	Each process data communication cycle can contain a data component for IRT and RT communication
Network topologies	• Line • Star • Tree
Information from the PN Gate	• Device number • Slot number with the associated subslot numbers • IO address • Diagnostic addresses • Module ID (vendor ID and module ID) • Send cycles and update times
Activating/deactivating	Activating and deactivating devices via the API without alarm triggering
Automatic address assignment	Topology-based initialization
Number of IO devices	A maximum of 64 devices
IO area in the controller	• 4096 bytes each, in and out • Maximum number of slots: 2048 • Maximum bytes per slot/module size: 254 bytes
Send cycle	• RT communication: 1 ms Update times RT 2^n with n = 0 to 9x send cycle • IRT communication 1 ms ... 4 ms in increments of 250 µs minimum send cycle of 1 ms for 32 devices. It is permissible to reduce the data per device.

6.6.2 Preconditions for PN Gate

Hardware

- SINAMICS CU320-2 PN with firmware version as of 4.5
- Communication Board Ethernet 20 (CBE20)
- Short Ethernet cable to connect CBE20 and CU320-2 PN (X150)
  Recommendation: Ethernet cable with the article number: 6SL3060-4AB00-0AA0
- Control hardware with standard Ethernet interface (100 Mbit/s or higher),
  for example, the SIMATIC Box IPC 427C.

Note

The Gate PC must guarantee the short latency times required for operating the PN Gate. Influencing variables are the CPU performance, mainboard hardware (Ethernet chipset and its connection), and the BIOS and the software components involved (operating system components such as memory mapping, Ethernet driver, interrupt link, configuration).

Software

- STARTER as of V4.3

  Note
  Startdrive

  Please note that you still cannot use this function with Startdrive.

  or
- Drive ES as of V5.5
  or
- SIMATIC STEP 7 as of V5.5 SP2
- Development kit for the development and configuration:
  - SINAMICS PN Gate DevKit (Article No. 6SL3071-0CA00-0XA0)
- Licenses
  - The PN Gate CU requires a runtime license with Article No. 6SL3074-0AA03-0AA0 or the Z option G01 for CFC.

PROFINET version

- SINAMICS PN Gate V2 is compatible with PROFINET V2.2

Scope of delivery PN Gate Dev Kit (Development Kit)

The PN Gate development kit is supplied on a DVD and contains the following components:

- STEP 7 add-on setup
  - CD1
    PN Gate add-on setup for STEP7 5.5 SP2, STARTER 4.3, SINAMICS 4.5
- PN Gate driver
  - Bin
    Binary files of the driver in the Tar format.
  - Src
    Source files as a zip file and unzipped.
  - Doc
    Doxygen documentation as zip file. The Doxygen documentation is available in HTML and PDF format.
- Application example
  - PROFIdrive sample applications in binary and in source code.
- Documentation
  - German
    PN Gate documentation in German.
  - English
    PN Gate documentation in English.

You can find additional information in the "SINAMICS 120 PN Gate Configuration Manual".

6.7 PROFINET with 2 controllers

6.7.1 Control Unit settings

Note

Operation with two controllers is only possible in conjunction with an F-CPU.

SINAMICS S120 allows 2 controllers to be connected simultaneously to a Control Unit via PROFINET, e.g. an automation controller (A-CPU) and a safety controller (F-CPU).

SINAMICS S supports for this communication the PROFIsafe standard telegrams 30 and 31, as well as the Siemens telegrams 901, 902 and 903 for the safety controller.

Example

The following diagram shows a configuration example of a drive with three axes. The A-CPU sends Siemens telegram 105 for axis 1 and Siemens telegram 102 for axis 2. The F-CPU sends PROFIsafe telegram 30 for axis 1 and axis 3.

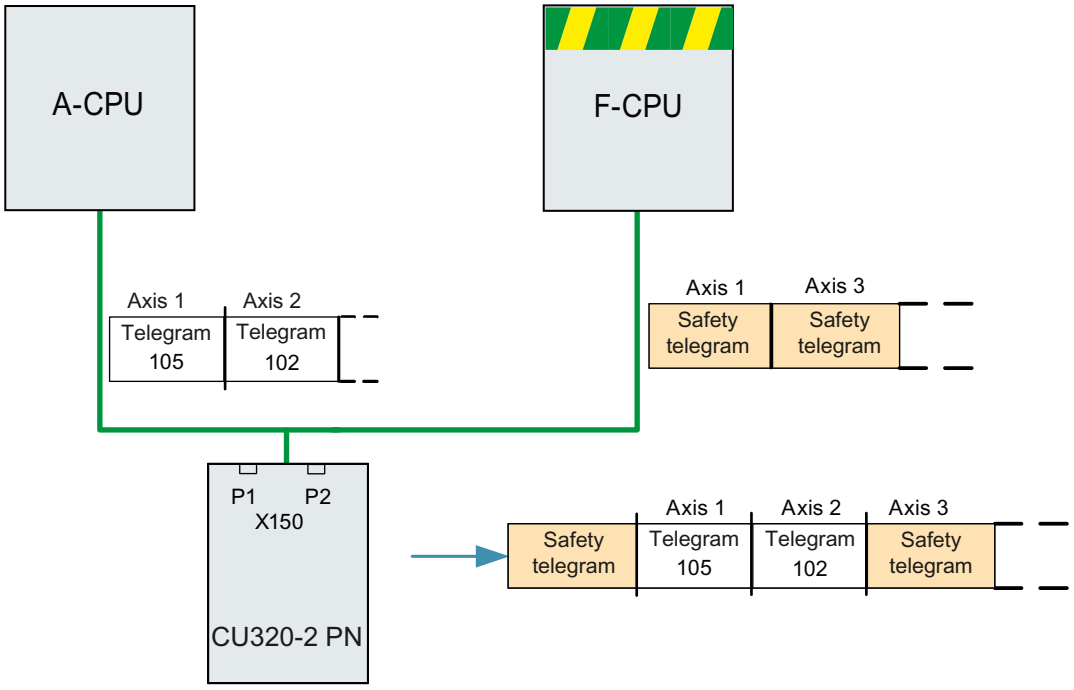


Figure 6-5 Example, communication sequence

Configuration

To configure the connection, proceed as follows:

1. Using parameters p9601.3 = p9801.3 = 1, enable PROFIsafe for axes 1 and 2.
2. Configure the PROFINET communication in HW Config (see section "Configuring the controllers").
   The controller establishes the communication.

Note

When booting, the drive system first requires the configuration data of A-CPU and then establishes a cyclic communication to this CPU taking into account the PROFIsafe telegrams expected.

As soon as the drive system has received the configuration data of the F-CPU, then cyclic communication is also established here and PROFIsafe telegrams are taken into consideration.

Note

CPU failure

Communication is carried out by both controllers independently of one another. In the event of failure of a CPU, communication with the other CPU is not interrupted, it continues to operate without interruption. Error messages are output regarding the components that have failed.

- Resolve the fault and acknowledge the messages. Communication to the CPU that failed is then automatically restored.

6.7.2 Configuring the shared device

Note

Startdrive

Please note that you still cannot use this function with Startdrive.

You have the following 2 options in "HW Config" when configuring the two controllers A-CPU and F-CPU:

- You configure both of the controllers using the shared device function in a common project
- Using GDSML, you configure each controller independently in its own project

The first of these options is described in the following example.

Note

Detailed information on configuring with "HW Config " is provided in the STEP 7 documentation.

6.7.3 Example: 2 controllers in a common project

Proceed as follows in the specified sequence:

- Required steps in STEP 7 (Page 136)
- Required steps in STARTER (Page 138)
- Configuring the Safety control (Page 140)
- Inserting the PROFIsafe controller in STEP 7 (Page 141)
- Configuring the F-CPU in HW Config (Page 142)

6.7.3.1 Required steps in STEP 7

Start STEP 7

1. Under S7, create an automation controller for the new project, in the example called A-CPU, based on a SIMATIC 300.

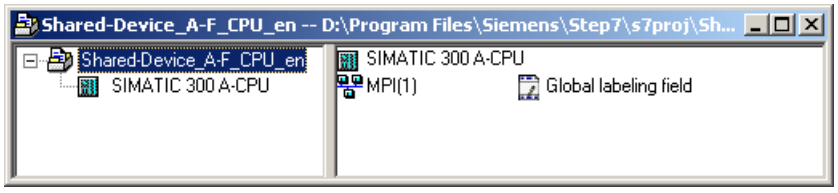


Figure 6-6 Creating a new S7 project

2. In HW Config, select the controller CPU 315-2 PN/DP and connect the PROFINET IO as a communication network.
3. Select an S120 drive from the object manager (in the example, a CU320-2 PN).

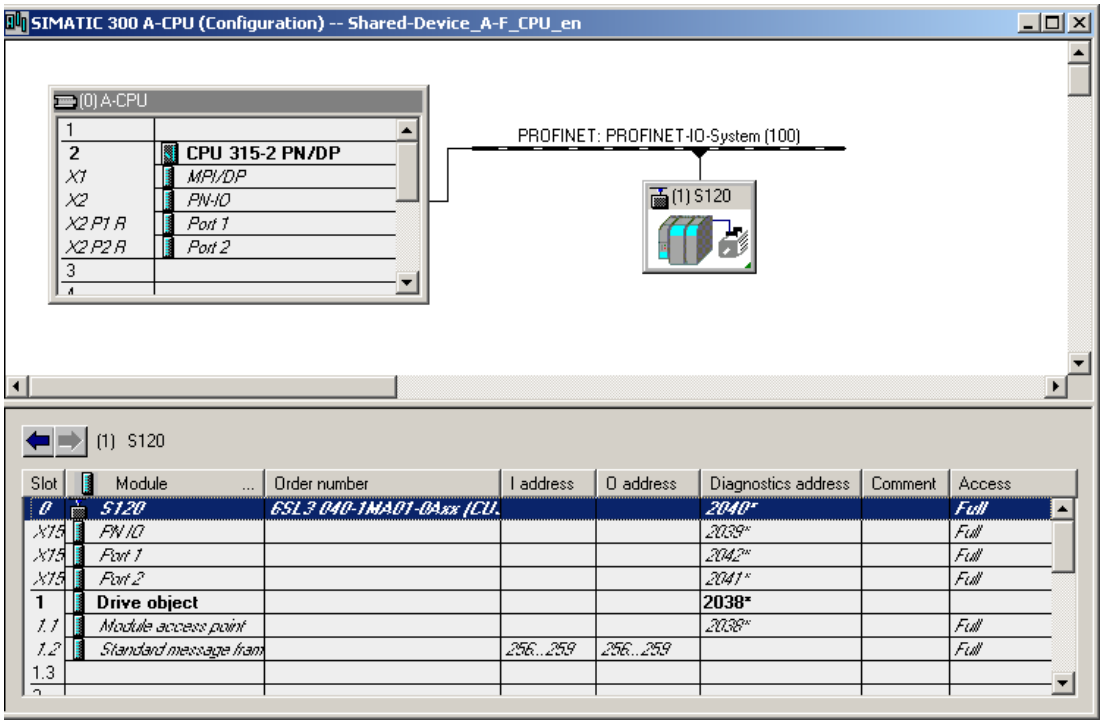


Figure 6-7 Automation controller created in HW Config

4. Select menu "Station/save and compile" (Ctrl+S).
   The previous project is saved.
5. To configure the drives in STARTER, from the shortcut menu of the S120 drive, select "Open object with STARTER".

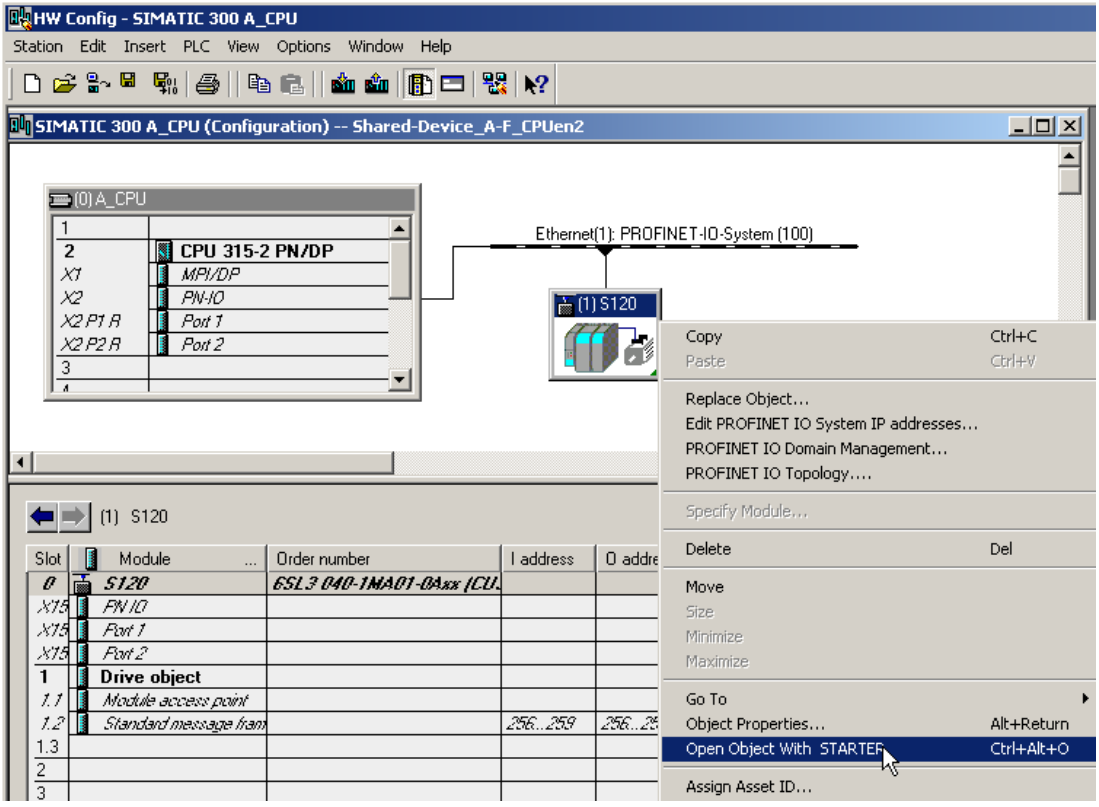


Figure 6-8 New project transferred from HW Config into STARTER

6.7.3.2 Required steps in STARTER

Configuring telegrams in STARTER

The STARTER window opens automatically and shows the project in the navigation window.

1. Configure an infeed and three drives in servo control. We have selected telegram 370 for the infeed communication, and standard telegrams 1, 2 and 3 for the drives.
   - Then click under project "Save and recompile all".
   - Click in the navigation window "Communication \ Telegram Configuration".

Object	Drive object	-No.	Assigned controller	Message frame type		Input data		Output data	
						Length	Address	Length	Address
1	Supply_1	2		SIEMENS telegram 370, PZD-1/1	!	1	???..???	1	???..???
2	Drive_1	3		Standard telegram 1, PZD-2/2	!	2	???..???	2	???..???
3	Drive_2	4		Standard telegram 2, PZD-4/4	!	4	???..???	4	???..???
4	Drive_3	5		Standard telegram 3, PZD-5/9	!	9	???..???	5	???..???
5	Control_Unit	1	PN-IO	Free telegram configuration with BICO	!	2	256..259	2	256..259
Without PZDs (no cyclic data exchange)									

Figure 6-9 Telegram overview for PROFIdrive channel IF1

2. Under ".....", add the safety telegrams 30 for the 1st and 3rd drive:
   - In the table, click the drive that you want to monitor with PROFIsafe.
   - Click the "Adapt telegram configuration" button and select "Add PROFIsafe".

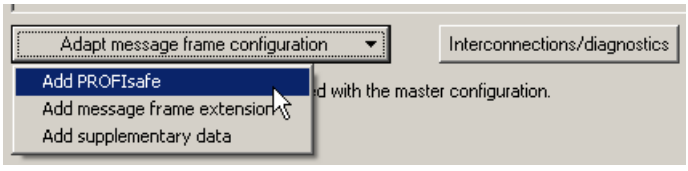


Figure 6-10 Add the PROFIsafe telegram to the drive

The PROFIsafe telegrams were added to the PROFIdrive table:

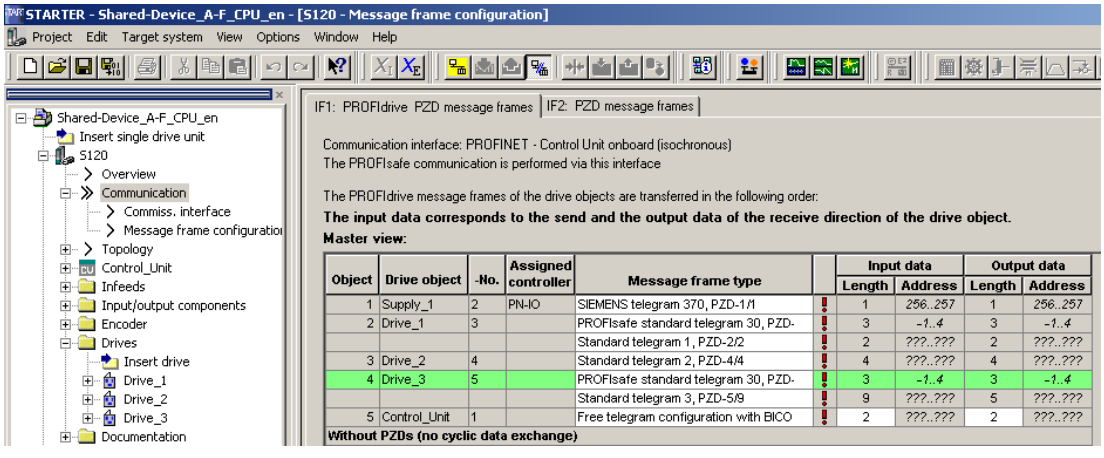


Figure 6-11 List of telegrams that are available

3. To transfer your telegram changes into HW Config, click on "Set up addresses".

IF1: PROFIdrive PZD message frames | IF2: PZD message frames

Communication interface: PROFINET - Control Unit onboard (isochronous)
The PROFIsafe communication is performed via this interface

The PROFIdrive message frames of the drive objects are transferred in the following order:
The input data corresponds to the send and the output data of the receive direction of the drive object.
Master view:

Object	Drive object	-No.	Assigned controller	Message frame type		Input data		Output data	
						Length	Address	Length	Address
1	Control_Unit	1	PN-IO	Free telegram configuration with BICO	✔	2	256..259	2	256..259
2	Supply_1	2	PN-IO	SIEMENS telegram 370, PZD-1/1	✔	1	260..261	1	260..261
3	Drive_1	3	PN-IO-1	PROFIsafe standard telegram 30, PZD-	✔	3	0..5	3	0..5
			PN-IO	Standard telegram 1, PZD-2/2	✔	2	262..265	2	262..265
4	Drive_2	4	PN-IO	Standard telegram 2, PZD-4/4	✔	4	266..273	4	266..273
5	Drive_3	5	PN-IO-1	PROFIsafe standard telegram 30, PZD-	✔	3	6..11	3	6..11
			PN-IO	Standard telegram 3, PZD-5/9	✔	9	274..291	5	274..283
Without PZDs (no cyclic data exchange)									

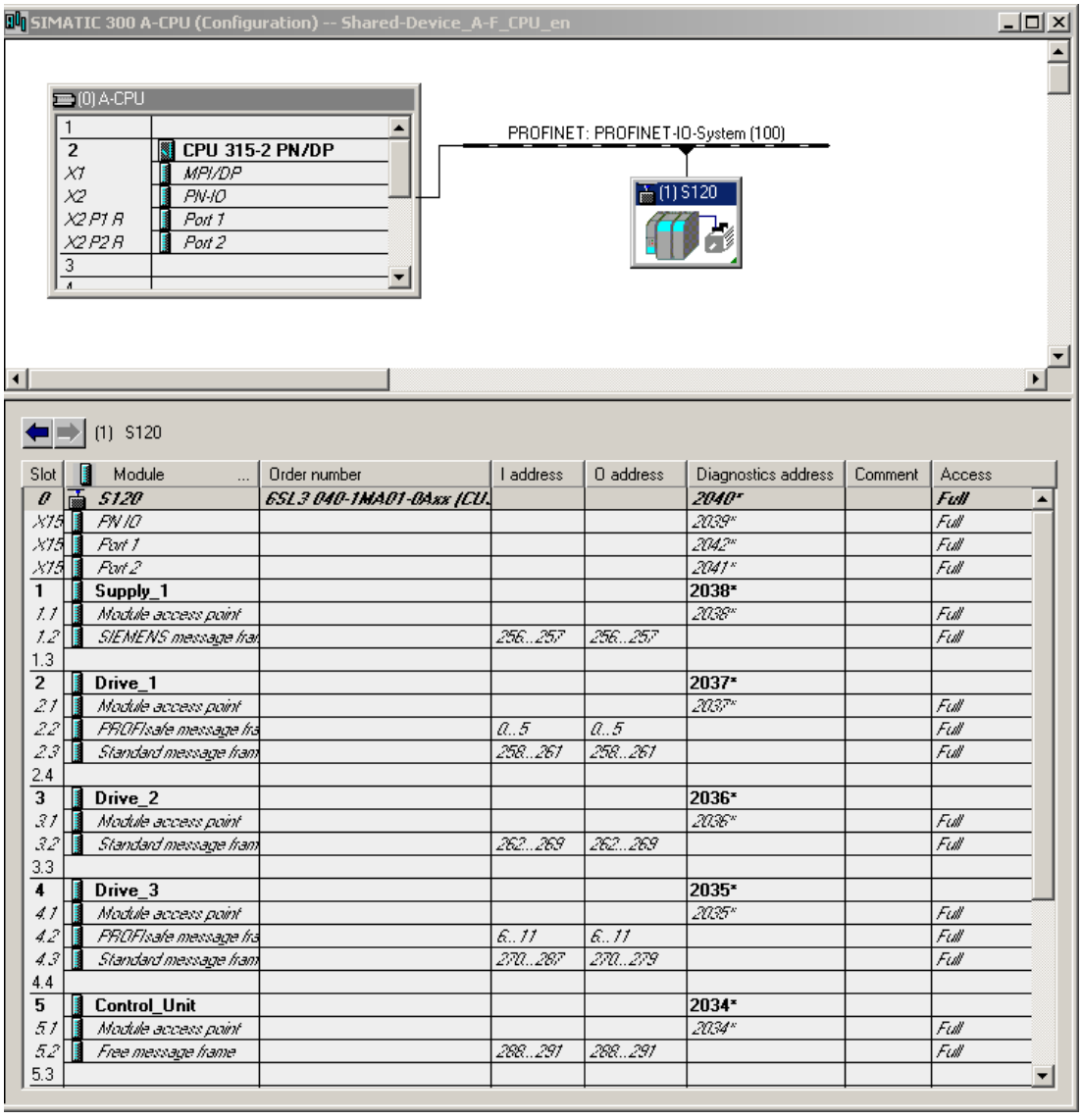
Figure 6-12 The telegrams were aligned with HW Config

After the telegrams have been successfully transferred to HW Config, the red exclamation mark is replaced by a checkmark.

6.7.3.3 Configuring the Safety control

Enable telegrams

1. In the HW Config window, click the S120 drive.



Slot	Module	Order number	I address	O address	Diagnostics address	Comment	Access
0	S120	6SL3 040-1MA01-0Axx (CU			2040*		Full
X15	PN IO				2039*		Full
X15	Port 1				2042*		Full
X15	Port 2				2041*		Full
1	Supply_1				2038*		
1.1	Module access point				2038*		Full
1.2	SIEMENS message fra		256...257	256...257			Full
1.3							
2	Drive_1				2037*		
2.1	Module access point				2037*		Full
2.2	PROFIsafe message fra		0...5	0...5			Full
2.3	Standard message fram		258...261	258...261			Full
2.4							
3	Drive_2				2036*		
3.1	Module access point				2036*		Full
3.2	Standard message fram		262...269	262...269			Full
3.3							
4	Drive_3				2035*		
4.1	Module access point				2035*		Full
4.2	PROFIsafe message fra		6...11	6...11			Full
4.3	Standard message fram		270...287	270...279			Full
4.4							
5	Control_Unit				2034*		
5.1	Module access point				2034*		Full
5.2	Free message frame		288...291	288...291			Full
5.3							

Figure 6-13 Updated project in HW Config

There is full access to all telegrams. You must enable this in order that the PROFIsafe controller can access telegram 30.

2. From the shortcut menu of the S120 drive, select menu "Object properties...".
3. In the following window, you lock the access of the PROFIsafe telegrams through the A-CPU.

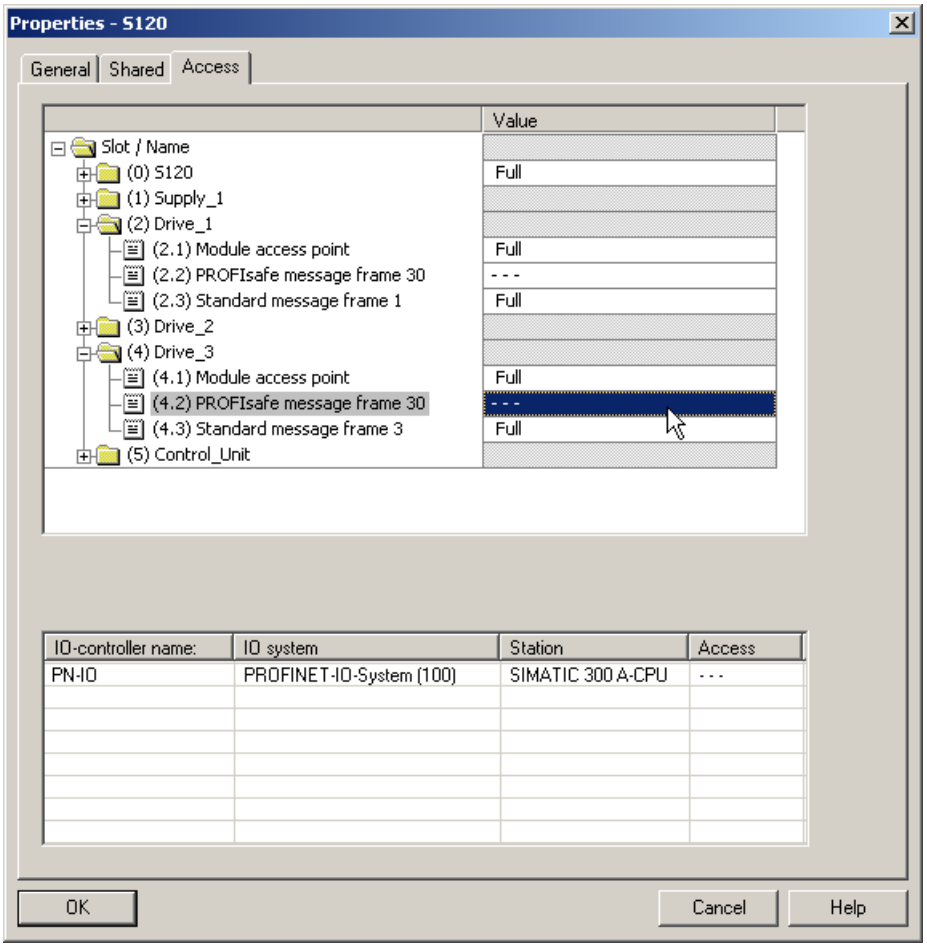


Figure 6-14 Safety telegrams of the A-CPU enabled

6.7.3.4 Inserting the PROFIsafe controller in STEP 7

You configure the PROFIsafe controller in precisely the same way as the automation controller under STEP 7.

6.7.3.5 Configuring the F-CPU in HW Config

1. Contrary to an automation controller, you now select a PROFIsafe-compatible controller, for example, a CPU 317F-2 PN/DP.
   We have manually renamed the PROFIsafe controller to "F-CPU".
2. To establish the communication, select PROFINET IO again.

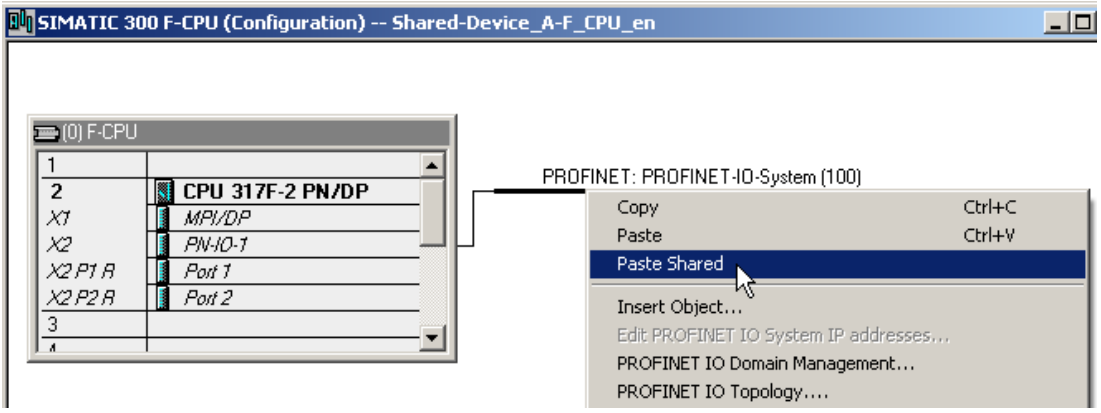


Figure 6-15 PROFIsafe controller configuration

3. In HW Config, click "Station\Save and compile".
4. In the automation controller window, click the S120 drive.
5. In the menu, select "Edit/copy" to start copying.
6. Return to the HW Config window of the PROFIsafe controller.
7. Right-click the PROFINET line.

8. Select "Insert shared" in the shortcut menu.
   The S120 automation controller is connected to the PROFINET of the PROFIsafe controller. In the table, the PROFIsafe controller has automatically been allocated full access for PROFIsafe telegram 30.

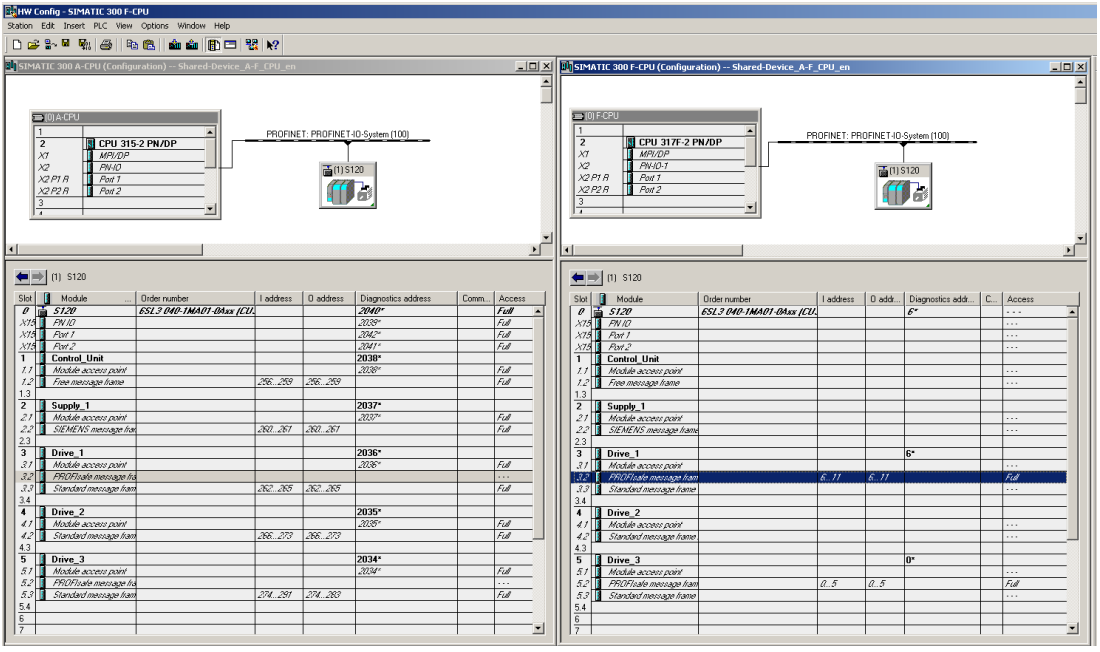
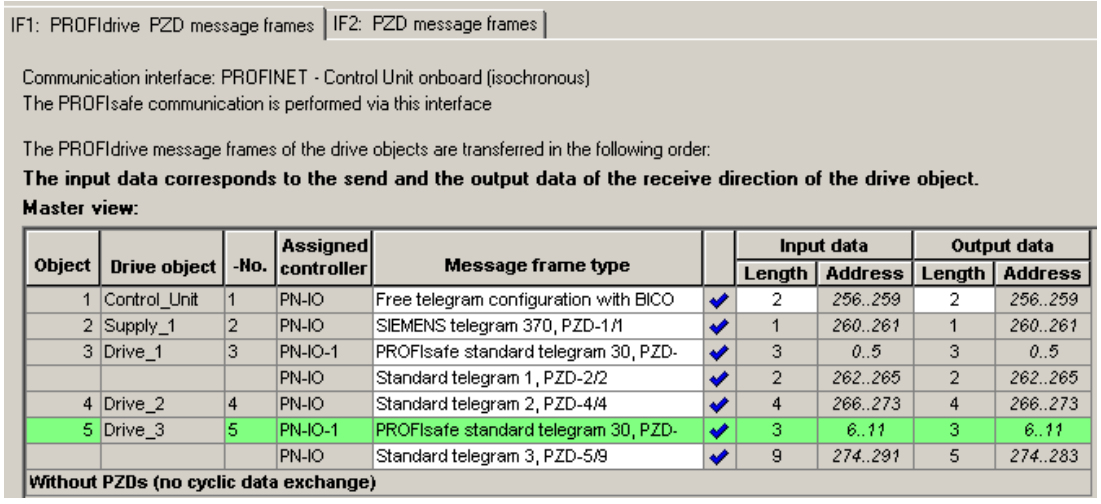


Figure 6-16 New project completed in HW Config

9. In HW Config, click "Station\Save and compile".

10. Click "Open object with STARTER" again
    After completing the last save operation, you will see in the STARTER window that the PROFIsafe telegrams have been assigned to PN-IO-1 and the drive telegrams to PN-IO.



IF1: PROFIdrive PZD message frames | IF2: PZD message frames

Communication interface: PROFINET - Control Unit onboard (isochronous)
The PROFIsafe communication is performed via this interface

The PROFIdrive message frames of the drive objects are transferred in the following order:
The input data corresponds to the send and the output data of the receive direction of the drive object.
Master view:

Object	Drive object	-No.	Assigned controller	Message frame type		Input data		Output data	
						Length	Address	Length	Address
1	Control_Unit	1	PN-IO	Free telegram configuration with BICO	✔	2	256..259	2	256..259
2	Supply_1	2	PN-IO	SIEMENS telegram 370, PZD-1/1	✔	1	260..261	1	260..261
3	Drive_1	3	PN-IO-1	PROFIsafe standard telegram 30, PZD-	✔	3	0..5	3	0..5
			PN-IO	Standard telegram 1, PZD-2/2	✔	2	262..265	2	262..265
4	Drive_2	4	PN-IO	Standard telegram 2, PZD-4/4	✔	4	266..273	4	266..273
5	Drive_3	5	PN-IO-1	PROFIsafe standard telegram 30, PZD-	✔	3	6..11	3	6..11
			PN-IO	Standard telegram 3, PZD-5/9	✔	9	274..291	5	274..283
Without PZDs (no cyclic data exchange)									

Figure 6-17 New project completed in STARTER

If there is a checkmark after each telegram type in STARTER, then the Shared Device has been successfully configured.

6.7.4 Overview of important parameters

Overview of important parameters (see SINAMICS S120/S150 List Manual)

- p9601 SI enable functions integrated in the drive (Control Unit)
- p9801 SI enable functions integrated in the drive (Motor Module)

6.8 PROFINET media redundancy

To increase the availability of PROFINET, you can create a ring topology. If the ring is interrupted at one point, the data paths between the devices are automatically reconfigured. Following reconfiguration, the devices can once again be accessed in the resulting new topology.

To create a ring topology with media redundancy, route the two ends of a line-type PROFINET topology to a switch which serves as redundancy manager (e.g. a suitable SCALANCE switch). Closing the linear bus topology is realized using two ports (ring ports) of the SCALANCE redundancy manager, which monitors the data telegrams in the PROFINET ring. All other connected PROFINET nodes are redundancy clients.

The Media Redundancy Protocol (MRP) is the standard procedure for media redundancy. Using this procedure, a maximum of 50 devices can participate in each ring. In the case of an interrupted cable, data transfer is only briefly interrupted as the system switches over to the redundant data path: This is the reason that the switchover is not bumpless (200 ms).

If a brief interruption is not permitted, then you have the following options

- Correspondingly set the failure monitoring time in the hardware configuration to more than 200 ms.
  or
- Set the data transfer to IRT High Performance.

The uninterruptible MRRT is automatically set. A SIMOTION controller (or another suitable controller) is required in this case.

The two integrated PROFINET IO interfaces of the Control Units CU320-2 PN and CU310-2 PN can be configured as redundancy clients.

From a CBE20, only the first two ports are capable of establishing a ring topology. Routing between the integrated PROFINET IO interfaces and a CBE20 is not possible.

6.9 PROFINET system redundancy

6.9.1 Overview

Thanks to SINAMICS S120 PROFINET Control Unit, the assembly of system-redundant systems is possible.

Precondition for system-redundant systems is a so-called H-system. The H-system consists of 2 fault-tolerant controls – master and reserve CPU – which are constantly synchronized via fiber-optic cables. If one controller fails, the other automatically takes on the job. This reduces system downtimes.

Requirements

- SIMATIC controller S7-400H with two PROFINET H-CPUs type 41xH (or newer: e.g. SIMATIC S7-1500 R/H)
- SINAMICS S120 PROFINET Control Unit (CU310-2 PN or CU320-2 PN)
- Redundant communication links

Benefits

- No system downtime in the case of a controller failure
- Component replacement possible during ongoing operation
- Configuration changes possible during ongoing operation
- Automatic synchronization after replacing components

Restrictions

- IRT is not supported
- No simultaneous operation of Shared Device and Shared I-Device
- Maximum 2 cyclical PROFINET connections
- System redundancy only via the onboard interface of SINAMICS S120 PROFINET Control Unit
- For the duration of switching from one controller to the other, the setpoints of the last connection remain frozen and valid.

6.9.2 Design, configuring and diagnostics

Configuration

The figure below shows a sample structure of a system-redundant controller with 3 converters.

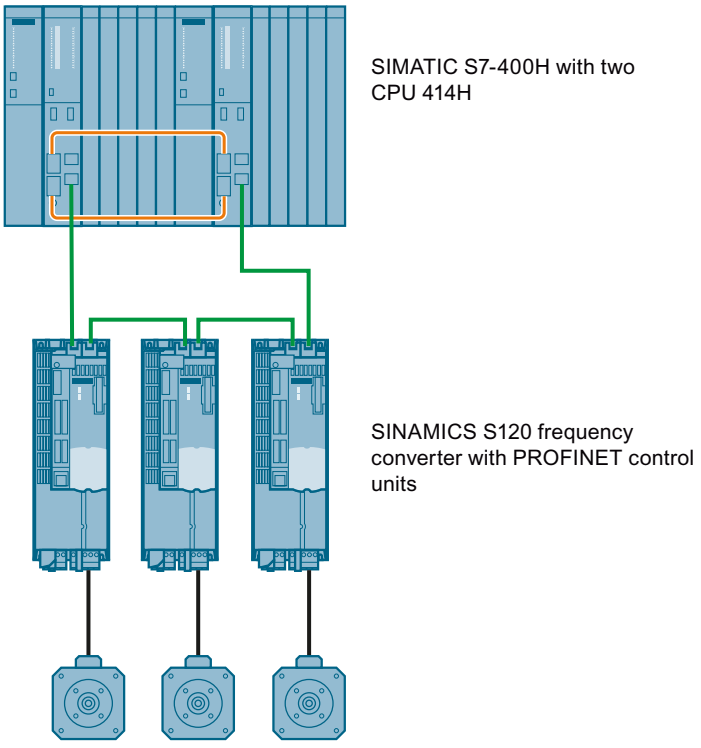


Figure 6-18 System redundancy with converters

Configuring

Configuring the redundancy takes place in STEP 7. In the converter, you only have to configure the communication via PROFINET.

System redundancy does not depend on the topology of the system.

Diagnostics LEDs

Diagnostics states are shown as follows using LEDs with PROFINET system redundancy:

Color	State	Significance
Green	Continuous light	2 redundancy connections available and setpoints are OK.
Green	Flashing light	Only one redundancy connection is available or setpoints are missing.
Red	Flashing light 2 Hz	No connection or setpoint failure (F01910).

Additional information

You can find further descriptions of the PROFINET system redundancy online in the following manuals:

- System manual “Fault-tolerant SIMATIC S7-400H systems”
  SIMATICS S7-400H Manual (https://support.industry.siemens.com/cs/ww/en/view/82478488)
- Application description Configuration examples for S7-400H PROFINET
  SIMATICS S7-400H Configuration examples (https://support.industry.siemens.com/cs/ww/en/view/90885106)
- Application example (https://support.industry.siemens.com/cs/de/en/view/109744811)

6.9.3 Messages and parameters

Faults and alarms (see SINAMICS S120/S150 List Manual)

- F01910 (N, A) Fieldbus: Setpoint timeout
- A01980 PN: Cyclic connection interrupted
- A01982 PN: Second controller missing
- A01983 PN: System redundancy switchover running

Overview of important parameters (see SINAMICS S120/S150 List Manual)

- r2043.0...2 BO: IF1 PROFIdrive PZD status
- r8843.0...2 BO: IF2 PZD status
- r8936[0...1] PN state of the cyclic connection
- r8937[0...5] PN diagnostics
- r8960[0...3] PN subslot controller assignment
- r8961[0...3] PN IP Address Remote Controller 1
- r8962[0...3] PN IP Address Remote Controller 2

6.10 PROFIenergy

PROFIenergy is an energy management system for production plants, based on the PROFINET communication protocol. The functionality is certified in the PROFIenergy profile of the PNO. Drive units which have PROFIenergy functionality, can be certified in an approved laboratory. Certified devices support the PROFIenergy commands and respond accordingly to the requirements and operating states.

SINAMICS supports the PROFIenergy profile V1.1. PROFIenergy commands are acyclically transferred from the controller to the drive with PROFINET data sets. The PROFIenergy commands are transferred using the PROFINET data set 0x80A0.

PROFIenergy data record access is only accepted via the connection types “RT connection” or “IRT connection”.

If access is made via another type of connection (e.g. Supervisor connection), system redundancy connection), the data record access is rejected with error code 0x80B0 “Invalid Index”.

There is exactly one PROFIenergy access point (PESAP) and this hangs on the MAP submodule of the CU drive object.

If access is made via another module/submodule, the data record access is rejected with error code 0x80B0 “Invalid Index”.

PROFIenergy properties of the SINAMICS S120 drive system

SINAMICS S120 drive system devices meet the following requirements:

- Are certified for PROFIenergy
- PROFIenergy function unit Class 3
- PROFIenergy energy-saving mode 2

SINAMICS devices support the following PROFIenergy functions:

Functions		SINAMICS support								
		S120 SERVO	S120 VECTOR	S150	G110M	G120D	G120x (otherwise not G120D)	G130	G150	ET200 pro FC-2
Control commands		X	X	X	X	X	X	X	X	X
Query commands		X	X	X	X	X	X	X	X	X
Measured values	ID 34	X	X	X	X	X	X	X	X	X
	ID 166	–	X	X	X	X	X	X	X	X
	ID 200	X	X	X	X	X	X	X	X	X
Measuring value access		X	X	X	X	X	X	X	X	X
PROFIenergy energy-saving mode 1	Shutdown Digital outputs	–	–	–	–	X	–	–	–	–
	Shutdown Encoder	–	–	–	–	X	–	–	–	–
PROFIenergy energy-saving mode 2	Switch on interlocking	X	X	X	X	–	X	X	X	X
Inhibit PROFIenergy		X	X	X	X	X	X	X	X	X
PROFIenergy energy-saving mode in PROFIdrive state S3/S4		–	–	–	X	X	X	X	X	X

Figure 6-19 PROFIenergy functions

6.10.1 Tasks of PROFIenergy

PROFIenergy is a data interface based on PROFINET. This data interface allows loads to be shut down during non-operational periods in a controlled fashion, and irrespective of the manufacturer and device. Consequently, the process should be given only the energy it actually requires. The majority of the energy is saved by the process, the PROFINET device itself contributes only a few watts to the saving potential.

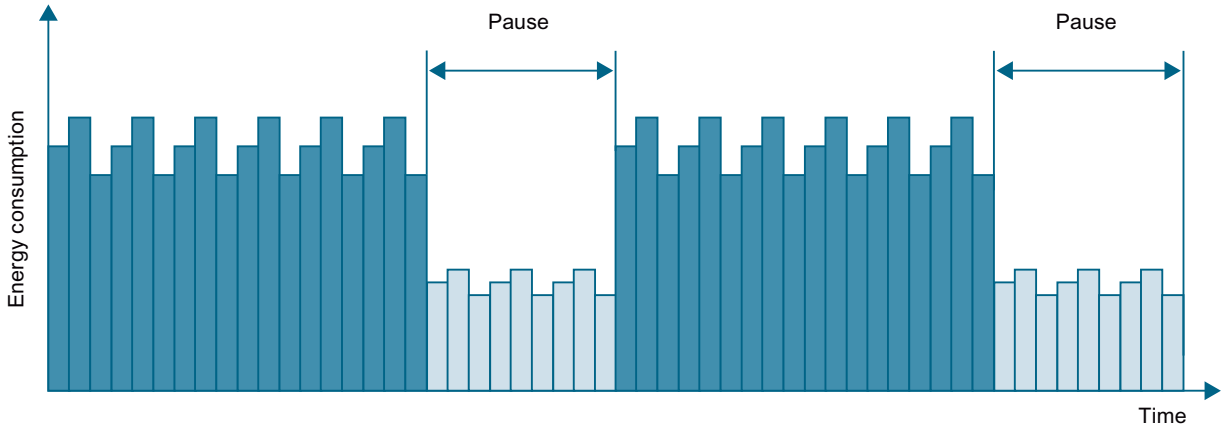


Figure 6-20 Energy saving during pauses with PROFIenergy

The following objectives are reached in detail by temporarily shutting down or stopping unused drives and equipment:

- Lower energy costs.
- Reduction of thermal emissions.
- Longer service life by reducing the effective operating times.
- The drive units provide standardized consumption data for analysis.
- The PROFIenergy state of the participating devices is displayed.
- The PROFIenergy state is available with BICO interconnections for further processing, e.g. to shutdown secondary systems that are not required.

Basics

The PROFINET devices and the power modules are shut down using special commands in the user program of the PROFINET IO controller. No additional hardware is required; the PROFIenergy commands are interpreted directly by the PROFINET devices.

6.10.2 PROFIenergy commands

Principle of operation

At the start and end of pauses, the plant operator activates or deactivates the pause function of the plant/system after which the IO controller sends the PROFIenergy "START_Pause" / "END_Pause" command to the PROFINET devices. The device then interprets the content of the PROFIenergy command and switches off or on again.

You can call up device information via additional PROFIenergy functions. You can use these to transfer the "START_Pause"/"END_Pause" command in plenty of time.

PROFIenergy control commands

Control commands	Description
START_Pause	Switches from the operating state to the energy-saving mode depending on the pause duration. Switches from the energy-saving mode to the operating state depending on the pause duration.
START_Pause_with_time_response	Switches from the operating state to the energy-saving mode and also specifies the transition times in the command response.
END_Pause	Switches from the energy-saving mode to the operating state. Cancels a switch from the operating state to the energy-saving mode.

PROFIenergy query commands

Query commands	Description
List_Energy_Saving_Modes	Determines all supported energy-saving modes.
Get_Mode	Determines the energy-saving mode.
PEM_Status	Determines the current PROFIenergy status.
PEM_Status_with_CTTO	Determines the actual PROFIenergy status, the same as for the command "PEM status" and in addition with the regular transition time to the operating state.
PE_Identify	Determines the supported PROFIenergy commands.
Query_Version	Shows the implemented PROFIenergy profile.
Get_Measurement_List	Returns the measured value IDs that can be accessed using the "Get_Measurement_Values" command.
Get_Measurement_List_with_object_number	Returns the measured value IDs and the associated object number that can be accessed using the "Get_Measurement_Values_with_object_number" command.

Query commands	Description
Get_Measurement_Values	Returns the requested measured value using the measured value ID: • For power measured values: The command addresses the sum of the measured value over all control drive objects. • For energy measured values: The command returns the sum of the measured value over all control drive objects. • For power factors: This measured value is supported only for a SINAMICS with a control drive object.
Get_Measurement_Values_with_object_number	Returns the requested measured values using the measured value ID and the object number. The object number corresponds to the drive object ID. The drive object ID of the Control Unit is used to address the measured values as with "Get_Measurement_Value".

6.10.3 PROFIenergy measured values

Table 6-6 Overview of the PROFIenergy measured values

PROFIenergy measured value		PROFIenergy accuracy		Unit	SINAMICS source parameters		Value range
ID	Name	Domain	Class		Parameters	Name	
34	Active power	1	12	W	r0032	Active power smoothed	Largest value for r2004 of all drive objects
166	Power factor	1	12	1	r0038	Smoothed power factor	0 ... 1
200	Active energy import	2	11	Wh	r0039[1]	Energy accepted	-

6.10.4 PROFIenergy energy-saving mode

SINAMICS S120 drive devices support PROFIenergy energy-saving mode 2. The following two parameters indicate the effective PROFIenergy mode:

- Parameter r5600 indicates the currently active PROFIenergy mode.
- Using interconnectable bits, the r5613 parameter indicates whether the PROFIenergy energy saving is active.

Activating the energy-saving mode

The energy-saving mode can activated or deactivated using the PROFIenergy control commands (see also PROFIenergy commands (Page 151)).

General converter behavior when in the PROFIenergy energy-saving mode

- When the PROFIenergy energy-saving mode is active, the converter issues alarm A08800.
- When the PROFIenergy energy-saving mode is active, the converter does not send any diagnostic alarms.
- If the PROFIenergy energy-saving mode is active, then the READY LED flashes green in the on / off ratio: 500 ms on, 3000 ms off.
- If the bus connection to the control system is interrupted while the converter is in the energy-saving mode, the converter exits the energy-saving mode and resumes normal operation ("ready_to_operate").
- The converter changes into normal operation if the control system goes into the stop condition while the converter is in the energy-saving mode.

6.10.5 PROFIenergy inhibit and pause time

Block PROFIenergy

If you set p5611.0 = 1, you inhibit the response of the inverter to PROFIenergy control commands. In this case, the converter ignores the PROFIenergy control commands.

Pause time

- Minimum pause time: p5602
  - When the pause time, which is sent using command "Start_Pause", is equal to or greater than the value in p5602[1], then the inverter goes into the energy-saving mode.
  - If the pause time is less than p5602[1], the inverter ignores the command.
- Maximum duration: p5606

6.10.6 Function diagrams and parameters

Function diagrams (see SINAMICS S120/S150 List Manual)

- 2381 PROFIenergy - Control commands / query commands
- 2382 PROFIenergy - States
- 2610 Sequence control - Sequencer

Overview of important parameters (see SINAMICS S120/S150 List Manual)

- r5600 Pe hibernation ID
- p5602[0...1] Pe hibernation pause time, minimum
- p5606[0...1] Pe hibernation duration, maximum
- p5611 Pe energy-saving properties, general
- r5613.0...1 CO/BO: Pe energy-saving active/inactive

6.11 Messages via diagnostics channels

Messages are not just able to be displayed via the Startdrive commissioning tools. After the activation of a diagnostic function, the messages are also transferred to the higher-level controller via the standardized diagnostic channels. The messages are evaluated there or forwarded for convenient display to the corresponding user interfaces (SIMATIC HMI, TIA Portal, etc.).

In this way, problems or faults can be located immediately regardless of the tool currently being used, and then corrected immediately.

Also note the general information on the diagnostics channels in Section Diagnostics channels (Page 64).

Activating the diagnostic function

The diagnostics function is activated or deactivated via the parameterization of the relevant configuration tool (HW Config, TIA Portal, etc.).

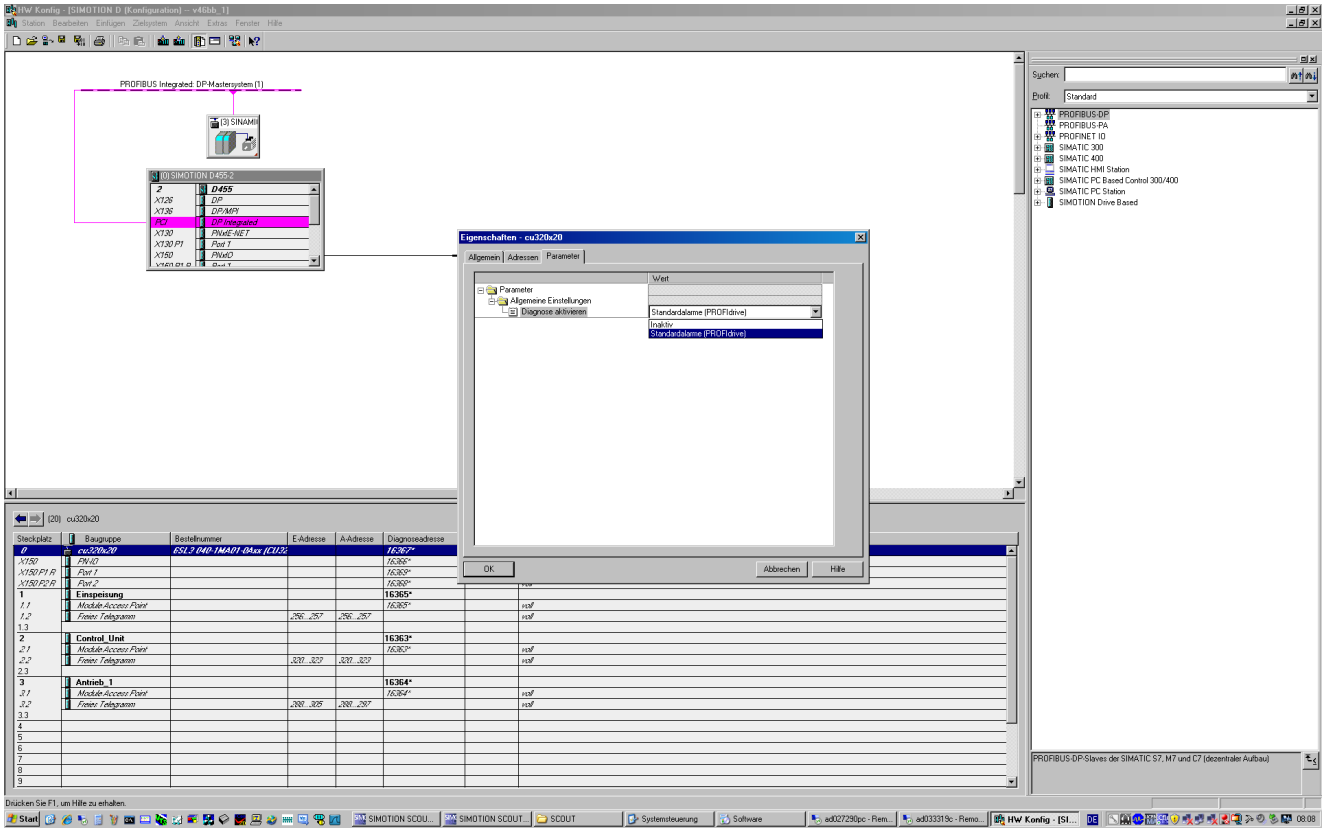


Figure 6-21 Activation of PROFINET

The following parameter assignments are possible:

Setting	Code for parameter assignment
Inactive	0
PROFIdrive error classes	1

When establishing the communication between SINAMICS and a controller, the activated diagnostics mode of this controller is first transferred to the drive. With activated diagnostics, SINAMICS first transfers all pending messages to the controller. Similarly, all currently active messages in the controller are deleted by SINAMICS when closing the communication connection.

Messages

The message texts are described in detail in the SINAMICS S120/S150 List Manual, Chapter "Explanations on the list of faults and alarms". A current list of the message texts can be found in the "Message classes and coding of different diagnostics interfaces" table.

6.12 Support of I&M data sets 1...4

Identification & Maintenance (I&M)

I&M data sets contain information for a standardized and simplified identification and maintenance of PROFIBUS/PROFINET devices. I&M data sets 1...4 contain plant-specific information, such as the installation location and date. PROFINET supports I&M data sets 0...4.

I&M data sets 1...3 can be set with the SIMATIC Manager (STEP 7) and also with HW Config (STEP 7).

The I&M data sets 1...4 are permanently stored in parameters p8806...p8809. Essential properties of these 3 parameters:

- They can be listed in the Startdrive "Parameter list".
- The SINAMICS "Reset parameter" (p0976 = 1, p0970 = 1) function does not have any effect on the content of the parameters.
- I&M data sets are not changed when the alternative parameter sets are stored or loaded. The transfer of parameter sets between a memory card and non-volatile device memory does not have any effect on the I&M data sets.

Overview of important parameters (see SINAMICS S120/S150 List Manual)

- p8806[0...53] Identification and Maintenance 1
- p8807[0...15] Identification and Maintenance 2
- p8808[0...53] Identification and Maintenance 3
- r8809[0...53] Identification and Maintenance 4

I&M parameters

Table 6-7 Parameter designation, assignment and meaning

I&M parameter designation	Format	Size/ octets	Initialization	SINAMICS parameters	Meaning
I&M 0: IM_SUPPORTED	-	-	-	r8820[62,63]	The parameter indicates which I&M data sets are supported. The value 0x1E indicates that I&M data sets 1...4 are available.
I&M 1: TAG_FUNCTION	Visible string	32	Space 0x20… 0x20	p8806[0...31]	Text that identifies the function or task of the device.
I&M 1: TAG_LOCATION	Visible string	22	Space 0x20… 0x20	p8806[32...53]	Text that identifies the device location.

I&M parameter designation	Format	Size/ octets	Initialization	SINAMICS parameters	Meaning
I&M 2: INSTALLATION_DATE	Visible string	16	Space 0x20… 0x7E	p8807[0...15]	Text with the date of the installation or the initial commissioning of the device. The following date formats are supported: • YYYY-MM-DD • YYYY-MM-DD hh:mm – YYYY: Year – MM: Month 01...12 – DD: Day 01...31 – hh: Hours 00...23 – mm: Minutes 00...59 The separators between the individual specifications, i.e. hyphen '-', blank ' ' and colon ':', must be entered.
I&M 3: DESCRIPTOR	Visible string	54	Space 0x20… 0x20	p8808[0...53]	Text with any comments or notes.
I&M 4: SIGNATURE	Octet string	54	Space 0x00… 0x00	r8809[0...53]	The parameter is automatically populated by the system, in which case it contains a functional check signature for the change tracking with Safety Integrated. The check signature has the following format: • The first four octets (0...3) contain the content of parameter r9781 index 0: "SI change monitoring checksum (Control Unit)". • The second four octets (4...7) contain the content of parameter r9782 index 0: "SI change monitoring time stamp (Control Unit)". • The remainder (octets 8...53) contains zeroes.

Communication via Modbus TCP 7

7.1 Overview

The Modbus protocol is a communication protocol based on a controller/device architecture.

Modbus offers three transmission modes:

- **Modbus ASCII -** via a serial interface
  data in the ASCII code. The data throughput is lower compared to RTU.
- **Modbus RTU -** via a serial interface
  data in the binary format. The data throughput is greater than in ASCII code.
- **Modbus TCP -** via Ethernet
  data as TCP/IP packages. TCP port 502 is reserved for Modbus TCP.

Only transfer type "Modbus TCP" is available for SINAMICS S120.

Possible drive units:

- CU320-2 PN
- CU320-2 DP (CBE20)
- CU310-2 PN

Modbus functionality

Process data and parameters are accessed via the Modbus register.

- Process data: 40100 - 40119
- Drive data: 40300 - 40522
- All parameters via DS47: 40601 - 40722

Modbus TCP always provides a basic Ethernet functionality, which corresponds to the functionality of Ethernet interface X127:

- Commissioning access for Startdrive with the S7 protocol
- DCP to set the IP address etc.
- SNMP for identification

General information about communication

Communication with Modbus TCP is established via the Ethernet/PROFINET interfaces:

- **X150**
  For Modbus TCP with a CU320-2 PN or CU310-2 PN.
- **X1400**
  For Modbus TCP with a CU320-2 PN or a CU320-2 DP via a CBE20.

Precisely one Modbus connection can be established. A simultaneous connection via the interfaces X150 and X1400 is not possible and is acknowledged with alarm A08555(1).

However, you can use one interface for Modbus TCP, and the other as PROFINET interface.

Drive object that can be addressed via Modbus

With Modbus TCP, you always address the first control-drive object from the list of drive objects (p0978[0]). A servo or vector drive object must be in this parameter.

- However, Modbus TCP is only activated if, under p0978[0], there is a drive object that is supported by Modbus TCP.
- If p0978[0] does not contain a valid drive object, then establishing communication is acknowledged with alarm A08555(2).

Diagnostics LEDs in Modbus TCP

Diagnostics states are shown as follows using LEDs with Modbus TCP:

- X150: "**PN**" LED
- X1400 (CBE20): "**OPT**" LED

The following states can be displayed by these LEDs:

Color	State	Meaning
Green	Continuous light	Connections and setpoints are OK.
Green	Flashing light	Connection is OK, but no setpoints (dependent on timeout).
Red	Flashing light 2 Hz	No connection or setpoint timeout.

7.2 Configuring Modbus TCP via interface X150

Activate Modbus TCP via X150 (CU320-2 PN or CU310-2 PN)

1. For drive object DO1, set p2030 = 13 (Modbus TCP).
2. Using p8921, set the IP address for the onboard PROFINET interface on the Control Unit.
3. Set the standard gateway using p8922.
4. Set the subnet mask using p8923.
5. Set the DHCP mode using p8924.
6. Select "Activate and save configuration" as interface configuration using p8925 = 2.
7. In the Startdrive commissioning tool, check the list of drive objects p0978.
   When required, change the sequence of the drive objects using the telegram configuration ("Drive device" > "Communication" > "Telegram configuration").
8. Save the settings in the Startdrive commissioning tool and carry out a POWER ON.

Modbus settings with interface X150

Using the following parameters, set the communication for Modbus TCP with a X150 interface:

Parameters	Explanation
p2040	Setting the monitoring time to monitor the received process data via fieldbus interface. If process data is not transferred within one cycle of the fieldbus monitoring time, then the drive shuts down with fault F01910.
r2050[0...19]	Connector output to interconnect the PZD received from the fieldbus controller via IF1.
p2051[0...24]	Selects the PZD (actual values) to be sent to the fieldbus controller in the word format via IF1.
r2053[0...24]	Displays the PZD (actual values) sent to the fieldbus controller in the word format via IF1.
r2054	Status display for the internal communication interface.
p8839[0...1]	Assigning the PN onboard interface (x150) via PZD interface 1 (IF1) and interface 2 (IF2).
r8850[0...19]	Connector output to interconnect the PZD (setpoints) received in the word format via IF2.
p8851[0...24]	Selects the PZD (actual values) to be sent in the word format via IF2.
r8853[0...24]	Displays the PZD (actual values) sent in the word format via IF2.
r8854	Status display for COMM BOARD.

7.3 Configuring Modbus TCP via interface X1400

Activating Modbus TCP via X1400 (CBE20)

1. For drive object DO1, set p8835 = 5 (Modbus TCP).
2. Set the IP address for the CBE20 using p8941.
3. Set the standard gateway for the CBE20 using p8942.
4. Set the subnet mask for the CBE20 using p8943.

5. Set the DHCP mode for the CBE20 using p8944.
6. Select the setting "Activate and save configuration" as interface configuration using p8945 = 2.
7. In the Startdrive commissioning tool, check the list of drive objects p0978.
   When required, change the sequence of the drive objects using the telegram configuration ("Drive device" > "Communication" > "Telegram configuration").
8. Save the settings in the Startdrive commissioning tool and carry out a POWER ON.

Modbus settings with interface X1400

Using the following parameters, set the communication for Modbus TCP with a X1400 interface:

Parameters	Explanation
r2050[0...19]	Connector output to interconnect the PZD received from the fieldbus controller via IF1.
p2051[0...24]	Selects the PZD (actual values) to be sent to the fieldbus controller in the word format via IF1.
r2053[0...24]	Displays the PZD (actual values) sent to the fieldbus controller in the word format via IF1.
r2054	Status display for the internal communication interface.
p8840	Setting the monitoring time to monitor the received process data via the COMM BOARD. If, within this time, the Control Unit does not receive any process data from the COMM BOARD, then the drive shuts down with fault F08501.
p8839[0...1]	Assigning the CBE20 interface (x1400) for cyclic communication via PZD interface 1 (IF1) and interface 2 (IF2).
r8850[0...19]	Connector output to interconnect the PZD (setpoints) received in the word format via IF2.
p8851[0...24]	Selects the PZD (actual values) to be sent in the word format via IF2.
r8853[0...24]	Displays the PZD (actual values) sent in the word format via IF2.
r8854	Status display for COMM BOARD.

7.4 Mapping tables

Modbus register and Control Unit parameters

The Modbus protocol contains register or bit numbers for addressing memory. You must assign the appropriate control words, status words, and parameters to these registers in the device.

The valid holding register address range extends from 40001 up to 40722. When trying to access other holding registers, the "Exception code" error is output

The process data are transferred into the register range from 40100 up to 40119.

Assigning the Modbus register to the parameters - process data

Table 7-1 Assigning the Modbus register to the parameters - process data

Register	Description	Access[1)]	Unit	Scaling	ON/OFF text or Value range	Data / parameter
Control data						
40100	Control word (see SINAMICS S120/150 List Manual, function diagram 2442)	R/W	-	1	-	Process data 1
40101	Main setpoint	R/W	-	1	-	Process data 2
40102	STW 3	R/W	-	1	-	Process data 3
40103	STW 4	R/W	-	1	-	Process data 4
40104	PZD 5	R/W	-	1	-	Process data 5
40105	PZD 6	R/W	-	1	-	Process data 6
40106	PZD 7	R/W	-	1	-	Process data 7
40107	PZD 8	R/W	-	1	-	Process data 8
40108	PZD 9	R/W	-	1	-	Process data 9
40109	PZD 10	R/W	-	1	-	Process data 10
Status data						
40110	Control word (see SINAMICS S120/150 List Manual, function diagram 2452)	R	-	1	-	Process data 1
40111	Main actual value	R	-	1	-	Process data 2
40112	ZSW 3	R	-	1	-	Process data 3
40113	ZSW 4	R	-	1	-	Process data 4
40114	PZD 5	R	-	1	-	Process data 5
40115	PZD 6	R	-	1	-	Process data 6
40116	PZD 7	R	-	1	-	Process data 7
40117	PZD 8	R	-	1	-	Process data 8
40118	PZD 9	R	-	1	-	Process data 9
40119	PZD 10	R	-	1	-	Process data 10

[1)] "R"; "W"; "R/W" in the “Access" column stands for read (with FC03); write (with FC06); read/write.

Assigning the Modbus register to the parameters - parameter data

Table 7-2 Assigning the Modbus register to the parameters - parameter data

Register	Description	Access[4)]	Unit	Scaling	ON/OFF text or Value range	Data / parameter
Drive identification						
40300	Actual power unit code number	R	-	1	0 … 65535	r0200
40301	Control Unit firmware	R	-	1	0 … 65535	r0018 / 10000
Drive data						
40320	Rated power of the power unit	R	kW	100	0 … 655.35	r0206
40321	Current limit	R/W	%	10	0.0 … 6553.5	p0640
40322	Ramp-up time [1)]	R/W	s	100	10.00 … 655.35	p1120

Register	Description	Access[4]	Unit	Scaling	ON/OFF text or Value range	Data / parameter
40323	Ramp-down time[1]	R/W	s	100	10.00 … 655.35	p1121
40324	Reference speed[2]	R/W	RPM	1	6 … 65535	p2000
Drive diagnostics						
40340	Speed setpoint[2]	R	RPM	1	-32768 … 32767	r0020
40341	Speed actual value[2]	R	RPM	1	-32768 … 32767	r0021
40342	Output frequency	R	Hz	100	- 327.68 … 327.67	r0024
40343	Output voltage	R	V	1	0 … 65535	r0025
40344	DC link voltage	R	V	1	0 … 65535	r0026
40345	Actual current value	R	A	100	0 … 655.35	r0027
40347	Actual active power	R	kW	100	0 … 655.35	r0032
40349	Control priority	R	-	1	HAND / AUTO	r0807
Fault diagnostics						
40400	Failure number, index 0	R	-	1	0 … 65535	r0947 [0]
40401	Failure number, index 1	R	-	1	0 … 65535	r0947 [1]
40402	Failure number, index 2	R	-	1	0 … 65535	r0947 [2]
40403	Fault number, index 3	R	-	1	0 … 65535	r0947 [3]
40404	Fault number, index 4	R	-	1	0 … 65535	r0947 [4]
40405	Fault number, index 5	R	-	1	0 … 65535	r0947 [5]
40406	Fault number, index 6	R	-	1	0 … 65535	r0947 [6]
40407	Fault number, index 7	R	-	1	0 … 65535	r0947 [7]
40408	Alarm number	R	-	1	0 … 65535	r2110 [0]
40409	Actual alarm code	R	-	1	0 … 65535	r2132
40499	PRM ERROR code	R	-	1	0 … 255	-
Technology controller[3]						
40500	Technology controller enable	R/W	-	1	0 … 1	p2200, r2349.0
40501	Technology controller MOP	R/W	%	100	-200.0 … 200.0	p2240
Adapt technology controller[3]						
40510	Time constant for actual-value filters of the technology controller	R/W	-	100	0.00 … 60.0	p2265
40511	Scaling factor for actual value of the technology controller	R/W	%	100	0.00 … 500.00	p2269
40512	Proportional amplification of the technology controller	R/W	-	1000	0.000 … 65.535	p2280
40513	Integral time of the technology controller	R/W	s	1	0 … 60	p2285
40514	Time constant D-component of the technology controller	R/W	-	1	0 … 60	p2274
40515	Max. limit of technology controller	R/W	%	100	-200.0 … 200.0	p2291
40516	Min. limit technology controller	R/W	%	100	-200.0 … 200.0	p2292
PID diagnostics						
40520	Effective setpoint acc. to internal technology controller MOP ramp-function generator	R	%	100	-100.0 … 100.0	r2250

Register	Description	Access[4]	Unit	Scaling	ON/OFF text or Value range	Data / parameter
40521	Actual value of technology controller after filter	R	%	100	-100.0 … 100.0	r2266
40522	Output signal technology controller	R	%	100	-100.0 … 100.0	r2294

1) For these registers, for S120 servo drives, parameters p1120 and p1121 are only available (and can only be parameterized) with the extended setpoint channel.

2) These registers are not supported for linear motors as the unit and value range differ from normal rotary drives.

3) You can only access the technology controller parameters if the "Technology controller" function module is also activated.

4) "R"; "W"; "R/W" in the "Access" column stands for read (with FC03); write (with FC06); read/write.

Assigning the Modbus register for general parameter access using DS4

Table 7-3 Assignment of the Modbus register for general parameter access using DS47

Register	Description	Access[1]	Unit	Scaling	ON/OFF text or Value range	Data / parameter
40601	DS47 Control	R/W	-	-	-	-
40602	DS47 header	R/W	-	-	-	-
40603	DS47 data 1	R/W	-	-	-	-
…	…					
40722	DS47 data 120	R/W	-	-	-	-

1) "R"; "W"; "R/W" in the “Access" column stands for read (with FC03); write (with FC06); read/write.

Note

Limited value range

Modbus TCP registers have a maximum 16 bit width. The values of display parameters (r parameters) cannot always be represented with 16 bits. In these particular cases, the maximum value that can be represented is displayed.

- Unsigned: 65535
- Signed min: -32768
- Signed max: 32767

7.5 Write and read access using function codes

Function codes used

For data exchange between the controller and device, predefined function codes are used for communication via Modbus.

The Control Unit uses the following Modbus function codes:

- FC 03: Holding register to read data from the inverter
- FC 06: Write single register to write to individual register
- FC 16: Write to multiple registers to write to several registers

Structure of a Modbus TCP message

Application Data Unit (ADU)					
Modbus Application Header				Protocol Data Unit (PDU)	
Transaction ID	Protocol ID	Length	Unit ID	FCode	Data
2 Bytes	2 Bytes	2 Bytes	1 Byte	1 Byte	0 ... 252 Bytes

Figure 7-1 Individual components, including Modbus Application Header (MBAP) and function code

Structure of a read request via Modbus function code 03 (FC 03)

Any valid register address is permitted as the start address.

Via FC 03, the control can address more than one register with one request. The number of addressed registers is contained in bytes 10 and 11 of the read request.

Table 7-4 Structure of a read request for device number 17, example

Value	Byte	Description
MBAP header		
03 h	7	
00 h	8	Register start address "High" (register 40110)
6D h	9	Register start address "Low"
00 h	10	Number of registers "High" (2 registers: 40110; 40111)
02 h	11	number of registers "Low"

The response returns the corresponding data set:

Table 7-5 Device response to the read request, example

Value	Byte	Description
MBAP header		
03 h	7	
04 h	8	Number of bytes (4 bytes are returned)
11 h	9	Data first register "High"
22 h	10	Data first register "Low"
33 h	11	Data second register "High"
44 h	12	Data second register "Low"

Table 7-6 Invalid read request

Read request	Converter response
Invalid register address	Exception code 02 (invalid data address)
Read a write-only register	Telegram in which all values are set to 0.
Read a reserved register	
Controller addresses more than 125 registers	Exception code 03 (invalid data value)
The start address and the number of registers of an address are located outside of a defined register block	Exception code 02 (invalid data address)

Structure of a write request via Modbus function code 06 (FC 06)

Start address is the holding register address.

Via FC 06, with one request, only precisely one register can be addressed. The value, which is written to the addressed register, is contained in bytes 10 and 11 of the write request.

Structure of a write request for device number 17, example

Value	Byte	Description
MBAP header		
06 h 00 h 63 h 55 h 66 h	7 8 9 10 11	Function code Register start address "High" (write register 40100) Register start address "Low" Register data "High" Register data "Low"
The response returns register address (bytes 8 and 9) and the value (bytes 10 and 11), which the higher-level control had written to the register.		

Device response to the write request, example

Value	Byte	Description
MBAP header		
06 h 00 h 63 h 55 h 66 h	7 8 9 10 11	Function code Register start address "High" Register start address "Low" Register data "High" Register data "Low"

Invalid write request

Write request	Converter response
Incorrect address (a holding register address does not exist)	Exception Code 02 - invalid data address
Write in a "read-only" tab	Exception Code 04 - device failure
Write to a reserved register	
For Exception Code 4, via the holding register 40499, you can read out the internal drive error code, which has occurred for the last parameter access via the holding register.	

7.6 Communication via data set 47

Via FC 16, with one request, up to 122 registers can be written to directly one after the other, while for Write Single Register (FC 06) you must individually write the header data for each register.

Header

In addition to the transfer type, the start address and the number of the following registers in the header.

User data

You control the access in the user data via register 40601.

In register 40602, you define the access as well as the length of the request data.

Register 40603 contains the request reference - it is defined by the user - and the access type -reading or writing.

From register 40603 and higher, the request aligns communication via data set 47 according to PROFIdrive.

Register 40604 contains the number of the drive object and the number of parameters that are read out or written to.

Register 40605 contains the attribute that you use to control whether you read out the parameter value or the parameter attribute. In the number of elements you specify how many indices are read.

7.6.1 Communication details

General parameter access is realized using the Modbus register 40601 … 40722.

Communication via DS47 is controlled using 40601. 40602 contains the function code (always = 47 = 2F hex) and the number of the following user data. User data are contained in registers 40603 … 40722.

Communication overview

Value in the register				Explanation
40601	40602		40603 ... 40722	
0	47	…	…	Write values for acyclic access
1	47	Request length [bytes]	Request data	Activate acyclic access
2	47	Response length [bytes]	Response data	Response for a successful request
2	47	0	Error code	Response for an erronous request

Error codes

1 hex: Invalid Length (invalid length)
2 hex: Invalid State (in the actual inverter state, this action is not permitted)

3 hex: Invalid function code (FC ≠ 2F hex)
4 hex: Response not ready (the response has still not been issued)
5 hex: Internal Error (general system error)

Incorrect access operations to parameters via data set 47 are logged in registers 40603 … 40722. The error codes are described in the PROFIdrive profile.

7.6.2 Examples: Read parameter

Write parameter request: Reading parameter value of r0002 from device number 17

Table 7-7 Write parameter request: Reading parameter value of r0002 from device number 17

Value	Byte	Description
MBAP header		
0010 h	7	Function code (Write multiple)
0258 h	8,9	Start address tab
0007 h	10,11	Number of registers to be read (40601 … 40607)
000E h	12	Number of data bytes (7 registers, each 2 bytes = 14 bytes)
0001 h	13,14	40601: DS47 Control = 1 (activate request)
2F0A h	15,16	40602: Function code 2F h (47), request length 10 bytes (0A h)
8001 h	17,18	40603: Request reference = 80 h, request identifier = 1 h
0101 h	19,20	40604: DO-ID = 1, number of parameters = 1
1001 h	21,22	40605: Attribute, number of elements = 1
0002 h	23,24	40606: Parameter number = 2
0000 h	25,26	40607: Subindex = 0

Start parameter request: Reading parameter value of r0002 from device number 17

Table 7-8 Start parameter request: Reading parameter value of r0002 from device number 17

Value	Byte	Description
MBAP header		
0003 h	7	Function code (read)
0258 h	8,9	Start address tab
0007 h	10,11	Number of registers to be read (40601 … 40607)
0010 h	12,13	Number of registers

Response for successful read operation

Table 7-9 Response for successful read operation

Value	Byte	Description
MBAP header		
0003 h 0020 h	7 8	Function code (read) Number of following data bytes (20 h: 32 bytes ≙ 16 registers)
0002 h 2F08 h 8001 h 0101 h 0301 h 001F h	9,10 11,12 13,14 15,16 17,18 19,20	40601: DS47 Control = 2 (the request was executed) 40602: Function code 2F h (47), response length 8 bytes 40603: Request reference mirrored = 80 h, Response = 1 (request parameter) 40604: DO-ID = 1, number of parameters = 1 40605: Format, number of elements = 1 40606: Parameter value = 1F h (31)

Response for unsuccessful read operation - read request still not completed

Table 7-10 Response for unsuccessful read operation - read request still not completed

Value	Byte	Description
MBAP header		
0003 h 0020 h	7 8	Function code (read) Number of following data bytes (20 h: 32 bytes ≙ 16 registers)
0001 h 2F00 h 0004 h	9,10 11,12 13,14	40601: Check value 1 = request is processed 40602: Function 2F h(47), response length 0 (fault) 40603: Error code: 0004 Response Not Ready (response has still not been issued)

7.6.3 Examples: Write parameter

Write parameter request: Writing the parameter value of p1121 from device number 17

Table 7-11 Write parameter request: Writing the parameter value of p1121 from device number 17

Value	Byte	Description
MBAP header		
0010 h	7	Function code (Write multiple)
0258 h	8,9	Start address tab
000A h	10,11	Number of registers to be written (40601 … 40610)
0014 h	12	Number of data bytes (10 registers, each 2 bytes = 20 bytes)
0001 h	13,14	40601: C1 (activate request)
2F10 h	15,16	40602: Function code 2F h (47), request length 16 bytes (10 h)
8002 h	17,18	40603: Request reference = 80 h, request identifier = 2 h (write)
0101 h	19,20	40604: DO-ID = 1, number of parameters = 1
1001 h	21,22	40605: Attribute, number of elements = 1
0461 h	23,24	40606: Parameter number = 1121
0000 h	25,26	40607: Subindex = 0
0801 h	27,28	40608: Format + number of values
4142 h	29,30	40609: Parameter value 12,15
6666 h	31,32	40610: Parameter value

Start parameter request: Writing the parameter value of p1121 from device number 17

Table 7-12 Start parameter request: Writing the parameter value of p1121 from device number 17

Value	Byte	Description
MBAP header		
0003 h	7	Function code (read)
0258 h	8,9	Start address tab
0007 h	10,11	Number of registers to be written (40601 … 40610)
0010 h	12,13	Number of registers

Response for successful write operation

Table 7-13 Response for successful write operation

Value	Byte	Description
MBAP header		
0003 h	7	Function code (read)
0020 h	8	Number of following data bytes (20 h: 32 bytes ≙ 16 registers)
0002 h	9,10	40601: DS47 Control = 2 (the request was executed)
2F04 h	11,12	40602: Function code 2F h (47), response length 4 bytes
8002 h	13,14	40603: Request reference mirrored = 80 h, Response = 2 (change parameter)
0101 h	15,16	40604: DO-ID = 1, number of parameters = 1

Response for unsuccessful write operation - write request still not completed

Table 7-14 Response for unsuccessful write operation - write request still not completed

Value	Byte	Description
MBAP header		
0003 h 0020 h	7 8	Function code (read) Number of following data bytes (20 h: 32 bytes ≙ 16 registers)
0001 h 2F00 h 0004 h	9,10 11,12 13,14	40601: DS47 Control = 1 (request is processed) 40602: Function 2F h(47), response length 0 (fault) 40603: Error code: 0004 Response Not Ready (response has still not been issued)

7.7 Communication procedure

Logical error

If the device detects a logical error within a request, it responds to the controller with an "exception response". In the response, the device sets the highest bit in the function code to 1. If the device receives, for example, an unsupported function code from the controller, the device responds with an "exception response" with code 01 (illegal function code).

Table 7-15 Overview of exception codes

Exception code	Modbus name	Remark
01	Illegal function code	An unknown (unsupported) function code was sent to the device.
02	Illegal Data Address	An invalid address was requested.
03	Illegal data value	An invalid data value was detected.
04	Server failure	The device terminated during processing.

Process data monitoring time (setpoint timeout)

The "Setpoint timeout" only applies for access to process data (40100 ... 40109, 40110 ... 40119). The "Setpoint timeout" is not generated for parameter data (40300 … 40522).

Fieldbus interface:

In parameter p2040 you define the time for cyclic data exchange for process data.

Setting range 0 - 2000 s.

The time depends on the amount of data to be transferred and the control.

"Setpoint timeout" (F01910) is issued by the Modbus if p2040 is set to a value > 0 ms and no process data is requested within this time period.

COMM BOARD:

In parameter p8840 you define the time for cyclic process data exchange.

Setting range 0 - 2000 s.

The time depends on the amount of data to be transferred and the control.

"Setpoint timeout" (F08501) is issued by the Modbus if p8840 is set to a value > 0 ms and no process data is requested within this time period.

7.8 Messages and parameters

Faults and alarms (see SINAMICS S120/S150 List Manual)

- F01910 Fieldbus: Setpoint timeout
- A01925 (F) Modbus TCP connection interrupted
- F08501 (N, A) PN/COMM BOARD: Setpoint timeout
- A08526 (F) PN/COMM BOARD: No cyclic connection
- A08555 Modbus TCP commissioning fault

Overview of important parameters (see SINAMICS S120/S150 List Manual)

- p0978[0...n] List of drive objects
- p2030 Fieldbus interface protocol selection
- p2040 Fieldbus interface monitoring time:
- r2050[0...19] CO: IF1 PROFIdrive PZD receive word
- p2051[0...24] CI: IF1 PROFIdrive PZD send word
- r2053[0...24] IF1 PROFIdrive diagnostics PZD send word
- r2054 PROFIBUS status
- p8835 CBE20 firmware selection
- p8839[0...1] PZD interface hardware assignment
- p8840 COMM BOARD monitoring time
- r8850[0...19] CO: IF2 PZD receive word
- p8851[0...24] CI: IF2 PZD send word
- r8853[0...24] IF2 diagnostics PZD send
- r8854 COMM BOARD state
- p8920[0...239] PN Name of Station
- p8921[0...3] PN IP address
- p8922[0...3] PN default gateway
- p8923[0...3] PN Subnet Mask
- p8924 PN DHCP mode
- p8925 PN interfaces configuration
- p8940[0...239] CBE2x Name of Station
- p8941[0...3] CBE2x IP address
- p8942[0...3] CBE2x Default Gateway
- p8943[0...3] CBE2x Subnet Mask
- p8944 CBE2x DHCP mode
- p8945 CBE2x interfaces configuration

Communication via Ethernet/IP (EIP) 8

8.1 Overview

EtherNet/IP (EIP) is a realtime Ethernet, and is mainly used in automation technology.

The EtherNet Industrial Protocol (EtherNet/IP) is an open standard for industrial networks. EtherNet/IP is used to transmit cyclic I/O data and acyclic parameter data. EtherNet/IP was developed by Rockwell Automation and the Open Device-Net Vendor Association (ODVA (https://www.odva.org/Technology-Standards/EtherNet-IP/Overview)), and standardized in the series of international IEC 61158 standards. EtherNet/IP uses the basis technology of Ethernet TCP/IP, which has been well proven in practice. Ethernet twisted-pair cables or fiber-optic cables are used as data transmission medium. The CIP protocol (Common Industrial Protocol) – known from DeviceNet and ControlNet – is used as application protocol.

General information about communication

Communication via EIP requires the following interfaces:

- The Ethernet interface (X1400) of the Ethernet CBE20 option board
- The onboard PROFINET interface (X150) at the CU320-2 PN and CU310-2 PN Control Units

The interfaces are either individually available at the different Control Units, or together at one Control Unit (e.g. at a CU320-2 PN with CBE20).

The following table provides an overview of the configurable Control Units and interfaces that are available for communication via EIP.

Table 8-1 Configurable Control Units and interfaces

Control Unit	EIP via X150	EIP via X1400 (CBE20)
CU320-2 PN	Yes	No
CU320-2 PN with CBE20 (optional)	Yes	Yes
CU310-2 PN	Yes	No
CU320-2 DP with CBE20	No	Yes

Independent of the configuration, only one interface can be assigned for communication via EIP. A simultaneous connection via the interfaces X150 and X1400 is not possible and is acknowledged with alarm A08555(1).

8.2 Connecting the drive device to EIP

In order that your drive can be connected to a control system via EIP, your control system requires a generic I/O module for cyclic communication via EIP. You manually create this generic I/O module in the control system.

Create generic I/O module and connect the drive to the control system

To connect the drive to a control system via EIP, proceed as follows:

1. Connect the drive to the control system via an Ethernet cable.
2. In your control system, create a generic I/O module with EIP functionality.
   - Insert a new module in your control system.
   - Select a generic Ethernet module from the selection.
   - Enter the network parameters for the newly inserted module (IP address, subnet mask, standard gateway, station name).
3. For the generic I/O module, enter the lengths of the process data for cyclic communication, which you have selected in Startdrive, r2067[0] (input), r2067[1] (output), for example: Standard telegram 2/2.
   In the Startdrive telegram configuration, read out the length of the process data for all drive objects (for input and output) - and add them (see PROFIdrive "Process data (Page 38)").
   - Input 101:
     Here, enter the sum of all input process data of your drive objects from Startdrive.
   - Output 102:
     Here, enter the sum of all output process data of your drive objects from Startdrive.
   - Configuration 1 or 103:
     Here, always enter a value of 0.
   - 4 ms is supported as the minimum value for RPI (Requested Packet Interval).
4. In Startdrive, set the same values for IP address, subnet mask, standard gateway and the name station as in the control system (see Chapter "Configuring EIP via the onboard PROFINET X150 interface (Page 177)")

Result:

You have connected the drive to the control system via EIP.

Further, you can find a detailed description of how to create a generic I/O module on the following Internet page:
(Gen_Module (https://support.industry.siemens.com/cs/ww/en/view/92045369)).

Routing and shielding Ethernet cables

You can find information on how to do this on the Internet page of "Open Device-Net Vendor Association (ODVAODVA (https://www.odva.org/Publication-Download))".

Commissioning the drive in an EIP network

To commission the drive, connect the drive via an interface (depending on the Control Unit type: PROFIBUS, PROFINET, Ethernet, etc.) with your computer on which Startdrive is installed.

You can find additional information in the SINAMICS S120 Commissioning Manual with Startdrive.

8.3 Requirements for communication

Check the communication settings using the following questions. If you answer "Yes" to the questions, you have correctly set the communication settings and can control the drive via the fieldbus.

- Is the drive correctly connected to the EtherNet/IP?
- Has a generic module been created in your control system?
- Have the bus interface and IP address been correctly set?
- Have the signals that the drive and the control system exchange been correctly interconnected?

8.4 Configuring EIP via the onboard PROFINET X150 interface

To communicate with a higher-level control via EIP, make the following settings for the PROFINET interface at the CU320-2 PN:

1. With p2030 = 10, set the firmware version of "EtherNet/IP".
2. Set the IP address using p8921.
   You can find the currently valid address in r8931.
3. Set the subnet mask using p8923.
   You can find the currently valid subnet mask in r8933.
4. Set the standard gateway using p8922.
   You can find the currently valid standard gateway in r8932.
5. Set the station name using p8920.
   You can find the currently valid station name in r8930.
6. Select the setting "Save and activate configuration" as interface configuration using p8925 = 2.
7. Save the data using command "Copy RAM to ROM".
   Then switch off the drive power supply.
8. Carry out a POWER ON (switch off the Control Unit and switch on again).
   Wait until all LEDs on the drive are dark before switching on. Your settings become active after switching on.

Result:

You have configured the onboard PROFINET X150 interface of the drive for communication via EIP .

8.5 Configuring EIP via the X1400 interface at the CBE20

To communicate with a higher-level control via EIP, make the following settings for the CBE20:

1. With p8835 = 4, set the firmware version of "EtherNet/IP".
2. Using p8941, set the IP address for the CBE20.
   You can find the currently valid address in r8951.
3. Set the subnet mask using p8943.
   You can find the currently valid subnet mask in r8953.
4. Set the standard gateway using p8942.
   You can find the currently valid standard gateway in r8952.
5. Set the station name using p8940.
   You can find the currently valid station name in r8950.
6. Select the setting "Save and activate configuration" as interface configuration using p8945 = 2.
7. Save the data using command "Copy RAM to ROM".
   Then switch off the drive power supply.
8. Carry out a POWER ON (switch off the Control Unit and switch on again).
   Wait until all LEDs on the drive are dark before switching on. Your settings become active after switching on.

Result:

You have configured interface X1400 of the CBE20 for communication via EIP .

8.6 Supported objects

Table 8-2 Overview

Object class		Object name	Objects required	SINAMICS objects
hex	dec			
1 hex	1	Identity object (Page 179)	x	-
4 hex	4	Assembly Object (Page 180)	x	-
6 hex	6	Connection Management Object (Page 181)	x	-
32C hex	812	Siemens Drive Object (Page 182)	-	x
32D hex	813	Siemens Motor Data Object (Page 184)	-	x
F5 hex	245	TCP/IP Interface Object (Page 185)[1)]	x	-
F6 hex	246	Ethernet Link Object (Page 186)[1)]	x	-
300 hex	768	Stack Diagnostic Object	-	x
302 hex	770	Adapter Diagnostic Object	-	x
303 hex	771	Explicit Messages Diagnostic Object	-	x
304 hex	772	Explicit Message Diagnostic List Object	-	x

Object class		Object name	Objects required	SINAMICS objects
hex	dec			
401 hex	1025	Parameter object (Page 188)	-	x
402 hex ... 43E hex	1026...1086	Parameter object (Page 189)	-	x

1) These objects are part of the EtherNet/IP system management.

For Assembly Object "4 hex" you define the data length. Assembly Object is assigned a cycle in the control system.

8.6.1 Identity Object

Identity Object, Instance Number: 1 hex

Supported services

Class
- Get Attribute all
- Get Attribute single

Instance
- Get Attribute all
- Get Attribute single
- Reset

Table 8-3 Class Attribute

No.	Service	Type	Name
1	get	UINT16	Revision
2	get	UINT16	Max Instance
3	get	UINT16	Num of Instances

Table 8-4 Instance Attribute

No.	Service	Type	Name	Value/explanation
1	get	UINT16	Vendor ID	1251
2	get	UINT16	Device Type - Siemens Drive	 0C hex
3	get	UINT16	Product code	r0964[1]
4	get	UINT16	Revision	-
5	get	UINT16	Status	See the following table
6	get	UINT32	Serial number	Bit 0 … 19: consecutive number; bits 20 … 23: Production identifier bits 24 … 27: Month of manufacture (0 = Jan, B = Dec) Bits 28 … 31: Year of manufacture (0 = 2002)
7	get	Short String	Product name	max. length 32 byte

Table 8-5 Explanation for No. 5 of the previous table

Byte	Bit	Name	Description
1	0	Owned	0: Converter is not assigned to a controller 1: Converter is assigned to a controller
	1	-	Reserved
	2	Configured	0: Ethernet/IP basic settings 1: Modified Ethernet/IP settings
	3	-	Reserved
	4 … 7	Extended Device Status	0: Self-test or status not known 1: Firmware update active 2: At least one I/O connection with error 3: No I/O connections 4: Incorrect configuration in the ROM 5: Fatal fault 6: At least one I/O connection is active 7: All I/O connections in the quiescent state 8 … 15: Reserved
2	8 … 11	-	Not used
	12 … 15	-	Reserved

8.6.2 Assembly Object

Assembly Object, Instance Number: 4 hex

Supported services

Class
- Get Attribute single

Instance
- Get Attribute single
- Set Attribute single

Table 8-6 Class Attribute

No.	Service	Type	Name
1	get	UINT16	Revision
2	get	UINT16	Max Instance
3	get	UINT16	Num of Instances

Table 8-7 Instance Attribute

No.	Service	Type	Name	Value/explanation
3	get	Array of UINT8	Assembly	1 byte array

8.6.3 Connection Management Object

Connection Management Object, Instance Number: 6 hex

Supported services

Class
- Get Attribute all
- Get Attribute single

Instance
- Forward open
- Forward close
- Get Attribute single
- Set Attribute single

Table 8-8 Class Attribute

No.	Service	Type	Name
1	get	UINT16	Revision
2	get	UINT16	Max Instance
3	get	UINT16	Num of Instances

Table 8-9 Instance Attribute

No.	Service	Type	Name	Value/explanation
1	get	UINT16	OpenReqs	Counters
2	get	UINT16	OpenFormat Rejects	Counters
3	get	UINT16	OpenResource Rejects	Counters
4	get	UINT16	OpenOther Rejects	Counters
5	get	UINT16	CloseReqs	Counters
6	get	UINT16	CloseFormat Rejects	Counters
7	get	UINT16	CloseOther Rejects	Counters
8	get	UINT16	ConnTimeouts	Counters Number of bus errors

8.6.4 Siemens Drive Object

Siemens Drive Object, Instance Number: 32C hex

Supported services

Class
- Get Attribute single

Instance
- Get Attribute single
- Set Attribute single

Table 8-10 Class Attribute

No.	Service	Type	Name
1	get	UINT16	Revision
2	get	UINT16	Max Instance
3	get	UINT16	Num of Instances

Table 8-11 Instance Attribute

No.	Service	Name	Value/explanation
2	get, set	Commisioning state	p0010 Commissioning, parameter filter
3 … 18	get	STW1	STW1 bit-by-bit access: Attr.3 = STW1.0 Attr.18 = STW1.15
19	get	Main setpoint	Main setpoint
20 … 35	get	ZSW1	ZSW1 bit-by-bit access: Attr.20 = ZSW1.0 Attr.35 = ZSW1.15
36	get	Actual Frequency	Main actual value (actual frequency)
37	get, set	Ramp Up Time	p1120[0] ramp-function generator ramp-up time
38	get, set	Ramp Down Time	p1121[0] ramp-function generator ramp-down time
39	get, set	Current Limit	p0640[0] current limit
40	get, set	Frequency MAX Limit	p1082[0] maximum speed
41	get, set	Frequency MIN Limit	p1080[0] minimum speed
42	get, set	OFF3 Ramp Down Time	p1135[0] OFF3 ramp-down time
43	get, set	PID Enable	p2200[0] technology controller enable
44	get, set	PID Filter Time Constant	p2265 Technology controller actual value filter time constant
45	get, set	PID D Gain	p2274 technology controller differentiation time constant
46	get, set	PID P Gain	p2280 Technology controller proportional gain
47	get, set	PID I Gain	P2285 Technology controller integral action time

No.	Service	Name	Value/explanation
48	get, set	PID Up Limit	p2291 technology controller maximum limiting
49	get, set	PID Down Limit	p2292 technology controller minimum limiting
50	get	Speed setpoint	r0020 speed setpoint
51	get	Output Frequency	r0024 output frequency
52	get	Output Voltage	r0025 output voltage
53	get	DC Link Voltage	r0026[0] DC link voltage
54	get	Actual Current	r0027 current actual value
55	get	Actual Torque	r0031 torque actual value
56	get	Output power	r0032 actual active power value
57	get	Motor Temperature	r0035[0] motor temperature
58	get	Power Unit Temperature	r0037[0] power unit temperature
59	get	Energy kWh	r0039 energy indicator
60	get	CDS Eff (Local Mode)	r0050 active command data set
61	get	Status Word 2	r2089[1] status word 2
62	get	Control Word 1	r0898 control word 1
63	get	Motor Speed (Encoder)	r0061 speed actual value
64	get	Digital Inputs	r0722 digital inputs status
65	get	Digital Outputs	r0747 digital outputs status
66	get	Analog Input 1	r0752[0] analog input 1
67	get	Analog Input 2	r0752[1] analog input 2
68	get	Analog Output 1	r0774[0] analog output 1
69	get	Analog Output 2	r0774[1] analog output 2
70	get	Fault Code 1	r0947[0] fault number 1
71	get	Fault Code 2	r0947[1] fault number 2
72	get	Fault Code 3	r0947[2] fault number 3
73	get	Fault Code 4	r0947[3] fault number 4
74	get	Fault Code 5	r0947[4] fault number 5
75	get	Fault Code 6	r0947[5] fault number 6
76	get	Fault Code 7	r0947[6] fault number 7
77	get	Fault Code 8	r0947[7] fault number 8
78	get	Pulse Frequency	r1801 actual pulse frequency
79	get	Alarm Code 1	r2110[0] alarm number 1
80	get	Alarm Code 2	r2110[1] alarm number 2
81	get	Alarm Code 3	r2110[2] alarm number 3
82	get	Alarm Code 4	r2110[3] alarm number 4
83	get	PID setpoint Output	r2260 technology controller setpoint after the ramp-function generator
84	get	PID Feedback	r2266 technology controller actual value after the filter
85	get	PID Output	r2294 technology controller output signal

The instances are assigned using the slot sequence in p0978.

8.6.5 Siemens Motor Object

Siemens Motor Data Object, Instance Number: 32D hex

Supported services

Class
- Get Attribute single

Instance
- Get Attribute single
- Set Attribute single

Object "32D hex" is only available on "SERVO" and "VECTOR" drive objects:

- SERVO DO = 11
- VECTOR DO = 12

Table 8-12 Class Attribute

No.	Service	Type	Name
1	get	UINT16	Revision
2	get	UINT16	Max Instance
3	get	UINT16	Num of Instances

Table 8-13 Instance Attribute

No.	Service	Type	Name	Value/explanation
2	get, set	UINT16	Commisioning state	p0010 commissioning parameter filter
3	get, set	INT16	Motor Type	p0300 motor type
6	get, set	REAL	Rated Current	p0305 rated motor current
7	get, set	REAL	Rated Voltage	p0304 rated motor voltage
8	get, set	REAL	Rated Power	p0307 rated motor power
9	get, set	REAL	Rated Frequency	p0310 rated motor frequency
10	get, set	REAL	Rated Temperature	p0605 threshold and temperature value for monitoring the motor temperature
11	get, set	REAL	Max Speed	p0322 maximum motor speed
12	get, set	UINT16	Pole pair number	p0314 motor pole pair number
13	get, set	REAL	Torque Constant	p0316 motor torque constant
14	get, set	REAL	Inertia	p0341 motor moment of inertia
15	get, set	REAL	Base Speed	p0311 rated motor speed
19	get, set	REAL	Cos Phi	p0308 rated motor power factor

The instances are assigned using the slot sequence in p0978.

8.6.6 TCP/IP Interface Object, Instance Number: F5 hex

Supported services

Class
- Get Attribute all
- Get Attribute single

Instance
- Get Attribute all
- Get Attribute single
- Set Attribute single

Table 8-14 Class Attribute

No.	Service	Type	Name
1	get	UINT16	Revision
2	get	UINT16	Max Instance
3	get	UINT16	Num of Instances

Table 8-15 Instance Attribute

No.	Service	Type	Name	Value/explanation
1	get	UNIT32	Status	Fixed value: 1 hex 1: Configuration acknowledged, by DHCP or saved values
2	get	UNIT32	Configuration Capability	Fixed value: 94 hex 4 hex: DHCP supported, 10 hex: Configuration can be adjusted, 80 hex: ACD-capable
3	get, set	UNIT32	Configuration Control	1 hex: Saved values 3 hex: DHCP
4	get	UNIT16	Physical Link	Path Size (in WORDs); fixed value: 2 hex
		UNIT8		Path (20 hex, F6 hex, 24 hex, 05 hex, where 5 hex is the number of instances of F6 hex): 4 physical ports plus an internal port).
5	get, set	STRING	Interface Configuration	r61000 Name of Station
		UNIT32		r61001 IP address
6	get, set	UNIT16	Host Name	Host Name Length
		STRING		-
10	get, set	UNIT8	Select ACD	local OM flash: 0: Disabled, 1: Enabled
11	get, set	UNIT8	Last Conflict Detected	local OM flash ACD Activity
		UNIT8		local OM flash Remote MAC
		UNIT8		local OM flash ARP PDU

8.6.7 LINK Object

Link Object, Instance Number: F6 hex

Supported services

Class
- Get Attribute all
- Get Attribute single

Instance
- Get Attribute all
- Get Attribute single
- Set Attribute single

Table 8-16 Class Attribute

No.	Service	Type	Name
1	get	UINT16	Revision
2	get	UINT16	Max Instance
3	get	UINT16	Num of Instances

Table 8-17 Instance Attribute

No.	Service	Type	Name	Value/explanation
1	get	UINT32	Interface Speed	0: link down, 10: 10 Mbps, 100: 100 Mbps
2	get	-	Interface Flags	Bit 1: Link-Status Bit 2: Duplex Mode (0: half duplex, 1 duplex) Bit 3 - 5: Automatic state identification Bit 6: Reset required Bit 7: Local hardware fault (0 = ok)
3	get	ARRAY	Physical Address	r8935 Ethernet MAC address
4	get, get_and_clear	Struct of	Interface Counters	Optional, required if the "Media Counters Attribute" is implemented.
		UINT32	In Octets	Received octets
		UINT32	In Ucast Packets	Received Unicast packets
		UINT32	In NUcast Packets	Received non-Unicast packets
		UINT32	In Discards	Incoming packets, not processed
		UINT32	In Errors	Incoming packets with errors
		UINT32	In Unknown Protos	Incoming packets with unknown protocol
		UINT32	Out Octets	Sent octets
		UINT32	Out Ucast Packets	Sent Unicast packets
		UINT32	Out NUcast packets	Sent non-Unicast packets
		UINT32	Out Discards	Outgoing packets, not processed
		UINT32	Out Errors	Outgoing packets, with errors

No.	Service	Type	Name	Value/explanation
5	get, get_and_clear	Struct of	Media Counters	Media-specific counters
		UINT32	Alignment Errors	Structure received, which does not match the number of octets
		UINT32	FCS Errors	Structure received, which does not pass the FCS check
		UINT32	Single Collisions	Structure successfully transmitted, precisely one collision
		UINT32	Multiple Collisions	Structure successfully transmitted, several collisions
		UINT32	SQE Test Errors	Number of SQE errors
		UINT32	Deferred Transmissions	First transmission attempt delayed
		UINT32	Late Collisions	Number of collisions that occurred delayed by 512 bit timers to the request
		UINT32	Excessive Collisions	Transmission unsuccessful as a result of intensive collisions
		UINT32	MAC Transmit Errors	Transmission unsuccessful as a result of an internal MAC sublayer transmission error.
		UINT32	Carrier Sense Errors	Number of errors when attempting to send a request frame, where the transmission condition was lost or was not assigned
		UINT32	Frame Too Long	Structure too large
		UINT32	MAC Receive Errors	Transmission unsuccessful as a result of an internal MAC sublayer receive error.
6	get, set	Struct of	Interface Control	-
		UINT16	Control Bits	-
		UINT16	Forced Interface Speed	-
10	get	String	Interface_Label	Interface-Label
11	get	-	Interface Capability	Bit 0: Manual Setting Bit 1: Auto-negotiate Bit 2: Auto-MDIX Bit 3: Manual Speed/Duplex Bit 4 - 31: reserved Remaining: Speed/Duplex Options

8.6.8 Parameter Object: 401 hex

Parameter Object, Instance Number: 401 hex

Supported services

Class
- Get Attribute all

Instance
- Get Attribute all
- Set Attribute single

Table 8-18 Class Attribute

No.	Service	Type	Name
1	get	UINT16	Revision
2	get	UINT16	Max Instance
3	get	UINT16	Num of Instances

Parameter access to drive object 0 (DO 0) is realized via this class.

Example: Read parameter 2050[10] (connector output to interconnect the PZD received from the fieldbus controller)

Get Attribute single function with the following values:

- Class = 401 hex
- Instance = 2050 = 802 hex ≙ parameter number
- Attribute = 10 = A hex ≙ Index 10

Example: Parameter 1520[0] writing (upper torque limit)

Set Attribute single function with the following values:

- Class = 401 hex
- Instance = 1520 = 5F0 hex ≙ parameter number
- Attribute = 0 = 0 hex ≙ index 0
- Data = 500.0 (value)

8.6.9 Parameter Object: 401 hex ... 43E hex

Parameter Object, Instance Number: 401 hex ... 43E hex

Supported services

Class
- Get Attribute All
- Get Attribute Single

Instance
- Get Attribute Single
- Set Attribute Single

Table 8-19 Class Attribute

No.	Service	Type	Name
1	get	UINT16	-
2	get	UINT16	Max slot num
3	get	UINT16	Max slot ID

Parameter access to drive object 0 (DO 0) is realized via this class.

The class structure is analog to 401 hex. Drive object (DO) is selected via the class number.

Example:

0x401 -> DO 1

0x402 -> DO 2

...

0x43E -> DO 62

8.7 Integrating the drive device into the EIP network via DHCP

Integrating the drive via the PROFINET onboard interface X150 into the EIP network

Proceed as follows to integrate the drive into the EIP network:

1. Set p8924 (PN DHCP mode) = 2 or 3

Parameterization	Meaning
p8924 = 2	The DHCP server assigns the IP address based on the MAC address.
p8924 = 3	The DHCP server assigns the IP address based on the station name.

2. Save the settings with p8925 = 2.
   The next time that it is run-up, the drive retrieves the IP address made available by a DHCP server. After the drive has run-up, you can address the drive as Ethernet participant.

Note

Immediate switchover without restart

The switchover to DHCP is performed immediately and without a restart if the change is carried out with the EIP command "Set Attribute Single" (class F5 hex, attribute 3), e.g. using:

- An EIP control
- An EIP commissioning tool

Result:

You have integrated the drive into the EIP network via DHCP.

Displays

- r8930: Station name of the onboard PROFINET interface X150
- r8934: DHCP mode of the onboard PROFINET interface X150
- r8935: MAC address of the onboard PROFINET interface X150

Integrating the drive into the EIP network via the X1400 interface at the CBE20

Integrating the drive into the EIP network via interface X1400 at the CBE20

1. Set p8944 (CBE2x DHCP mode) = 2 or 3.

Parameterization	Meaning
p8944 = 2	The DHCP server assigns the IP address based on the MAC address.
p8944 = 3	The DHCP server assigns the IP address based on the station name.

2. Save the settings with p8945 = 2.
   The next time that it is run-up, the drive retrieves the IP address made available by a DHCP server. After the drive has run-up, you can address the drive as Ethernet participant.

Note

Immediate switchover without restart

The switchover to DHCP is performed immediately and without a restart if the change is carried out with the EIP command "Set Attribute Single" (class F5 hex, attribute 3), e.g. using:

- An EIP control
- An EIP commissioning tool

Result:

You have integrated the drive into the EIP network via DHCP.

Displays

- r8950: Station name of interface X1400 at the CBE20
- r8954: DHCP mode of interface X1400 at the CBE20
- r8955: MAC address of interface X1400 at the CBE20

8.8 Messages and parameters

Faults and alarms (see SINAMICS S120/S150 List Manual)

- F08501 (N,A) PN/COMM BOARD: Setpoint timeout
- F01910 (N,A) Fieldbus: Setpoint timeout
- A08526 (F) PN/COMM BOARD: No cyclic connection
- A01980 (F) PN: Cyclic connection interrupted
- A50011 (F) EtherNetIP/COMM BOARD: Configuration error
- A01906 (F) EtherNet/IP Configuration error

Overview of important parameters (see SINAMICS S120/S150 List Manual)

- p0978[0...n] List of drive objects
- p0922 IF1 PROFIdrive PZD telegram selection
- p0999[0...99] List of modified parameters 10
- p2030 Fieldbus interface protocol selection
- p8835 CBE20 firmware selection
- p8842 COMM BOARD activate send configuration
- p8920[0...239] PN name of station
- p8921[0...3] PN IP address
- p8922[0...3] PN default gateway
- p8923[0...3] PN Subnet Mask
- p8924 PN DHCP mode
- p8925 Activate PN interfaces configuration
- p8930[0...239] PN Name of Station actual
- p8931[0...3] PN IP Address actual
- p8932[0...3] PN Default Gateway actual
- p8933[0...3] PN Subnet Mask actual
- p8934 PN DHCP Mode actual
- p8935[0...5] PN MAC Address
- p8940[0...239] CBE2x Name of Station
- p8941[0...3] CBE2x IP address
- p8942[0...3] CBE2x Default Gateway
- p8943[0...3] CBE2x Subnet Mask
- p8944 CBE2x DHCP mode
- p8945 CBE2x interfaces configuration
- r8950[0...239] CBE2x Name of Station actual
- r8951[0...3] CBE2x IP address actual
- r8952[0...3] CBE2x Default Gateway actual
- r8953[0...3] CBE2x Subnet Mask actual

- r8954 CBE2x DHCP Mode actual
- r8955[0...5] CBE2x MAC address

Communication via SINAMICS Link 9

9.1 Basic principles of SINAMICS Link

A drive unit (with a node number) most frequently comprises a Control Unit with a number of connected drive objects (DOs). SINAMICS Link allows data to be directly exchanged between up to 64 CU320-2 PN or CU320-2 DP Control Units or CUD. All of the participating Control Units must be equipped with a CBE20 in order that SINAMICS Link functions. Possible applications are, for example:

- Torque distribution for n drives
- Setpoint cascading for n drives
- Load distribution of drives coupled through a material web
- Master/slave function for infeed units
- Links between SINAMICS DC-MASTER and SINAMICS S120

Requirements

The following preconditions must be fulfilled to operate SINAMICS Link:

- One CBE20 must be inserted for each drive object.
- In the isochronous mode (p8812[0] = 1), the bus cycle time (p8812[1]) must be an integer multiple of p0115[0] (current controller sampling time).
- In the isochronous mode, the current controller sampling time must be set to 125 µs, 250 µs or 500 µs. A sampling time with 400 µs is not permitted. For 400 µs, alarm A01902[4] is output. As countermeasure, set the current controller sampling time with p0115[0] to 500 µs.

Note

The "SINAMICS Link" function is not available for the Control Unit CU310-2.

Note

SINAMICS Link for chassis format

For the following devices in the chassis format, you must set parameter p0115[0] to 250 µs or 500 µs:

- 380 - 480 V 3-phase AC: All devices with rated current index ≥ 605 A
- 500 - 690 V 3-phase AC: All devices

Send and receive data

The SINAMICS Link telegram contains 32 indices (0...31) for the process data (PZD1...32). Each PZD is precisely 1 word long (= 16 bits). Indices that are not required are automatically filled with "0". There is always a fixed assignment between the index and PZD: The index i corresponds to PZD i+1.

Index	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PZD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

SINAMICS Link telegram content, Part 1

Index	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
PZD	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

SINAMICS Link telegram content, Part 2

Each transfer cycle, every SINAMICS Link node can send 1 telegram with 32 PZD. Each node receives all of the telegrams that are sent. For each transfer cycle clock, a node can select and process up to 32 PZD from all telegrams that have been received. The converter can send and receive single words and double words. You must write double words in two consecutive PZDs.

Limitations:

- Within a telegram, a PZD may only be sent and received once. If a PZD occurs more than once in a telegram, then Alarm A50002 or A50003 is output.
- It is not possible to read in your own send data. SINAMICS S then initiates the corresponding alarms. The following alarms are possible:
  - A50006: According to what has been parameterized, data sent by itself should be received. This action is not permitted.
  - A50007: The send telegram word is larger than possible in the project.
  - A50008: The receive telegram word is larger than possible in the project.
- The maximum number of PZDs that can be received and sent also depends on the drive object. The number of PZDs that can be evaluated corresponds to communication according to PROFIdrive; however, for SINAMICS Link, it is limited to a maximum of 32 PZDs.
- If CBE20 parameters were changed as a result of a project download, then alarm A08531 is output. In this case, a POWER ON is required to activate the values.

Transmission time

With SINAMICS Link, a transmission time of up to 500 µs is possible (with a max. controller cycle of 500 µs; synchronous bus cycle of 500 µs).

Bus cycle and number of nodes

You can operate the bus cycle of the SINAMICS Link with the current controller cycle, either synchronized or non-synchronized.

- You set synchronized operation with p8812[0] = 1. A maximum of 64 nodes can then communicate with one another via SINAMICS Link. To do so, set the maximum number of nodes with p8811 (project selection):

Number of nodes/ project no.	PZD count	Bus cycle (ms)
64	16	1 or 2
16	16	0.5
12	24	0.5
8	32	0.5

- A maximum of 64 participants can communicate with one another via SINAMICS Link.

If you change at least one of the parameters p8811, p8812, p8835 or p8836, then you must carry out a POWER ON to accept the settings.

9.2 Configuring and commissioning

When commissioning, proceed as follows:

1. Set the Control Unit parameter p0009 = 1 (device configuration).
2. Set the Control Unit parameter p8835 = 3 (SINAMICS Link).
3. Using p8839, define which interface should be used (for example for IF1: p8839[0] = 2).
4. If SINAMICS Link is assigned to IF1, set parameter p2037 of the drive objects to 2 (do not freeze setpoints).
   If SINAMICS Link was assigned IF2, then p8837 must be used for the setting.
5. Assign the nodes in parameter p8836 to the SINAMICS Link node number.
   The first Control Unit is always assigned the number 1. Node number 0 means that for this Control Unit SINAMICS Link has been shut down. Observe the specifications under "Topology".
6. Check and/or correct the following parameters:
   – p8811 must be identical for all nodes
   – p8812[1] must be identical for all nodes
   – p8812[0] may be different for local nodes
7. Set the Control Unit parameter p0009 = 0 (ready).
8. Execute a "Copy RAM to ROM".
9. Carry out a POWER ON (switch off the Control Unit and switch on again).

9.2.1 Sending data

Note

The parameters listed in the following description refer to the assignment of SINAMICS Link to IF1. If you assigned SINAMICS Link to IF2, then you find the corresponding parameters in the "Table 9-5 Corresponding parameters (Page 202)".

In this example, the first "Control Unit 1" node has two drive objects: "Drive 1" and "Drive 2". Proceed as follows to send data:

1. If SINAMICS Link is assigned to IF1, then for each drive object, in its associated parameter p2051[0...31], you define which data (PZDs) should be sent.
   If SINAMICS Link was assigned IF2, then p8851 must be used for the setting. The data is simultaneously reserved in the send slot of the p8871[0...31].
2. Enter the double words in p2061[x].
   Double word data is simultaneously written to p8861[0...31].
3. For each drive object, allocate the send parameters in p8871[0...31] to a send slot of its own node.

Table 9-1 Compile send data of drive 1 (DO2)

p2051[x] Index	p2061[x] Index	Contents	From parameter	Telegram word p8871
0	-	ZSW1	r0899	1
-	1	Actual speed value part 1	r0061[0]	2
-		Actual speed value part 2		3
-	3	Actual torque value part 1	r0080	4
-		Actual torque value part 2		5
5	-	Actual fault code	r2131	6
6	-	0	0	0
...	-	...	-	...
15	-	0	0	0
...	-	...	-	...
31	-	0	0	0

Table 9-2 Compile send data of drive 2 (DO3)

p2051[x] Index	p2061[x] Index	Contents	From parameter	Slots in the send buffer p8871[x]	
				x	Telegram word
-	-	-	-	0...5[1)]	0
0	-	ZSW1	r0899	6	7

p2051[x] Index	p2061[x] Index	Contents	From parameter	Slots in the send buffer p8871[x]	
				x	Telegram word
-	1	Actual speed value part 1	r0061[0]	7	8
-		Actual speed value part 2		8	9
-	3	Actual torque value part 1	r0080	9	10
-		Actual torque value part 2		10	11
5	-	Actual fault code	r2131	11	12
6	-	0	0	12	0
...		...		...	...
15	-	0	0	15	0
...	-	...	-	...	...
31	-	0	0	31	0

1) 0...5 here remain free, as they are already assigned by DO2.

Table 9-3 Compile send data of Control Unit 1 (DO1)

p2051[x] Index	p2061[x] Index	Contents	From parameter	Slots in the send buffer p8871[x]	
				x	Telegram word
-	-	-	-	0...11[2)]	0
0	-	Control word, faults/alarms	r2138	12	13
-	1	Missing enables part 1	r0046	13	14
-		Missing enables part 2		14	15
15	-	0	0	15	0
...	-	...	-	...	...
31	-	0	0	31	0

2) 0...11 here remain free, as they are already assigned by DO2 and DO3.

Send slots PZD 16 to 31 are not required for this telegram and are therefore filled with a zero.

1. For double words (e.g. 1 + 2), assign two consecutive send slots, e.g. p2061[1] => p8871[1] = PZD 2 and p8871[2] = PZD 3.
2. Enter the following PZD into the next parameter slots of p2051[x] or p2061[2x].
3. Populate the unused slots of p8871[0...31] with zeros.
4. The sequence of the PZDs in the send telegram of this node are defined in parameter p8871[0...31] by the entries in the required slots.

9.2.2 Receiving data

The sent telegrams of all nodes are simultaneously available at the SINAMICS Link. Each telegram has a length of 32 PZD. Each telegram has a marker of the sender. You select those PZD that you want to receive for the relevant node from all telegrams. You can process a maximum of 32 PZD.

Note

If you have not deactivated the evaluation of bit 10 with p2037 = 2, the first word of the receive data (PZD 1) must be a control word, where bit 10 = 1 is set.

In this example, Control Unit 2 receives selected data from the telegram of Control Unit 1. Proceed as follows to receive data:

1. In parameter p8872[0…31] enter the address of the node for which you want to read one or more PZDs (e.g. p8872[3] = 1 → from node 1, read in PZD 4, p8872[15] = 0 → do not read in PZD 16).
2. After setting the parameters, using parameter r2050[0…31] or r2060[0…31] you can read out the values.

Table 9-4 Receive data for Control Unit 2

From the sender		Receiver					
Transfer from	Tel. word[1] p8871[x]	Address p8872[x]	Receive buffer p8870[x]	Data transferred in		Parameter	Contents
				r2050[x]	r2060[x]		
p2051[0]	0	1	PZD 1	0	-	r0899	ZSW1
p2061[1]	1	1	PZD 2	-	1	r0061[0]	Actual speed value part 1
	2	1	PZD 3	-		r0061[0]	Actual speed value part 2
p2061[3]	3	1	PZD 4	-	3	r0080	Actual torque value part 1
	4	1	PZD 5	-			Actual torque value part 2
p2051[5]	5	1	PZD 6	5	-	r2131	Actual fault code
p2051[4]	6	1	PZD 7	6	-	r0899	ZSW1
p2061[5]	7	1	PZD 8	-	7	r0061[0]	Actual speed value part 1
	8	1	PZD 9	-			Actual speed value part 2
p2061[6]	9	1	PZD 10	-	9	r0080	Actual torque value part 1
	10	1	PZD 11	-			Actual torque value part 2
p2051[7]	11	1	PZD 12	11	-	r2131	Actual fault code
p2051[8]	12	1	PZD 13	12	-	r2138	Control word, faults/alarms
p2061[9]	13	1	PZD 14	-	13	r0046	Missing enables part 1
	14	1	PZD 15	-			Missing enables part 2
-	15	0	PZD 16	15	-	0	Empty
...	...	...	...	...	...	...	...
-	31	0	PZD 32	31	0	0	-

[1] Tel.word = telegram word

Note

For double words, two PZD must be read in succession. To do this, read in a 32 bit setpoint, which is on PZD 2 + PZD 3 of the telegram of node 2. Emulate this setpoint on PZD 2 + PZD 3 of node 1:
p8872[1] = 2, p8870[1] = 2, p8872[2] = 2, p8870[2] = 3

9.2.3 Activating the SINAMICS Link

To activate SINAMICS Link connections, perform a POWER ON for all nodes.

Without POWER ON, the following can be changed:

- The assignments of p2051[x]/2061[2x] and the links of the read parameters r2050[x]/2060[2x]
- Parameters p8870, p8871, and p8872 In this case, the SINAMICS Link connections can also be connected via p8842 = 1.

9.3 Topology

Only a line topology with the following structure is permitted for SINAMICS Link. You must manually set the parameters in the parameter views of the Control Units and drive objects. To do this, use the Startdrive commissioning tool.

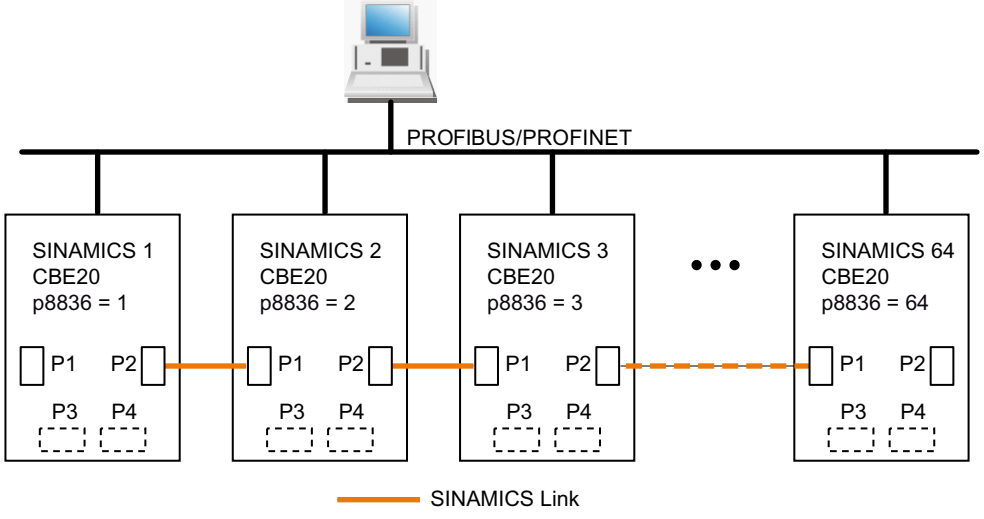


Figure 9-1 Maximum topology

Features

- The CBE20 can be assigned to IF1 or IF2 when SINAMICS Link is used.
  The interface, assigned to the CBE20, must be switched into synchronous operation if p8812[0] = 1 is set.
  You must also make the following parameter settings in order to assign, e.g. IF1 to SINAMICS Link:
  - For IF1: p8839[0] = 2 (COMM BOARD)
  - For IF2: p8839[1] = 1 (Control Unit onboard)

  The data in the additional description are applicable for the case (IF1 ≙ SINAMICS Link).
- The number of the respective node must be entered manually in parameter p8836. Each node must be assigned a different number. Enter the numbers in ascending order starting with 1.
- If p8836 is set to 0, the nodes and the complete following line is shut down for SINAMICS Link.
- Gaps in the numbering are not permitted, as then SINAMICS Link would not function.
- The node with the number 1 is automatically the sync master of the communication link.
- The ports of the CBE20 must be interconnected strictly in accordance with the above diagram. You must always connect port 2 (P2) of node n with port 1 (P1) of node n + 1.
- In the "SINAMICS Link" mode, ports 3 and 4 of the CBE20 can only be used in conjunction with the Startdrive commissioning tool.

Corresponding parameters for IF1 or IF2

Use different parameters for configuring, depending on which interface SINAMICS Link is assigned:

Table 9-5 Corresponding parameters

Parameters	IF1	IF2
Setting of the processing mode for PROFIdrive STW1.10 "Control by PLC".	p2037	p8837
Connector output to interconnect the PZD (setpoints) received from the fieldbus controller in the word format.	r2050	r8850
Selects the PZD (actual values) to be sent to the fieldbus controller in the word format.	p2051	p8851
Displays the PZD (actual values) sent to the fieldbus controller in the word format.	r2053	r8853
Connector output to interconnect the PZD (setpoints) received from the fieldbus controller in the double word format.	r2060	r8860
Selects the PZD (actual values) to be sent to the fieldbus controller in the double word format.	p2061	p8861
Displays the PZD (actual values) sent to the fieldbus controller in the double word format.	r2063	r8863

9.4 Examples: Transmission times for SINAMICS Link

Example 1: Transmission times at a communication cycle of 1 ms

p2048 or p8848 = 1 ms

Bus cycle	Transmission time			
	Sync both	Sync send	Sync receive	Async both
0.5	1.0	1.5	1.3	1.6
1.0	1.5	2.1	2.1	2.2
2.0	3.0	3.6	3.1	2.8

Example 2: Transmission times at a communication cycle of 4 ms

p2048 or p8848 = 4 ms

Bus cycle	Transmission time			
	Sync both	Sync send	Sync receive	Async both
0.5	1.0	3.0	2.8	4.6
1.0	1.5	3.6	3.6	5.2
2.0	3.0	5.1	4.6	5.8

9.5 Communication failure when booting or in cyclic operation

If at least one sender does not correctly boot after commissioning or fails in cyclic operation, then alarm A50005 is output to the other nodes: "Sender was not found on the SINAMICS Link." The message contains the number of the faulted node. After you have resolved the fault at the node involved and the system has identified the node, the system automatically withdraws the alarm.

If several nodes are involved, the message occurs a multiple number of times consecutively with different node numbers. After you have resolved all of the faults, the system automatically withdraws the alarm.

When a node fails in cyclic operation, in addition to alarm A50005, fault F08501 is output: "COMM BOARD: Monitoring time, process data expired"

At node 1, fault F08501 is not triggered. This node should be used for specifying setpoint values to other nodes.

9.6 Example

Task

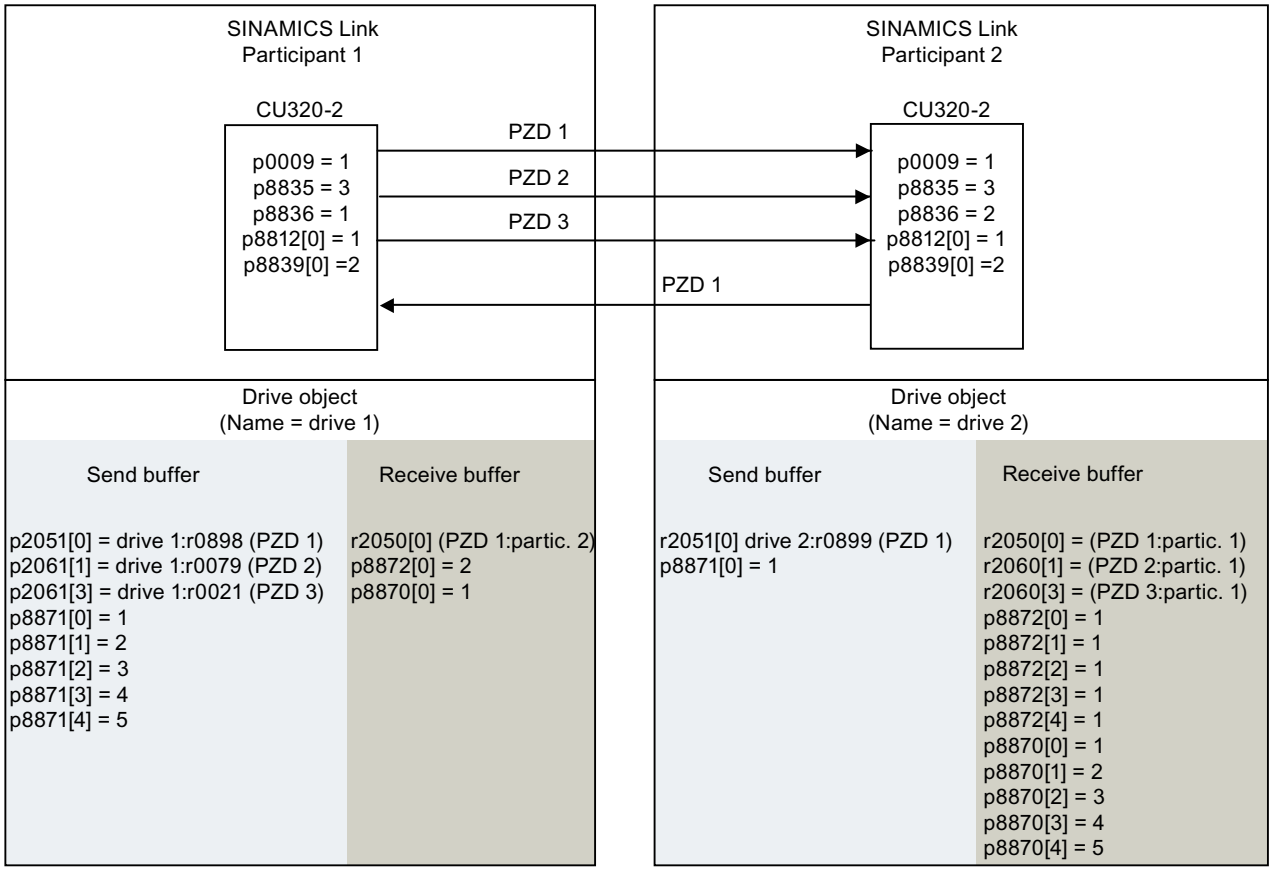
Configure SINAMICS Link for two nodes and transfer the following values:

- Send data from node 1 to node 2
  - r0898 CO/BO: Control word, sequence control, drive 1 (1 PZD), in the example PZD 1
  - r0079 CO: Total torque setpoint (2 PZD), in the example PZD 2
  - r0021 CO: Smoothed actual speed (2 PZD), in the example PZD 3
- Send data from node 2 to node 1
  - r0899 CO/BO: Status word, sequence control, drive 2 (1 PZD), in the example PZD 1
- IF1 is used for SINAMICS Link.

Procedure

1. For all nodes, set p0009 = 1 to change the device configuration.
2. For all CBE20 nodes, set the "SINAMICS Link" mode using p8835 = 3.
3. Limit the maximum number of nodes for all nodes with p8811 = 8. By setting p8811, parameter p8812[1] is preassigned, and parameter p8836, if necessary, is corrected.
4. Assign the node numbers for the devices involved:
   - Node 1 (≙ device 1): p8836 = 1
   - Node 2 (≙ device 2): p8836 = 2
5. Set all CBE20 to the isochronous mode by setting p8812[0] = 1.
6. Make the following interface setting for all nodes:
   - For IF1: p8839[0] = 2 (COMM BOARD)
   - For IF2: p8839[1] = 1 (Control Unit onboard)
7. For both nodes p0009 = 0, carry out a "Copy RAM to ROM" followed by a POWER ON in order to activate the modified firmware versions and the new settings in the CBE20.
8. Define the send data for node 1:
   - Define the PZD that node 1 should send:
     p2051[0] = drive 1:r0898 (PZD 1)
     p2061[1] = drive1:r0079 (PZD 2 + PZD 3)
     p2061[3] = drive1:r0021 (PZD 4 + PZD 5)
   - Place these PZD in the send buffer (p8871) of node 1:
     p8871[0] = 1 (r0898)
     p8871[1] = 2 (r0079 1st part)
     p8871[2] = 3 (r0079 2nd part)
     p8871[3] = 4 (r0021 1st part)
     p8871[4] = 5 (r0021 2nd part)

9. Define the receive data for node 2:
   - Specify that the data placed in the receive buffer p8872 of node 2 in locations 0 to 4 will be received by node 1:
     p8872[0] = 1
     p8872[1] = 1
     p8872[2] = 1
     p8872[3] = 1
     p8872[4] = 1
   - Specify that PZD1, PZD2, and PZD3 of node 1 will be placed in the receive buffer p8870 of node 2 in locations 0 to 4:
     p8870[0] = 1 (PZD1)
     p8870[1] = 2 (PZD2 1st part)
     p8870[2] = 3 (PZD2 2nd part)
     p8870[3] = 4 (PZD3 1st part)
     p8870[4] = 5 (PZD3 2nd part)
   - r2050[0], r2060[1] and r2060[3] subsequently contain (after step 13) the values of PZD 1, PZD 2 and PZD 3 of node 1.
10. Define the send data for node 2:
    - Specify the PZD that node 2 should send:
      :p2051[0] = drive1:r0899 (PZD length is 1 word)
    - Place this PZD in the send buffer (p8871) of node 2:
      p8871[0] = 1
11. Define the receive data for node 1:
    - Specify the data that should be placed in the receive buffer p8872 of node 1 in location 0, received from node 2:
      p8872[0] = 2
    - Define that PZD1 of node 2 is saved in the receive buffer p8870 of node 1 in location 0:
      p8870 [0] = 1
    - r2050[0] subsequently contains (after step 13) the value of PZD 1 of node 2.
12. At the two nodes carry-out a "Copy RAM to ROM" to backup the parameterization and the data.
13. Set p8842 =1, to activate parameters p8870, p8871 and p8872.



r0021: Speed actual value smoothed
r0079: Total torque setpoint
r0898: Control word sequence control drive 1
r0899: Status word sequence control drive 2

Figure 9-2 SINAMICS Link: Configuration example

9.7 Function diagrams and parameters

Function diagrams (see SINAMICS S120/S150 List Manual)

- 2197 Control Unit communication - SINAMICS Link overview (r0108.31 = 1, p8835 = 3)
- 2198 Control Unit communication - SINAMICS Link configuration (r0108.31 = 1, p8835 = 3)
- 2199 Control Unit communication - SINAMICS Link receive data (r0108.31 = 1, p8835 = 3)
- 2200 Control Unit communication - SINAMICS Link send data (r0108.31 = 1, p8835 = 3)

Overview of important parameters (see SINAMICS S120/S150 List Manual)

- p0115[0] Current controller sampling time
- p2037 IF1 PROFIdrive STW1.10 = 0 mode
- r2050[0...31] CO: IF1 PROFIdrive PZD receive word
- p2051[0...31] CI: IF1 PROFIdrive PZD send word
- r2060[0...30] CO: IF1 PROFIdrive PZD receive double word
- p2061[0...30] CI: IF1 PROFIdrive PZD send double word
- p8811 SINAMICS Link project selection
- p8812[0...1] SINAMICS Link cycle settings
- p8835 CBE20 firmware selection
- p8836 SINAMICS Link node address
- p8839[0...1] PZD interface hardware assignment
- p8870[0...31] SINAMICS Link PZD receive word
- p8871[0...31] SINAMICS Link PZD send word
- p8872[0...31] SINAMICS Link PZD receive address

Communication via USS

10

The USS protocol is a serial data link between a master and up to 31 slaves.

A master is, for example:

- A programmable logic controller (e.g. SIMATIC S7-200)
- A PC

The converter is always a slave.

The maximum cable length is:

Maximum cable length	Baud rate	Maximum number of nodes
1200 m	≤ 38400 bit/s	32
1000 m	187500 bit/s	30

Interface for the USS protocol

The X140 serial interface is located on the underside of the Control Unit.

10.1 Basic settings for communication

Procedure

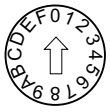
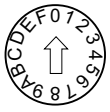
Proceed as follows to set communication via USS for CU320-2 DP or CU310-2 DP:

1. Set the bus protocol via p2030:
   p2030 = 6
2. Set the converter address.
3. Make additional changes based on the parameters listed in the following section.
4. Back up the settings so that they are protected against power failure.

10.1.1 Setting the address

Set the address as a hexadecimal value via 2 rotary coding switches. You can set values from 0_{dec} (00_{hex}) to 127_{dec} ($7F_{hex}$). At the upper rotary coding switch (H) you set the hexadecimal value for 16^1 and at the lower rotary coding switch (L) you set the hexadecimal value for 16^0.

Table 10-1 Address switches

Rotary coding switches	Significance	Examples	
		21_{dec}	31_{dec}
		15_{hex}	$1E_{hex}$
 USS H	$16^1 = 16$	1	2
 USS L	$16^0 = 1$	5	3

Setting the address

Observe the properties of the rotary coding switch:

- The rotary coding switches used to set the address are located beneath the cover.
- The factory setting for the rotary coding switches is 0_{dec} (00_{hex}).
- The currently set address of the rotary coding switch is displayed in parameter r2057.
- When several Control Units are connected to a USS communication, you set the addresses with a value different to the factory setting. Each address can only be assigned once. Either set the address in absolute terms using the rotary coding switches or selectively in parameter p2021. Each change made to the bus address is not effective until POWER ON.

Note

- Only values from 1 to 31 ($1E_{hex}$) are valid for USS addressing. If you set values above 31, the set value is interpreted as "0".
- If the address 0 or an address above 31 is set using the address switch, the value in parameter p2021 defines the USS address.

You will find additional information in the manual for your converter.

10.1.2 Parameters to set communication via USS

Setting	Parameter	Comment
Fieldbus protocol selection	p2030 = 6 (USS (X140))	-
Baud rate	p2020 = 8, 38400 bit/s	-
Drive object that receives the PZD[1)]	p0978[0]	USS PZD go to the drive object that you entered under p0978[0] "List of drive objects".
PKW addressee[1)]	p2035	USS PKW address the drive object that you entered under p2035 "Fieldbus interface USS PKW drive object number".
Fieldbus interface USS PZD number	p2022 = 2	Setting the number of 16-bit words in the PZD part of the USS telegram
Fieldbus interface USS PKW number	p2023 = 127	Setting the number of 16-bit words in the PKW part of the USS telegram
Fieldbus error statistics	r2029	Displaying receive errors at the fieldbus interface
Fieldbus monitoring time	p2040 = 100 ms	The more slaves that are connected in the network, the longer you need to set the fieldbus monitoring time. If process data is not transferred within one cycle of the fieldbus monitoring time, the converter shuts down with fault F01910.

1) The factory settings of these parameters have been selected such that the USS communication extends to the drive object of the control.

10.2 Telegram structure

Overview

A USS telegram comprises a series of elements with a defined sequence. Each element contains 11 bits.

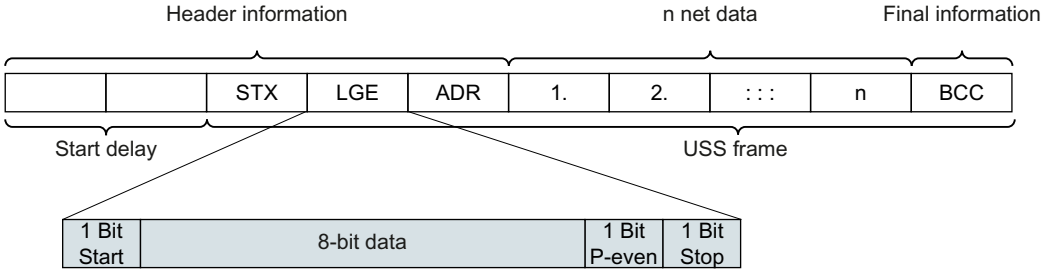


Figure 10-1 Structure of a USS telegram

Telegram part	Description		
Start delay / response delay	There is always a start and/or response delay between 2 telegrams. Telegram monitoring (Page 223)		
STX	An ASCII character (02 hex) indicates the beginning of the message.		
LGE	The telegram length "LGE" is calculated as follows: LGE = user data (n bytes) + ADR (1 byte) + BCC (1 byte)		
ADR	7 Special telegram; 6 Mirror telegram; 5 Broadcast bit; 4 3 2 1 0 Address		
	Bit 7	= 0	Normal data exchange
		= 1	Transferring telegrams that require a net data structure different from the device profile.
	Bit 6	= 0	Normal data exchange
		= 1	Testing the bus connection The converter returns the telegram unchanged to the master.
	Bit 5	= 0	Normal data exchange
		= 1	Not supported by the converter.
	Bits 0 … 4		Address of the converter
User data	Specify user data of telegram (Page 213)		
BCC	Checksum (exclusive or) across all telegram bytes – with the exception of BCC		

10.3 Specify user data of telegram

Overview

The user data of the telegram consist of the following elements:

- Parameter channel (PKW) for writing and reading parameter values
- Process data (PZD) for controlling the drive

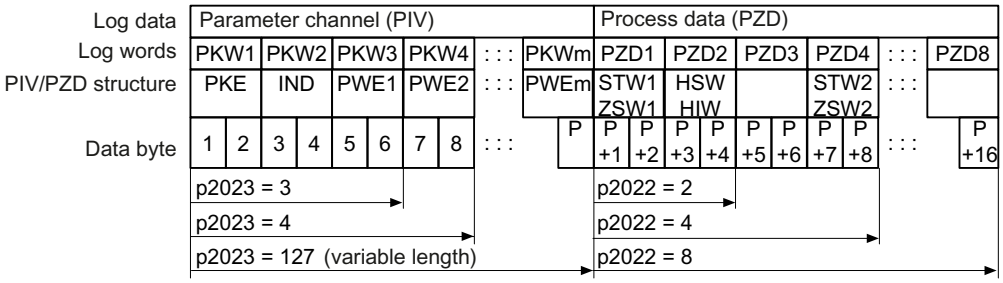


Figure 10-2 USS telegram - user data structure

Function description

Parameter channel

You specify the length of the parameter channel in parameter p2023:

- p2023 = 0
  No parameter values are transferred with this setting.
- p2023 = 3
  Select this setting if you only want to read or write 16-bit data or alarm messages.
- p2023 = 4
  If you want to read or write 32-bit values (for example indexed parameters or bit parameters, e.g. r0722.2), this setting is required. In this case, the send or receive telegram always contains four words, even if only three would be required. The values are entered right-justified in the 4th word.
- p2023 = 127
  If you set p2023 = 127 (variable length), the send and response telegrams are exactly as long as the task requires.

Process data

Parameter p2022 defines the length for the process data. You can transfer up to eight process data items in one telegram (p2022 = 0 … 8). For p2022 = 0, no process data is transferred.

Parameters

Parameter	Description	Factory setting
p2022	Fieldbus interface USS PZD number	2
p2023	Fieldbus interface USS PKW number	127

10.4 USS parameter channel

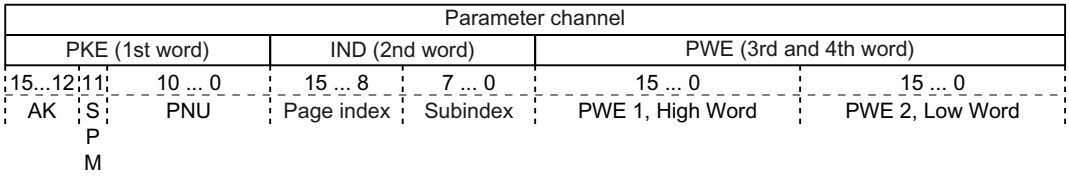
Structure of the parameter channel

Depending on the setting in p2023, the parameter channel has a fixed length of 3 or 4 words, or a variable length, depending on the length of the data to be transferred.

The 1st and 2nd words contain the parameter number and index as well as the type of job (read or write). The other words of the parameter channel contain parameter contents. The parameter contents can be 8-bit values, 16-bit values (such as baud rate) or 32-bit values (e.g. CO parameters). The parameter contents are entered right justified in the word with the highest number. Words that are not required are assigned 0.

Bit 11 in the 1st word is reserved and is always assigned 0.

The diagram shows a parameter channel that is four words long.



You can find examples of telegrams at the end of this section.

Function description

AK: Request and response ID

Table 10-2 Request identifiers, control → converter

AK	Description	Response identifier	
		Positive	Negative
0	No request	0	7 / 8
1	Request parameter value	1 / 2	7 / 8
2	Change parameter value (word)	1	7 / 8
3	Change parameter value (double word)	2	7 / 8
4	Request descriptive element[1)]	3	7 / 8
6 [2)]	Request parameter value (field)[1)]	4 / 5	7 / 8
7 [2)]	Change parameter value (field, word)[1)]	4	7 / 8
8 [2)]	Change parameter value (field, double word)[1)]	5	7 / 8
9	Request number of field elements	6	7 / 8

1) The required element of the parameter is specified in IND (2nd word).

2) The following request identifiers are identical: 1 ≡ 6, 2 ≡ 7 and 3 ≡ 8. Use identifiers 6, 7, and 8.

Table 10-3 Response identifiers, converter → control

AK	Description
0	No response
1	Transfer parameter value (word)
2	Transfer parameter value (double word)
3	Transfer descriptive element[1)]
4	Transfer parameter value (field, word)[2)]
5	Transfer parameter value (field, double word)[2)]
6	Transfer number of field elements
7	Converter cannot process the request. In the most significant word of the parameter channel, the converter sends an error number to the control, refer to the following table.
8	No master controller status / no authorization to change parameters of the parameter channel interface

1) The required element of the parameter is specified in IND (2nd word).

2) The required element of the indexed parameter is specified in IND (2nd word).

Table 10-4 Error numbers for response identifier 7

No.	Description
00 hex	**Inadmissible parameter number** Access to a parameter that does not exist
01 hex	**Parameter value cannot be changed** Change request for a parameter value that cannot be changed
02 hex	**Upper or lower value limit exceeded** Change request with value outside value limits
03 hex	**Incorrect subindex** Access to a subindex that does not exist
04 hex	**No array** Access with subindex to non-indexed parameter
05 hex	**Incorrect data type** Change request with a value that does not match the data type of the parameter
06 hex	**Setting not permitted, only reset** Change request with a value not equal to 0 without permission
07 hex	**Descriptive element cannot be changed** Change request to a descriptive element that cannot be changed
0B hex	**No master control** Change request with no master control, see also p0927
0C hex	**Keyword missing**
11 hex	**Request cannot be executed due to operating status** Access is temporarily not possible for unspecified reasons.
14 hex	**Inadmissible value** Change request with a value that is within the limits but which is inadmissible for other permanent reasons, i.e. a parameter with defined individual values

No.	Description
65 hex	**Parameter number is currently deactivated** Dependent on the operating status of the converter
66 hex	**Channel width is insufficient** Communication channel is too small for response
68 hex	**Inadmissible parameter value** The parameter can only assume certain values
6A hex	**Request not included / task is not supported.** The valid request identifiers can be found in the table "Request identifiers control → converter"
6B hex	**No change access for enabled controller**. The operating status of the converter prevents a parameter change
86 hex	**Write access only for commissioning (p0010 = 15)** The operating status of the converter prevents a parameter change
87 hex	**Know-how protection active, access locked**
C8 hex	**Change request below currently valid limit** Change request for a value that, although within "absolute" limits, is below the currently valid lower limit
C9 hex	**Change request above currently valid limit** Example: A parameter value is too large for the converter rating
CC hex	**Change request not permitted** Change is not permitted as the access code is not available

PNU (parameter number) and page index

Parameter number	PNU	Page index
0000 … 1999	0000 … 1999	0 hex
2000 … 3999	0000 … 1999	80 hex
6000 … 7999	0000 … 1999	90 hex
8000 … 9999	0000 … 1999	20 hex
10000 … 11999	0000 … 1999	A0 hex
20000 … 21999	0000 … 1999	50 hex
29000 … 29999	0000 … 1999	70 hex
30000 … 31999	0000 … 1999	F0 hex
60000 … 61999	0000 … 1999	74 hex

Subindex

For indexed parameters, the parameter index is located in the subindex as a hexadecimal value.

PWE: Parameter value or connector

Parameter values or connectors can be located in the PWE.

Table 10-5 Parameter value or connector

	PWE 1	PWE 2		
Parameter value	Bits 15 … 0	Bits 15 … 8		Bit 7 … 0
	0	0		8-bit value
	0	16-bit value		
	32-bit value			
Connector	Bit 15 … 0	Bit 15 … 10	Bit 9 … 0	
	Number of the connector	3F hex	The index or bit field number of the connector	

Example

Read request: Read out memory card serial number (p7843[2])

To obtain the value of the indexed parameter p7843, you must fill the telegram of the parameter channel with the following data:

- **PKE, bits 12 … 15 (AK): = 6** (request parameter value (field))
- **PKE, bits 0 … 10 (PNU): = 1843** (parameter number without offset)
  Parameter number = PNU + offset (page index)
  (7843 = 1843 + 6000)
- **IND, bits 8 … 15 (subindex): = 2** (index of parameter)
- **IND, bits 0 … 7 (page index): = 90 hex** (offset 6000 corresponds to 90 hex)
- As you want to read the parameter value, words 3 and 4 in the parameter channel are irrelevant for requesting the parameter value. Therefore assign, for example, the value 0 to words 3 and 4.

Parameter channel							
PKE, 1st word			IND, 2nd word		PWE1 - high, 3rd word	PWE2 - low, 4th word	
15...12	11	10 ... 0	15 ... 8	7 ... 0	15 ... 0	15 ... 10	9 ... 0
AK		Parameter number	Subindex	Page index	Parameter value	Drive object	Index
0 1 1 0	0	1 1 1 0 0 1 1 0 0 0 1	0 0 0 0 0 0 1 0	1 0 0 1 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0

Figure 10-3 Telegram for a read request from p7843[2]

Parameter number

Parameter numbers < 2000	PNU = parameter number. Write the parameter number into the PNU (PKE bit 10 ... 0).
Parameter numbers ≥ 2000	PNU = parameter number - offset. Write the parameter number minus the offset into the PNU (PKE bit 10 … 0). Write the offset in the page index (IND bit 15 … 8).

Table 10-6 Offset and page index of the parameter numbers

Parameter number	Offset	Page index								
		Hex	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8
0000 … 1999	0	0 hex	0	0	0	0	0	0	0	0
2000 … 3999	2000	80 hex	1	0	0	0	0	0	0	0
6000 … 7999	6000	90 hex	1	0	0	1	0	0	0	0
8000 … 9999	8000	20 hex	0	0	1	0	0	0	0	0
10000 … 11999	10000	A0 hex	1	0	1	0	0	0	0	0
20000 … 21999	20000	50 hex	0	1	0	1	0	0	0	0
29000 … 29999	28000	70 hex	0	1	1	1	0	0	0	0
30000 … 31999	30000	F0 hex	1	1	1	1	0	0	0	0
60000 … 61999	60000	74 hex	0	1	1	1	0	1	0	0

Indexed parameters

For indexed parameters, you must write the index as a hexadecimal value into the subindex (IND bits 7 … 0).

Parameter contents

Parameter contents can be parameter values or connector parameters. For connector parameters you require 2 words.

Enter the parameter value in the parameter channel right-justified as follows:

- 8-bit values Low word, bits 0 … 7 Bits 8 … 15 are zero.
- 16-bit values Low word, bits 0 … 15
- 32-bit values Low word and high word

Enter a connector parameter right-justified as follows:

- Number of the connector parameter — High word
- Drive object of the connector parameter — Low word, bits 10 … 15
- The index or bit field number of the connector parameter — Low word, bits 0 … 9

10.4.1 Telegram examples, length of the parameter channel = 4

Read request: Read out memory card serial number (p7843[2])

To obtain the value of the indexed parameter p7843, you must fill the telegram of the parameter channel with the following data:

- **PKE, bits 12 … 15 (AK) = 6** (request parameter value (field))
- **PKE, bits 0 … 10 (PNU) = 1843** (parameter number without offset)
  Parameter number = PNU + offset (page index)
  (7841 = 1843 + 6000)

- **IND, bits 8 … 15 (page index) = 90 hex** (offset 6000 corresponds to 90 hex)
- **IND, bits 0 … 7 (subindex) = 2** (index of parameter)
- As you want to read the parameter value, words 3 and 4 in the parameter channel are irrelevant for requesting the parameter value. Therefore assign, for example, the value 0 to words 3 and 4.

Parameter channel							
PKE (1st word)			IND, 2nd word		PWE1 - high, 3rd word	PWE2 - low, 4th word	
15...12	11	10 ... 0	15 ... 8	7 ... 0	15 ... 0	15 ... 10	9 ... 0
AK		Parameter number	Page index	Subindex	Parameter value	Drive Object	Index
0 1 1 0	0	1 1 1 0 0 1 1 0 0 0 1	1 0 0 1 0 0 0 0	0 0 0 0 0 0 1 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0

Figure 10-4 Telegram for a read request from p7843[2]

Write request: Changing the automatic restart mode (p1210)

Parameter p1210 defines the automatic restart mode:

- **PKE, bit 12 … 15 (AK): = 7** (change parameter value (field, word))
- **PKE, bit 0 … 10 (PNU): = 4BA hex** (1210 = 4BA hex, no offset, as 1210 < 1999)
- **IND, bit 8 … 15 (page index): = 0 hex** (offset 0 corresponds to 0 hex)
- **IND, bit 0 … 7 (subindex): = 0 hex** (parameter is not indexed)
- **PWE1, bit 0 … 15: = 0 hex**
- **PWE2, bit 0 … 15: = 1A hex** (26 = 1A hex)

Parameter channel						
PKE, 1st word			IND, 2nd word		PWE1 - high, 3rd word	PWE2 - low, 4th word
15...12	11	10 ... 0	15 ... 8	7 ... 0	15 ... 0	15 ... 0
AK		Parameter number	Page index	Subindex	Parameter value (bit 16 ... 31)	Parameter value (bit 0 ... 15)
0 1 1 1	0	1 0 0 1 0 1 1 1 0 1 0	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 1 1 0 1 0

Figure 10-5 Telegram, to activate the automatic restart with p1210 = 26

Write request: Assign digital input 2 with the function ON/OFF1 (p0840[1] = 722.2)

In order to link digital input 2 with ON/OFF1, you must assign parameter p0840[1] (source, ON/OFF1) the value 722.2 (DI 2). To do this, you must fill the telegram of the parameter channel as follows:

- **PKE, bit 12 … 15 (AK): = 7 hex** (change parameter value (field, word))
- **PKE, bit 0 … 10 (PNU): = 348 hex** (840 = 348 hex, no offset, as 840 < 1999)
- **IND, bit 8 … 15 (page index): = 0 hex** (offset 0 corresponds to 0 hex)
- **IND, bit 0 … 7 (subindex): = 1 hex** (command data set CDS1 = index1)
- **PWE1, bit 0 … 15**: = **2D2 hex** (722 = 2D2 hex)

- **PWE2, bit 10 … 15: = 3f hex** (drive object - for SINAMICS G120 always 63 = 3f hex)
- **PWE2, bit 0 … 9: = 2 hex** (index or bit number of the parameter: DI 2 = r0722.2)

Parameter channel							
PKE, 1st word			IND, 2nd word		PWE1 - high, 3rd word	PWE2 - low, 4th word	
15...12	11	10 ... 0	15 ... 8	7 ... 0	15 ... 0	15 ... 10	9 ... 0
AK		Parameter number	Page index	Subindex	Parameter value	Drive Object	Index
0 1 1 1	0	0 1 1 0 1 0 0 1 0 0 0	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 1	0 0 0 0 0 0 1 0 1 1 0 1 0 0 1 0	1 1 1 1 1 1	0 0 0 0 0 0 0 0 1 0

Figure 10-6 Telegram, to assign DI 2 with ON/OFF1

10.5 USS process data channel (PZD)

Function description

The process data channel (PZD) contains the following data depending on the transmission direction:

- Control words and setpoints for the slave
- Status words and actual values for the master

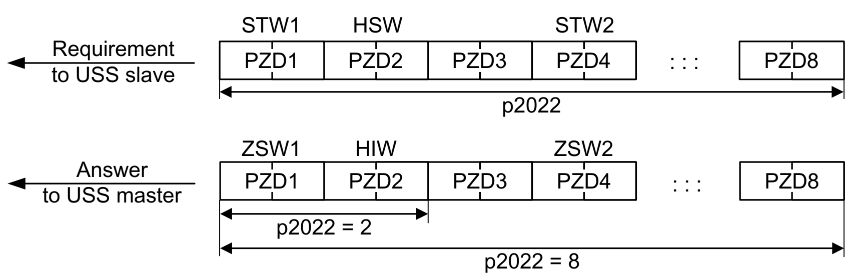


Figure 10-7 Process data channel

With the exception of telegram 999 (free interconnection), the telegrams use the word-by-word transfer of send and receive data (r2050/p2051).

If you require an individual telegram for your application (e.g. for transferring double words), you can adapt one of the predefined telegrams using parameters p0922 and p2079. For details, please refer to the List Manual, function diagrams 2420 and following.

Control word 1 (STW1)

Bit	Meaning		Explanation	Signal interconnection in the converter
	Telegram 20	All other telegrams		
0	0 = OFF1		The motor brakes with the ramp-down time p1121 of the ramp-function generator. The converter switches off the motor at standstill.	p0840[0] = r2090.0
	0 → 1 = ON		The converter goes into the "ready" state. If, in addition, bit 3 = 1, the converter switches on the motor.	

Bit	Meaning		Explanation	Signal interconnection in the converter
	Telegram 20	All other telegrams		
1	0 = OFF2		Switch off the motor immediately, the motor then coasts down to a standstill.	p0844[0] = r2090.1
	1 = No OFF2		The motor can be switched on (ON command).	
2	0 = Quick stop (OFF3)		Fast stopping The motor brakes with the OFF3 ramp-down time p1135 down to standstill.	p0848[0] = r2090.2
	1 = No quick stop (OFF3)		The motor can be switched on (ON command).	
3	0 = Inhibit operation		Immediately switch-off motor (cancel pulses).	p0852[0] = r2090.3
	1 = Enable operation		Switch-on motor (pulses can be enabled).	
4	0 = Disable RFG		The converter immediately sets its ramp-function generator output to 0.	p1140[0] = r2090.4
	1 = Do not disable RFG		The ramp-function generator can be enabled.	
5	0 = Stop RFG		The output of the ramp-function generator stops at the actual value.	p1141[0] = r2090.5
	1 = Enable RFG		The output of the ramp-function generator follows the setpoint.	
6	0 = Inhibit setpoint		The converter brakes the motor with the ramp-down time p1121 of the ramp-function generator.	p1142[0] = r2090.6
	1 = Enable setpoint		Motor accelerates with the ramp-up time p1120 to the setpoint.	
7	0 → 1 = Acknowledge faults		Acknowledge fault. If the ON command is still active, the converter switches to the "switching on inhibited" state.	p2103[0] = r2090.7
8, 9	Reserved			
10	0 = No control via PLC		Converter ignores the process data from the fieldbus.	p0854[0] = r2090.10
	1 = Control via PLC		Control via fieldbus, converter accepts the process data from the fieldbus.	
11	1 = Direction reversal		Invert setpoint in the converter.	p1113[0] = r2090.11
12	Not used			
13	---[1)]	1 = MOP up	Increase the setpoint saved in the motorized potentiometer.	p1035[0] = r2090.13
14	---[1)]	1 = MOP down	Reduce the setpoint saved in the motorized potentiometer.	p1036[0] = r2090.14
15	CDS bit 0	Reserved	Changes over between settings for different operation interfaces (command data sets).	p0810 = r2090.15

[1)] If you change over from another telegram to telegram 20, then the assignment of the previous telegram is kept.

Status word 1 (ZSW1)

Bit	Meaning		Remarks	Signal interconnection in the converter
	Telegram 20	All other telegrams		
0	1 = Ready for switching on		Power supply switched on; electronics initialized; pulses locked.	p2080[0] = r0899.0
1	1 = Ready		Motor is switched on (ON/OFF1 = 1), no fault is active. With the command "Enable operation" (STW1.3), the converter switches on the motor.	p2080[1] = r0899.1
2	1 = Operation enabled		Motor follows setpoint. See control word 1, bit 3.	p2080[2] = r0899.2
3	1 = Fault active		The converter has a fault. Acknowledge fault using STW1.7.	p2080[3] = r2139.3
4	1 = OFF2 inactive		Coast down to standstill is not active.	p2080[4] = r0899.4
5	1 = OFF3 inactive		Quick stop is not active.	p2080[5] = r0899.5
6	1 = Switching on inhibited active		It is only possible to switch on the motor after an OFF1 followed by ON.	p2080[6] = r0899.6
7	1 = Alarm active		Motor remains switched on; no acknowledgement is necessary.	p2080[7] = r2139.7
8	1 = Speed deviation within the tolerance range		Setpoint / actual value deviation within the tolerance range.	p2080[8] = r2197.7
9	1 = Master control requested		The automation system is requested to accept the converter control.	p2080[9] = r0899.9
10	1 = Comparison speed reached or exceeded		Speed is greater than or equal to the corresponding maximum speed.	p2080[10] = r2199.1
11	1 = current or torque limit reached	1 = torque limit reached	Comparison value for current or torque has been reached or exceeded.	p2080[11] = r0056.13 / r1407.7
12	---[1]	1 = Holding brake open	Signal to open and close a motor holding brake.	p2080[12] = r0899.12
13	0 = Alarm, motor overtemperature		--	p2080[13] = r2135.14
14	1 = Motor rotates clockwise		Internal converter actual value > 0	p2080[14] = r2197.3
	0 = Motor rotates counter-clockwise		Internal converter actual value < 0	
15	1 = CDS display	0 = Alarm, converter thermal overload	--	p2080[15] = r0836.0 / r2135.15

[1] If you change over from another telegram to telegram 20, then the assignment of the previous telegram is kept.

10.6 Telegram monitoring

Function description

You require the telegram runtimes in order to set the telegram monitoring. The character runtime is the basis of the telegram runtime:

Table 10-7 Character runtime

Baud rate in bit/s	Transmission time per bit	Character run time (= 11 bits)
9600	104.170 µs	1.146 ms
19200	52.084 µs	0.573 ms
38400	26.042 µs	0.286 ms
57600	17.361 µs	0.191 ms
115200	8.681 µs	0.095 ms

The telegram runtime is longer than just purely adding all of the character runtimes (=residual runtime). You must also take into consideration the character delay time between the individual characters of the telegram.

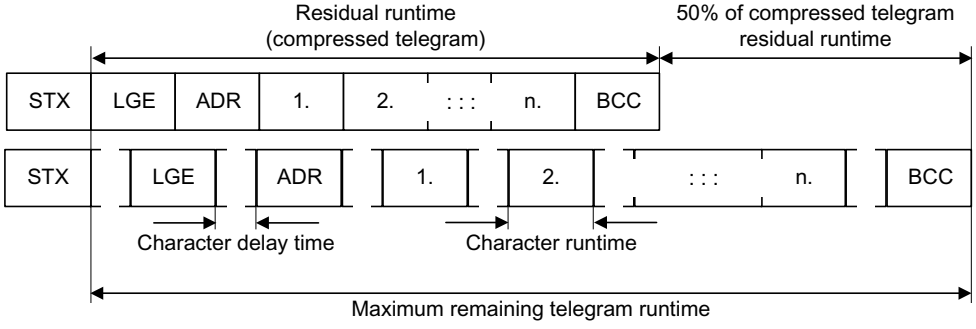


Figure 10-8 Telegram runtime as the sum of the residual runtime and character delay times

The total telegram runtime is always less than 150% of the pure residual runtime.

Before each request telegram, the master must maintain the start delay. The start delay must be > 2 × character runtime.

The slave only responds after the response delay has expired.

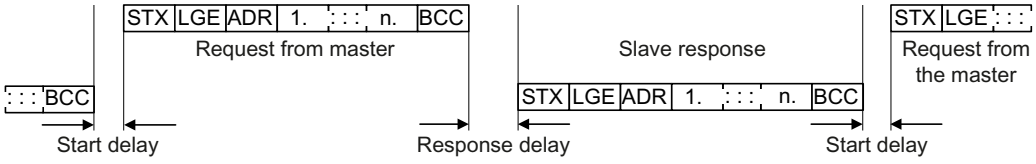


Figure 10-9 Start delay and response delay

Table 10-8 Start delay

Baud rate in bit/s	Transmission time per character (= 11 bits)	Min. start delay
9600	1.146 ms	> 2.291 ms
19200	0.573 ms	> 1.146 ms

Baud rate in bit/s	Transmission time per character (= 11 bits)	Min. start delay
38400	0.286 ms	> 0.573 ms
57600	0.191 ms	> 0.382 ms
115200	0.095 ms	> 0.191 ms

The character delay time must be shorter than the start delay.

Telegram monitoring of the master

With your USS master, we recommend that the following times are monitored:

- Response delay:
  Response time of the slave to a request from the master
  The response delay must be < 20 ms, but longer than the start delay
- Telegram runtime:
  Transmission time of the response telegram sent from the slave

Telegram monitoring of the converter

The converter monitors the time between two requests of the master. Parameter p2040 defines the permissible time in ms. If a time p2040 ≠ 0 is exceeded, then the converter interprets this as telegram failure and responds with fault F01910.

150% of the residual runtime is the guide value for the setting of p2040, i.e. the telegram runtime without taking into account the character delay times.

For communication via USS, the converter checks bit 10 of the received control word 1. If the bit is not set when the motor is switched on ("Operation"), the converter responds with fault F07220.

Parameters

Parameter	Description	Factory setting
p2040	Fieldbus interface monitoring time	1 000 ms

Appendix

A

A.1 List of abbreviations

Note

The following list of abbreviations includes all abbreviations and their meanings used in the entire SINAMICS family of drives.

A

Abbreviation	Derivation of abbreviation	Meaning
A…	Alarm	Warning
AC	Alternating Current	Alternating current
ADC	Analog Digital Converter	Analog digital converter
AI	Analog Input	Analog input
AIM	Active Interface Module	Active Interface Module
ALM	Active Line Module	Active Line Module
AO	Analog Output	Analog output
AOP	Advanced Operator Panel	Advanced Operator Panel
APC	Advanced Positioning Control	Advanced Positioning Control
AR	Automatic Restart	Automatic restart
ASC	Armature Short-Circuit	Armature short-circuit
ASCII	American Standard Code for Information Interchange	American coding standard for the exchange of information
AS-i	AS-Interface (Actuator Sensor Interface)	AS-Interface (open bus system in automation technology)
ASM	Asynchronmotor	Induction motor
AVS	Active Vibration Suppression	Active load vibration damping
AWG	American Wire Gauge	American Wire Gauge (Standard for cross-sections of cables)

B

Abbreviation	Derivation of abbreviation	Meaning
BB	Betriebsbedingung	Operation condition
BERO	-	Contactless proximity switch
BI	Binector Input	Binector input
BIA	Berufsgenossenschaftliches Institut für Arbeitssicherheit	BG Institute for Occupational Safety and Health
BICO	Binector Connector Technology	Binector connector technology

Abbreviation	Derivation of abbreviation	Meaning
BLM	Basic Line Module	Basic Line Module
BO	Binector Output	Binector output
BOP	Basic Operator Panel	Basic operator panel

C

Abbreviation	Derivation of abbreviation	Meaning
C	Capacitance	Capacitance
C…	-	Safety message
CAN	Controller Area Network	Serial bus system
CBC	Communication Board CAN	Communication Board CAN
CBE	Communication Board Ethernet	PROFINET communication module (Ethernet)
CD	Compact Disc	Compact disc
CDS	Command Data Set	Command data set
CF Card	CompactFlash Card	CompactFlash card
CI	Connector Input	Connector input
CLC	Clearance Control	Clearance control
CNC	Computerized Numerical Control	Computer-supported numerical control
CO	Connector Output	Connector output
CO/BO	Connector Output/Binector Output	Connector/binector output
COB-ID	CAN Object-Identification	CAN Object Identification
CoL	Certificate of License	Certificate of License
COM	Common contact of a change-over relay	Center contact of a change-over contact
COMM	Commissioning	Commissioning
CP	Communication Processor	Communications processor
CPU	Central Processing Unit	Central processing unit
CRC	Cyclic Redundancy Check	Cyclic redundancy check
CSM	Control Supply Module	Control Supply Module
CU	Control Unit	Control Unit
CUA	Control Unit Adapter	Control Unit Adapter
CUD	Control Unit DC	Control Unit DC

D

Abbreviation	Derivation of abbreviation	Meaning
DAC	Digital Analog Converter	Digital analog converter
DC	Direct Current	Direct current
DCB	Drive Control Block	Drive Control Block
DCBRK	DC Brake	DC braking
DCC	Drive Control Chart	Drive Control Chart
DCN	Direct Current Negative	Direct current negative
DCP	Direct Current Positive	Direct current positive

Abbreviation	Derivation of abbreviation	Meaning
DDC	Dynamic Drive Control	Dynamic Drive Control
DDS	Drive Data Set	Drive Data Set
DHCP	Dynamic Host Configuration Protocol	Dynamic Host Configuration Protocol (Communication protocol)
DI	Digital Input	Digital input
DI/DO	Digital Input/Digital Output	Digital input/output, bidirectional
DIN	Deutsches Institut für Normung	Deutsches Institut für Normung (German Institute for Standardization)
DMC	DRIVE-CLiQ Hub Module Cabinet	DRIVE-CLiQ Hub Module Cabinet
DME	DRIVE-CLiQ Hub Module External	DRIVE-CLiQ Hub Module External
DMM	Double Motor Module	Double Motor Module
DO	Digital Output	Digital output
DO	Drive Object	Drive object
DP	Decentralized Peripherals	Distributed I/O
DPRAM	Dual Ported Random Access Memory	Dual-Port Random Access Memory
DQ	DRIVE-CLiQ	DRIVE-CLiQ
DRAM	Dynamic Random Access Memory	Dynamic Random Access Memory
DRIVE-CLiQ	Drive Component Link with IQ	Drive Component Link with IQ
DSC	Dynamic Servo Control	Dynamic Servo Control
DSM	Doppelsubmodul	Double submodule
DTC	Digital Time Clock	Timer

E

Abbreviation	Derivation of abbreviation	Meaning
EASC	External Armature Short-Circuit	External armature short-circuit
EDS	Encoder Data Set	Encoder data set
EEPROM	Electrically Erasable Programmable Read-Only Memory	Electrically Erasable Programmable Read-Only Memory
EGB	Elektrostatisch gefährdete Baugruppen	Electrostatic sensitive devices
EIP	EtherNet/IP	EtherNet Industrial Protocol (real-time Ethernet)
ELCB	Earth Leakage Circuit Breaker	Residual current operated circuit breaker
ELP	Earth Leakage Protection	Ground-fault monitoring
EMC	Electromagnetic Compatibility	Electromagnetic compatibility
EMF	Electromotive Force	Electromotive force
EMK	Elektromotorische Kraft	Electromotive force
EMV	Elektromagnetische Verträglichkeit	Electromagnetic compatibility
EN	Europäische Norm	European standard
EnDat	Encoder-Data-Interface	Encoder interface
EP	Enable Pulses	Pulse enable
EPOS	Einfachpositionierer	Basic positioner
ES	Engineering System	Engineering system
ESB	Ersatzschaltbild	Equivalent circuit diagram

Abbreviation	Derivation of abbreviation	Meaning
ESD	Electrostatic Sensitive Devices	Electrostatic sensitive devices
ESM	Essential Service Mode	Essential service mode
ESR	Extended Stop and Retract	Extended stop and retract

F

Abbreviation	Derivation of abbreviation	Meaning
F…	Fault	Fault
FAQ	Frequently Asked Questions	Frequently Asked Questions
FBLOCKS	Free Blocks	Free function blocks
FCC	Function Control Chart	Function control chart
FCC	Flux Current Control	Flux current control
FD	Function Diagram	Function diagram
F-DI	Failsafe Digital Input	Fail-safe digital input
F-DO	Failsafe Digital Output	Fail-safe digital output
FEPROM	Flash-EPROM	Non-volatile write and read memory
FG	Function Generator	Function generator
FI	-	Fault current
FOC	Fiber-Optic Cable	Fiber-optic cable
FP	Funktionsplan	Function diagram
FPGA	Field Programmable Gate Array	Field Programmable Gate Array
F-PLC	Fail-safe PLC	Fail-safe PLC
FW	Firmware	Firmware

G

Abbreviation	Derivation of abbreviation	Meaning
GB	Gigabyte	Gigabyte
GC	Global Control	Global control telegram (broadcast telegram)
GND	Ground	Reference potential for all signal and operating voltages, usually defined as 0 V (also referred to as M)
GSD	Gerätestammdaten	Device master data: Describe the features of a PROFIBUS slave
GSV	Gate Supply Voltage	Gate supply voltage
GUID	Globally Unique Identifier	Globally Unique Identifier

H

Abbreviation	Derivation of abbreviation	Meaning
HF	High frequency	High frequency
HFD	Hochfrequenzdrossel	Radio frequency reactor
HLA	Hydraulic Linear Actuator	Hydraulic linear actuator

Abbreviation	Derivation of abbreviation	Meaning
HLG	Hochlaufgeber	Ramp-function generator
HM	Hydraulic Module	Hydraulic Module
HMI	Human Machine Interface	Human Machine Interface
HTL	High-Threshold Logic	Logic with high interference threshold
HTTP	Hypertext Transfer Protocol	Hypertext Transfer Protocol (communication protocol)
HTTP	Hypertext Transfer Protocol Secure	Hypertext Transfer Protocol Secure (communication protocol)
HW	Hardware	Hardware

I

Abbreviation	Derivation of abbreviation	Meaning
i. V.	In Vorbereitung	Under development: This property is currently not available
I/O	Input/Output	Input/output
I2C	Inter-Integrated Circuit	Internal serial data bus
IASC	Internal Armature Short-Circuit	Internal armature short-circuit
IBN	Inbetriebnahme	Commissioning
ID	Identifier	Identification
IE	Industrial Ethernet	Industrial Ethernet
IEC	International Electrotechnical Commission	International Electrotechnical Commission
IF	Interface	Interface
IGBT	Insulated Gate Bipolar Transistor	Insulated gate bipolar transistor
IGCT	Integrated Gate-Controlled Thyristor	Semiconductor power switch with integrated control electrode
IL	Impulslöschung	Pulse suppression
IP	Internet Protocol	Internet Protocol
IPO	Interpolator	Interpolator
ISO	Internationale Organisation für Normung	International Standards Organization
IT	Isolé Terre	Non-grounded three-phase line supply
IVP	Internal Voltage Protection	Internal voltage protection

J

Abbreviation	Derivation of abbreviation	Meaning
JOG	Jogging	Jogging

K

Abbreviation	Derivation of abbreviation	Meaning
KDV	Kreuzweiser Datenvergleich	Data cross-check
KHP	Know-how protection	Know-how protection
KIP	Kinetische Pufferung	Kinetic buffering
Kp	-	Proportional gain
KTY84-130	-	Temperature sensor

L

Abbreviation	Derivation of abbreviation	Meaning
L		
L	-	Symbol for inductance
LED	Light Emitting Diode	Light emitting diode
LIN	Linearmotor	Linear motor
LR	Lageregler	Position controller
LSB	Least Significant Bit	Least significant bit
LSC	Line-Side Converter	Line-side converter
LSS	Line-Side Switch	Line-side switch
LU	Length Unit	Length unit
LWL	Lichtwellenleiter	Fiber-optic cable

M

Abbreviation	Derivation of abbreviation	Meaning
M	-	Symbol for torque
M	Masse	Reference potential for all signal and operating voltages, usually defined as 0 V (also referred to as GND)
MB	Megabyte	Megabyte
MCC	Motion Control Chart	Motion Control Chart
MDI	Manual Data Input	Manual data input
MDS	Motor Data Set	Motor data set
MLFB	Maschinenlesbare Fabrikatebezeichnung	Machine-readable product code
MM	Motor Module	Motor Module
MMC	Man-Machine Communication	Man-machine communication
MMC	Micro Memory Card	Micro memory card
MRCD	Modular Residual Current protection Device	Modular Residual Current protection Device
MSB	Most Significant Bit	Most significant bit
MSC	Motor-Side Converter	Motor-side converter
MSCY_C1	Master Slave Cycle Class 1	Cyclic communication between master (class 1) and slave

Abbreviation	Derivation of abbreviation	Meaning
MSR	Motorstromrichter	Motor-side converter
MT	Messtaster	Probe

N

Abbreviation	Derivation of abbreviation	Meaning
N. C.	Not Connected	Not connected
N…	No Report	No report or internal message
NAMUR	Interessengemeinschaft Automatisierungstechnik der Prozessindustrie	User association of automation technology in the process industry
NC	Normally Closed (contact)	NC contact
NC	Numerical Control	Numerical control
NEMA	National Electrical Manufacturers Association	Standardization association in USA (United States of America)
NM	Nullmarke	Zero mark
NO	Normally Open (contact)	NO contact
NSR	Netzstromrichter	Line-side converter
NTP	Network Time Protocol	Standard for synchronization of the time of day
NVRAM	Non-Volatile Random Access Memory	Non-volatile read/write memory

O

Abbreviation	Derivation of abbreviation	Meaning
OA	Open Architecture	Software component which provides additional functions for the SINAMICS drive system
OAIF	Open Architecture Interface	Version of the SINAMICS firmware as of which the OA application can be used
OASP	Open Architecture Support Package	Expands the commissioning tool by the corresponding OA application
OC	Operating Condition	Operation condition
OCC	One Cable Connection	One-cable technology
OEM	Original Equipment Manufacturer	Original equipment manufacturer
OLP	Optical Link Plug	Bus connector for fiber-optic cable
OMI	Option Module Interface	Option Module Interface

P

Abbreviation	Derivation of abbreviation	Meaning
p…	-	Adjustable parameters
P1	Processor 1	CPU 1
P2	Processor 2	CPU 2
PB	PROFIBUS	PROFIBUS
PcCtrl	PC Control	Master control

Abbreviation	Derivation of abbreviation	Meaning
PD	PROFIdrive	PROFIdrive
PDC	Precision Drive Control	Precision Drive Control
PDS	Power unit Data Set	Power unit data set
PDS	Power Drive System	Drive system
PE	Protective Earth	Protective ground
PELV	Protective Extra Low Voltage	Safety extra-low voltage
PFH	Probability of dangerous failure per hour	Probability of dangerous failure per hour
PG	Programmiergerät	Programming device
PI	Proportional Integral	Proportional integral
PID	Proportional Integral Differential	Proportional integral differential
PLC	Programmable Logical Controller	Programmable logic controller
PLL	Phase-Locked Loop	Phase-locked loop
PM	Power Module	Power Module
PMI	Power Module Interface	Power Module Interface
PMSM	Permanent-magnet synchronous motor	Permanent-magnet synchronous motor
PN	PROFINET	PROFINET
PNO	PROFIBUS Nutzerorganisation	PROFIBUS user organization
PPI	Point to Point Interface	Point-to-point interface
PRBS	Pseudo Random Binary Signal	White noise
PROFIBUS	Process Field Bus	Serial data bus
PS	Power Supply	Power supply
PSA	Power Stack Adapter	Power Stack Adapter
PT1000	-	Temperature sensor
PTC	Positive Temperature Coefficient	Positive temperature coefficient
PTP	Point To Point	Point-to-point
PWM	Pulse Width Modulation	Pulse width modulation
PZD	Prozessdaten	Process data

Q

Abbreviation	Derivation of abbreviation	Meaning
No entries		

R

Abbreviation	Derivation of abbreviation	Meaning
r…	-	Display parameters (read-only)
RAM	Random Access Memory	Memory for reading and writing
RCCB	Residual Current Circuit Breaker	Residual current operated circuit breaker
RCD	Residual Current Device	Residual current device
RCM	Residual Current Monitor	Residual current monitor
REL	Reluctance motor textile	Reluctance motor textile

Abbreviation	Derivation of abbreviation	Meaning
RESM	Reluctance synchronous motor	Synchronous reluctance motor
RFG	Ramp-Function Generator	Ramp-function generator
RJ45	Registered Jack 45	Term for an 8-pin socket system for data transmission with shielded or non-shielded multi-wire copper cables
RKA	Rückkühlanlage	Cooling unit
RLM	Renewable Line Module	Renewable Line Module
RO	Read Only	Read only
ROM	Read-Only Memory	Read-only memory
RPDO	Receive Process Data Object	Receive Process Data Object
RS232	Recommended Standard 232	Interface standard for cable-connected serial data transmission between a sender and receiver (also known as EIA232)
RS485	Recommended Standard 485	Interface standard for a cable-connected differential, parallel, and/or serial bus system (data transmission between a number of senders and receivers, also known as EIA485)
RTC	Real Time Clock	Real-time clock
RZA	Raumzeigerapproximation	Space-vector approximation

S

Abbreviation	Derivation of abbreviation	Meaning
S1	-	Continuous operation
S3	-	Intermittent duty
SAM	Safe Acceleration Monitor	Safe acceleration monitoring
SBC	Safe Brake Control	Safe brake control
SBH	Sicherer Betriebshalt	Safe operating stop
SBR	Safe Brake Ramp	Safe brake ramp monitoring
SBT	Safe Brake Test	Safe brake test
SCA	Safe Cam	Safe cam
SCC	Safety Control Channel	Safety Control Channel
SCSE	Single Channel Safety Encoder	Single-channel safety encoder
SD Card	SecureDigital Card	Secure digital memory card
SDC	Standard Drive Control	Standard Drive Control
SDI	Safe Direction	Safe motion direction
SE	Sicherer Software-Endschalter	Safe software limit switch
SESM	Separately-excited synchronous motor	Separately excited synchronous motor
SG	Sicher reduzierte Geschwindigkeit	Safely limited speed
SGA	Sicherheitsgerichteter Ausgang	Safety-related output
SGE	Sicherheitsgerichteter Eingang	Safety-related input
SH	Sicherer Halt	Safe stop
SI	Safety Integrated	Safety Integrated
SIC	Safety Info Channel	Safety Info Channel

Abbreviation	Derivation of abbreviation	Meaning
SIL	Safety Integrity Level	Safety Integrity Level
SITOP	-	Siemens power supply system
SLA	Safely-Limited Acceleration	Safely limited acceleration
SLM	Smart Line Module	Smart Line Module
SLP	Safely-Limited Position	Safely Limited Position
SLS	Safely-Limited Speed	Safely limited speed
SLVC	Sensorless Vector Control	Sensorless vector control
SM	Sensor Module	Sensor Module
SMC	Sensor Module Cabinet	Sensor Module Cabinet
SME	Sensor Module External	Sensor Module External
SMI	SINAMICS Sensor Module Integrated	SINAMICS Sensor Module Integrated
SMM	Single Motor Module	Single Motor Module
SN	Sicherer Software-Nocken	Safe software cam
SOS	Safe Operating Stop	Safe operating stop
SP	Service Pack	Service pack
SP	Safe Position	Safe position
SPC	Setpoint Channel	Setpoint channel
SPI	Serial Peripheral Interface	Serial peripheral interface
SPS	Speicherprogrammierbare Steuerung	Programmable logic controller
SS1	Safe Stop 1	Safe Stop 1 (time-monitored, ramp-monitored)
SS1E	Safe Stop 1 External	Safe Stop 1 with external stop
SS2	Safe Stop 2	Safe Stop 2
SS2E	Safe Stop 2 External	Safe Stop 2 with external stop
SSI	Synchronous Serial Interface	Synchronous serial interface
SSL	Secure Sockets Layer	Encryption protocol for secure data transfer (new TLS)
SSM	Safe Speed Monitor	Safe feedback from speed monitor
SSP	SINAMICS Support Package	SINAMICS support package
STO	Safe Torque Off	Safe torque off
STW	Steuerwort	Control word

T

Abbreviation	Derivation of abbreviation	Meaning
TB	Terminal Board	Terminal Board
TEC	Technology Extension	Software component which is installed as an additional technology package and which expands the functionality of SINAMICS (previously OA application)
TIA	Totally Integrated Automation	Totally Integrated Automation
TLS	Transport Layer Security	Encryption protocol for secure data transfer (previously SSL)
TM	Terminal Module	Terminal Module

Abbreviation	Derivation of abbreviation	Meaning
TN	Terre Neutre	Grounded three-phase line supply
Tn	-	Integral time
TPDO	Transmit Process Data Object	Transmit Process Data Object
TSN	Time-Sensitive Networking	Time-Sensitive Networking
TT	Terre Terre	Grounded three-phase line supply
TTL	Transistor-Transistor-Logic	Transistor-transistor logic
Tv	-	Rate time

U

Abbreviation	Derivation of abbreviation	Meaning
UL	Underwriters Laboratories Inc.	Underwriters Laboratories Inc.
UPS	Uninterruptible Power Supply	Uninterruptible power supply
USV	Unterbrechungsfreie Stromversorgung	Uninterruptible power supply
UTC	Universal Time Coordinated	Universal time coordinated

V

Abbreviation	Derivation of abbreviation	Meaning
VC	Vector Control	Vector control
Vdc	-	DC link voltage
VdcN	-	Partial DC link voltage negative
VdcP	-	Partial DC link voltage positive
VDE	Verband der Elektrotechnik, Elektronik und Informationstechnik	Association of Electrical Engineering, Electronics and Information Technology
VDI	Verein Deutscher Ingenieure	Verein Deutscher Ingenieure [Association of German Engineers]
VPM	Voltage Protection Module	Voltage Protection Module
Vpp	Volt peak to peak	Volt peak to peak
VSM	Voltage Sensing Module	Voltage Sensing Module

W

Abbreviation	Derivation of abbreviation	Meaning
WEA	Wiedereinschaltautomatik	Automatic restart
WZM	Werkzeugmaschine	Machine tool

X

Abbreviation	Derivation of abbreviation	Meaning
XML	Extensible Markup Language	Extensible markup language (standard language for Web publishing and document management)

Y

Abbreviation	Derivation of abbreviation	Meaning
No entries		

Z

Abbreviation	Derivation of abbreviation	Meaning
ZK	Zwischenkreis	DC link
ZM	Zero Mark	Zero mark
ZSW	Zustandswort	Status word

A.2 Documentation overview

General documentation/catalogs			
SINAMICS	G110	D 11	- Converter Chassis Units 0.12 kW up to 3 kW
	G120	D 31	- SINAMICS Converters for Single-Axis Drives and SIMOTICS Motors
	G130, G150	D 11	- Converter Chassis Units - Converter Cabinet Units
	S120, S150	D 21.3	- SINAMICS S120 Chassis Units and Cabinet Modules - SINAMICS S150 Converter Cabinet Units
	S120	D 21.4	- SINAMICS S120 and SIMOTICS
Manufacturer/service documentation			
SINAMICS	G110		- Getting Started - Operating Instructions - List Manuals
	G120		- Getting Started - Operating Instructions - Installation Manuals - Function Manual Safety Integrated - List Manuals
	G130		- Operating Instructions - List Manual
	G150		- Operating Instructions - List Manual
	GM150, SM120/SM150, GL150, SL150		- Operating Instructions - List Manuals
	S110		- Equipment Manual - Getting Started - Function Manual - List Manual
	S120		- Getting Started - Commissioning Manual - Function Manual Drive Functions - Function Manual Communication (from firmware V5.2) - Function Manual Safety Integrated - Function Manual DCC - List Manual - Equipment Manual for Control Units and Supplementary System Components - Equipment Manual for Booksize Power Units - Equipment Manual for Air-Cooled Chassis Power Units - Equipment Manual for Liquid-Cooled Chassis Power Units - Equipment Manual for Water-Cooled Chassis Power Units for Common Cooling Circuits - Equipment Manual Combi - Equipment Manual for Cabinet Modules - Equipment Manual for AC Drives - SINAMICS S120M Equipment Manual Distributed Drive Technology - SINAMICS HLA System Manual Hydraulic Drive
	S150		- Operating Instructions - List Manual
	S210		- SINAMICS S210 Operating Instructions
Motors			- Configuration Manuals, Motors
General			- Configuration Manual, EMC Installation Guideline

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Additional information

Siemens:
www.siemens.com

Industry Online Support (service and support):
www.siemens.com/online-support

IndustryMall:
www.siemens.com/industrymall

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